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Factors That Associated to Completed Doses of Immunization During Polio Supplementary Immunization Activities (SIA) in Mimika District 2024

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Abstract. *In 2024, circulating vaccine-derived poliovirus type 2 (cVDPV2) was detected in Indonesia. In response, the Government of Indonesia declared a polio outbreak and launched a Polio Supplementary Immunization Activity (SIA) providing two doses of the Novel Oral Polio Vaccine type 2 (nOPV2) to children aged 0–7 years. This study aimed to identify factors associated with completion of the required nOPV2 doses during the Polio SIA in Mimika District, Central Papua Province. An analytic observational study with a cross-sectional design was conducted among children aged 0–7 years. A total of 356 respondents representing 776 eligible children were selected through systematic random sampling across seven primary health centers (Puskesmas) and 17 urban and rural villages. Data were collected using a structured questionnaire and analyzed to determine factors associated with complete nOPV2 immunization. Several factors showed significant associations with nOPV2 dose completion, including fear of adverse events following immunization (AEFI), accessibility of immunization posts and schedules, parental availability, and exposure to negative rumours about immunization. In contrast, parental knowledge about the Polio SIA was not significantly associated with nOPV2 completion among children aged 0–7 years. These findings highlight the importance of strengthening information dissemination, improving service accessibility, and enhancing health promotion strategies to increase community acceptance and ensure successful implementation of immunization programs.*

Keywords: *Immunization, outbreak, polio, nOPV2 completion*

1. Introduction

Poliomyelitis, commonly known as polio with most infections are either asymptomatic or present with mild, influenza-like symptoms. In fewer than 1% of symptomatic cases, the illness progresses rapidly to asymmetric acute flaccid paralysis accompanied by loss of reflexes in the affected limb (paralytic poliomyelitis), with neurological complications developing in roughly two-thirds of these patients (Committee on Infectious Diseases, 2012).

Global progress toward polio eradication has unfolded alongside major challenges, including declines in routine immunization coverage during the COVID-19 pandemic, slow recovery efforts, growing conflict and political instability, and increased climate-related disasters in high-risk areas. These difficulties are intensified by programmatic issues, such as unexpected large outbreaks of type 2 variant poliovirus after the 2016 shift from tOPV to bOPV, occasional vaccine supply interruptions, and uneven campaign quality (World Health Organization, 2021).

Targets for certifying the eradication of wild poliovirus type 1 (WPV1) and eliminating type 2 variant poliovirus (cVDPV2) are behind schedule. Considering current transmission trends and expert recommendations, the Global Polio Eradication Initiative has revised its

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goals to certify WPV1 eradication by 2027 and cVDPV2 elimination by 2029 (World Health Organization, 2021).

In 2024, global coverage for three polio vaccine doses reached 84%. In OPV-using countries, first-dose IPV coverage is estimated at 85% and second-dose coverage at 68%, up from 43% in 2023. While transmission persists only in Afghanistan and Pakistan, all nations—especially those with weak health systems and close ties to endemic regions—remain at risk of polio importation (World Health Organization, 2022).

By 2019-2023, BOPV and IPV coverage in Indonesia have not reached the national target of 95%. National coverage for children witrh completed BOPV (bOPV4) in Indonesia showed a downward trend from 94.2% in 2019 to 80.2% in 2021, likely influenced by disruptions during the COVID-19 pandemic, followed by a substantial rebound to 94.4% in 2022 and further exceeding target levels at 104% in 2024. Similarly, national coverage for the inactivated polio vaccine (IPV) increased from 77% in 2019 to 108% in 2023, despite experiencing a sharp decline to 37% in 2020 and fluctuating rates of 66% in 2021 and 87% in 2022 due to COVID-19 pandemic (WHO, 2024a)

From 2019 to 2023, OPV4 and IPV coverage in Central Papua Province showed considerable variation, with many districts remaining below optimal levels. In Mimika District, coverage consistently fell within the 60–94% range throughout the period, indicating moderate but incomplete achievement of immunization targets (WHO, 2024a). These figures indicate low and uneven immunization coverage in Indonesia, particularly in Central Papua Province and Mimika District, placing these areas among the regions at high risk for polio.

Given that low coverage of polio vaccination, cases of circulating vaccine-derived poliovirus type 2 (cVDPV2) and vaccine-derived poliovirus type 1 (VDPV1) were detected in Mimika District, with eight stool samples from healthy children testing positive. This finding added to the trend of polio outbreak with VDPV detectionn in Indonesia after detecting also in other provinces such as Aceh, West Java, East Java, Papua Mountains, and South Papua during 2022-2024. In response, the government launched a polio Supplementary immunization activities (SIA) by providing two doses Novel Oral Polio Vaccine type 2 (nOPV2) targeting all children aged 0–7 years, with 95% coverage for all provinces. The campaign was conducted from May-November 2024 (WHO, 2024b).

As one of the Polio outbreak epicentrum, the Polio SIA coverage in Mimika district had not achieve national target. Completed polio SIA coverage in Mimika district was 72.3% leaving 12,948 unvaccinated children with 4.4% drop out rate (Kesehatan: & Direktorat Pengelolaan Imunisasi, 2024).

Various factors associated with the administration of polio vaccinations. A research shows that current parents employment may affect the children access to completed doses of polio (Mediarti et al., 2020). Furthermore knowledge of the mother about immunization campaign affect the utilization of immunization services (Harizon et al., 2020)as well as leading to positive attitude for polio immunization (Erna Rahmawati, 2023). Parents also refused vaccination due to rumors they heard that affect to their fear of sterility; lack of faith in the polio vaccine; scepticism about the vaccination programme, and fear that the vaccine might contain religiously forbidden ingredients (Khowaja et al., 2012). Medical condition of mother or children may also affect zero dose and incompleted of vaccination status (Anwar et al., 2023). Parents also afraid of events of AEFI and are hesitant to continue vaccination in circumstances when children need medical treatment (Gopalan et al., 2025) and (Yenyi, 2019).

Despite the global progress toward polio eradication, evidence on the determinants of Supplementary Immunization Activity (SIA) completion in remote, high-risk, and socio-culturally complex settings remains limited. Mimika District in Central Papua represents one of Indonesia's most challenging areas for outbreak response due to geographic barriers, mobile populations, and historically low routine immunization coverage. Following the detection of circulating vaccine-derived poliovirus type 2 (cVDPV2) in 2024, understanding the factors influencing nOPV2 SIA completion in this context is critical. This study provides novel, context-specific evidence on behavioral, structural, and communication-related determinants of SIA completion in an understudied region. The findings contribute essential insights for strengthening outbreak response strategies in similar high-risk settings across Indonesia and globally

2. Methods

This study was a cross-sectional analytic design conducted in Mimika District, Central Papua Province, Indonesia following the 2024 Polio Supplementary Immunization Activities (SIA) May – November 2024. The study population consisted of children aged 0–7 years who were eligible to receive nOPV2. A systematic random sampling method was used to select participants. A total of 356 respondents were interviewed, representing 776 children. Respondents who were not present during data collection, declined participation, or could not confirm their child's immunization status were excluded. Data were collected using a structured questionnaire developed based on WHO and Indonesian Ministry of Health guidelines for immunization monitoring. The questionnaire underwent expert review for content validity and was pilot-tested in one non-study village to ensure clarity and reliability.

The dependent variable in this study was the completion of nOPV2 doses, categorized as complete or incomplete. Independent variables included afraid of AEFI, immunization post and schedule, parental employment status, negatif rumour on immunization, and parental awareness on Polio SIA implementation. Data were collected using a structured questionnaire administered to parents or caregivers, combined with verification of immunization cards and field observations to ensure data accuracy and reliability.

Because several 2×2 contingency tables contained very small cell counts—including zero values a standard binary logistic regression model could not meet the assumptions required for model convergence. Zero-cell conditions are known to cause complete or quasi-complete separation, which leads to unstable or extreme odds ratios when using maximum likelihood estimation. Therefore, logistic regression outputs were not used for interpretation.

Instead, bivariate analysis was conducted using Fisher's Exact Test, which is the recommended procedure for sparse categorical data and datasets with zero cells. Odds ratios (ORs) and their 95% confidence intervals were calculated using the Haldane–Anscombe continuity correction to address zero-cell bias and improve estimator stability. Variables with p-values below the significance threshold were further analyzed using multivariate logistic regression to determine independent predictors of vaccination completeness. Ethical approval for this study was obtained from the local ethics committee, and informed consent was secured from all participating parents or guardians prior to data collection.

3. Results and Discussion

Several variables showed statistically significant associations with nOPV2 completion when tested using Fisher's Exact Test. These included fear of AEFI ($p = 0.0073$), immunization

post and schedule (p = 0.001), parental employment status (p = 0.01), and negative rumours on immunization (p = 0.012). This finding indicates that the occurrence or perception of post-vaccination side effects may negatively influence caregivers' decisions to complete the full immunization schedule. The calculated odds ratios appeared extremely small (e.g., 0.0015–0.12). These values are expected due to the presence of zero cells specifically categories in which no children completed the required nOPV2 doses. Such structural zeros mathematically shift the odds ratio toward zero, even after continuity correction. Therefore, these ORs should be interpreted qualitatively (direction of association) rather than as precise quantitative estimates

The accessibility of immunization services, particularly the immunization post and timing, was also significantly associated with nOPV2 completion (p = 0.001; 95% CI = 0.0015–0.12), suggesting that logistical barriers such as inconvenient service hours or distant immunization sites contribute to missed doses. Similarly, parental employment status showed a significant association (p = 0.01; 95% CI = 0.00047–0.1307), indicating that working parents may face time constraints or scheduling conflicts that limit their ability to bring children for vaccination.

Furthermore, negative rumors related to immunization were significantly associated with incomplete immunization (p = 0.012; 95% CI = 0.0029–1.158), implying that misinformation or community distrust can adversely affect participation in vaccination programs.

In contrast, parental knowledge about the Polio Supplementary Immunization Activities (SIA) was not significantly associated with vaccination completeness (p = 0.99; 95% CI = 0.637–1.578). This suggests that while caregivers may possess adequate information about the campaign, knowledge alone does not necessarily translate into vaccine uptake when other behavioral, social, or logistical barriers persist.

Overall, these results highlight that both contextual (access, employment, timing) and psychosocial factors (AEFI concerns, rumors) play critical roles in determining nOPV2 dose completion among children aged 0–7 years in Mimika District.

Table 1. Statistical test results of independent variables on the completeness of nOPV2 Polio National Immunization Week (PIN) doses in Mimika District

Variables	**P Value**	***Confidence Interval***
afraid of AEFI	0.0073	*0.0016 – 1.243*
immunization post and schedule	0.001	*0.0015 – 0.12*
parental employment status	0.01	*0.00047 – 0.1307*
negatif rumour on immunization	0.012	*0.0029 – 1.158*
parental awareness on Polio SIA implementation	0.99	*0.637-1.578*

3.1. AEFI as a barrier to completion of immunization

The result that AEFI is significantly associated with incomplete polio SIA vaccination aligns with evidence from prior studies: perceived or actual adverse events may undermine caregivers' trust in vaccine safety and lead to dropouts or refusal of subsequent doses(Gopalan et al., 2025). Families often interpret mild side effects (such as fever, pain, or local swelling) more gravely, especially when not adequately counseled (Omoleke et al., 2022). If caregivers observe or hear about AEFI, they may hesitate to return for follow-up immunization sessions, disrupting the full completion of the vaccine schedule. Therefore, the presence of AEFI or even fear thereof acts as a psychological and behavioral barrier to full vaccination.

This finding is consistent with evidence from multiple low- and middle-income settings, where even minor or transient AEFI have been shown to negatively influence caregivers' willingness to complete vaccine series. Studies in Nigeria and India reported that communities with inadequate post-immunization counseling were more likely to perceive AEFI as serious or life-threatening, leading to vaccine refusal or delayed completion of subsequent doses (Gopalan et al., 2025). Similarly, a study in sub Sahara, Africa revealed that parents who experienced or heard about AEFI among peers were significantly less likely to present their children for follow-up immunization visits, citing fear of recurrence and distrust in health workers' ability to manage side effects (Bangura et al., 2020).

Furthermore, research in Pakistan has demonstrated that perceptions of unsafe vaccines or prior AEFI episodes within the community can reduce completion rates of oral and inactivated polio vaccines (Soofi et al., 2023). These studies highlight that AEFI-related fear can quickly spread through social networks and local rumor systems, especially where health communication is weak. A similar trend has been reported in Indonesia, where caregivers' fear of AEFI and misinformation about vaccine safety were found to significantly affect vaccine acceptance and completion (Lu'luil Ma'rifati, Ari Udijono, 2023).

Transparent communication about AEFI and effective health system responsiveness are essential to maintaining confidence in immunization programs. Inadequate risk communication such as failing to explain that mild fever or local swelling are normal immune responses can amplify fear, foster rumors, and reduce trust. Hence, effective AEFI management and communication are not merely clinical priorities but also crucial behavioral strategies to sustain high vaccine coverage and completion (Omoleke et al., 2022)

3.2 Immunization post and schedule

Accessibility of immunization service, especially on the immunization post and schedule is significantly associated to completed doses of Polio SIA status in Mimika. Some research enhance this finding showing that accessibility, availability of health worker, and flexibilty of immunization schedule affect to immunization target participants. The study in Nigeria revealed that parents who live in remote area or working at the immunization schedule have high opportunity to not attend immunization service (Solomon, 2023). Research in Cambodja and Philiphine showed that by adjusting immunization schedule to parents availability can improve immunization coverage with completed doses. The health cadres may support the vaccinators to adjust parents availability with immunization schedule as well as strategies to reach the uncompleted immunization doses (Zhang et al., 2025)

3.3 Parents employment status

Parents' employment status demonstrated a significant association with participation in the Polio SIA in this study. This finding highlights how structural and time-related constraints influence caregivers' ability to engage with immunization services. Working parents, particularly those employed full-time or involved in informal labor sectors, often face rigid schedules that limit their availability during typical immunization operating hours. Similar barriers have been documented in previous studies showing that employed caregivers frequently struggle to attend vaccination sessions due to competing work demands and limited flexibility in visiting health facilities during daytime hours (Prusty et al., 2013)

Employment constraints also interact with other practical limitations, including transportation availability, childcare responsibilities, and the opportunity cost of missing work. For families relying on daily wages, losing income to attend vaccination sessions can be a substantial deterrent. Evidence from Bangladesh indicates that long working hours and inflexible employment conditions contribute to under-vaccination and missed immunization opportunities. These time-related barriers reflect broader socioeconomic inequities that disproportionately affect coverage among working households (Hajizadeh, 2018)

Furthermore, reviews of immunization barriers have consistently identified work-related constraints as one of the most common reasons children are not brought for vaccination, even during intensified campaigns such as SIAs (Favin et al., 2012). Given this evidence, SIA programs should consider adapting service delivery models to better accommodate employed caregivers. Strategies may include extending hours into evenings, offering weekend immunization posts, conducting mobile outreach in high-traffic community or work areas, and coordinating with employers or local leaders to facilitate access. Strengthening these operational adjustments can help overcome structural barriers and improve SIA participation among working parents, supporting higher and more equitable coverage.

3.4 Negatif rumour on immunization

The presence of negative rumours surrounding immunisation significantly undermines caregiver trust and impedes participation in SIA campaigns. Rumours often amplify fears about vaccine safety, invoke distrust in health systems, and spread misinformation through social networks—each of which can decrease vaccine uptake. For example, a comprehensive review of vaccine hesitancy described how anxieties about vaccines, circulating conspiracy theories, and the rapid spread of non-evidence-based information were key drivers of reluctance (Nuwarda et al., 2022).

In the context of SIAs, particularly in areas with low routine coverage or fragile health communication systems, rumours may have outsized impact. Caregivers confronted with stories of adverse events—whether verified or not—may refuse or delay vaccination, limiting reach. Moreover, in settings where the SIA is viewed as externally driven or abrupt, rumours such as vaccines causing infertility, being unsafe for children, or being experiments may flourish (Izzati et al., 2020).

Rumours also interact with other barriers: they exploit structural mistrust (for example, among remote-area populations), reinforce misconceptions, and reduce the effectiveness of standard communication messages. A recent Indonesian study on hesitancy noted that misinformation, cultural beliefs, and previous negative vaccine experiences were key contextual drivers of reduced confidence (Sinuraya et al., 2024).

From an operational standpoint, negative rumours mean that even when immunisation posts are available and schedules well-advertised, uptake may still falter because caregivers choose to opt-out or delay due to perceived risk. This underscores the necessity of complementing logistical planning (posts, schedule, manpower) with tailored risk-communication strategies. Such strategies should include: engaging trusted community or religious leaders, addressing specific rumours proactively (e.g., infertility, side-effects, "foreign agenda"), establishing transparent adverse-event monitoring, and employing two-way communication rather than one-way messaging.

In summary, negative rumours form a critical barrier to SIA participation that goes beyond merely informing caregivers of time and place. Unless rumours are addressed and trust is built, even well-planned campaigns can fail to reach optimal coverage. Given the statistical significance of rumours in our findings ($p = 0.012$), we recommend that future campaigns in Central Papua embed a formal "rumour-management" component alongside outreach, service delivery, and monitoring.

3.5 Parents awareness on Polio SIA implementation

Despite the intuitive assumption that parental awareness of a campaign such as the Polio Supplementary Immunization Activity (SIA) would directly drive participation, our finding of no significant association ($p = 0.99$; CI 0.637–1.578) suggests that awareness, while necessary, may not be sufficient for action. In other words, knowing about a campaign does not always translate into immunization uptake.

First, awareness alone can mask deeper issues of engagement and trust. Several studies have shown that while many parents may report general knowledge of immunization or campaigns, that knowledge does not always reflect a full understanding of when, where, or how to participate. For example, in a study from Saudi Arabia, 73.3 % of parents scored good knowledge of childhood immunization, yet less than half exhibited a positive attitude regarding immunization services (Alshammari et al., 2021). This disparity illustrates that knowing about immunization is one step but readiness to act, logistical capability, and confidence are additional steps.

Second, the campaign-specific context matters. Even when parents know an SIA is planned, they may be unaware of key details (such as eligible age, time, location, or purpose) which hampers participation. In India, a study found that 40 % of parents were unaware of the vaccination schedule, and this lack of precise awareness was associated with partial immunisation (Upadhye et al., 2018). Thus, general awareness might exist, but not sufficiently precise awareness of the SIA's specifics.

Third, awareness without empowerment may still lead to inertia. If caregivers lack confidence in the service, face structural barriers (distance, time, cost) or have competing priorities, then even a well-advertised SIA may not achieve high participation. The link between knowledge/awareness and practice is well documented: a mixed-methods study in Iraq found a statistically significant correlation between parental knowledge-practice scores and children's immunization completeness (Qutaiba B Al-lela et al., 2014). In our study, parental awareness did not translate into action highlighting that other factors (fear of AEFI, access/logistics, employment constraints, negative rumors) may override the effect of awareness.

Fourth, in the context of Central Papua (or similar remote/underserved settings) there may be nuances around "awareness" as a concept. Awareness may be achieved via mass

messages, but message comprehension, cultural resonance, trust in providers, and readiness to act may vary. For example, awareness campaigns tied to social marketing in Tanzania showed that while awareness improved, measurable uptake occurred only when combined with easier access and community engagement (Ngui et al., 2015). Therefore, when we observe no significant effect of awareness in our model, it signals that the program must go beyond spreading information.

3.5 Study limitations

The study was conducted only in seven Puskesmas, and while these facilities represent diverse geographic and socio-cultural settings in Mimika, the findings may not be fully generalizable to the entire district or other regions of Papua. Additionally, sparse cell counts led to analytical constraints, although appropriate statistical corrections were applied.

Conclusions

This study highlights that achieving optimal uptake during the Polio Supplementary Immunization Activity (SIA) requires more than simply increasing parental awareness of the campaign. Although most caregivers reported knowing about the SIA, this awareness did not show a significant association with children's participation. The findings underscore that awareness alone is insufficient to drive immunization behavior when structural, social, and perceptual barriers remain unaddressed. Broader determinants—including logistical constraints, employment patterns, negative rumors, uncertainty about vaccine safety, and limited trust in health services—may override the effect of awareness and inhibit participation.

To strengthen future SIA performance, communication strategies must move beyond general information dissemination toward actionable and contextualized messaging that is understandable, trusted, and relevant for caregivers. Program implementers should integrate awareness-building with community engagement, service accessibility improvements, and tailored risk-communication approaches. Strengthening these dimensions will be essential to ensure that awareness translates into meaningful uptake, thereby maximizing the impact of SIAs and safeguarding communities from poliovirus transmission.

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Conflicts of Interest

The authors declare no conflict of interest.

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