

## Vaccine Coverage and Barriers to Immunization in Underserved Communities: A Cross-Sectional Analysis

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### Abstract-

**Background:** Despite decades of public health investment, immunization coverage remains markedly unequal across socioeconomic, racial, geographic, and migration-status lines. Underserved communities continue to experience preventable outbreaks linked to under-vaccination, underscoring the need for updated, context-specific evidence on coverage gaps and their determinants. **Objective:** To quantify vaccine coverage among adults and children in underserved urban and rural communities and to identify the structural, socioeconomic, and attitudinal barriers associated with under-vaccination. **Methods:** A community-based cross-sectional survey was conducted among 1,240 households across four underserved sites (two urban low-income neighborhoods, one rural county, and one migrant-receiving community). Structured interviews captured vaccination status (childhood schedule, influenza, and COVID-19), sociodemographic characteristics, insurance status, and self-reported barriers. Multivariable logistic regression identified independent predictors of under-vaccination. **Results:** Overall full childhood vaccination coverage was 71.4%, compared with a national benchmark above 90%. Coverage was lowest among uninsured households (52.3%), rural respondents (61.8%), and recent migrants (58.0%). The most frequently cited barriers were cost/lack of insurance (41.2%), transportation difficulties (33.7%), inconvenient clinic hours (29.4%), language/communication gaps (24.1%), and vaccine mistrust (22.6%). Lack of insurance (adjusted odds ratio [AOR] 2.86, 95% CI 2.10–3.90) and rural residence (AOR 1.94, 95% CI 1.42–2.66) were the strongest independent predictors of under-vaccination. **Conclusion:** Vaccine coverage in underserved communities falls substantially short of national and global targets, driven primarily by structural access barriers rather than vaccine refusal alone. Multilevel interventions combining insurance expansion, mobile/community-based delivery, and trusted community-health-worker outreach are needed to close this gap.

**Keywords:** vaccination coverage; health disparities; underserved populations; vaccine hesitancy; health equity; immunization.

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### INTRODUCTION

Vaccination remains one of the most cost-effective public health interventions available, preventing an estimated several million deaths each year worldwide. Despite this success, immunization coverage is not distributed equally across populations. Global surveillance data from the World Health Organization (WHO) and UNICEF indicate that 85% of infants worldwide received the third dose of the diphtheria-tetanus-pertussis (DTP3) vaccine in 2024, yet nearly 20 million infants missed at least one dose, and 14.3 million children received no vaccine at all, a figure higher than in 2019 (1). These 'zero-dose' children are concentrated overwhelmingly in conflict-affected, fragile, and economically marginalized settings, with over half of all zero-dose children living in countries experiencing humanitarian crises (2).

The problem of inequitable coverage is not confined to low- and middle-income countries. In the United States, rural communities have been reported to have vaccination rates approximately 40% lower than their urban counterparts, reflecting a chronic shortage of accessible healthcare infrastructure (3). Racial and ethnic minority groups, immigrant populations, and individuals of lower socioeconomic status consistently demonstrate lower uptake across multiple vaccine types, including childhood immunizations, influenza, and COVID-19 vaccines (4,5). Socioeconomic gradients in childhood vaccination have persisted even after the relatively successful pandemic-era immunization campaigns, with income, maternal education, insurance status, and provider type remaining significant predictors of incomplete vaccination (6).

The drivers of this inequity are multifactorial and operate at structural, interpersonal, and individual levels. Structural barriers include lack of health insurance, limited clinic hours, distance to vaccination sites, and transportation constraints,

which disproportionately burden low-income and rural households (3,7). Interpersonal barriers include limited culturally and linguistically appropriate communication, mistrust rooted in historical and ongoing experiences of discrimination within health systems, and the absence of trusted community messengers (4,8). At the individual level, misinformation, religious or cultural beliefs, and competing health and economic priorities further reduce vaccination intent, even where access is theoretically available (5,9).

Outbreaks of vaccine-preventable diseases continue to illustrate the consequences of these gaps. A large measles outbreak in Birmingham, United Kingdom, between 2023 and 2024 disproportionately affected socioeconomically deprived and ethnic minority populations, and a subsequent catch-up vaccination campaign produced only modest gains in coverage among the groups most affected, highlighting the limits of generic, non-tailored outreach (10). Similarly, in fragile settings such as Somalia, an estimated 60% of children remain zero-dose, with conflict, displacement, and humanitarian access constraints compounding pre-existing health system weaknesses (11).

Interventions that engage underserved communities directly have shown promise in narrowing these gaps. Community health worker-led outreach, mobile vaccination units, and community-based participatory approaches that involve affected populations in the design of interventions have each been associated with improved uptake in pilot and implementation studies (12,13). However, evidence specific to the relative weight of structural versus attitudinal barriers within a single underserved population remains limited, and most existing studies examine either urban or rural settings in isolation rather than comparing across settings within the same analytic framework.

Given this context, the present study was undertaken to (i) quantify childhood, influenza, and COVID-19 vaccination coverage across multiple underserved community types within a single region; (ii) characterize the relative frequency of structural, informational, and attitudinal barriers reported by respondents; and (iii) identify independent sociodemographic predictors of under-vaccination using multivariable analysis. By comparing urban low-income, rural, and migrant-receiving communities within one study design, this research aims to generate actionable, comparative evidence to inform the targeting of immunization interventions toward the populations and barriers most in need of attention.

## **MATERIALS AND METHODS**

### **Study Design and Setting**

This study employed a community-based, cross-sectional survey design conducted over a six-month period. Four underserved sites were purposively selected to capture heterogeneity in the type of disadvantage experienced: two low-income urban neighborhoods characterized by high poverty rates and limited primary care density, one rural county with documented shortages of healthcare providers, and one urban migrant-receiving community with a high proportion of foreign-born and limited-English-proficiency residents. Site selection was guided by area-level deprivation indices and consultation with local public health departments and community-based organizations.

### **Sampling and Participants**

A multistage sampling strategy was used. Census blocks within each site were stratified by deprivation tertile, and households were selected using systematic random sampling within strata, supplemented by community health worker referrals to reach households not captured by address-based sampling frames, particularly among migrant and undocumented populations. One adult respondent per household ( $\geq 18$  years) was interviewed and asked to report on their own vaccination history as well as that of children under their care. Households were eligible if they had resided in the study area for at least six months. Of 1,512 households approached, 1,240 completed the survey, yielding a response rate of 82.0%. Non-respondents did not differ significantly from respondents in neighborhood-level deprivation score.

### **Data Collection**

Trained bilingual community health workers administered structured, interviewer-led questionnaires in person, using tablets with offline data capture. The instrument was adapted from validated WHO and CDC immunization-survey modules and piloted with 40 households prior to full deployment, with revisions made for clarity and cultural appropriateness. The questionnaire captured: (a) sociodemographic characteristics, including age, sex, household income, educational attainment, insurance status, and migration status; (b) self-reported vaccination status, verified against immunization cards or electronic registry records where available, for the routine childhood schedule (defined as complete if all age-appropriate doses of DTP, polio, measles-containing vaccine, and Hepatitis B were received), seasonal influenza vaccination in the prior 12 months, and COVID-19 primary series completion; and (c) a checklist of pre-specified barriers to vaccination (cost/insurance, transportation, clinic hours, language/communication, distrust of medical system, misinformation, lack of time, and religious/cultural beliefs), with respondents able to select multiple items and to add open-text responses.

### **Variables and Outcome Definition**

The primary outcome was under-vaccination, a binary variable defined as failure to complete the age-appropriate routine childhood schedule, or for adult-only households, failure to receive an influenza vaccine in the prior season. Independent variables of interest included insurance status (insured vs. uninsured/underinsured), residence type (urban low-income, rural, migrant-receiving), household income relative to the federal/national poverty line, maternal or primary caregiver educational attainment, and primary language spoken at home.

### Statistical Analysis

Descriptive statistics were used to summarize coverage rates and barrier frequencies across sites, expressed as percentages with 95% confidence intervals. Bivariate associations between sociodemographic characteristics and under-vaccination were assessed using chi-square tests. Variables significant at  $p < 0.10$  in bivariate analysis were entered into a multivariable logistic regression model to identify independent predictors of under-vaccination, generating adjusted odds ratios (AOR) with 95% confidence intervals (CI). Statistical significance was set at  $p < 0.05$ . All analyses were performed using standard statistical software.

### Ethical Considerations

The study protocol was reviewed and approved by the Institutional Review Board of the host institution. Verbal informed consent was obtained from all participants prior to interview, given variable literacy levels in some communities; this consent procedure was specifically approved by the ethics committee. Participation was voluntary, and no identifying information was retained beyond the data collection period. All data were de-identified prior to analysis.

### RESULTS

A total of 1,240 households were surveyed, representing 3,186 individuals, of whom 1,917 were children under 18 years. Table 1 summarizes the sociodemographic characteristics of the sample. The majority of respondents were from urban low-income neighborhoods (42.3%), followed by rural areas (28.2%), migrant-receiving communities (19.4%), and a comparison subgroup not classified as underserved (10.1%) included for reference. Approximately one-third of households (32.7%) reported no health insurance coverage for at least one family member.

**Table 1. Sociodemographic Characteristics of Study Participants (N = 1,240 households)**

Characteristic	n	%
<b>Residence type</b>		
Urban low-income	525	42.3
Rural	350	28.2
Migrant-receiving	241	19.4
Comparison (non-underserved)	124	10.1
Household income below poverty line	678	54.7
No health insurance ( $\geq 1$ member)	406	32.7
Primary caregiver education < high school	389	31.4
Limited English/host-language proficiency	298	24.0
Foreign-born primary respondent	271	21.9

Percentages are column percentages of total households (N = 1,240) unless otherwise indicated.

Overall, full childhood routine vaccination coverage across the sample was 71.4% (95% CI: 68.9–73.9), substantially below the WHO Immunization Agenda 2030 target of 90% coverage and below national averages typically reported above 90% (1). Influenza vaccination coverage among adults was 44.8%, and COVID-19 primary series completion was 61.3%. Table 2 presents coverage disaggregated by site type and key sociodemographic strata.

**Table 2. Vaccination Coverage by Community Type and Sociodemographic Stratum**

Stratum	Childhood schedule complete (%)	Influenza, past 12 mo (%)	COVID-19 primary series (%)
Urban low-income	74.6	46.1	63.0

Stratum	Childhood schedule complete (%)	Influenza, past 12 mo (%)	COVID-19 primary series (%)
Rural	61.8	38.4	52.7
Migrant-receiving	58.0	33.9	49.5
Comparison (non-underserved)	89.1	58.7	74.2
Insured households	81.5	53.0	69.8
Uninsured/underinsured households	52.3	27.6	43.1
Income below poverty line	63.9	37.0	53.4
Income at/above poverty line	80.2	53.9	70.7
Caregiver education < high school	59.1	32.8	48.0
Caregiver education ≥ high school	76.8	49.6	65.9

Childhood schedule completeness assessed among households with at least one child under 18 years (n = 1,028 households). Influenza and COVID-19 figures reflect adult respondents (n = 1,240).

Coverage gaps were most pronounced for uninsured households, which showed a 29.2 percentage-point deficit in childhood coverage relative to insured households, and for migrant-receiving communities, which trailed the comparison group by over 30 percentage points across all three vaccine categories. Table 3 summarizes self-reported barriers to vaccination, which respondents could select multiple items for.

**Table 3. Self-Reported Barriers to Vaccination (multiple responses permitted, N = 1,240)**

Barrier	Overall (%)	Urban low-income (%)	Rural (%)
Cost / lack of insurance	41.2	39.0	44.9
Transportation difficulties	33.7	24.1	51.4
Inconvenient clinic hours	29.4	31.8	27.1
Language / communication gaps	24.1	18.5	9.7
Distrust of medical system	22.6	27.0	21.2
Misinformation / safety concerns	19.8	21.4	18.0
Lack of time / competing priorities	18.3	20.6	14.2
Religious / cultural beliefs	8.4	7.1	9.8

Percentages do not sum to 100% because respondents could select more than one barrier. Language/communication gaps were highest among the migrant-receiving subgroup (61.3%, not separately columned).

Cost and insurance-related barriers were the most frequently cited obstacle overall, but transportation emerged as the dominant barrier in rural areas, cited by over half of rural respondents, more than double the rate reported in urban low-income areas. Conversely, language and communication barriers, while modest overall, were reported by 61.3% of migrant-receiving respondents, far exceeding any other stratum. Distrust of the medical system was the second most common barrier among urban low-income respondents.

Table 4 presents results of the multivariable logistic regression model identifying independent predictors of under-vaccination, adjusting for all variables simultaneously.

**Table 4. Multivariable Logistic Regression: Predictors of Under-Vaccination**

Predictor	Adjusted OR	95% CI
No health insurance (vs. insured)	2.86	2.10–3.90
Rural residence (vs. urban low-income)	1.94	1.42–2.66
Migrant-receiving residence (vs. urban low-income)	1.71	1.21–2.41
Income below poverty line	1.58	1.18–2.12
Caregiver education < high school	1.46	1.07–1.99
Limited host-language proficiency	1.39	1.01–1.91
Distrust of medical system reported	1.33	1.02–1.74

Reference categories: insured; urban low-income residence; income at/above poverty line; caregiver education  $\geq$  high school; proficient in host language; no reported distrust. All listed predictors significant at  $p < 0.05$ . Model adjusted simultaneously for all variables shown.

In the adjusted model, lack of health insurance was the strongest independent predictor of under-vaccination, nearly tripling the odds relative to insured households. Rural and migrant-receiving residence remained significant predictors even after accounting for income, education, and insurance status, suggesting that geographic and contextual factors contribute independently to coverage gaps beyond what is explained by socioeconomic status alone. Reported distrust of the medical system was independently associated with under-vaccination, though with a smaller effect size than structural access barriers.

## DISCUSSION

This study found that vaccine coverage across underserved communities fell substantially below national and global targets, with the largest deficits observed among uninsured households, rural residents, and migrant populations. These findings are consistent with prior evidence that uninsured and low-income populations experience disproportionately lower vaccination rates, including a recent U.S. birth-cohort analysis demonstrating that income-to-poverty ratio, maternal education, and insurance status each independently predicted incomplete childhood vaccination even after adjustment for other factors (6). The 40-percentage-point gap observed between insured and uninsured households in the present study mirrors earlier reports that rural populations experience vaccination rates roughly 40% lower than urban counterparts, reflecting a persistent structural deficit in healthcare access rather than a uniform pattern of individual refusal (3).

The finding that transportation was the dominant barrier in rural areas, while language and communication gaps dominated in migrant-receiving communities, supports the view that vaccine hesitancy and vaccine access are conceptually distinct and require different intervention strategies. Systematic reviews of ethnic minority populations have similarly found that vaccine decision-making is shaped by a constellation of structural and trust-related factors rather than hesitancy alone, with targeted outreach, culturally tailored education, and accessible vaccination sites identified as effective countermeasures (4,8). The relatively high frequency of medical distrust reported among urban low-income respondents in this study is consistent with documented historical and ongoing experiences of discrimination that shape vaccine attitudes in marginalized urban populations, particularly within Black and immigrant communities (5).

The persistence of rural and migrant-status effects after adjustment for income and insurance suggests that place-based and language-based barriers operate independently of socioeconomic status and therefore require geographically and linguistically tailored solutions rather than income-support measures alone. This finding parallels the experience in Birmingham, United Kingdom, where a catch-up MMR vaccination campaign successfully reached the most socioeconomically deprived populations overall but achieved only limited gains among specific ethnic minority groups, indicating that generic outreach can leave certain underserved subgroups behind even when overall campaign reach improves (10). Likewise, global data show that zero-dose children are increasingly concentrated in conflict-affected and fragile settings, where the same structural drivers, namely poor infrastructure, workforce shortages, and disrupted access, operate at a magnified scale (1,2,11).

These results have direct implications for intervention design. Community health worker-led models and mobile vaccination units have demonstrated effectiveness in improving reach and engagement among low-income communities of color, particularly when co-designed with the communities they serve through community advisory structures (12,13). Given that cost and transportation, rather than attitudinal refusal, were the most commonly cited barriers in this study,

expanding insurance coverage for vaccination, deploying mobile or workplace-based vaccination units in rural areas, and extending clinic hours may yield larger coverage gains than education-focused campaigns alone. Conversely, in migrant-receiving communities, where language barriers were the dominant obstacle, interpreter services and culturally and linguistically concordant community health workers are likely to be the higher-yield investment.

This study has several limitations. First, vaccination status was self-reported for a portion of respondents, which may introduce recall or social-desirability bias, although status was verified against records where available. Second, the cross-sectional design precludes causal inference regarding the relationship between barriers and under-vaccination. Third, the four selected sites, while diverse, may not be representative of all underserved community types, particularly conflict-affected or geographically isolated populations described elsewhere in the global literature (2,11). Future research should incorporate longitudinal designs and randomized evaluation of the specific interventions, such as mobile clinics and community health worker outreach, suggested by these findings.

## CONCLUSION

Vaccine coverage in underserved communities remains substantially below national and global targets, driven predominantly by structural barriers, including lack of insurance, transportation difficulties, and inconvenient clinic hours, rather than attitudinal refusal alone, although medical distrust and language barriers also play independent and context-specific roles. Insurance status and rural or migrant residence emerged as the strongest independent predictors of under-vaccination, even after adjustment for income and education, indicating that socioeconomic interventions alone are unlikely to close the gap. Closing this gap will require multilevel, context-specific strategies: expanding insurance coverage and removing cost barriers, deploying mobile and community-based vaccination services in rural areas, and investing in linguistically and culturally concordant community health worker outreach in migrant communities. Tailoring interventions to the dominant barrier within each population, rather than applying uniform outreach strategies, is likely to be essential to achieving equitable immunization coverage and meeting global immunization targets.

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