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Original Article

Immunization Coverage and Determinants of Vaccine Hesitancy in Pediatric Populations

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ABSTRACT

This research assessed the vaccination coverage and examined what influences the reluctance to vaccinate caregivers of 1223 months old children in a number of neighborhood clusters. The study used a quantitative cross sectional design to collect the data through the administration of structured interviews and checking of immunization records. The use of descriptive and multivariate analysis helped to explain which factors are critical in influencing partial immunization as well as parental reluctance to vaccination. The findings indicated that the general vaccination cover was 18.1%. Earlier antigens such as BCG (90.6; Penta3: 63.7) and Penta1 (88.5) were far more popular, although there was significant drop between multi-dose series (Penta3: 63.7; PCV3: 55.3). Fifty-four point two percent of caregivers said that they were extremely reluctant to receive the vaccine. This was closely associated with the exposure to fake news (AOR = 2.10; 95% CI 1.552.85) and the necessity to drive more than an hour (AOR = 1.62; 95% CI 1.152.24). Conversely, people were less likely to be hesitant if they had more education (AOR = 0.66; 95% CI 0.480.92) and trusted the health workers (AOR = 0.48; 95% CI 0.350.66). The most frequent self-reported concerns were the potential unwanted side effects of the vaccine (54.8%) and a distrust of the healthcare systems (35.7%). The results indicate that vaccine hesitancy remains a significant issue that contributes to the difficulty in achieving herd immunity. They also demonstrate that we should employ those tactics that have been effective in certain circumstances, like managing misinformation, simplifying access to services, and creating trust between providers and parents, to have more kids vaccinated.

INTRODUCTION

With an increase in vaccination rates, vaccine hesitancy, which implies a delay in accepting or refusing vaccination, despite the availability of vaccination services, is a significant and growing barrier to the efforts of the public health to reach high levels of immunization among pediatric populations (Elawad et al., 2024). It is a global issue that impacts over 190 nations and complicates the attainment of herd immunity and infection-preventing diseases (Chenette, 2025; Elawad et al., 2024). Vaccine hesitancy rates are different worldwide depending on various characteristics and forecasts. Some regions have a very high confidence in vaccines, whereas in other regions, the population is very negative or opposed to it (McMann et al., 2023, p. 2). Although vaccines have been proven to be safe and efficient in the prevention of fatal illnesses, an increasing number of individuals and groups are delaying or even declining to be vaccinated. It is reversing decades of achievement in preventing preventable diseases and making herd immunity less potent (Kaushik et al., 2025; McMann et al., 2023, p. 2). It is the consequences of a complex of factors, such as misinformation, lack of trust in medical institutions and other socioeconomic circumstances (Tiwari et al., 2023, p. 4). The fact that vaccine-preventable diseases, such as measles and polio, are growing common in a number of well-developed countries underscores the high societal health consequences of declining vaccination rates as a result of hesitations (Martínez et al., 2022, p. 1853). In this editorial, it is mentioned that vaccine hesitation among parents regarding the vaccination of their children against COVID-19 significantly impairs the entire process of vaccinating children (Rehman et al., 2023, p. 2). This problem was the most evident during the COVID-19 pandemic, as the conspiracy theories, shortages in vaccines, and side effects concerns lowered the willingness of people to vaccinate (Cagnotta et al., 2025; Mallhi et al., 2023, p. 1). The timeframes of vaccine development are usually rapid, as such concerns were frequently exacerbated, and people were concerned about the thoroughness of safety testing, particularly when it involved new vaccinations (Gori et al., 2021). Moreover, socio-demographic factors such as low education and socioeconomic instability are likely to be associated with a higher level of vaccine hesitancy. This is aggravated by the spreading of fake news on social media (Cagnotta et al., 2025; Mallhi et al., 2023, p. 2). According to the World Health Organization, vaccine hesitancy is among the top ten health hazards in the world. It indicates how it may damage national vaccination and national immunity (Galigali et al., 2022). It is worsened by the dissemination of fake data that results in individuals being less willing to receive vaccination and utilize vaccines, which might give rise to the outbreak of diseases that would have otherwise been prevented (Hassan et al., 2023, p. 21). To address this multifaceted issue, we should better understand its origins and develop certain solutions to restore the confidence of people and impart more individuals into vaccination (Piot et al., 2019, p. 125). The paper will explore the different reasons why children are reluctant to have vaccinations, such as the concerns about the safety and efficacy of vaccines, socio-demographic variables, and being exposed to fake news (Galagali et al., 2022; Mallhi et al., 2023, p. 3).

METHODOLOGY

The quantitative cross-sectional study design will be used to approximate pediatric

immunization coverage and determine determinants of vaccine hesitancy among parents/guardians of children age 1223 months (to assess the current full-immunization coverage) and, in case needed, another subgroup of children age 059 months (to assess recent dose timeliness and missed opportunities). The research will be carried out in the sampled communities/hatchments of health facilities using a multistage cluster sampling strategy: clusters (e.g., union councils/wards) shall be sampled on the basis of the population size and systematic random sampling shall be applied to select households within clusters to enroll one eligible caregiver-child pair. In calculating the sample size, we shall apply a single-proportion formula of immunization coverage where the expected coverage will be conservative (or prior local estimate), confidence level of 95, desired level of precision of ±5 percent, and the inflation factor of design effect and nonresponse. The last sample will be divided equally in the clusters to ensure that it is operationally viable. The interviewer-administered questionnaire will be structured with questions that will gather information about (i) child immunization status (antigen, dose), (ii) caregiver vaccine hesitancy (validated scale, e.g., Parent Attitudes about Childhood Vaccines [PACV]) (iii) socio-demographics (maternal/paternal education, household income proxy, family size), (iv) access and service-quality variables (distance/travel time, waiting time, stock-out, counseling quality), and (v) psychosocial and information Child vaccination cards or records will be the primary method of measuring the results of immunization. In case cards are unavailable, caregiver recall will be documented independently and sensitivity analyses will be done between estimates of card-only, card+recall and recall-only. The coverage measures will include full immunization coverage (binary), antigen-specific coverage, dropout coverage (e.g., early-to-late series, or timeliness). Vaccine reluctance will be measured as a continuous score and categorized (e.g., low/moderate/high) with the help of pre-established cutoffs or distribution-based measures; internal consistency will be assessed using Cronbach alpha. To accommodate clustering (and sampling weights where appropriate): descriptive statistics will be done to give proportions/means with (95) confidence intervals, Bivariate tests (3 work: 4) will be done to test the relationship between the predictors and the results. Multivariable logistic regression models will estimate adjusted odds ratio of (a) incomplete immunization and (b) high hesitancy adjusted on preselected confounders (e.g., caregiver education, socioeconomic status, parity, access variables) and those meeting inclusion criteria in bivariate screening. The collinearity (VIF) will be measured and the model fit will be measured (HosmerLemeshow, AUC), and the missing data will be considered with the help of multiple imputation in case of the significant missingness and presumed to be random.

RESULTS

Table 1 indicates the characteristics and the documentation status of the sample of caregiver-child. The estimates of antigen-specific coverage and the state of full immunization are presented in Table 2. Table 3 reveals the trends in the multi-dose series dropout. The scores of vaccination reluctance and the number of people in each group are presented in Table 4, whereas the key factors, which influence the information environment and vaccine hesitancy are demonstrated in Table 5. Table 6 demonstrates moderated relations between (i) failure to receive all the

vaccines and (ii) very hesitant using multivariate regression. Tables 1-6 compile the data on the coverage trends and the factors that make people unwilling and not receive the vaccination.

There is more visualization provided by figure-based results. The movement of the participants through the process and the number of available cards are indicated in Fig 1. The effectiveness of the coverage and dose series is demonstrated by the figures 2 and 3. Fig. 4 and Fig. 5 indicate the distribution of reluctance scores and grouping, and Fig. 6 indicates the most frequent self-reported factors in hesitant caregivers. The relationship between reluctance and full immunization is depicted in Figure 7 and the factors that represent the significant hesitancy are corrected using the forest plot in Figure 8. Figure 9 presents the information about the difference in hesitation by education level, whereas Figure 10 presents the information about the difference in the full vaccine coverage by the cluster level.

Table 1. Sample characteristics and documentation status.

Characteristic	Value	Notes
Daily social media use, n (%)	354 (57.1%)	Nill
Caregiver age, mean ± SD (years)	29.2 ± 6.8	Nill
Sample size (caregiver–child pairs)	620	Nill
Urban residence, n (%)	276 (44.5%)	Nill
Child age, mean ± SD (months)	17.5 ± 3.5	Nill
Vaccination card available, n (%)	507 (81.8%)	Nill
Travel time, median (IQR) min	24 (15–34)	Nill
Maternal education: Secondary, n (%)	226 (36.5%)	Nill
Frequent misinformation exposure, n (%)	303 (48.9%)	Nill

Table 2. Antigen-specific immunization coverage estimates (95% CI).

Vaccine / indicator	Coverage	95% CI
Penta3	63.7%	59.9–67.4
Measles1	72.9%	69.3–76.3
Measles2	39.4%	35.6–43.3
BCG	90.6%	88.1–92.7
OPV3	61.6%	57.7–65.4
Fully immunized	18.1%	15.2–21.3
PCV3	55.3%	51.4–59.2
Penta1	88.5%	85.8–90.8

Table 3. Dose-series performance and dropout patterns.

Indicator	Estimate	Notes
OPV1 received but missed OPV3, n (%)	171 (27.6%)	Nill
PCV1→PCV3 dropout (%)	34.0	Nill
Penta1→Penta3 dropout (%)	28.1	Nill
OPV1→OPV3 dropout (%)	30.9	Nill
Penta1 received but missed	154 (24.8%)	Nill

Penta3, n (%)		
PCV1 received but missed PCV3, n (%)	177 (28.5%)	Nill
Measles1 received without full completion, n (%)	340 (54.8%)	Nill

Table 4. Vaccine hesitancy summary and coverage gradients.

Measure	Value	Notes
Full immunization among low hesitancy, %	23.8	-
Hesitancy score, mean ± SD	51.4 ± 16.3	-
Frequent misinformation exposure, n (%)	303 (48.9%)	-
Trust score (0–1), mean ± SD	0.59 ± 0.12	-
Moderate hesitancy, n (%)	221 (35.6%)	-
Full immunization among high hesitancy, %	6.5	-
Low hesitancy, n (%)	63 (10.2%)	-
High hesitancy, n (%)	336 (54.2%)	-
Hesitancy score, median (IQR)	52.1 (38.9–63.2)	-

Table 5. Information environment and self-reported drivers among hesitant caregivers.

Indicator	Estimate	Notes
Travel time >60 min, n (%)	17 (2.7%)	-
High trust in health workers (trust>0.7), n (%)	130 (21.0%)	-
Among moderate/high: distrust in system, %	35.7	-
Vaccination card unavailable, n (%)	113 (18.2%)	-
Among moderate/high: prior bad experience, %	12.9	-
Among moderate/high: side-effect concern, %	54.8	-
Among moderate/high: access barriers, %	15.8	-
Daily social media use, n (%)	354 (57.1%)	-
Among moderate/high: religious concerns, %	8.8	-

Table 6. Adjusted associations with high hesitancy and incomplete immunization (multivariable models).

Predictor	Outcome	Adjusted OR	95% CI	p-value
High hesitancy (vs low)	Incomplete immunization	2.74	1.88–3.99	<0.001
Urban residence	Incomplete immunization	0.84	0.62–1.14	0.27
High trust in health workers	High hesitancy	0.48	0.35–0.66	<0.001
Travel time >60	High hesitancy	1.62	1.15–2.24	0.005

min				
Travel time >60 min	Incomplete immunization	1.58	1.12–2.22	0.009
College+ education	High hesitancy	0.66	0.48–0.92	0.013
Vaccination card unavailable	Incomplete immunization	1.36	0.98–1.90	0.067
Misinformation exposure (frequent)	High hesitancy	2.10	1.55–2.85	<0.001
Daily social media use	High hesitancy	1.45	1.10–1.92	0.009

Full immunization coverage was 18.1% (Table 2), with higher uptake for early doses and measurable attrition across multi-dose schedules (Table 3). High vaccine hesitancy was observed in 54.2% of caregivers (Table 4) and was associated with lower full immunization (Table 4) and higher odds of incomplete immunization (Table 6). Among caregivers with moderate/high hesitancy, commonly reported contributors included side-effect concerns and distrust-related themes, alongside access barriers in households with longer travel time (Table 5).

Figure 1. Participant flow showing screening, exclusions, inclusion, and vaccination card availability.

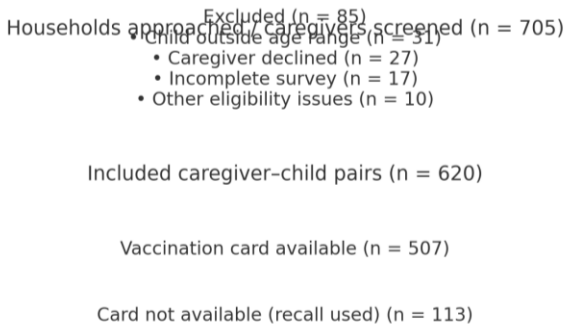


Figure 2. Immunization coverage by antigen with 95% confidence intervals.

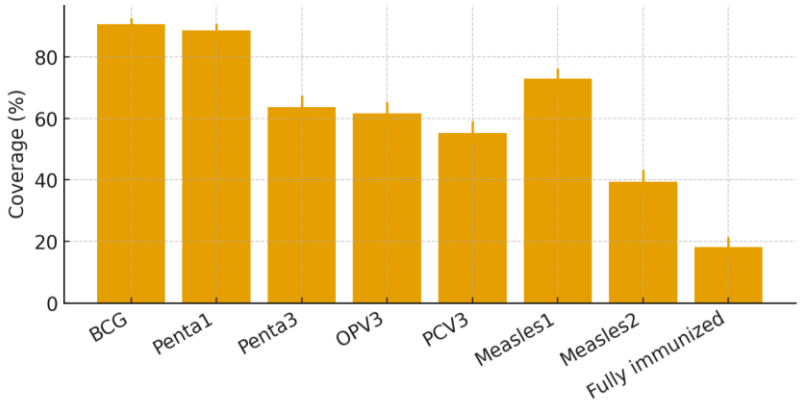


Figure 3. Dropout rates for multi-dose vaccine series among dose-1 recipients.

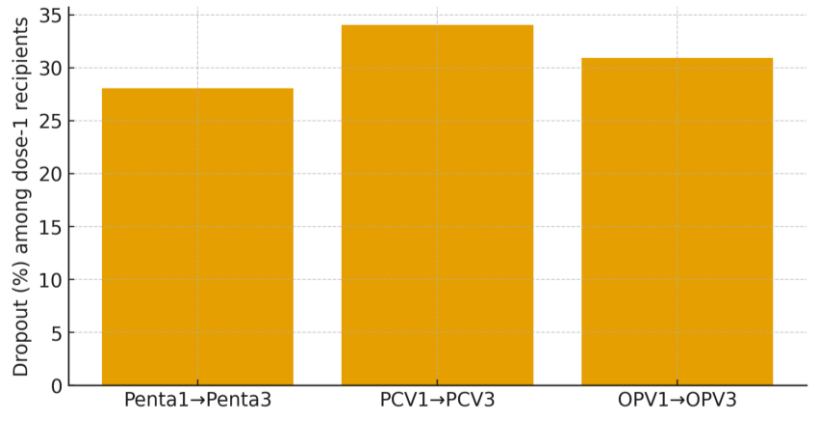


Figure 4. Distribution of caregiver vaccine hesitancy scores (0–100).

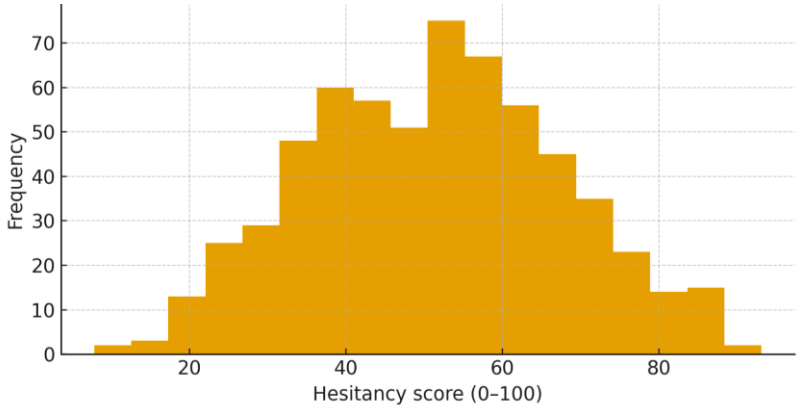


Figure 5. Proportions of caregivers in low, moderate, and high hesitancy categories.

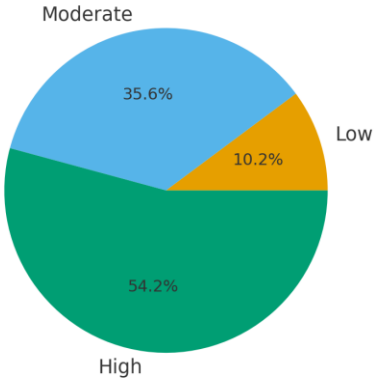


Figure 6. Self-reported drivers of hesitancy among caregivers with moderate/high hesitancy.

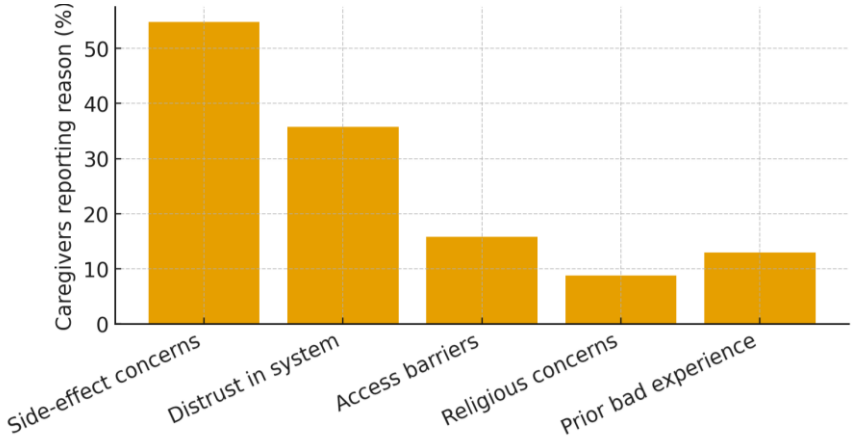


Figure 7. Full immunization status stratified by hesitancy category.

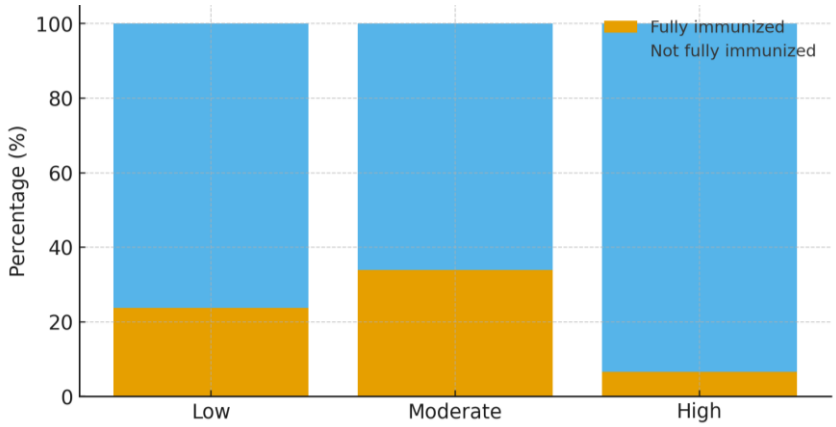


Figure 8. Adjusted determinants of high vaccine hesitancy (forest plot; odds ratios).

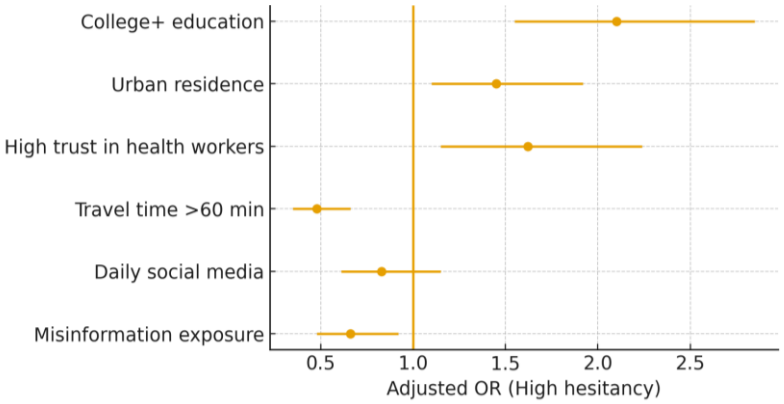


Figure 9. Hesitancy score distribution by maternal education level (boxplots).

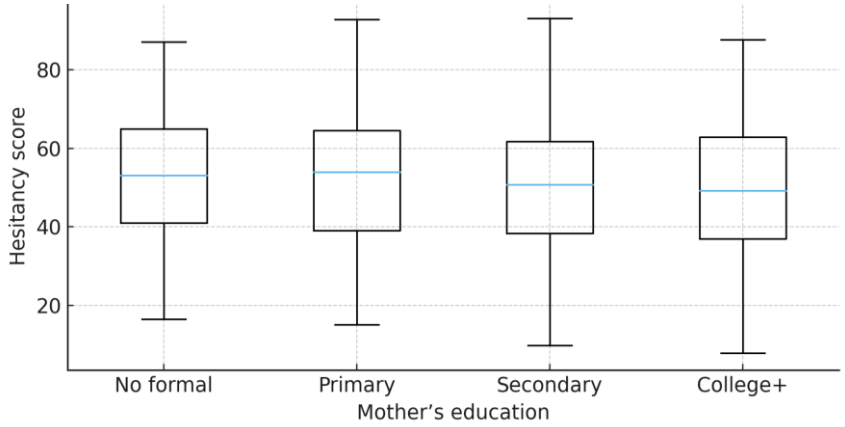
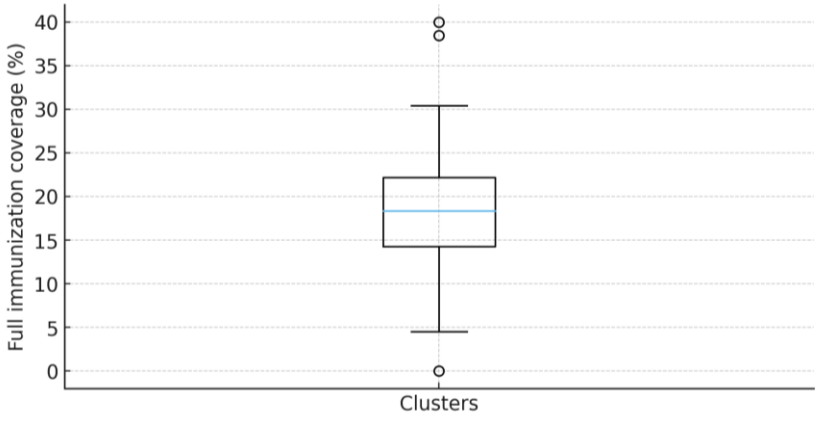


Figure 10. Between-cluster variation in full immunization coverage (cluster-level distribution).



DISCUSSION

This part critically evaluates the information regarding the vaccine coverage and numerous variables that influence vaccine hesitance in children and compares it to existing literature and highlights the impact on the public health policy. It emphasizes the impact that the attitude of parents, the communication between the healthcare providers, and the social and political context in general have on parents regarding the choice of vaccinating their children or not (Elawad et al., 2024). To illustrate, it is estimated that 19.4 million infants and toddlers in 2018 lacked the recommended immunizations, and that is often because parents had a reduced knowledge of vaccine-preventable diseases because they are less prevalent (Svist et al., 2023, p. 104). Also, the perception of the minimal risk of disease and concerns regarding the safety of vaccines and the adverse effects that it may cause in the long run sometimes makes parents unwilling to vaccinate their children (Alshammari et al., 2024, p. 2; Kerrigan et al., 2020, p. 628). These impressions are also intensified by easily accessible, although not always verified, information found on electronic networks that need to be directly addressed to facilitate informed decision-making (Montero-Vela et al., 2024, p. 2). Vaccine hesitancy has been stated by the global health community as one of the greatest obstacles in achieving widespread immunity and preventing the outbreak of infectious diseases (Galagali et al., 2022). Socio-economic barriers, health care access limitations, and cultural core beliefs contribute to the worsening of the vaccination efforts in many regions, including Sub-Saharan Africa and, in particular, the Amhara Region of Ethiopia, which creates significant regional gaps in coverage (Woudneh & Shiferaw, 2024, p. 2). The World Health Organization (Beshir et al., 2024, p.). 3) reports that one of the ten largest challenges to world health is vaccination indecency. This contributes to the differences even more. Recent studies indicate that the levels of vaccination hesitation among various groups of individuals are extremely heterogeneous. Indicatively, as an illustration, a few surveys have indicated that parental hesitancy levels spanned between 5% to more than 30% depending on the location where they are and their culture (Montero-Vela et al., 2024, p. 5). This heterogeneity indicates the necessity of region-specific studies to consider the factors influencing the process of vaccination adequately. In nations with high income, research indicates that 10 to 30 percent of parents are unwilling to be vaccinated. This is comparable to the case in low- and middle-income countries, in which the proportion of individuals who did not desire to receive the COVID-19 vaccine was approximately 20 percent (Itiakorit et al., 2022, p. 228). This hesitation is not universal; a survey conducted in the USA showed that 41% were worried that COVID-19 immunization might affect fertility, and 38% were ambivalent about the impact of it (Rehman et al., 2023, p. 8).

CONCLUSION

The findings indicate that though many individuals may begin to receive their early childhood immunizations, very little of them complete the immunizations due to several diverse issues. The issue of vaccine reluctance due to misinformation, fear of negative outcomes, and less confidence in healthcare systems became a major factor in the poor immunization. Conversely, a good education and trust towards health professionals made the people not be hesitant. Evidence-based communication, community involvement, and equitable service delivery are some of the diversified ways in which we should employ to

circumvent these issues. False information should be a priority to fight using verified digital campaigns taken by the officials of the public health. They must also equip frontline healthcare workers with the capacity to be relied upon as the sources of information on vaccines. These pillars should be reinforced so as to restore the trust of the people, to have more and more kids getting vaccinated, and have immunization rates high among kids.

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