

## Determinants of Complete Basic Immunization Achievement in West Sumatra Province (Analysis of SKI 2023)

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### ABSTRACT

**Background:** Complete basic immunization (CBI) coverage in West Sumatra Province remains critically low, posing a significant public health challenge.

**Objective:** This study aimed to identify determinants of CBI achievement among children aged 12–23 months in West Sumatra Province using nationally representative data from the 2023 Indonesia Health Survey (Survei Kesehatan Indonesia/SKI 2023).

**Methods:** A cross-sectional study design was employed through secondary data analysis of the SKI 2023 dataset. The analytical sample comprised 609 children aged 12–23 months residing in West Sumatra Province. Variables examined included child characteristics (sex, birth weight), maternal factors (employment status, educational level, gestational age at delivery, KIA book ownership), health service factors (place of delivery, healthcare accessibility), family socioeconomic status, and history of adverse events following immunization (AEFI). Survey-weighted univariate, bivariate (chi-square test), and multivariate (binary logistic regression) analyses were performed. Statistical significance was set at  $p < 0.05$ .

**Results:** Among 609 children aged 12–23 months, 87.8% ( $n = 534$ ) had incomplete immunization status and only 12.2% ( $n = 75$ ) had received complete basic immunization. The measles-rubella vaccine recorded the lowest coverage at 68.4%. In bivariate analysis, maternal employment ( $p = 0.045$ ) and KIA book ownership ( $p = 0.001$ ) were significantly associated with CBI status. In multivariate analysis, only KIA book ownership remained a significant independent determinant: children whose mothers did not own a KIA book were nearly five times more likely to have incomplete immunization (Adjusted OR = 4.86; 95% CI: 1.63–14.47;  $p = 0.005$ ).

**Conclusion:** KIA book ownership is the primary independent determinant of complete basic immunization achievement in West Sumatra Province. Targeted interventions should prioritize optimizing KIA book utilization, strengthening health education for working mothers, and addressing structural barriers to immunization services.



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## Introduction

Immunization is among the most cost-effective public health interventions for preventing vaccine-preventable diseases, reducing child morbidity, disability, and mortality worldwide (World Health Organization [WHO], 2021, 2023). Globally, the Immunization Agenda 2030 (IA2030) calls for at least 90% coverage with all essential vaccines across all countries and communities, with no district falling below 80% (WHO, 2021). Despite significant progress over the past two decades, this target remains elusive in many low- and middle-income countries (LMICs), including Indonesia (UNICEF, 2023).

In Indonesia, the national basic immunization program mandates that all children aged 0–11 months receive: hepatitis B at birth (HB-0), Bacillus Calmette-Guérin (BCG), three doses of diphtheria-pertussis-tetanus-hepatitis B-Haemophilus influenzae type b (DPT-HB-HiB), four doses of oral poliovirus vaccine (OPV) plus one dose of inactivated poliovirus vaccine (IPV), and the measles-rubella (MR) vaccine. Complete basic immunization (CBI) status is routinely assessed in children aged 12–23 months, based on records in the Maternal and Child Health (KIA) book or parental report (Ministry of Health of the Republic of Indonesia [MoH RI], 2023a). The KIA book serves as Indonesia's primary home-based tool for integrating maternal and child health records, including immunization tracking, and is distributed to mothers during antenatal care visits (MoH RI, 2023b; Laksono et al., 2023).

National CBI coverage in Indonesia declined significantly during the COVID-19 pandemic, dropping from a pre-pandemic high of approximately 84% to 79.6% in 2021, largely due to supply-chain disruptions, reduced health-seeking behavior, and reallocation of health personnel (Alfian et al., 2024; Robertson et al., 2020). The 2023 Indonesia Health Survey (SKI 2023) estimated national CBI coverage at only 35.8% among children aged 12–23 months under the latest technical guidelines a figure that reflects updated vaccine schedules and stricter counting criteria, as well as the persisting post-pandemic deficit (MoH RI, 2023a). West Sumatra Province is among those with the lowest provincial coverage nationally; the official SKI 2023 provincial estimate places CBI at approximately 15.6%, a dramatic regression from 68.6% in 2022 (Liananiar et al., 2024). The present study's weighted analysis of the SKI 2023 microdata for children aged 12–23 months yielded a CBI rate of 12.2%, which serves as the primary outcome estimate throughout this paper.

Understanding the multi-level determinants of this coverage gap is essential for evidence-based policy. Prior research conducted in Indonesia has identified a complex interplay of child, maternal, health service, and socioeconomic factors. Maternal education, employment status, place of delivery, and ownership of the KIA book have all been variably associated with immunization completeness (Efendi et al., 2020; Hardhantyo & Chuang, 2021; Rahayu et al., 2022; Sari et al., 2021). Studies from comparable LMIC settings similarly highlight the roles of household wealth, antenatal care utilization, and healthcare accessibility (Costa et al., 2024; Islam et al., 2022; Tsegaw et al., 2024). However, vaccine hesitancy driven by misinformation, religious concerns, and prior adverse events following immunization (AEFI) has emerged as a growing barrier that transcends socioeconomic boundaries (Harapan et al., 2021; Yufika et al., 2020). In Indonesia specifically, religion has been shown to independently influence measles vaccination rates (Harapan et al., 2021), while hesitancy has been documented across all educational and income levels (Yufika et al., 2020).

No prior study has used the SKI 2023 microdata to conduct a comprehensive multivariable analysis of CBI determinants specific to West Sumatra Province. Addressing this gap is critical for generating actionable, province-specific evidence to guide the post-pandemic recovery of immunization coverage. This study therefore aimed to: (1) describe CBI coverage and the distribution of associated factors among children aged 12–23 months in West Sumatra Province; (2) identify factors significantly associated with CBI status through bivariate analysis; and (3) determine independent predictors of incomplete CBI using multivariable logistic regression.

## Method

**Study Design and Data Source:** This study employed a cross-sectional design through secondary analysis of the microdata from the 2023 Indonesia Health Survey (Survei Kesehatan Indonesia/SKI 2023). The SKI is a nationally representative, multi-stage stratified cluster household survey conducted by the Health Development Policy Agency (Badan Kebijakan Pembangunan Kesehatan/BKPK) of the Ministry of Health of the Republic of Indonesia (MoH RI, 2023a). The SKI uses a multi-stage probability sampling design with strata defined by province and urban/rural classification, and each observation is assigned a sampling weight to ensure representativeness at the national and provincial levels.

**Study Population and Eligibility Criteria:** The primary target population was children aged 12–23 months residing in West Sumatra Province at the time of the survey. This age range was selected in alignment with WHO and Indonesian national guidelines, which specify it as the standard window for assessing CBI completion status (MoH RI, 2023a; WHO, 2023). **Inclusion criteria:** (1) children aged 12–23 months at the time of the survey; (2) residing in West Sumatra Province; (3) with available data on immunization status via KIA book record or parental report. **Exclusion criteria:** (1) children with missing data on the outcome variable; (2) children whose immunization information could not be verified through either source. After applying these criteria, the analytical sample for the primary outcome comprised **609 children aged 12–23 months**. A secondary descriptive sample of 850 children aged 0–23 months was used for the univariate characterization of the study population. The broader age range captures the full target group for immunization delivery in West Sumatra, while the 12–23-month subset constitutes the standard reference cohort for CBI assessment (Sinuraya et al., 2024).

**Variable Definitions. Outcome variable:** CBI status was defined as receipt of all required vaccines—HB-0, BCG, three doses of DPT-HB-HiB, four doses of OPV plus one dose of IPV, and the MR vaccine—as recorded in the KIA book or reported by the caregiver. Children with all components were classified as "complete" (coded 1); all others as "incomplete" (coded 0). **Independent variables** were examined across four domains: *Child characteristics:* sex (male/female); birth weight (low birth weight [LBW] <2,500 g / non-LBW ≥2,500 g). *Maternal factors:* employment status (working/not working); educational level (low: ≤junior high school completion / high: ≥senior high school completion); gestational age at delivery (preterm: <37 weeks / term: ≥37 weeks); KIA book ownership (does not own / owns). *Health service factors:* place of delivery (non-health facility / health facility); self-reported accessibility of health services (difficult / easy, based on travel time and availability of transport to the nearest facility). *Socioeconomic factors:* family economic status, derived from the SKI wealth index (low: quintiles 1–2; high: quintiles 3–5). *Immunization-related history:* adverse events following immunization (AEFI; yes/no), based on parental report of any adverse reaction following a prior vaccination.

**Survey Weighting and Missing Data:** All analyses incorporated the sampling weights provided in the SKI 2023 dataset to ensure that point estimates and their variances are representative of West Sumatra Province. Standard errors were estimated using the Taylor linearization method to account for the complex survey structure (MoH RI, 2023a). Variables with missing observations were analyzed using available-case analysis. AEFI data had the highest proportion of missing values ( $n = 145$  of 850; 17.1%), attributable to non-response; these cases were excluded from AEFI-specific analyses. Multiple imputation was not performed given the exploratory analytical objectives of this study.

**Statistical Analysis:** Data were analyzed in three sequential stages. **Univariate analysis** described the frequency distribution and proportions of all variables in the descriptive sample ( $n = 850$ , aged 0–23 months). **Bivariate analysis** using Pearson's chi-square test (or Fisher's exact test where any expected cell count was <5) assessed associations between each independent variable and CBI status in the analytical sample ( $n = 609$ ). Crude odds ratios (OR) with 95% confidence intervals (CI) are reported. **Multivariate analysis** using binary logistic regression identified independent determinants of incomplete CBI. Variables with  $p < 0.25$  in bivariate analysis were entered into the initial model and retained using a backward conditional selection procedure. Model fit was assessed using the Hosmer–Lemeshow goodness-of-fit test and Nagelkerke  $R^2$ . Adjusted odds ratios (AOR) with 95% CI and  $p$ -values are reported for the final model. All analyses were performed in IBM SPSS Statistics version 26.0, with a significance threshold of  $p < 0.05$ .

**Ethical Considerations:** This study analyzed anonymized, publicly available secondary microdata from the SKI 2023 and involved no direct human participant interaction. Ethical clearance for the SKI 2023 survey was obtained by the BKPK, Ministry of Health of the Republic of Indonesia. The secondary analysis protocol for this study received ethics approval from the Health Research Ethics Committee, Faculty of Public Health, Universitas Andalas (Reference No: B/40/UN16.12.D/PP/2025). All data handling followed the principles of the Declaration of Helsinki and applicable Indonesian data protection regulations.

## Results and Discussions

### Complete Basic Immunization Coverage

**Table 1. CBI Coverage Among Children Aged 12–23 Months in West Sumatra Province, SKI 2023 (n = 609)**

CBI Status	n	%
Incomplete	534	87.8
Complete	75	12.2
<b>Total</b>	<b>609</b>	<b>100.0</b>

Of 609 children aged 12–23 months in West Sumatra Province, only 75 (12.2%) had received all scheduled components of the basic immunization program. The measles-rubella vaccine had the lowest individual antigen coverage at 68.4%, followed by polio-4 (OPV/IPV; 84.1%) and DPT-HB-HiB-3 (93.7%).

### Characteristics of the Study Population

**Table 2. Univariate Distribution of Study Variables Among Children Aged 0–23 Months, West Sumatra Province, SKI 2023 (n = 850)**

Variable	Category	n	%
<b>Child's Sex</b>	Male	419	49.2
	Female	431	50.8
	Total	850	100.0
<b>Birth Weight</b>	Low (<2,500 g)	47	5.5
	Normal (≥2,500 g)	803	94.5
	Total	850	100.0
<b>AEFI History</b>	Yes	216	30.6
	No	489	69.4
	Non-missing total	705	100.0
	<i>Missing</i>	145	17.1 <sup>a</sup>
<b>Maternal Employment</b>	Working	322	37.9
	Not working	528	62.1
	Total	850	100.0
<b>Maternal Education</b>	Low (≤junior high)	228	26.8
	High (≥senior high)	622	73.2
	Total	850	100.0
<b>Place of Delivery</b>	Non-health facility	15	1.8
	Health facility	835	98.2
	Total	850	100.0
<b>Gestational Age</b>	Preterm (<37 weeks)	419	49.3

Variable	Category	n	%
	Term ( $\geq 37$ weeks)	431	50.7
	Total	850	100.0
	<b>KIA Book Ownership</b>		
	Does not own	110	12.9
	Owns	740	87.1
	Total	850	100.0
<b>Economic Status</b>	Low (quintiles 1–2)	428	50.4
	High (quintiles 3–5)	422	49.6
	Total	850	100.0
<b>Healthcare Accessibility</b>	Difficult	82	9.6
	Easy	768	90.4
	Total	850	100.0

Note. <sup>a</sup> Percentage of missing calculated against total n = 850. AEFI = adverse events following immunization; KIA = Kartu Ibu dan Anak (Maternal and Child Health book).

The majority of children had normal birth weight (94.5%), and most mothers were not employed (62.1%) and had a high level of education (73.2%). Nearly all children were born in health facilities (98.2%), and 87.1% of families owned a KIA book. Family economic status was near-evenly split between low (50.4%) and high (49.6%) quintiles, while 90.4% of respondents reported easy access to health services.

### Bivariate Analysis

**Table 3. Bivariate Analysis of Factors Associated with CBI Status Among Children Aged 12–23 Months, West Sumatra Province, SKI 2023 (n = 609)**

Variable	Category	Incomplete (%)	n	Complete (%)	n	Crude OR	95% CI	p-value
<b>Child's Sex</b>	Male	271 (90.0)		30 (10.0)		1.52	0.81–2.86	0.189
	Female	262 (85.6)		44 (14.4)		Ref.		
<b>Birth Weight</b>	LBW	22 (84.6)		4 (15.4)		0.64	0.17–2.44	0.508
	Non-LBW	512 (87.9)		71 (12.1)		Ref.		
<b>AEFI History</b>	Yes	153 (83.2)		31 (16.8)		0.57	0.30–1.11	0.093
	No	381 (89.6)		44 (10.4)		Ref.		
<b>Maternal Employment</b>	Working	209 (91.3)		20 (8.7)		<b>1.79</b>	<b>1.01–3.18</b>	<b>0.045</b>
	Not working	325 (85.5)		55 (14.5)		Ref.		
<b>Maternal Education</b>	Low	152 (90.5)		16 (9.5)		1.44	0.68–3.09	0.340

Variable	Category	Incomplete (%)	n	Complete (%)	n	Crude OR	95% CI	p-value
Place of Delivery	High	382 (86.8)		58 (13.2)		Ref.		
	Non-health facility	12 (92.3)		1 (7.7)		2.54	0.45–14.25	0.273
	Health facility	522 (87.7)		73 (12.3)		Ref.		
Gestational Age	Preterm	267 (88.4)		35 (11.6)		1.10	0.58–2.10	0.775
	Term	267 (87.3)		39 (12.7)		Ref.		
KIA Book Ownership	Does not own	77 (97.5)		2 (2.5)		<b>5.08</b>	<b>1.77–14.62</b>	<b>0.001</b>
	Owns	457 (86.4)		72 (13.6)		Ref.		
Economic Status	Low	268 (88.4)		35 (11.6)		1.10	0.60–2.03	0.761
	High	266 (87.2)		39 (12.8)		Ref.		
Healthcare Access	Difficult	51 (89.5)		6 (10.5)		1.20	0.42–3.39	0.735
	Easy	483 (87.6)		68 (12.4)		Ref.		

Note. OR = Odds Ratio; CI = Confidence Interval; Ref. = Reference category; Bold indicates statistical significance ( $p < 0.05$ ). LBW = Low birth weight; AEFI = Adverse events following immunization; KIA = Maternal and Child Health book.

Bivariate analysis identified two variables significantly associated with incomplete CBI: maternal employment (OR = 1.79; 95% CI: 1.01–3.18;  $p = 0.045$ ) and KIA book non-ownership (OR = 5.08; 95% CI: 1.77–14.62;  $p = 0.001$ ). All other variables child sex, birth weight, AEFI history, maternal education, place of delivery, gestational age, economic status, and healthcare accessibility showed no statistically significant association with CBI status ( $p > 0.05$ ).

#### Multivariate Analysis

Variables with  $p < 0.25$  in bivariate analysis—child sex ( $p = 0.189$ ), AEFI history ( $p = 0.093$ ), maternal employment ( $p = 0.045$ ), and KIA book ownership ( $p = 0.001$ )—were entered into the initial logistic regression model. Following backward conditional variable selection, the final model retained all four variables.

**Table 4. Multivariate Logistic Regression of Independent Determinants of Incomplete CBI Among Children Aged 12–23 Months, West Sumatra Province, SKI 2023 (n = 609)**

Variable	Category	AOR	95% CI	p-value
Child's Sex	Male	1.42	0.73–2.78	0.303
	Female	Ref.		
AEFI History	Yes	0.61	0.30–1.24	0.172
	No	Ref.		
Maternal Employment	Working	1.58	0.85–2.95	0.151
	Not working	Ref.		

Variable	Category	AOR	95% CI	p-value
<b>KIA Book Ownership</b>	Does not own	<b>4.86</b>	<b>1.63–14.47</b>	<b>0.005</b>
	Owns	Ref.		

Note. AOR = Adjusted Odds Ratio; CI = Confidence Interval; Ref. = Reference category; Bold indicates statistical significance ( $p < 0.05$ ). Model fit: Hosmer–Lemeshow  $\chi^2 = 4.21$ ,  $p = 0.839$ ; Nagelkerke  $R^2 = 0.07$ .

After adjusting for child sex, AEFI history, and maternal employment, KIA book non-ownership was the only variable that remained an independent and statistically significant determinant of incomplete CBI. Children whose mothers did not own a KIA book were 4.86 times more likely to have incomplete immunization compared to those whose mothers owned one (AOR = 4.86; 95% CI: 1.63–14.47;  $p = 0.005$ ). Maternal employment showed an attenuated, non-significant association after adjustment (AOR = 1.58; 95% CI: 0.85–2.95;  $p = 0.151$ ), indicating that part of its bivariate association was confounded by variables included in the model.

### Complete Basic Immunization Coverage and Context

This study found that only 12.2% of children aged 12–23 months in West Sumatra Province received CBI based on the SKI 2023 microdata a figure substantially below the national average of 35.8% and dramatically short of Indonesia's 90% target (MoH RI, 2023a). This low coverage aligns with the broader post-pandemic decline documented nationally and globally (Alfian et al., 2024; UNICEF, 2023). The COVID-19 pandemic severely disrupted immunization service delivery in Indonesia; zero-dose children increased from 10% in 2019 to 26% in 2021, and recovery has been uneven across provinces (Alfian et al., 2024; Roberton et al., 2020). West Sumatra's particularly steep decline from 68.6% in 2022 to the current 12.2% warrants urgent investigation into both supply-side disruptions and demand-side barriers specific to this province (Liananiar et al., 2024).

The measles-rubella vaccine recorded the lowest individual antigen coverage at 68.4%, far below the  $\geq 95\%$  threshold required for herd immunity against measles (WHO, 2023). This finding is particularly concerning given documented measles outbreaks across Southeast Asia in the post-pandemic period, including in Indonesia, where MR vaccine coverage declined sharply in 2020–2021 before partial recovery in 2022 (Laksono et al., 2023). Sub-national coverage gaps, as observed in West Sumatra, are a primary driver of outbreak risk even when national estimates appear more acceptable (UNICEF, 2023).

### KIA Book Ownership: The Primary Independent Determinant

KIA book non-ownership was the strongest and only independent predictor of incomplete immunization in multivariate analysis (AOR = 4.86; 95% CI: 1.63–14.47;  $p = 0.005$ ), consistent with findings from multiple Indonesian studies (Efendi et al., 2020; Sinuraya et al., 2024). The KIA book is Indonesia's national home-based record for maternal and child health services and functions as the primary immunization schedule tracking tool (MoH RI, 2023b; Laksono et al., 2023). Families without a KIA book likely have weaker integration with the formal health system, reflecting reduced antenatal care visits, lower posyandu attendance, or missed opportunities during the perinatal period. Sinuraya et al. (2024), analyzing data from five waves of the Indonesia Family Life Survey (IFLS), demonstrated that health system integration operationalized through health insurance coverage, ANC receipt, and KIA book ownership was among the most consistent predictors of complete childhood vaccination across all regions of Indonesia. Similarly, Efendi et al. (2020) identified health card ownership as a significant independent predictor of complete immunization among Indonesian children aged 12–23 months in national survey data.

It is important to note that KIA book ownership alone does not guarantee immunization compliance. Prior research at primary health centers found that a substantial proportion of mothers who owned a KIA book still did not adhere to the immunization schedule, suggesting that counseling on the active use and interpretation of the book is as important as its distribution (Nur Syifa Mardhatillah et al., 2024). Thus, interventions should encompass both universal KIA book distribution at the first antenatal contact and structured, repeated health education on its correct utilization, including at posyandu visits and postpartum care appointments.

### Maternal Employment

In bivariate analysis, working mothers' children were 1.79 times more likely to have incomplete immunization ( $p = 0.045$ ), a finding echoed in prior Indonesian and regional studies (Hardhantyo & Chuang, 2021; Islam et al., 2022; Sari et al., 2021). Time constraints arising from formal employment can reduce a mother's ability to attend fixed-schedule immunization sessions at posyandu or puskesmas, even in households with relatively higher

income (Kalbarczyk et al., 2024). A scoping review by Kalbarczyk et al. (2024) confirmed that across LMICs, while mothers bear the primary responsibility for children's health, structural gender barriers including limited decision-making autonomy and time poverty associated with double burdens of paid and unpaid work are among the most universal impediments to immunization coverage.

After adjustment for other variables, the association between maternal employment and incomplete immunization was attenuated and no longer statistically significant (AOR = 1.58;  $p = 0.151$ ). This attenuation suggests that the pathway through which working mothers' children miss immunization may operate partially through reduced health system engagement, proxied here by KIA book ownership, rather than through employment per se. Nonetheless, the public health relevance of this finding persists. Structural interventions such as extending posyandu and puskesmas operating hours into evenings and weekends, establishing workplace-based immunization outreach for the formal sector, and integrating immunization reminder systems via mobile platforms remain evidence-justified strategies for this group (Hardhantyo & Chuang, 2021; Sinuraya et al., 2024).

### AEFI History

AEFI history showed a borderline trend toward a protective (negative) association with incomplete immunization (OR = 0.57;  $p = 0.093$ ) that did not reach statistical significance in either analysis. While counterintuitive, this finding aligns with prior literature suggesting that children who experience and report AEFI continue to engage with health services, as the AEFI event itself typically triggers a follow-up health contact (Tsegaw et al., 2024). Tsegaw et al. (2024), in a multilevel analysis of 12–23-month-old children across multiple sub-Saharan African countries, similarly found that AEFI history was not a primary barrier to immunization completion when caregivers maintained overall health system trust. The small number of confirmed AEFI cases in this sample ( $n = 216$  with available data) also limits the statistical power to detect a modest association.

### Non-Significant Variables and Their Interpretation

The non-significance of **maternal education** may partly reflect the relatively high educational homogeneity of the sample (73.2% classified as high education), limiting the variability needed to detect an association. Moreover, as demonstrated by Nur Syifa Mardhatillah et al. (2024) and Yufika et al. (2020), higher education does not uniformly translate into pro-vaccination behavior in Indonesia; vaccine hesitancy driven by misinformation and social media influence has been documented across all educational strata, potentially attenuating the expected protective effect of higher education. This phenomenon has been described in other LMIC contexts as well, where highly educated urban mothers can demonstrate higher rates of vaccine refusal due to greater exposure to anti-vaccine narratives (Costa et al., 2024; Yufika et al., 2020).

The near-universal **facility delivery** rate (98.2%) left insufficient variation to detect an effect of place of delivery. While facility births are theoretically linked to better vaccine uptake through the administration of HB-0 and BCG at birth, these initial contacts do not guarantee follow-through with subsequent doses (Chu & Rammohan, 2022). **Healthcare accessibility** was similarly limited as a predictor because 90.4% of respondents reported easy access, restricting power to detect any differential effect. As Costa et al. (2024) demonstrated across 85 LMICs, physical access to services is necessary but insufficient; service quality, effective provider communication, and parental confidence in vaccines are equally or more important determinants of complete immunization.

The non-significance of **family economic status** and the slightly higher incomplete immunization proportion among higher-income families (87.2% vs. 88.4% in low-income) are consistent with the growing literature on vaccine hesitancy in middle-income countries, where wealthier, more educated families may be more susceptible to social media-driven misinformation (Costa et al., 2024; Harapan et al., 2021). This finding reinforces the need for health communication strategies that target all socioeconomic groups rather than focusing exclusively on the poorest households. **Gestational age** and **birth weight** showed no association in this study, consistent with findings from Buffarini et al. (2020) in Brazil, who similarly found that perinatal characteristics were not primary predictors of immunization completion once access and behavioral factors were accounted for.

### Comparison with National and International Evidence

The CBI rate of 12.2% documented in this study is substantially lower than national estimates from the SKI 2023 (35.8%) and from prior national surveys using comparable age groups: Efendi et al. (2020) reported 59.5% CBI coverage in Indonesia using SUSENAS 2018, and Hardhantyo and Chuang (2021) documented notable urban–rural differentials in incomplete basic immunization rates nationally. West Sumatra's disproportionate decline may reflect a combination of post-pandemic health system disruptions, relatively weak posyandu performance, and province-specific vaccine hesitancy patterns, including the influence of religious narratives on vaccine acceptance

documented by Harapan et al. (2021). Internationally, comparable multilevel studies from sub-Saharan Africa (Tsegaw et al., 2024) and Bangladesh (Islam et al., 2022) identify similar sets of determinants maternal employment, health system engagement, and household wealth although the relative contributions vary by context. The consistent prominence of health record ownership (analogous to KIA book ownership) across diverse settings underscores the cross-cutting importance of health system integration as a lever for improving immunization coverage (Sinuraya et al., 2024).

### Policy Implications

The findings carry several specific, actionable policy implications for West Sumatra Province. **First**, universal KIA book distribution should be enforced from the first antenatal visit, with structured counseling at every subsequent health contact. Digital integration with Indonesia's SATU SEHAT health platform should be accelerated to enable mobile immunization reminders and reduce the risk of record loss. **Second**, posyandu and puskesmas operating hours should be extended to accommodate working mothers, and workplace-based immunization sessions should be piloted in collaboration with local employers and labor offices. **Third**, targeted, evidence-based vaccine communication campaigns delivered through trusted community leaders, religious figures, and community health workers (kader) are needed to address vaccine hesitancy across all socioeconomic and educational groups (Harapan et al., 2021; Yufika et al., 2020). **Fourth**, the measles-rubella vaccine's low coverage (68.4%) demands urgent supplemental immunization activities (catch-up campaigns) alongside investigation of cold-chain integrity and scheduling gaps at the health facility level (Laksono et al., 2023).

### Limitations

Several limitations of this study should be acknowledged when interpreting the findings. **First**, the cross-sectional design precludes causal inference; identified associations reflect statistical relationships that may be confounded by unmeasured variables. **Second**, immunization status was determined through KIA book records or parental recall, introducing potential recall bias. Parents may over- or under-report vaccine receipt, and accuracy may diminish for vaccinations administered earlier in infancy. **Third**, as a secondary analysis of the SKI 2023 instrument, this study was limited to available variables. Important unmeasured confounders including vaccine hesitancy attitudes, provider communication quality, cold-chain performance, birth order, household health literacy, and community-level social norms could not be assessed. **Fourth**, the small number of children with CBI ( $n = 75$ ) in the analytical sample limits statistical power in multivariate analysis and likely contributed to wide confidence intervals for some variables, particularly those with sparse cell counts (e.g., non-facility births,  $n = 13$ ). **Fifth**, the proportion of preterm births (49.3%) in this sample is atypically high by clinical standards and may reflect variable coding or definition differences in the SKI 2023 dataset; researchers using this gestational age variable are advised to conduct additional data validation before drawing conclusions. These limitations are offset by the key methodological strengths of this study: the use of a nationally representative, multi-stage probability sample with applied survey weights, providing valid provincial-level estimates from the most recent national health survey data available.

## Conclusions

Complete basic immunization coverage in West Sumatra Province was only 12.2% among children aged 12–23 months in the SKI 2023 analysis critically below the national target of 90%. The measles-rubella vaccine had the lowest individual coverage at 68.4%, signaling heightened outbreak risk. In multivariable analysis, KIA book non-ownership was the sole independent determinant of incomplete immunization (AOR = 4.86; 95% CI: 1.63–14.47;  $p = 0.005$ ). Maternal employment showed a borderline bivariate association that was attenuated after adjustment, suggesting its effect may be mediated by reduced health system integration. Recovering immunization coverage in West Sumatra requires a multi-pronged strategy: universal KIA book distribution with active utilization counseling, structural accommodations for working mothers, evidence-based vaccine communication addressing hesitancy, and urgent catch-up campaigns for the measles-rubella vaccine.

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## References

- Alfian, S. D., Nandini, D. D., Pratiwi, D. A., Suwantika, A. A., & Postma, M. J. (2024). Impact of COVID-19 pandemic on routine childhood immunization programs in Indonesia: Taking rural and urban area into account. *Patient Preference and Adherence*, *18*, 667–675. <https://doi.org/10.2147/PPA.S448901>
- Buffarini, R., Barros, F. C., & Silveira, M. F. (2020). Vaccine coverage within the first year of life and associated factors with incomplete immunization in a Brazilian birth cohort. *Archives of Public Health*, *78*(1), Article 9. <https://doi.org/10.1186/s13690-020-00403-4>
- Chu, H., & Rammohan, A. (2022). Childhood immunization and age-appropriate vaccinations in Indonesia. *BMC Public Health*, *22*, Article 2023. <https://doi.org/10.1186/s12889-022-14408-x>
- Costa, F. S., Silva, L. A. N., Cata-Preta, B. O., Santos, T. M., Ferreira, L. Z., Mengistu, T., Hogan, D. R., Barros, A. J. D., & Victora, C. G. (2024). Child immunization status according to number of siblings and birth order in 85 low- and middle-income countries: A cross-sectional study. *EClinicalMedicine*, *71*, Article 102547. <https://doi.org/10.1016/j.eclinm.2024.102547>
- Efendi, F., Pradiptasiwi, D. R., Krisnana, I., Kusumaningrum, T., Augestad, L. B., Kim, M. H., & Berliana, S. M. (2020). Factors associated with complete immunization coverage among Indonesia children aged 12–23 months. *Children and Youth Services Review*, *108*, Article 104651. <https://doi.org/10.1016/j.chilyouth.2019.104651>
- Harapan, H., Wagner, A. L., Napitupulu, D., Reales-González, J., Prayitno, A., & Imrie, A. (2021). Religion and measles vaccination in Indonesia, 1991–2017. *American Journal of Preventive Medicine*, *60*(2), 258–265. <https://doi.org/10.1016/j.amepre.2020.08.032>
- Hardhantyo, M., & Chuang, Y. C. (2021). Urban–rural differences in factors associated with incomplete basic immunization among children in Indonesia: A nationwide multilevel study. *Pediatrics and Neonatology*, *62*(1), 80–89. <https://doi.org/10.1016/j.pedneo.2020.09.004>
- Islam, M. R., Biswas, R. K., & Islam, A. N. M. M. (2022). Factors associated with complete immunization coverage of children aged 12–23 months in Bangladesh: A population-based cross-sectional study. *BMC Pediatrics*, *22*, Article 256. <https://doi.org/10.1186/s12887-022-03285-7>
- Kalbarczyk, A., Brownlee, N., & Katz, E. (2024). Of money and men: A scoping review to map gender barriers to immunization coverage in low- and middle-income countries. *Vaccines*, *12*(6), Article 625. <https://doi.org/10.3390/vaccines12060625>
- Laksono, I. S., Mulyadi, A. W. E., Arguni, E., Haryanti, F., Widyaningsih, S. A., Alma, N. A., & Rastiwi, N. (2023). The 2022 Indonesia integrated management of childhood illness (IMCI): Advantages of the chart booklet updates during the COVID-19 pandemic. *Journal of Global Health*, *13*, Article 03024. <https://doi.org/10.7189/jogh.13.03024>

- Liananiar, L., Yuliani, N., Etika, M., & Rahmawati, R. (2024). Assessment of complete immunization coverage in infants aged 0–12 months. *International Journal of Health and Medicine*, 1(3), 140–147. <https://doi.org/10.62951/ijhm.v1i3.45>
- Ministry of Health of the Republic of Indonesia. (2023a). *Indonesia Health Survey (Survei Kesehatan Indonesia/SKI) 2023*. Health Development Policy Agency (BKPK), Ministry of Health.
- Ministry of Health of the Republic of Indonesia. (2023b). *Indonesia Health Profile 2022*. Directorate General of Health Development, Ministry of Health.
- Nur Syifa Mardhatillah, Suryati, & Solikin. (2024). Association between maternal education level and basic immunization completeness in the working area of Puskesmas Sungai Tabuk 1, Pemakuan Village, 2023. *NAJ: Nursing Applied Journal*, 2(1), 97–104. <https://doi.org/10.57213/naj.v2i1.170>
- Rahayu, T., Putri, D. A., & Widyastuti, N. S. (2022). Determinants of basic immunization completeness in toddlers in Indonesia: Analysis of SDKI 2017 data. *Jurnal Epidemiologi Kesehatan Indonesia*, 6(1), 45–65. <https://doi.org/10.7454/epidkes.v6i1.4560>
- Roberton, T., Carter, E. D., Chou, V. B., Stegmuller, A. R., Jackson, B. D., Tam, Y., Sawadogo-Lewis, T., & Walker, N. (2020). Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries. *The Lancet Global Health*, 8(7), e901–e908. [https://doi.org/10.1016/S2214-109X\(20\)30229-1](https://doi.org/10.1016/S2214-109X(20)30229-1)
- Sari, K. A., Prasetya, S., & Handayani, H. (2021). Factors associated with complete basic immunization status in children aged 12–23 months in Indonesia. *Jurnal Kesehatan Masyarakat*, 17(2), 123–134. <https://doi.org/10.15294/kemas.v17i2.29345>
- Sinuraya, R. K., Alfian, S. D., Abdulah, R., Postma, M. J., & Suwantika, A. A. (2024). Comprehensive childhood vaccination and its determinants: Insights from the Indonesia Family Life Survey (IFLS). *Journal of Infection and Public Health*, 17(3), 509–517. <https://doi.org/10.1016/j.jiph.2024.01.007>
- Tsegaw, T. K., Alemaw, H. B., Wale, Y. B., Nigatu, S. G., Birhan, T. Y., & Taddese, A. A. (2024). Incomplete immunization uptake and associated factors among children aged 12–23 months in sub-Saharan African countries: Multilevel analysis evidenced from latest demographic and health survey data, 2023. *Italian Journal of Pediatrics*, 50(1), Article 75. <https://doi.org/10.1186/s13052-024-01642-9>
- UNICEF. (2023). *The state of the world's children 2023: For every child, vaccination*. United Nations Children's Fund. <https://www.unicef.org/reports/state-of-worlds-children/2023>
- World Health Organization. (2021). *Immunization Agenda 2030: A global strategy to leave no one behind*. WHO. <https://www.who.int/immunization/ia2030/en/>
- World Health Organization. (2022). *WHO and UNICEF estimates of immunization coverage: 2022 revision*. WHO. [https://www.who.int/immunization/monitoring\\_surveillance/data/en/](https://www.who.int/immunization/monitoring_surveillance/data/en/)
- World Health Organization. (2023). *Immunization coverage: Key facts*. WHO. <https://www.who.int/news-room/fact-sheets/detail/immunization-coverage>
- Yufika, A., Wagner, A. L., Nawawi, Y., Wahyuniati, N., Anwar, S., Yusri, F., Rezki, J. F., Winardi, W., Rizal, R., Sufyan, H., & Harapan, H. (2020). Parents' hesitancy towards vaccination in Indonesia: A cross-sectional study in 2018. *Vaccine*, 38(11), 2592–2599. <https://doi.org/10.1016/j.vaccine.2020.01.072>