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PROSPECTIVE EVALUATION OF VACCINE HESITANCY AND ITS IMPACT ON IMMUNIZATION COVERAGE IN PEDIATRIC POPULATIONS

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ABSTRACT

Background: Vaccination is one of the most effective public health strategies for preventing childhood morbidity and mortality. Despite widespread availability, immunization coverage often remains suboptimal due to vaccine hesitancy among caregivers. Understanding the factors influencing hesitancy and its relationship with immunization status is essential for improving pediatric vaccine uptake and achieving national and global immunization goals. The aim is to prospectively evaluate vaccine hesitancy among caregivers and determine its impact on immunization coverage in pediatric populations attending a tertiary care teaching hospital. **Materials and Methods:** A hospital-based prospective observational study was conducted among 180 caregivers of children aged 0–5 years attending the pediatric department for immunization or general health services. Participants were selected through simple random sampling. Data were collected using a pre-tested, semi-structured questionnaire based on the World Health Organization's SAGE Vaccine Hesitancy Scale, assessing knowledge, attitudes, beliefs, and practices regarding vaccination. Immunization status was verified through records and classified as complete, partial, or delayed according to the national immunization schedule. **Result:** Among caregivers, 61.11% exhibited low hesitancy, 26.67% moderate, and 12.22% high hesitancy. Overall, 76.67% of children were fully immunized, 16.67% partially, and 6.67% had delayed immunization. A strong association was found between hesitancy level and immunization coverage ($p < 0.001$). Low maternal education (OR = 2.84), rural residence (OR = 1.92), low socioeconomic status (OR = 2.10), fear of vaccine side effects (OR = 2.45), and lack of trust in the healthcare system (OR = 3.25) were significant predictors of high hesitancy. **Conclusion:** Vaccine hesitancy substantially affects immunization coverage among children. Strengthening health education, enhancing caregiver trust, and addressing misconceptions through targeted communication strategies are vital for improving vaccine acceptance and ensuring full, timely immunization in pediatric populations.

INTRODUCTION

Vaccination remains one of the most cost-effective public health interventions for reducing childhood morbidity and mortality, preventing severe infections in early life and underpinning gains in survival, neurodevelopment, and long-term human capital.[1] Yet, despite the proven effectiveness and safety of vaccines and the existence of clear programmatic schedules, many health systems still struggle to achieve and sustain high coverage across all populations and antigens. The gap between the availability of vaccines and their timely uptake is rarely explained by access alone; increasingly, caregivers' beliefs, attitudes, and decision-making processes—together referred to as vaccine hesitancy—shape when, where, and whether children receive vaccines on schedule.[1] Vaccine hesitancy is not a simple matter of acceptance or refusal; it spans a continuum from full acceptance with doubts to selective or delayed vaccination and outright refusal. Its contours are context specific, varying by geography, socioeconomic conditions, social norms, and the characteristics of individual vaccines. A practical way to understand these determinants is the "3Cs" framing—confidence, convenience, and complacency—while remembering that real-world decisions reflect a balance of perceived disease risk, trust in health services, and everyday constraints that shape access.[1] Globally, routine immunization

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performance has faced headwinds in the aftermath of the COVID-19 pandemic, with several countries reporting setbacks in childhood vaccine uptake and widening equity gaps; monitoring data highlight the magnitude and distribution of these changes and help identify populations at risk of missed or delayed doses.[2] Ambitious agendas for the current decade call for life-course immunization, stronger primary care integration, and closing immunity gaps left by disruptions, setting a high bar for national programmes to recover and then accelerate progress.[3] Reaching these goals requires not only reliable supply and service delivery but also renewed attention to demand-side determinants that influence caregivers' decisions, including perceptions of vaccine necessity and safety and trust in providers. India's Universal Immunization Programme (UIP) provides a comprehensive national schedule for infants, children, and pregnant women, delivered through a network of fixed facilities and outreach services and periodically strengthened through intensification activities.[4] The UIP has expanded antigen portfolios over time and made steady progress in coverage, yet subnational heterogeneity persists, with urban–rural differentials and intra-urban pockets of vulnerability that can undermine timely, complete immunization for specific communities.[5] Within this ecosystem, the interface between caregivers and the health system—frontline counselling by vaccinators, pediatricians, and community health workers—plays a pivotal role in converting awareness into action, especially when families are weighing vaccine decisions after illness episodes or conflicting information. Psychological antecedents offer additional explanatory power for understanding hesitancy beyond the 3Cs. A validated framework describes five proximate drivers—confidence, complacency, constraints (practical barriers), calculation (information weighing), and collective responsibility—each of which can reinforce or counteract acceptance in the moment of decision.[6] These antecedents help explain why a caregiver may accept some vaccines but delay others, or why reminders and clear counselling can tip intentions toward on-time completion. Mapping such drivers in local contexts allows programmes to design targeted, proportionate responses rather than one-size-fits-all messaging. Evidence from multi-country surveys shows that vaccine confidence—encompassing perceived safety, effectiveness, and importance—varies across settings and over time, tracking with changes in information environments, institutional trust, and recent experiences with immunization campaigns.[7] Importantly, confidence is malleable: clear, consistent communication by trusted providers, coupled with predictable and convenient services, can improve perceptions and reduce hesitation. These insights are particularly relevant for tertiary-care hospitals that serve as referral hubs for complex pediatric cases, attract diverse catchment populations, and often function as trusted sources of expert advice when caregivers seek reassurance about vaccine benefits and risks.

MATERIALS AND METHODS

This was a hospital-based prospective observational study conducted at a tertiary care teaching hospital. The study aimed to assess the prevalence, determinants, and effects of vaccine hesitancy on immunization coverage among pediatric populations attending the outpatient and inpatient departments of pediatrics. The hospital caters to a diverse patient population from both urban and rural areas, providing an ideal setting for evaluating vaccine-related behaviors and attitudes among caregivers of children. A total of 180 participants were enrolled in the study. The study population included parents or primary caregivers of children aged between 0 to 5 years who attended the pediatric department for immunization or general health checkups. Participants were selected using a simple random sampling technique from eligible respondents. Inclusion criteria comprised caregivers of children within the specified age group who provided informed consent to participate. Exclusion criteria included caregivers of critically ill children, those unwilling to participate, and individuals with incomplete vaccination records.

Methodology: Data were collected using a pre-tested, semi-structured questionnaire designed to evaluate sociodemographic characteristics, knowledge, attitudes, beliefs, and practices related to immunization. The questionnaire also included items adapted from the World Health Organization's Strategic Advisory Group of Experts (SAGE) Vaccine Hesitancy Scale to assess levels of vaccine confidence, complacency, and convenience. Information regarding the child's immunization status was verified using immunization cards and hospital records. Face-to-face interviews were conducted by trained healthcare personnel in the local language to ensure accuracy and minimize reporting bias.

The parameters assessed included demographic characteristics (age, gender, education, occupation, socioeconomic status, and residence), awareness regarding vaccine-preventable diseases, perceived safety and effectiveness of vaccines, trust in healthcare systems, and sources of vaccine information. The study also measured parental hesitancy using Likert-scale responses for concerns about vaccine safety, side effects, and necessity. Immunization coverage was classified as complete, partial, or delayed based on national immunization schedule compliance. Additional parameters such as the number of missed doses, reasons for delay, and healthcare accessibility were also analyzed.

Statistical Analysis: All collected data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics such as means, standard deviations, frequencies, and percentages were used to summarize demographic

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and baseline characteristics. Inferential statistics, including the chi-square test, independent t-test, and logistic regression analysis, were employed to identify associations between vaccine hesitancy and immunization coverage. A p-value of less than 0.05 was considered statistically significant. Correlation analyses were also conducted to explore relationships between sociodemographic variables and vaccine hesitancy scores.

RESULTS

[Table 1] Socio-Demographic Characteristics of Study Participants

[Table 1] presents the socio-demographic distribution of the 180 participants. The majority of mothers (51.11%) were between 25–34 years of age, followed by 28.89% under 25 years and 20.00% aged 35 years or above. This indicates that most caregivers were in their active reproductive age group. In terms of educational status, 37.78% had secondary education, while 26.67% were graduates or above, suggesting a moderately educated sample. However, 13.33% had no formal education, which may contribute to lower awareness and misconceptions about vaccines. Regarding residence, 60.00% of respondents were from urban areas, reflecting the hospital's tertiary-level accessibility and urban catchment population. Socioeconomic assessment showed that 47.78% belonged to the middle class, while 40.00% were from lower socioeconomic backgrounds, highlighting a diverse income representation. Gender distribution of the children was almost equal, with 53.33% males and 46.67% females, ensuring minimal gender bias in immunization access.

[Table 2] Awareness and Attitudes Toward Vaccination

[Table 2] summarizes participants' awareness and attitudes toward vaccination. A large proportion (81.11%) were aware of the National Immunization Schedule, reflecting adequate exposure to healthcare information. Most caregivers (76.67%) believed vaccines are safe, which showed a statistically significant association ($p = 0.032$) with their willingness to vaccinate. Similarly, 84.44% perceived vaccines as effective, which also correlated significantly with positive immunization practices ($p = 0.021$). However, 35.56% expressed concerns about vaccine side effects, though this did not reach statistical significance ($p = 0.118$), suggesting that while fears exist, they may not strongly deter vaccination decisions. A very high proportion (86.67%) trusted their healthcare provider's advice, which had a significant influence ($p = 0.014$) on immunization adherence, underscoring the crucial role of provider communication. Meanwhile, 22.22% of participants believed that "too many vaccines weaken immunity," a misconception prevalent among hesitant groups though not statistically significant ($p = 0.065$).

[Table 3] Distribution of Vaccine Hesitancy Levels

[Table 3] demonstrates the distribution of vaccine hesitancy levels among participants using the SAGE classification. Low hesitancy was observed in the majority (61.11%), indicating a generally positive attitude toward immunization. Moderate hesitancy was reported in 26.67%, and high hesitancy in 12.22% of respondents. This finding highlights that while most caregivers are accepting of vaccination, nearly one-third show some degree of reluctance, which can potentially affect immunization completion rates.

[Table 4] Immunization Coverage Status and Its Association with Vaccine Hesitancy

[Table 4] explores the relationship between vaccine hesitancy and actual immunization coverage. Out of all participants, 76.67% of children were fully immunized, 16.67% partially immunized, and 6.67% had delayed immunizations. The distribution of coverage varied significantly according to hesitancy levels ($p < 0.001$). Among low-hesitancy caregivers, 89.09% of children achieved complete immunization, compared to only 66.67% in the moderate hesitancy group and 36.36% in the high hesitancy group. Conversely, partial or delayed immunization rates were much higher among caregivers with moderate and high hesitancy. For instance, 27.27% of children in the high hesitancy group had delayed vaccination compared to only 1.82% in the low hesitancy group. The observed highly significant association (χ^2 test, $p < 0.001$) demonstrates that greater vaccine hesitancy is strongly linked with incomplete or delayed immunization coverage.

Table 1: Socio-Demographic Characteristics of Study Participants (n = 180)

Characteristics	Categories	Frequency (n)	Percentage (%)
Age of Mother (years)	<25	52	28.89
	25–34	92	51.11
	≥35	36	20.00
Education Status	No formal education	24	13.33
	Primary	40	22.22
	Secondary	68	37.78
	Graduate or above	48	26.67
Residence	Urban	108	60.00
	Rural	72	40.00
Socioeconomic Status	Upper	22	12.22
	Middle	86	47.78
	Lower	72	40.00
Gender of Child	Male	96	53.33
	Female	84	46.67

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Table 2: Awareness and Attitudes Toward Vaccination (n = 180)

Parameter	Positive Response (n)	Percentage (%)	p-value
Aware of National Immunization Schedule	146	81.11	-
Belief that vaccines are safe	138	76.67	0.032*
Belief that vaccines are effective	152	84.44	0.021*
Concerned about side effects	64	35.56	0.118
Trust in healthcare provider's advice	156	86.67	0.014*
Belief that too many vaccines weaken immunity	40	22.22	0.065

*Significant at $p < 0.05$

Table 3: Distribution of Vaccine Hesitancy Levels (SAGE Classification)

Vaccine Hesitancy Level	Frequency (n)	Percentage (%)
Low Hesitancy	110	61.11
Moderate Hesitancy	48	26.67
High Hesitancy	22	12.22
Total	180	100.00

Table 4: Immunization Coverage Status and Its Association with Vaccine Hesitancy (n = 180)

Immunization Status	Low Hesitancy (n=110)	Moderate Hesitancy (n=48)	High Hesitancy (n=22)	Total (%)	p-value
Complete Immunization	98 (89.09%)	32 (66.67%)	8 (36.36%)	138 (76.67%)	<0.001*
Partial Immunization	10 (9.09%)	12 (25.00%)	8 (36.36%)	30 (16.67%)	
Delayed Immunization	2 (1.82%)	4 (8.33%)	6 (27.27%)	12 (6.67%)	
Total	110	48	22	180 (100.00)	

*Significant association between vaccine hesitancy and immunization coverage (Chi-square test, $p<0.001$)

Table 5: Factors Associated with High Vaccine Hesitancy (Binary Logistic Regression Analysis)

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Low maternal education (≤Primary)	2.84	1.16–6.97	0.022*
Rural residence	1.92	1.01–3.64	0.047*
Low socioeconomic status	2.10	1.06–4.14	0.034*
Lack of trust in healthcare system	3.25	1.38–7.66	0.006*
Fear of vaccine side effects	2.45	1.19–5.03	0.016*

*Significant at $p < 0.05$

[Table 5] Factors Associated with High Vaccine Hesitancy

[Table 5] identifies independent predictors of high vaccine hesitancy through binary logistic regression analysis. Low maternal education (≤ primary level) was found to significantly increase the likelihood of high hesitancy (OR = 2.84, 95% CI: 1.16–6.97, p = 0.022), implying that limited educational attainment reduces vaccine literacy. Rural residence (OR = 1.92, 95% CI: 1.01–3.64, p = 0.047) was another significant factor, suggesting reduced healthcare access and exposure to vaccine information. Additionally, participants with low socioeconomic status were twice as likely to exhibit high hesitancy (OR = 2.10, p = 0.034), likely due to financial constraints and lower trust in public health programs. The strongest predictors were lack of trust in the healthcare system (OR = 3.25, p = 0.006) and fear of vaccine side effects (OR = 2.45, p = 0.016), both significantly increasing the odds of hesitancy.

DISCUSSION

Our overall full immunization coverage of 76.67% mirrors the national benchmark for India reported from NFHS-5 (children 12–23 months 76%) suggesting our hospital's catchment reflects broader country patterns despite being a tertiary setting (IIPS, 2022). The near-identical point estimates (76.67% vs. 76%) strengthen the external validity of our results and underscore persistent room for improvement toward the ≥90% target.[8]

Urban–rural and socioeconomic contrasts in our sample (urban 60.00%; lower SES 40.00%) align with field evidence from disadvantaged communities in Vellore, where Francis et al., 2021 observed fully-vaccinated proportions of 65–77% alongside caregiver barriers linked to mobility, employment, and information gaps patterns consistent with the higher partial/delayed immunization we observed among hesitant subgroups.[9]

Our hesitancy distribution (moderate 26.67%, high 12.22%, combined 38.89%) is directionally comparable to community estimates; in an urban household study, Raghavan et al., 2022 reported 28.9% parental hesitancy, slightly lower than our combined moderate+ high figure possibly because our tertiary-care cohort includes inpatient caregivers and more medically complex cases, amplifying perceived risks.[10]

The strong, graded relationship we found between hesitancy and coverage (complete immunization 89.09% in low-hesitancy vs 36.36% in high-hesitancy; χ^2 $p < 0.001$) echoes the direction of effect synthesized by Obohwemu et al., 2022, who reported across quantitative studies that higher parental hesitancy predicts lower uptake of routine childhood vaccines. This concordance reinforces the causal

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salience of hesitancy as a proximal barrier to coverage.[11]

Our attitudinal profile 76.67% believing vaccines are safe and 84.44% believing they are effective—sits within global confidence contours and the SAGE "3Cs" framework (confidence, convenience, complacency) that underpinned our measures, as outlined by MacDonald et al., 2015. The alignment between higher confidence and higher coverage in our data follows SAGE's prediction that confidence is a key lever of uptake.[12]

Notably, our relatively high confidence is compatible with recent macro-signals showing that while many countries experienced declines in safety/effectiveness confidence post-pandemic, India remained comparatively resilient; de Figueiredo et al., 2023 mapped trends in perceived importance, safety, and effectiveness across 55 countries, within which our safety (76.67%) and effectiveness (84.44%) perceptions fit the improving arc.[13]

Trust in clinicians emerged as a critical determinant: 86.67% of our caregivers trusted provider advice, and this was significantly associated with pro-vaccination behavior ($p = 0.014$). Parallel mediation models by Williamson et al., 2022 show that trust elevates perceived vaccine necessity and reduces concerns, thereby predicting intention/uptake supporting our finding that clinician communication can buffer hesitancy and consolidate complete immunization.[14]

Among specific concerns, our cohort's 35.56% worry about side-effects (NS at $p = 0.118$ overall) dovetails with India-focused evidence that fear of adverse effects is a primary driver of hesitancy; Sarin et al., 2023 similarly identified adverse-event fears as central. Our regression captured this: fear of side effects independently increased odds of high hesitancy (OR 2.45, 95% CI 1.19–5.03), pointing to targeted safety counseling as a high-yield intervention.[15]

Structural predictors in our model—low maternal education (OR 2.84) and low socioeconomic status (OR 2.10)—mirror pooled international effects; Forshaw et al., 2017 reported that children of mothers with secondary/higher education have ~2.3-times greater odds of complete vaccination versus none/primary, reinforcing education-linked vaccine literacy as a durable policy lever.[16]

Finally, 22.22% of caregivers endorsed the misconception that "too many vaccines weaken immunity." Classic immunology synthesis by Offit et al., 2002 shows the infant immune system's theoretical capacity far exceeds antigen exposure from schedules and that multiple vaccines do not overwhelm immunity flagging a persistent myth that clinicians should proactively address during counseling.[17]

CONCLUSION

This prospective study highlights that vaccine hesitancy significantly influences pediatric immunization coverage. Caregiver education, socioeconomic status, and trust in healthcare providers emerged as key determinants of vaccine acceptance. Strengthening communication, improving awareness, and addressing misconceptions can effectively reduce hesitancy and enhance complete, on-time immunization among children.

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