BKM
Berita Kedokteran Masyarakat

Volume 42 Number 10, 2026, Pages e32841
DOI: 10.22146/bkm.v42i10.32841

Factors associated with the one-month prevalence of health worker-diagnosed acute respiratory infection among children aged 12–59 months in West Sumatra, Indonesia: A cross-sectional analysis of the 2024 Indonesian Nutritional Status Survey

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Abstract

Purpose: To identify factors associated with the one-month prevalence of health-worker-diagnosed acute respiratory infection (ARI) among children aged 12–59 months in West Sumatra, Indonesia. **Methods:** This cross-sectional analysis used the 2024 Indonesian Nutritional Status Survey. Of 12,456 surveyed children in West Sumatra, 1,917 were excluded for age outside 12–59 months and 10 for incomplete analytic data, yielding 10,529 records. Caregiver-reported diagnosis by a health worker in the preceding month was used to define ARI. Survey-weighted logistic regression accounted for primary sampling units, strata, and individual sampling weights. Variables with crude $p < 0.25$ were entered into the initial multivariable model; the reduced model excluded age after assessing changes in its estimate. **Results:** The reported survey-based ARI prevalence was 4.7%. In the reduced model, polluting cooking fuel had the largest adjusted prevalence odds ratio (aPOR 2.26; 95% CI 1.24–4.13), followed by incomplete vitamin A supplementation (1.95; 1.32–2.87), substandard household space per person (1.76; 1.25–2.47), and incomplete basic immunization (1.59; 1.16–2.16). **Conclusion:** Household cooking conditions, dwelling space, vitamin A supplementation, and immunization were associated with the prevalence of diagnosed ARI. Provincial and district/city health authorities should integrate feasible household-environment improvements with routine child health services; this analysis does not support causal or spatial-clustering interpretations.

Keywords: acute respiratory infection; children under five; cooking fuel; immunization; survey-weighted regression

Submitted:
July 26th, 2026
Accepted:
October 29th, 2026
Published:
October 31st, 2026

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INTRODUCTION

Acute respiratory infection (ARI) is a respiratory illness caused by microorganisms such as viruses, bacteria, and fungi [1]. Viruses include respiratory syncytial virus, influenza, and rhinovirus, while bacterial agents include *Streptococcus pneumoniae* and *Haemophilus influenzae* type b (Hib) [2]. Infection may affect the upper or lower respiratory tract and associated tissues. Clinical manifestations include fever, cough, sore throat, rhinorrhea, and shortness of breath [3]. In this study, ARI refers specifically to caregiver-reported, health worker-diagnosed ARI in the preceding month, rather than symptoms alone [4]. ARI can affect all age groups, but children under five are the most vulnerable, owing to their immature immune

systems and narrower airway anatomy, which tend to produce more severe clinical manifestations [5]. Host factors (age, nutritional status, and immunization completeness) interact with adverse environmental determinants such as inadequate housing ventilation, household crowding, and indoor air pollution from biomass fuel use to shape this risk [5]. Left untreated, ARI may impair child growth through reduced appetite or progress to severe pneumonia, respiratory insufficiency, and death among children under five [6], while also imposing a substantial socio-economic burden on families through direct medical costs, health-service utilization, and caregivers' lost productivity [7].

Globally, ARI remains one of the largest contributors to morbidity and mortality from infectious disease, affecting approximately 120 million people annually with about 1.4 million deaths, including an estimated 13 million under-five deaths worldwide, most of which occur in developing countries [8]. Countries with dense populations, such as India, Indonesia, Bangladesh, and Pakistan, collectively contribute a substantial share of the global pneumonia mortality burden [9].

To address this burden, WHO and UNICEF have implemented the Global Action Plan for the Prevention and Control of Pneumonia and Diarrhea (GAPPD) through a comprehensive protect–prevent–treat approach, supporting the Sustainable Development Goals target of ending preventable under-five deaths [10]. In Indonesia, ARI control is pursued through integrated government programs, including Pneumococcal (PCV) immunization as part of the national routine immunization schedule since 2022 [11], the Integrated Management of Childhood Illness (IMCI) strategy at primary care facilities, and promotive-preventive interventions covering clean and healthy living behavior, child nutrition improvement, and environmental control [12]. Nevertheless, national prevalence has continued to rise: 12.8% (Riskesdas, 2018), 34.2% (SKI 2023), and 36.9% (SSGI 2024) [13,14]. In West Sumatra Province, prevalence rose sharply from 12.8% (Riskesdas, 2018) to 29.8% (SKI 2023) [13,15], and ARI was the leading cause of morbidity among the ten most common diseases reported by the West Sumatra Provincial Health Office in 2023, with 294,981 cases [16]. SSGI 2024 data place West Sumatra 9th nationally (5.2%) by clinical symptoms alone, but 4th nationally (42.6%) by combined diagnosis and symptoms—above the national average and highest among all Sumatra provinces [17].

Gordon's epidemiological triad holds that disease transmission depends on the interaction among host, agent, and environment [18], a framework applicable to ARI in children under five. Previous studies cited in the manuscript examined age, sex, residence, maternal education, immunization, vitamin A supplementation, cooking fuel, and household crowding, with differing findings. Purnama et al. reported significant associations between ARI and age, sex, and area of residence [19], consistent with Miswarti et al., who found associations with age, sex, and housing density [17]. Ginting et al. also identified vitamin A supplementation and immunization status as significant factors [20]. In contrast, Halitopo found no significant association between ARI and age or sex, but identified maternal education level and immunization status as significant [21]. Woolley et al. found no association with sex or maternal education, but reported significant associations with age, cooking fuel, vitamin A supplementation, housing density, and area of residence [22].

Variation across studies supports examining these associations in the local context. This study aimed to assess factors associated with the one-month prevalence of caregiver-reported, health worker-diagnosed ARI among children aged 12–59 months in West Sumatra Province, using SSGI 2024 data. The study also intended a descriptive assessment of its district/city distribution, subject to verification of geographic denominators and outputs.

METHODS

Study design, setting, sampling, and participants

This cross-sectional secondary-data study assessed factors associated with the one-month prevalence of ARI among children aged 12–59 months in 19 districts/cities of West Sumatra, Indonesia, using data from the 2024 Indonesian Nutritional Status Survey (SSGI). Researchers collected the original data nationally from October 2024 to February 2025 across 38 provinces, 510 districts/cities, and 33,681 census blocks. The months of fieldwork specifically in West Sumatra have not been verified. The separately reported secondary-analysis period was November 2025–April 2026.

The source survey employed a stratified, two-stage sampling design involving probability-proportional -to-size selection of census blocks followed by systematic household selection. National field teams comprised two enumerators each and visited 273,959 households with children under five. Interview respondents were household informants and mothers/ caregivers who reported on child information.

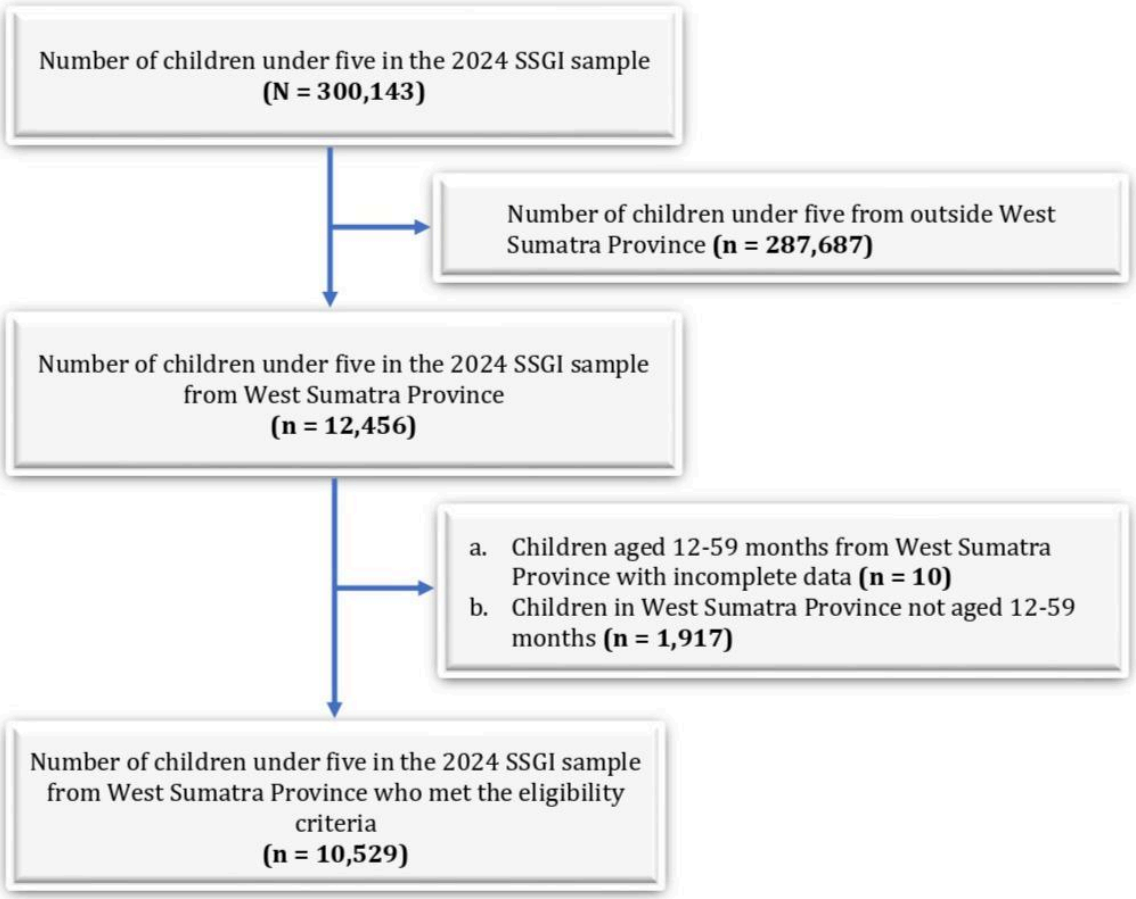


Figure 1. Flowchart of sample selection meeting eligibility using the 2024 Indonesian Nutritional Status Survey (SSGI) data in West Sumatra Province

Of the 300,143 children recorded nationally, 12,456 were in West Sumatra; 1,917 were excluded for ages outside 12–59 months, and 10 for incomplete analytic data, leaving 10,529 children (based on the author's supplied sample accounting). All qualifying records were analyzed without a separate secondary-study sample-size calculation. The rationale for the 12-month lower limit and the ten exclusions requires verification against the analysis dataset.

Data collection, outcome, variables, and operationalization

SSGI collected household and individual information through computer-assisted personal interviewing (CAPI) using CSPro, alongside anthropometric measurements. The six household- questionnaire blocks covered identification, fieldwork results, enumerators, household composition, environmental health, and assets/social protection. Ten individual blocks covered child information, morbidity, pregnancy, immunization, breastfeeding/complementary feeding, family support and supplementary feeding, healthcare access, stunting knowledge/attitudes, anthropometry, and maternal consumption for infants aged 0–6 months. The original survey used digital scales (0.1 kg precision), length/height devices (1 mm precision), and mid-upper-arm circumference tapes (1 mm precision); anthropometry was not the primary outcome of this analysis. ARI was derived from individual item P801: caregiver-reported health-worker diagnosis within the preceding month (codes 1–2 = yes; 3 = no; 8 = unknown/missing). This was a diagnosis-based period prevalence, not symptom prevalence or prevalence; ascertainment may be influenced by access to care.

Original fields and response categories were cross-checked against author-provided SPSS variable and value labels (see Appendix A). Exposures comprised basic immunization (HB-0, BCG, three DPT–HB–Hib doses, four polio doses, and measles–rubella), vitamin A administration frequency during the preceding 12 months (P1301FK4), living space per person (P602/P207), and principal cooking fuel (P605). Additional covariates included child age (P4072B), sex (P404), urban/rural residence (P105), and maternal education (RT item 409, with mother–child linkage requiring verification). The prespecified dwelling-space categories were <8 and ≥8 m²/person. Electricity/LPG and kerosene/charcoal/firewood were the explicitly

defined fuel groups; handling of natural gas/biogas and non-cooking households remains unresolved. Table 1 specifies the original item codes and remaining categorization decisions.

Statistical and geographic analysis

The supplied analytical documentation uses R's survey package with primary sampling units (PSU), sampling strata (STRATA), and individual weights (w_ind_final): svydesign(ids = ~PSU, strata = ~STRATA, weights = ~w_ind_final, nest = TRUE). Frequencies (f) refer to unweighted records and survey percentages to weighted estimates—survey-weighted logistic regression (svyglm) generated prevalence odds ratios (PORs) and 95% confidence intervals. Five variables screened at crude $p < 0.25$ (age, immunization, vitamin A, dwelling space, and cooking fuel) were entered into the initial model; the supplied reduced model retained the latter four after removing age (adjusted $p = 0.054$). Statistical significance was assessed at $p < 0.05$. Because confounder-retaining reanalysis, outcome-event direction, and design-domain checks remain outstanding, the supplied reduced model's results should not be presented as fully validated adjusted associations. District/city mapping was descriptive and used unweighted sample proportions without testing for spatial autocorrelation; therefore, it cannot demonstrate population-level clusters.

The authors reported accessing de-identified data through Ministry of Health data-sharing and non-disclosure arrangements. This study used secondary data from the 2024 Indonesian Nutrition Status Survey (SSGI), which received ethical approval from the Health Research Ethics Committee (KEPK) of the Jakarta II Public Health Polytechnic under the Ministry of Health (approval number DP.04.03/I/KE /230/2024).

RESULTS

The 2024 Indonesian Nutritional Status Survey (SSGI) identified 300.143 target children under five in 19 districts/cities of West Sumatra. Researchers interviewed and measured 12,456 children (98.7% of the target), leaving 170 without a completed assessment (1.3%). Among the 12,456 records, 1,917 children fell outside the specified age range of 12–59 months, and a further 10 were reported to have incomplete analytic data. Thus, the reported complete-case analytic sample comprised 10,529 children. The manuscript does not report the number of exclusions attributable to missing outcome, immunization, vitamin A, housing density, cooking fuel, and individual covariate data.

Table 1 presents the characteristics of the 10,529 children included in the analysis. A total of 489 children (4.6%) had caregiver-reported, health worker-diagnosed ARI during the preceding month, while 10,040 (95.4%) had no reported diagnosis. These percentages represent unweighted sample proportions. Most children were aged 25–59 months (74.9%), and 51.8% were male. 55.5% of children had incomplete immunization, whereas 85.0% had complete vitamin A supplementation. Regarding household crowding, 18.7% of children lived in households that did not meet the specified standard. More than half (58.3%) resided in urban areas. Most children lived in households that used polluting cooking fuels (86.2%), while 13.8% lived in households that used clean fuels. Maternal education was classified as high for 65.2% of children and low for 34.8%.

Table 1. Characteristics of respondents (n=10,529)

Variable	n	%
Acute respiratory infection (ARI)		
Yes	489	4.6
No	10,040	95.4
Age (months)		
12–24	2,648	25.1
25–59	7,881	74.9
Sex		
Male	5,455	51.8
Female	5,074	48.2
Immunization status		
Incomplete	5,843	55.5
Complete	4,686	44.5
Vitamin A supplementation		
Incomplete	1,582	15.0
Complete	8,947	85.0
Household crowding		
Does not meet the standard	1,966	18.7
Meets the standard	8,563	81.3
Place of residence		
Urban	6,135	58.3
Rural	4,394	41.7
Cooking fuel type		
Polluting fuel	9,075	86.2
Clean fuel	1,454	13.8
Maternal education level		
Low	3,661	34.8
High	6,868	65.2

The descriptive geographic assessment covered 19 districts/cities. In the manuscript, Padang Pariaman accounted for 128 ARI records and was assigned a reported prevalence of 22.4%, while Payakumbuh and Kepulauan Mentawai were assigned reported prevalences of 15.5% and 9.5%, respectively. Dharmasraya and Sawahlunto were reported with zero ARI cases. However, the supplied manuscript did not include district-level denominators, survey-weighted prevalence estimates, confidence intervals, or explicit verification of the Padang Pariaman value. Consequently, treat the figures as provisional, and do not interpret zero recorded cases as an absence of disease (Figure 2).

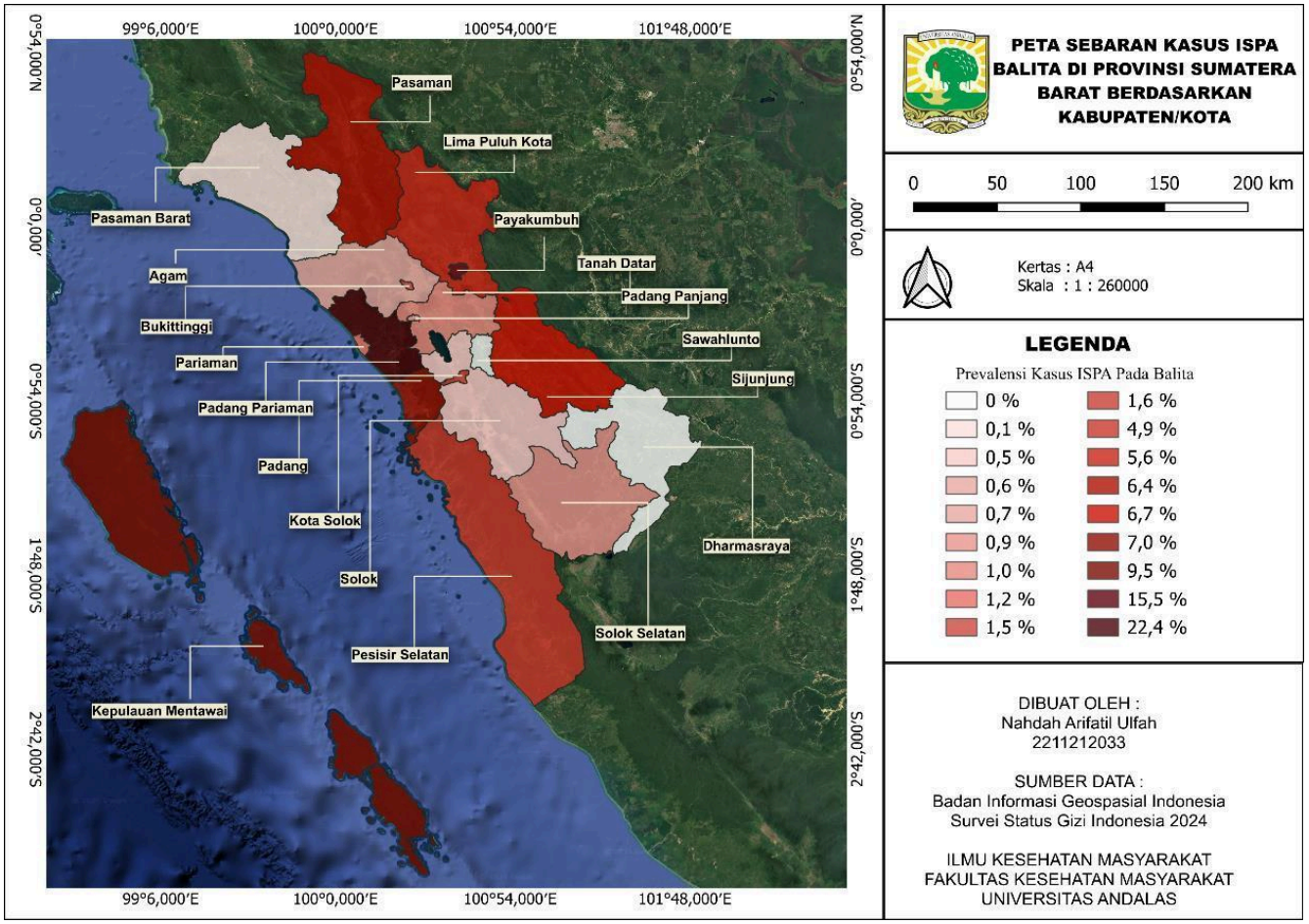


Figure 2. Spatial distribution of ARI prevalence among children under five by district/city in West Sumatra Province, SSGI 2024

Table 2. Association between independent variables and ARI prevalence among children under five (n=10,529)

Variable	ARI yes n (%)	ARI no n (%)	POR (95% CI)	p-value
Age (months)				
12–24	154 (5.8)	2,494 (94.2)	1.34(1.09–1.66)	0.006
25–59	335 (4.3)	7,546 (95.7)		
Sex				
Male	262 (4.8)	5,193 (95.2)	1.01(0.79–1.28)	0.9
Female	227 (4.5)	4,847 (95.5)		
Immunization status				
Incomplete	335 (5.7)	5,508 (94.3)	1.66(1.22–2.25)	0.001
Complete	154 (3.3)	4,532 (96.7)		
Vitamin A supplementation				
Incomplete	157 (9.9)	1,425 (90.1)	2.05(1.39–3.01)	<0.001
Complete	332 (3.7)	8,615 (96.3)		
Household crowding				
Does not meet the standard	137 (7.0)	1,829 (93.0)	1.69(1.21–2.35)	0.002
Meets the standard	352 (4.1)	8,211 (95.9)		
Place of residence				
Urban	260 (4.2)	5,875 (95.8)	1.02(0.71–1.46)	>0.9
Rural	229 (5.2)	4,165 (94.8)		
Cooking fuel type				
Polluting fuel	456 (5.0)	8,619 (95.0)	2.03(1.15–3.61)	0.015
Clean fuel	33 (2.3)	1,421 (97.7)		
Maternal education level				
Low	196 (5.4)	3,465 (94.6)	1.11(0.83–1.48)	0.5
High	293 (4.3)	6,575 (95.7)		

Table 2 presents the within-category unweighted proportions of ARI and the reported prevalence odds ratios (PORs). The proportion of children with ARI was higher among those aged 12–24 months than among those aged 25–59 months (5.8% vs. 4.3%). The reported POR indicated 1.34 times the odds of ARI in the younger age group (95% CI: 1.09–1.66; p = 0.006). Children with incomplete immunization had a higher ARI proportion than those with complete immunization (5.7% vs. 3.3%), with a reported POR of 1.66 (95% CI: 1.22–2.25; p

= 0.001). Similarly, children with incomplete vitamin A supplementation had a higher ARI proportion than those with complete supplementation (9.9% vs. 3.7%; POR = 2.05; 95% CI: 1.39–3.01; p < 0.001).

The proportion of children with ARI was also higher in households that did not meet the crowding standard than in those that met the standard (7.0% vs. 4.1%; POR = 1.69; 95% CI: 1.21–2.35; p = 0.002). Children living in households classified as using polluting cooking fuels had a higher ARI proportion than those in households using clean fuels (5.0% vs. 2.3%; POR = 2.03; 95% CI: 1.15–3.61; p = 0.015). In contrast, the reported associations were not statistically significant for sex (male vs. female: POR = 1.01; 95% CI: 0.79–1.28; p = 0.9), place of residence (urban vs. rural: POR = 1.02; 95% CI: 0.71–1.46; p > 0.9), or maternal education (low vs. high: POR = 1.11; 95% CI: 0.83–1.48; p = 0.5) (Table 2). The corresponding unweighted ARI proportions were 4.8% versus 4.5% for males and females, 4.2% versus 5.2% for urban and rural residents, and 5.4% versus 4.3% for children whose mothers had low and high education levels, respectively.

Five variables met the prespecified bivariate screening threshold (p < 0.25): child age, basic immunization status, vitamin A supplementation, housing density, and cooking fuel type. All five were included in the full multivariable model. In that model, age 12–24 months was associated with an adjusted POR of 1.27 (95% CI 1.00–1.62; p = 0.054) relative to 25–59 months. The adjusted PORs for incomplete immunization, incomplete vitamin A supplementation, housing density below the standard, and polluting cooking fuel were 1.62 (95% CI 1.18–2.23; p = 0.003), 1.86 (95% CI 1.23–2.81; p = 0.003), 1.76 (95% CI 1.25–2.47; p = 0.001), and 2.26 (95% CI 1.24–4.13; p = 0.008), respectively. The supplied analysis omitted the age variable from the reduced model because its p-value exceeded 0.05. However, a p-value alone is not sufficient to conclude that age can be excluded as a potential confounder.

Table 3 shows crude PORs and the adjusted estimates from both the full five-variable model and the reduced four-variable model. After age was removed, the adjusted POR changed from 1.62 to 1.59 for incomplete immunization (1.9% relative change), from 1.86 to 1.95 for incomplete vitamin A supplementation (4.8% relative change), and remained 1.76 for substandard housing density and 2.26 for polluting cooking fuel (0.0% change for each). Thus, none of the four retained exposure estimates changed by more than 10% on the POR scale, according to the displayed rounded estimates. This comparison supports—but does not by itself establish—the exclusion of age under a change-in-estimate approach; age may still warrant retention on substantive grounds, and the model fit and design-adjusted estimates require confirmation. In the reduced model, polluting versus clean fuel had the largest reported adjusted POR (2.26; 95% CI 1.24–4.13; p = 0.008), followed by incomplete vitamin A supplementation (1.95; 95% CI 1.32–2.87; p < 0.001), substandard housing density (1.76; 95% CI 1.25–2.47; p = 0.001), and incomplete immunization (1.59; 95% CI 1.16–2.16; p = 0.004). These confidence intervals overlap, so the ordering of point estimates does not demonstrate that cooking fuel has a statistically stronger association than the other exposures. The reduced model adjusts only for the other three retained exposures and not for age, sex, residence, maternal education, or socioeconomic indicators.

Table 3. Crude estimates alongside adjusted PORs from the full and reduced multivariable models

Exposure (reference)	Crude POR (95% CI)	Full model aPOR (95% CI); p	Reduced model aPOR (95% CI); p	Change in aPOR
Age 12–24 months (25–59)	1.34 (1.09–1.66)	1.27 (1.00–1.62); 0.054	Excluded	—
Incomplete immunization (complete)	1.66 (1.22–2.25)	1.62 (1.18–2.23); 0.003	1.59 (1.16–2.16); 0.004	−1.9%
Incomplete vitamin A (complete)	2.05 (1.39–3.01)	1.86 (1.23–2.81); 0.003	1.95 (1.32–2.87); <0.001	+4.8%
Housing below standard (meets)	1.69 (1.21–2.35)	1.76 (1.25–2.47); 0.001	1.76 (1.25–2.47); 0.001	0.0%
Polluting fuel (clean)	2.03 (1.15–3.61)	2.26 (1.24–4.13); 0.008	2.26 (1.24–4.13); 0.008	0.0%

DISCUSSION

Household cooking fuel had the largest point estimate among the factors associated with caregiver-reported, health worker-diagnosed ARI in children aged 12–59 months. This association is biologically plausible because combustion-related fine particles and gaseous irritants may compromise airway defenses and increase susceptibility to respiratory illness [23]. Al-Janabi et al. reported a more modest adjusted association between biomass fuel and symptom-defined ARI across 37 low- and middle-income countries (adjusted odds ratio 1.17) [23]. In contrast, Woolley et al. found higher odds of

symptom-defined ARI for wood versus charcoal use in Uganda (1.36) [22]. These effect sizes are not directly comparable with ours: fuel contrasts, outcome definitions, covariate adjustment, and underlying populations differ. Indonesian Riskesdas, SKI, and SSGI reports also use differing ARI indicators and should not be treated as a uniform trend without harmonizing definitions [13–15]. The unusually large proportion assigned to polluting fuels in our data requires validation of questionnaire codes and the clean-fuel reference category before a substantive explanation is advanced. Concurrent use of LPG and firewood (fuel stacking) is plausible, especially in rural households, but a single principal-fuel variable cannot establish it. Fuel choice may also serve as a proxy for household deprivation; absent a wealth adjustment, residual socioeconomic confounding remains possible.

Housing crowding was another associated household factor, consistent with reports linking constrained living space to respiratory transmission. Close contact can facilitate spread of respiratory pathogens, although crowding itself does not measure ventilation or indoor pollutant concentrations. The analytic variable in this study represents total dwelling floor area per person, classified using an 8 m^2/person threshold; it should therefore not be described as the regulatory minimum for sleeping-room area. Further verification of the source variable and any applicable regulatory standards is necessary before making a legal compliance claim [21]. The study did not establish the co-occurrence of crowding and polluting fuels, nor did it test their interaction. Practical housing assessments should examine occupancy, airflow, and cooking conditions separately rather than infer combined exposure from these regression estimates.

Incomplete basic immunization and vitamin A supplementation were also associated with diagnosed ARI, consistent with earlier Indonesian and international findings. Routine childhood immunization protects against selected vaccine-preventable respiratory infections, while adequate vitamin A status supports epithelial integrity and immune function; neither exposure provides comprehensive protection against all causes of ARI [24]. Relevant vaccines include measles-containing and pertussis-containing vaccines, while pneumococcal conjugate vaccine (PCV) specifically targets pneumococcal disease. Indonesia expanded PCV nationally in 2022; children aged 25–59 months surveyed in 2024 may have been born before routine eligibility under that expansion, and PCV was not part of the basic-immunization composite analyzed here [25]. Both immunization completion and vitamin A receipt can also indicate contact with healthcare services. Because the ARI outcome required a reported professional diagnosis, greater healthcare access among service-connected families could increase case detection and potentially attenuate an inverse association; however, this cannot eliminate detection bias or establish causation.

Sex, urban–rural residence, and maternal education showed no clear associations in the reported analyses, despite associations identified in some previous studies [25]. Such differences may reflect regional context, sample composition, exposure classification, healthcare access, or differences in adjustment rather than a true absence of social gradients. Geographic variation in mapped diagnosed ARI warrants similar caution. Higher reported proportions in Padang Pariaman, Payakumbuh, and Kepulauan Mentawai could reflect differences in household exposures, care-seeking, access to health professionals, interview season, or small local samples; these are hypotheses, not demonstrated explanations. Do not treat locations with no observed cases as disease-free. The marked difference between diagnosis-only prevalence and the broader diagnosis-or-symptom measure suggests that case definitions and healthcare access are critical to interpretation. It does not, by itself, quantify missed diagnoses because the two indicators and their denominators must first be reconciled [15].

These findings have implications for equitable primary healthcare and household-environment programs. Consistent with the WHO–UNICEF protect–prevent–treat approach [10], local health offices and Puskesmas could combine counseling on safer cooking, assessment of crowded living conditions, verification of routine immunization records, and vitamin A outreach through Posyandu and other community channels [12]. Programs should prioritize feasible improvements and affordable access to cleaner energy, without assuming all households can switch fuels immediately. The potential social impact lies in reducing avoidable respiratory risks while avoiding additional burdens on economically disadvantaged families. Geographic maps may guide further district-level assessment, but unverified small-area estimates should not be used alone to rank districts or allocate resources.

Several limitations constrain interpretation. The cross-sectional design prevents determination of temporality and causality, and the reduced regression model did not adjust for household wealth or socioeconomic status, leaving potentially substantial residual confounding. The authors did not include household smoking or measured ventilation, although SSGI 2024 collected household environmental information; they have not confirmed whether these items are available and complete in this analytic dataset. Caregivers reported diagnosed ARI, which

depends on healthcare access and may introduce recall, detection, and outcome misclassification biases. Immunization and vitamin A histories may also rely partly on maternal recall rather than documented records. Survey fieldwork occurred across different months and potentially seasons, but the authors did not assess the precise West Sumatra interview dates or potential seasonality. District/city mapping used descriptive sample proportions without verified local denominators, confidence intervals, or spatial tests; sparse denominators could produce unstable values, including apparently zero-case areas. Fuel-category coding, the unusually high proportion of polluting fuel, and comparability of outcome definitions remain unresolved validation issues.

Future studies should validate SSGI fuel coding and distinguish primary-fuel reporting from multiple-fuel use; incorporate socioeconomic resources, household smoking, ventilation, and access to care; and assess case ascertainment against clinical records where feasible. Prospective studies could clarify the timing of the relationship between environmental exposures and respiratory illness. At the same time, analyses that control for plausible confounders, irrespective of screening p-values, would strengthen effect estimates. Survey-design-aware district estimates with uncertainty intervals, along with appropriately powered multilevel or spatial models, could then test whether observed geographic contrasts persist after accounting for healthcare access, season, and community-level conditions. These steps would inform testable prevention strategies.

CONCLUSION

In this cross-sectional analysis of 10,529 children aged 12–59 months in West Sumatra, the reported one-month prevalence of caregiver-reported, health-worker-diagnosed acute respiratory infection (ARI) was 4.7%. Descriptive district/city mapping suggested geographic variation but did not establish statistically significant spatial clustering. In the reduced multivariable model, polluting cooking fuel had the largest adjusted prevalence odds ratio (POR 2.26; 95% CI 1.24–4.13), followed by incomplete vitamin A supplementation (POR 1.95; 95% CI 1.32–2.87), substandard household space per person (POR 1.76; 95% CI 1.25–2.47), and incomplete basic immunization (POR 1.59; 95% CI 1.16–2.16). These findings indicate associations rather than causal effects: cooking fuel was a proxy exposure, not a direct measure of household air pollution, and overlapping confidence intervals do not establish that one factor is statistically dominant.

The West Sumatra Provincial Health Office, together with the district/city health offices of Padang Pariaman, Payakumbuh, and the Mentawai Islands, should consider integrating safer-cooking counseling, household-space assessments, vitamin A outreach, and immunization follow-up into Puskesmas and Posyandu services. Program priorities should be guided by verified local prevalence estimates, service gaps, and household feasibility rather than descriptive maps alone. Further survey-design-aware analyses and validation of cooking-fuel coding are needed before making stronger geographic or causal inferences.

Acknowledgments
The author would like to thank the Health Policy Agency (Badan Kebijakan Pembangunan Kesehatan), Ministry of Health of the Republic of Indonesia, for granting access to the SSGI 2024 dataset for West Sumatra Province, and Statistics Indonesia (BPS) for the census block sampling frame used in the original survey. The author also thanks the Faculty of Public Health, Universitas Andalas, for facilitating the data-request process.

Authors' contributions
M.: Conceptualization, Methodology, Supervision, Writing review & editing; N.A.U.: Formal analysis, Data curation, Writing original draft; Y.P.: Investigation, Validation, Visualization; F.F.: Resources, Software, Writing review & editing. All authors approved the final manuscript.

Funding
The Faculty of Public Health, Universitas Andalas, funded this research through the DIPA FKM UNAND 2026 research grant scheme.

Data availability
The data used in this study were obtained from the Health Policy Agency of the Ministry of Health of the Republic of Indonesia under a signed Non-Disclosure Agreement and are not publicly available due to data-sharing restrictions. The corresponding author may make de-identified data available upon reasonable request and with permission from the Ministry of Health.

Ethics statement
This study used secondary data from the 2024 Indonesian Nutrition Status Survey (SSGI), which received ethical approval from the Health Research Ethics Committee (KEPK) of the Jakarta II Public Health Polytechnic under the Ministry of Health, with approval number DP.04.03/I/KE/230/2024.

Conflicts of interest
The author declares no conflicts of interest regarding this article.

Use of artificial intelligence (AI)
The author refined portions of this manuscript using Claude for linguistic clarity and grammar checking. The author has

validated all outputs and takes full responsibility for the integrity and accuracy of the final content.

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Appendix A: Operational definitions

Variable	Original field	Definition and verification
ARI [R1]	IND 801; P801	Question: [In the past month, has (toddler's name) ever been diagnosed with an ARI by a healthcare professional?"] "Dalam 1 bulan terakhir, apakah [NAMA BALITA] pernah didiagnosis ISPA oleh tenaga kesehatan?" Codes 1 = yes, ≤2 weeks; 2 = yes, >2 weeks–1 month; 3 = no; 8 = unknown. D4 used 1–2 versus 3; others were excluded. IND 802 records doctor, midwife, or nurse; IND 803 records symptoms and was not part of the outcome. D2's broad 801–803 listing was clarified. D3 p. 1; D4 recoding.
Age and sex [R6]	RT 407b, P4072B; RT 404, P404	Age: 12–24 versus 25–59 months; sex: male (1) versus female (2). D4's ≥25 rule lacks an explicit ≤59 restriction. Verify the observed age range. RT items are documented in D2; the household questionnaire was not supplied.
Basic immunization [R2][R3]	IND 1001 and 1002, column 2	HB-0: 1002a / P1002AK2, birth–7 days; BCG: 1002b / P1002BK2, soon after birth, before 1 month; DPT-HB-Hib 1: 1002c / P1002CK2, 2 months; dose 2: 1002d / P1002DK2, 3 months; dose 3: 1002e / P1002EK2, 4 months. MR: 1002j / P1002JK2, from 9 months. D3 pp. 3–4.
Polio component [R2][R3]	IND 1002o–r, column 2	Polio 1: P1002OK2 (OPV: birth/1 month; IPV: 2 months); polio 2: P1002PK2 (OPV: 2 months; IPV: 3 months); polio 3: P1002QK2 (OPV: 3 months; IPV: 4 months); polio 4: P1002RK2 (OPV: 4 months). Column 5 distinguishes route for rows o–q. The supplied composite excludes boosters, PCV, rotavirus, and additional IPV rows s–t. D3 p. 4; D4.
Receipt and age appropriateness [R2][R3]	IND 1002, columns 2–4	Copy KIA/immunization records first; ask recall if undocumented. Column 2: 1 = documented with date; 2 = documented without date; 3 = recall; 4 = not immunized; 7 = not yet due; 8 = unknown. Dates are in column 3 and age at vaccination in column 4 (88 = unknown). Complete receipt requires all selected due doses coded 1– 3. A verified missing due dose supports incomplete status; otherwise unresolved responses remain unknown. Code 7 requires age/date validation and cannot automatically mean nonreceipt. All selected doses are due before age 12 months; valid not-yet-due classifications are therefore unexpected in this target group. Receipt does not itself prove timely vaccination.
Immunization implementation [R2][R3]	D4 status_imunisasi	D4 required HB-0 = 1, BCG = 1, DPT 1 ≥2, DPT 2 ≥3, DPT 3 ≥4, MR ≤11, polio 1 ≥1, polio 2 ≥2, polio 3 ≥3, polio 4 ≥4. These are status/source codes, not dose counts or ages: some nonreceipt/unknown codes satisfy these tests, while valid receipt codes fail them. The fallback assigns incomplete status. Supplied counts and related models require reanalysis.
Vitamin A [R4]	IND 1301f, column 4; P1301FK4	Original frequency of high-dose vitamin A service use over the last 12 months. Sources: KIA/other records/maternal or respondent recall. D2: complete = exactly 2; incomplete = 0 or 1 valid administration. D3 column 2: 1 = yes, 2 = no, 7 = not applicable, 8 = unknown; non-yes responses skip frequency. A confirmed no-service skip may represent zero only after validation. Missing, unknown, not applicable, and >2 require separate review; >2 is not "<2" and is not automatically implausible. The supplied documents do not establish eligibility throughout the recall window, a valid maximum, or coding of all frequency skips. Do not assert two eligible opportunities for every child. D3 p. 7.
Residence [R5]	RT 105; P105	Urban (1) versus rural (2). D2 describes village-level classification based on population density, agricultural households, and access to facilities/infrastructure. [PERLU KONFIRMASI PENULIS: supply the official source/version confirming BPS provenance; D1's BPS census-frame acknowledgment does not establish P105 classification provenance.]
Maternal education and linkage [R5]	RT 409; P409; IND 707b	D2: low ≤SMP (codes 1–5), high ≥SMA (codes 6–8). P409 is labeled education of a household member, not inherently the mother. D3 P707b identifies the biological mother's roster number (00 if outside household); household identifiers plus that number can support linkage to her RT 409 record. D4 supplies no join code. Confirm unique mother–child matching, unmatched/00 handling, and whether imported P409 already refers to the mother. D4 sends missing values to low and uses ≥6 without checking the upper valid code.
Dwelling space [R7]	RT 602 / RT 207; P602/P207	D2: <8 m²/person versus ≥8 m²/person. D4 instead uses ≤8 versus >8. Counts and regression rows below describe D4's implemented groups; they cannot be relabeled as D2 groups without rerunning. Validate nonpositive area or household size and missing inputs.
Cooking fuel [R7]	RT 605; P605	D2 definitions: polluting = kerosene, charcoal, firewood; clean = electricity/LPG. D2 labels also identify natural gas/biogas (3) and no cooking (7). D4 grouped codes 1, 2, 3, 7 as clean and 4, 5, 6 as polluting. No-cooking households are not a fuel type. Confirm treatment of codes 3 and 7 against the intended definition; household questionnaire code verification remains unavailable.
Breastfeeding indicator [R6][R7]	IND 1102 and 1106	D3 restricts this block to 0–23 months; children 24–59 months skip it. D4 maps P1106 codes 8–9 to yes and remaining/missing values to no, without using P1102. D2 has labels but no operational definition for this exposure. Its whole-sample classification is not a validated exclusive-breastfeeding measure. Preserve structural missingness and reconsider inclusion before rerunning. D3 p. 5.