



RESEARCH ARTICLE

Who Decides and Who Acts? Gender Roles in School-Age Immunization Decisions in Sorong City, Southwest Papua

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Abstract

School-based immunization in Indonesia (Bulan Imunisasi Anak Sekolah; BIAS) has declined in Sorong City, Southwest Papua, and household pathways behind low uptake remain unclear. This dyadic study compared fathers and mothers of the same child to examine whether gendered roles are reflected in immunization knowledge and decision-making/action. We conducted a cross-sectional survey in two elementary schools and enrolled 151 father-mother pairs through school-primary care coordination. Parents completed a knowledge scale and a 10-item decision-making/action scale covering consent, scheduling, accompaniment, information seeking, and responses to adverse events following immunization. Within-couple differences were tested using paired-samples *t* tests. Knowledge did not differ between fathers and mothers (mean difference = -1.58, SD = 27.57; *t*(150) = -0.70, *p* = .483; Cohen's *d* $\approx$ -0.06). Decision-making/action differed markedly, with fathers scoring lower than mothers (mean difference = -38.46, SD = 18.07; *t*(150) = -26.16, *p* < .001; Cohen's *d* $\approx$ -2.13). Mothers scored higher on 9 of 10 items, while fathers more often endorsed refusal when side effects occur. Barriers therefore cluster in decision authority and task execution rather than information deficits. BIAS should strengthen couple-oriented consent and deliver father-targeted risk communication on expected reactions and care-seeking, and align school messages for both parents.

Keywords: school-based immunization; gender roles; dyadic design; parental decision-making; Southwest Papua

Abstrak. Imunisasi berbasis sekolah di Indonesia (Bulan Imunisasi Anak Sekolah; BIAS) mengalami penurunan di Kota Sorong, Papua Barat Daya, dan jalur rumah tangga yang mendasari rendahnya cakupan masih belum jelas. Studi dyadik ini membandingkan ayah dan ibu dari anak yang sama untuk menilai apakah peran berbasis gender tercermin pada pengetahuan imunisasi serta pengambilan keputusan/tindakan. Survei potong lintang dilakukan di dua sekolah dasar dan melibatkan 151 pasangan ayah-ibu melalui koordinasi sekolah dengan layanan kesehatan primer. Orang tua mengisi skala pengetahuan dan skala pengambilan keputusan/tindakan berisi 10 butir yang mencakup persetujuan, penjadwalan, pendampingan, pencarian informasi, serta respons terhadap kejadian ikutan pascaimunisasi. Perbedaan dalam pasangan diuji menggunakan uji *t* berpasangan. Pengetahuan tidak berbeda antara ayah dan ibu (selisih rerata = -1,58, SD = 27,57; *t*(150) = -0,70, *p* = 0,483; Cohen's *d* $\approx$ -0,06). Sebaliknya, pengambilan keputusan/tindakan berbeda secara bermakna, dengan skor ayah lebih rendah dibanding ibu (selisih rerata = -38,46, SD = 18,07; *t*(150) = -26,16, *p* < 0,001; Cohen's *d* $\approx$ -2,13). Ibu memiliki skor lebih tinggi pada 9 dari 10 butir, sedangkan ayah lebih sering menyatakan kecenderungan menolak bila ada efek samping. Dengan demikian, hambatan lebih terkonsentrasi pada otoritas keputusan dan pelaksanaan tugas daripada defisit informasi. Program BIAS perlu memperkuat persetujuan yang mendorong diskusi pasangan, komunikasi risiko yang menarget ayah tentang reaksi yang diharapkan dan langkah mencari layanan, serta penyelarasan pesan sekolah kepada kedua orang tua.

Kata kunci: imunisasi berbasis sekolah; peran gender; desain dyadik; pengambilan keputusan orang tua; Papua Barat Daya

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INTRODUCTION

Indonesia's School Children's Immunization Month (Bulan Imunisasi Anak Sekolah; BIAS) is a school-based platform designed to deliver booster immunizations for elementary school-aged children through a scheduled, periodic approach. In practice, BIAS typically includes measles-rubella (MR) vaccination for Grade 1, diphtheria-tetanus boosters (DT/Td) across selected grades, and human papillomavirus (HPV) vaccination for female students in upper elementary grades, depending on local

implementation guidance (Kementerian Kesehatan Republik Indonesia, 2023). Achieving high coverage in school-age immunization is a public health priority because it supports population immunity, sustains measles–rubella elimination progress, and advances long-term prevention goals such as HPV-related cancer reduction (Chacko et al., 2023; World Health Organization [WHO], 2023). Consistent with this agenda, the national immunization program sets ambitious coverage targets for school-age immunization; however, real-world uptake often varies across districts due to heterogeneity in service readiness, school–health coordination, and household decision processes (Kementerian Kesehatan Republik Indonesia, 2023; WHO, 2023).

Recent program monitoring in Sorong City, Southwest Papua, indicates a notable decline in school-age immunization coverage over a two-year period, suggesting a widening gap between policy intent and implementation outcomes. Local reports show that MR coverage decreased from 82% in 2023 to 74% in 2024, while HPV coverage fell from 79% in 2023 to 60% in 2024 (Dinas Kesehatan Provinsi Papua Barat Daya, 2024). A decline of this magnitude warrants a balanced problem statement that recognizes both supply-side and demand-side determinants. On the service side, coverage shortfalls in school-based immunization programs may be shaped by scheduling constraints, the reliability of school–primary care communication, consent workflows, availability of vaccinators and supplies, and the credibility of risk communication—especially around adverse events following immunization (AEFI). On the demand side, parental confidence, perceived benefits and risks, prior experiences, and exposure to misinformation influence immunization decisions, often interacting with health-system trust (Kaufman et al., 2021; Sinuraya, 2022). Therefore, while gender dynamics may be important, they should be positioned as one determinant within a broader service–household ecosystem rather than as a single-cause explanation.

A key pathway that remains underexamined in many school-based immunization settings is how gendered roles within households shape access to information, authority in decision-making, and the execution of immunization-related tasks (Feletto & Sharkey, 2019). Importantly, the term *gender* refers to socially constructed roles, responsibilities, norms, and power relations, whereas *sex* refers to biological attributes; studies that claim “barriers by gender” should demonstrate that they are capturing social-role dynamics rather than biological differences (World Health Organization, 2021). In immunization programs, gender norms may influence who attends school meetings, who receives and interprets information from teachers or health workers, who holds decision authority, and who has the time and mobility to bring a child for vaccination or to respond to follow-up needs (Feletto & Sharkey, 2019; Tracey et al., 2024). Global and regional literature increasingly emphasizes that gender-related constraints can operate through multiple domains—resources, social norms, agency, and institutional practices—creating patterned inequities in immunization access and uptake (Feletto & Sharkey, 2019; Tracey et al., 2024; WHO, 2021). In Indonesia, program-oriented analyses have likewise highlighted that gender dynamics can intersect with education, household labor division, and trust in institutions, shaping routine immunization and HPV vaccine decision-making in diverse local settings (Ganguly & Langworthy, 2025; Siramaneerat & Agushybana, 2021; Frianto et al., 2022).

This study integrates two complementary lenses to frame “barriers by gender” in the Sorong City BIAS context: (1) family decision-making theory, which treats household choices as a function of negotiation, authority, and role differentiation within couples (Blood & Wolfe, 1960), and (2) the WHO Gender & Immunization perspective, which conceptualizes gender as a cross-cutting determinant that influences information access, decision authority, and service use (WHO, 2021). Within this integrated framework, gender norms and household power relations are expected to shape (a) exposure to immunization information (e.g., school communications, health-worker counseling), (b) perceived risk—especially concerns related to AEFI and safety narratives, (c) decision authority regarding consent and approval, and (d) the practical actions needed for completion (e.g., scheduling, accompanying the child, responding to follow-up requirements) (Davies et al., 2021; Tracey et al., 2024; Grandahl et al., 2017). These mechanisms are particularly relevant for school-based vaccination where the “decision arena” spans school communications, primary care services, and within-household negotiation around consent—rather than being confined to a single clinic visit—making dyadic approaches especially informative for identifying where gendered constraints concentrate across the implementation pathway (Davies et al., 2021; Grandahl et al., 2017; Frianto et al., 2022).

The Papua context provides additional justification for explicitly testing gendered pathways rather than assuming that parental roles are uniform across regions. Anthropological and public health literature on Papua has documented how gendered divisions of labor, mobility for work, and community norms can shape health engagement and access to services, including the distribution of caregiving responsibilities and the visibility of children’s health needs within households (Butt & Munro, 2022; Munro, 2018). In settings where fathers spend substantial time outside the household for work and mothers are more consistently involved in day-to-day caregiving, the household may develop an implicit “division of immunization labor,” potentially producing gaps between who knows, who decides, and who executes immunization actions. Such dynamics can be consequential in BIAS because timely consent, risk appraisal, and coordinated follow-through are essential for reaching high coverage.

Despite these plausible mechanisms, an explicit and measurable research gap remains: the paired (dyadic) difference in mothers’ versus fathers’ immunization knowledge and decision-making within the same child and household in the Sorong BIAS context has not been quantified using a couple-based design. Most evidence in Indonesia tends to analyze parents as independent respondents or emphasizes maternal determinants without directly modeling the interdependence of father–mother responses (Prasetyo, 2017). A paired design is methodologically appropriate here because mothers and fathers of the same child share household context, exposure to the same school-based program, and overlapping constraints; treating their responses as independent would violate the assumption of independence and may inflate error or obscure within-household contrasts (Kenny et al., 2006). By comparing mothers and fathers within each household, a dyadic approach also reduces confounding by child- and household-level factors, yielding a more precise estimate of gendered differences in knowledge and decision authority.

Accordingly, this study aims to examine gender-related barriers to school-age immunization coverage in Sorong City by comparing mothers' and fathers' roles within the same household using paired data from father-mother dyads. The study specifically evaluates two domains that are conceptually proximal to coverage outcomes: immunization-related knowledge and immunization-related decision-making. Guided by the framework above, we test the following hypotheses: H1—there is a significant difference between mothers' and fathers' decision-making scores regarding school-age immunization in the BIAS context; and H2—there is a significant difference between mothers' and fathers' immunization knowledge scores. By quantifying within-household gendered differences and situating them within the BIAS service ecosystem, the study is intended to inform more targeted, family-based strategies—such as strengthening father engagement and refining school-health communication—rather than relying on education-only approaches.

METHODS

Study Design

This study used an observational, cross-sectional, dyadic comparative design to examine within-household differences between fathers' and mothers' immunization-related knowledge and decision-making for the same school-aged child. The dyadic (paired) approach was selected because the unit of inference is the father-mother pair linked to one child; therefore, within-pair comparisons reduce between-family confounding and provide a more precise estimate than independent-group comparisons. The study was conducted in Sorong City, Southwest Papua, within the context of Indonesia's school-based immunization service delivery (BIAS), where immunization activities are coordinated through schools in collaboration with the local primary health care center (puskesmas). Data collection took place on school premises.

Study Sites, Population, and Sampling

Two elementary schools participated in this study. Participants (father-mother pairs) were identified and invited by the schools in coordination with the local puskesmas partner, reflecting a school-facilitated (non-probability) recruitment approach rather than individual-level random selection. The target population comprised parents of elementary school children listed as eligible for the school immunization program in the participating schools; the accessible population size referenced for planning was 445 schoolchildren. A target sample size of 151 parent dyads (151 fathers and 151 mothers) was used, consistent with the minimum sample estimated for paired comparisons assuming a small effect size ($d = 0.20$) from the accessible population.

Eligibility Criteria

Eligible respondents were father-mother pairs (dyads) of the same enrolled child who were invited by the school and agreed to participate. Dyads were included when both parents attended the data-collection session at the school and provided informed consent. Dyads were excluded

when only one parent was present or when either parent declined consent, because paired analysis requires complete dyads.

Measures and Instrumentation

Parental decision-making regarding school-age immunization was assessed using a 10-item scale reflecting family decision-making concepts (Blood & Wolfe, 1960) and domains aligned with the World Health Organization Gender and Immunization framework (e.g., authority/agency in decisions, initiative and concrete action, risk/side-effect concerns, and information seeking). Items covered practical and relational aspects of immunization decisions (e.g., deciding about immunization, taking initiative to bring the child, accompanying the child, discussing with a spouse, considering health worker advice, refusing immunization if side effects occur, and seeking immunization information).

Responses were recorded on a 5-point agreement-type scale, with higher scores indicating greater involvement/authority in immunization decision-making and related actions. A total decision-making score was computed by summing item responses (possible range depends on the number of items and response options), producing a continuous paired outcome for father-mother comparisons. The decision-making construct was grounded in the classic family decision-making work by Blood and Wolfe (1960). In that work, the reported coefficients of reproducibility were 0.88 for wives and 0.86 for husbands, and the reported alpha was 0.62.

Parental immunization knowledge was measured using a structured questionnaire covering key topics relevant to school-age immunization (e.g., purpose/benefits, schedule/logistics, eligibility, and adverse events). Knowledge was operationalized as a total score, with higher values reflecting higher knowledge.

Data Collection Procedures

Data collection was conducted at the participating schools by gathering father-mother pairs during a scheduled session arranged by the school in coordination with the local puskesmas. Before participation, each parent received a written statement of willingness to participate and an explanation of study procedures, including respondents' rights (voluntary participation, refusal without penalty, confidentiality) and obligations (honest responses and completion of the questionnaire). To minimize potential partner influence on responses, fathers and mothers should be instructed to complete questionnaires independently (seated separately and asked not to discuss responses during completion), with monitoring by data collectors to maintain privacy.

Statistical Analysis

Paired-samples analyses were used because outcomes were measured on matched father-mother dyads. Differences in knowledge and decision-making scores between fathers and mothers were tested using a paired-samples t-test (two-tailed). Assumptions should be assessed using the distribution of within-pair difference scores (e.g., normality checks and outlier screening). If normality of difference scores is not supported, a non-parametric alternative (Wilcoxon signed-rank test) should be prespecified. Practical significance should be reported using an appropriate paired-samples effect size. For missing data, paired analysis requires complete dyads;

therefore, dyads with incomplete father or mother data on the outcomes should be excluded from the paired test for that outcome (pairwise deletion at the dyad level).

RESULTS OF STUDY

Parental demographic requirements

A total of 151 father–mother dyads participated in the study (151 fathers and 151 mothers). Fathers were, on average, older than mothers (mean age: 36.39 years, SD = 7.59; range = 22–50 vs. 32.62 years, SD = 7.75; range = 20–48). In terms of educational attainment, fathers showed a higher proportion of postsecondary education compared with mothers. Specifically, 59.6% of fathers (n = 90) reported education at diploma level or higher (Diploma I/III, Diploma IV/Bachelor's, or Master's/Doctoral), whereas only 17.2% of mothers (n = 26) were in these categories. Conversely, lower educational attainment

(below senior high school) was more frequent among mothers (57.6%, n = 87) than fathers (29.1%, n = 44), while the proportion with senior high school education was comparable across parents (fathers: 11.2%, n = 17; mothers: 25.2%, n = 38).

Occupational patterns differed markedly by parent gender. More than half of mothers reported not working/housewife status (56.6%, n = 86), followed by government employment (16.4%, n = 25), self-employment/entrepreneurship (15.8%, n = 24), and professional work (10.5%, n = 16). Fathers were distributed across diverse employment categories, with the largest group reporting volunteer/freelancer work (32.9%, n = 50), followed by farmer/fisherman/rancher (11.8%, n = 18), professional work (10.5%, n = 16), self-employed/entrepreneurship (9.9%, n = 15), laborer/daily worker (9.9%, n = 15), government employment (7.2%, n = 11), and technical occupations (6.6%, n = 10). An additional 10.6% of fathers (n = 16) were classified as other/unclassified.

Table 1. Parental Characteristics (N = 151 fathers; N = 151 mothers)

Domain	Variable / Category	Father n (%) or value	Mother n (%) or value
Age (years)	N	151	151
	Min	22	20
	Max	50	48
	Mean	36.39	32.62
	SD	7.59	7.75
Education	Did not complete elementary school/MI	17 (11.2%)	22 (14.5%)
	Elementary school	17 (11.2%)	34 (22.4%)
	Junior high school	10 (6.6%)	31 (20.4%)
	Senior high school	17 (11.2%)	38 (14.5%)*
	Diploma I	20 (13.2%)	0 (0%)
	Diploma III	23 (15.1%)	0 (0%)
	Diploma IV/Bachelor's degree	34 (22.4%)	25 (16.4%)
	Master's or doctoral degree	13 (8.6%)	1 (0.7%)
Occupation	Not working/Housewife	0 (0%)	86 (56.6%)
	Government employee	11 (7.2%)	25 (16.4%)
	Professional	16 (10.5%)	16 (10.5%)
	Self-employed/Entrepreneur	15 (9.9%)	24 (15.8%)
	Farmer/Fisherman/Rancher	18 (11.8%)	0 (0%)
	Laborer/Daily worker	15 (9.9%)	0 (0%)
	Technical	10 (6.6%)	0 (0%)
	Volunteer/Freelancer	50 (32.9%)	0 (0%)
	Other/Unclassified	16 (10.6%)	0 (0%)

(Source : SPSS Output)

Table 2. Parental Knowledge Differences Test Result

Pair 1	Mean	Std.Dev	t	df	Sig.	95%CI
Knowledge	-1.576	27.573	-0.702	150	0.483	-6.010 2.857

(Source : SPSS Output)

Table 3. Parental Decision-Making Differences Test Result

Pair 2	Mean	Std.Dev	t	df	Sig.	95%CI
Decisions	-38.464	18.067	-26.161	150	<0.001	-41.369 -35.558

(Source : SPSS Output)

Table 4. Parental decision-making score distribution

No	Statement on the Decision-Making Scale	Average Score (Father)	Average Score (Mother)	Difference	Dominance
1	Making decisions about child immunization	2.95	4.83	+1.88	Mother
2	Taking the initiative to bring the child for immunization	2.71	4.90	+2.19	Mother
3	Accompanying the child during immunization	3.10	4.87	+1.77	Mother
4	Discussing with spouse before immunization	3.42	4.75	+1.33	Mother
5	Considering health workers' advice	3.15	4.92	+1.77	Mother
6	Agreeing to immunization without being asked	2.88	4.95	+2.07	Mother
7	Refusing immunization if there are side effects	3.85	3.40	-0.45	Father
8	Supporting immunization as a parental responsibility	4.32	4.98	+0.66	Mother
9	Determining the child's immunization schedule	2.90	4.96	+2.06	Mother
10	Seeking information about immunization	3.22	4.97	+1.75	Mother

(Source : SPSS Output)

Knowledge of immunization between mothers and fathers

The average knowledge score for fathers was 1.576 points lower than that of mothers, according to a comparison comparing mothers' and fathers' knowledge of vaccinations for school-aged children. Fathers scored somewhat lower than mothers, according to this negative value (table 2).

With a standard deviation of 27.573, the knowledge score difference between mothers and fathers varies significantly. Even though the pair's "mean" value (father minus mother) is only -1.576 on average, this shows a rather wide range of knowledge disparities between the two. The direction of the difference tends toward the father's knowledge being marginally lower than the mother's, according to a t-value of -0.702 (df = 150). However, this difference is not statistically significant, as indicated by the significance level (Sig.) of 0.483 ($p > 0.05$). In other words, the test findings did not support a significant difference between fathers and mothers in terms of vaccine knowledge (95% CI from -6.010 to +2.857), despite the fact that moms had slightly higher numerical knowledge scores.

Decision-making between father and mother

The average score for the father's decisions was 38.464 points lower than the mother's, according to the analytical test for father-mother decision-making. This indicates that the woman was more active and in control when it came to deciding whether or not schoolchildren should be immunized (table 3).

With an average (Mean) difference of -38.464 and a standard deviation (Std.Dev) of 18.067, the differences in the judgments made by mothers and fathers are clearly visible. With 150 degrees of freedom (df) and a t-value of -26.161, the difference is extremely statistically significant, as indicated by the sig. < 0.001 . When the score direction is negative, it means that the father's decisions were consistently different or much lower than the mother's. The 95% CI, which excluded zero, was between -41.369 and -35.558, confirming that this discrepancy was not the result of pure chance. In light of this, it can be said that moms and fathers differ greatly and strongly in this study's decision-making regarding vaccinations, with mothers often scoring far higher than fathers.

Distribution of Parental Decision-Making Scores

As shown in Table 4. The distribution results of the average decision-making scores show that for 9 out of 10 statements (90%), mothers had higher scores than fathers, indicating that mothers are more active and dominant in the decision-making process and the implementation of child immunization. For example, on the aspects of "taking the child for immunization" and "determining the child's immunization schedule," the difference reached +2.19 and +2.06, respectively, indicating very high maternal involvement compared to paternal involvement. Meanwhile, on one aspect, "refusing immunization if there are side effects," the father's score (3.85) was higher than the mother's (3.40) with a difference of -0.45, indicating that fathers were slightly more likely to refuse immunization if there were concerns about side effects compared to mothers. From the data. In this study, it was found that mothers are the primary figures, while fathers appear to have a more limited role in concrete actions and direct decision-making regarding child immunization, with the exception of a tendency to refuse if concerns about side effects arise.

DISCUSSION

This dyadic study provides a within-household view of gendered barriers to school-age child immunization in Sorong City by comparing fathers and mothers of the same child (151 father-mother pairs). The central finding is a clear divergence between knowledge and decision-making/action: parental knowledge scores did not differ meaningfully between mothers and fathers, whereas decision-making scores showed a very large and statistically robust gap favoring mothers. This pattern is consistent with gender-and-immunization scholarship that distinguishes between information and agency/operational authority in navigating immunization pathways (World Health Organization, 2021; Tracey et al., 2024).

First, mothers and fathers demonstrated broadly comparable knowledge about school-age immunization. The paired comparison yielded a small mean difference (father minus mother = -1.58), was not statistically significant ($t(150) = -0.70$, $p = .483$), and implies a trivial standardized within-pair effect (Cohen's $d_z \approx -0.06$). Substantively, this suggests that information exposure may be shared within households and through common channels (e.g., school announcements, household communication, and interactions with health personnel),

which can compress knowledge differences even when parents differ in formal educational attainment. At the same time, the broader immunization literature emphasizes that knowledge alone rarely explains uptake: caregivers can be adequately informed yet still delay or refuse because of confidence/trust issues, risk appraisal, social influence, and health-system frictions (Kaufman et al., 2021; Panico et al., 2025).

In contrast, decision-making regarding immunization differed dramatically by parent gender. Fathers scored much lower than mothers on the total decision-making scale (mean difference = -38.46 , $SD = 18.07$), with an extremely large test statistic ($t(150) = -26.16$, $p < .001$) and a tight confidence interval excluding zero (95% CI [-41.37 , -35.56]). The implied standardized within-pair difference is very large (Cohen's $d \approx -2.13$), indicating that the disparity is not only statistically significant but also practically substantial. This knowledge-action gap aligns with frameworks arguing that gender norms and power relations shape who performs care work, who navigates service "contact points," and who executes health decisions—even when both parents are similarly informed (World Health Organization, 2021; Tracey et al., 2024; Nyasulu et al., 2023).

Item-level patterns clarify the mechanism and program-relevant levers. Mothers scored higher on 9 of 10 decision-making statements, including initiating immunization, accompanying the child, seeking information, following health-worker advice, and determining the immunization schedule. These items reflect operational authority (who does the work and carries the process forward), not merely abstract agreement. From a gender roles perspective, the pattern is consistent with a gendered division of labor in which mothers are positioned as primary managers of children's routine health activities, while fathers may be less engaged in day-to-day caregiving logistics (World Health Organization, 2021; UNICEF Indonesia, 2025). This aligns with the logic of gender-responsive immunization guidance that urges programs to map "decision points" (who receives information, who signs consent, who brings the child, and who resolves concerns) and to design communication pathways that reflect real household role structures (World Health Organization, 2021; World Health Organization, 2024).

Notably, the only item where fathers scored higher was "refusing immunization if there are side effects." This nuance suggests fathers may be less involved in routine execution but become more influential at the moment of perceived risk—particularly around adverse events or anticipated harm. This is consistent with evidence that safety concerns and fear of adverse effects are among the most persistent, high-impact drivers of hesitancy and refusal, sometimes overriding otherwise adequate knowledge (Kaufman et al., 2021; Gopalan et al., 2025). Programmatically, this indicates that "father engagement" should not be framed only as increasing participation, but also as targeted risk communication and confidence-building—especially clarifying expected mild reactions, explaining AEFI management pathways, and reinforcing where and how families can obtain timely clinical guidance (World Health Organization, 2021; Panico et al., 2025).

The demographic profile of dyads provides plausible contextual support for the observed pattern. In this sample, mothers were more likely to report not working/housewife status, while fathers were older on average and distributed across diverse employment categories, including informal/flexible work. These characteristics plausibly

increase mothers' availability at school-based touchpoints and strengthen mothers' exposure to school-health communication loops, while fathers' work patterns may reduce attendance during school-scheduled activities. Importantly, fathers' higher representation in postsecondary education did not translate into higher immunization knowledge scores, reinforcing that in school-based delivery systems, knowledge may be shaped by proximity to service communication and caregiving routines rather than schooling alone (World Health Organization, 2024; UNICEF Indonesia, 2025).

These findings also reinforce why a paired (dyadic) design is analytically appropriate for the research question. Because each father is directly compared with the mother of the same child, estimates of parent differences are less confounded by child-level factors (e.g., school, eligibility) than in independent-group comparisons. Dyadic and intra-household perspectives are particularly valuable when immunization decisions involve bargaining, disagreement, and gendered authority, because these mechanisms operate within families (Kenny et al., 2006; Wachinger et al., 2022). Indonesian evidence likewise underscores that joint parental decision-making and paternal characteristics can be consequential for childhood vaccination, supporting the relevance of explicitly modeling father roles rather than treating "parents" as a single homogeneous unit (Prastyo, 2021).

Implications for school-based immunization in Sorong are therefore twofold. First, strategies that focus only on increasing parental knowledge may have limited marginal impact if the binding constraint is household decision authority and execution pathways. Second, programs should deliberately design communication and consent workflows that reach fathers as well as mothers—particularly messaging on vaccine safety, expected minor reactions, and clear guidance for AEFI management and referral. These recommendations align with gender-responsive immunization guidance and with emerging evidence emphasizing the importance of engaging fathers as stakeholders in immunization uptake (World Health Organization, 2021; Tracey et al., 2024; Musuka, 2025).

Several limitations should be considered when interpreting these results. The study involved only two schools and used school-facilitated recruitment, which may limit generalizability and may under-represent fathers who could not attend school-based data collection. In addition, the large variability in knowledge difference scores suggests heterogeneity in understanding or potential measurement scaling issues; future work should report score ranges, distributional diagnostics, and internal consistency for the current sample to strengthen interpretability. Finally, self-report dyadic data can be vulnerable to social desirability and partner influence; stronger privacy procedures (separate completion) and triangulation with program records would improve robustness, while still recognizing the cross-sectional nature of inference (Kaufman et al., 2021; World Health Organization, 2024).

Future research in Southwest Papua could extend this dyadic approach by (a) modeling predictors of the within-couple "decision gap" (e.g., maternal workload, paternal mobility, household power indicators, trust in schools/health services), (b) integrating service-delivery variables (communication quality, consent procedures, outreach intensity), and (c) testing targeted interventions such as couple-focused school meetings, father-directed AEFI risk communication, and community "male champion" strategies—while monitoring uptake and

confidence outcomes. These steps would directly operationalize the shift recommended in gender-and-immunization frameworks from gender-blind education toward gender-responsive (and when feasible, gender-transformative) program design (World Health Organization, 2021; UNICEF Indonesia, 2025; Tracey et al., 2024).

CONCLUSION

The conclusions of this dyadic study indicate that the primary barrier to school-age child immunization in the Sorong BIAS context is not a parental knowledge deficit, but rather an imbalance in household roles in immunization decision-making and execution. Mothers and fathers demonstrated broadly comparable immunization knowledge; however, mothers consistently played a more dominant role in initiating, organizing, accompanying the child, seeking information, and carrying out operational decisions related to immunization. One important nuance is that fathers showed a higher tendency to refuse immunization when side effects occur or are anticipated, suggesting that paternal influence is most salient at risk-sensitive decision points where vaccine safety concerns shape approval. Overall, these findings highlight a “knowledge–action gap,” whereby relatively similar knowledge does not translate into equally shared authority and participation in immunization-related actions.

Based on these findings, strengthening BIAS implementation in Sorong should prioritize the decision and action phases rather than focusing primarily on knowledge-based education. Consent procedures and communication workflows should be designed to explicitly encourage father–mother discussion, so that decisions do not default to a single parent and operational responsibility is not concentrated solely on mothers. Risk communication should be strengthened with clear, action-oriented messages about side effects—what is expected, what requires attention, and how to respond—while ensuring that these messages reach fathers directly, given their greater influence when safety concerns are salient. In addition, schools should be reinforced as proactive information mediators for both parents by consistently delivering schedule information, consent instructions, and side-effect response guidance through communication channels that fathers can realistically access. This approach makes program actions more targeted: not simply “engaging fathers,” but improving the specific decision points, attendance logistics, and risk communication processes that most closely reflect the observed imbalance in roles in immunization decision-making and execution.

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DECLARATION

Ethics approval and consent to participate

Ethical clearance for this study was obtained from University of Papua (UNIPA) under approval number: 556/UN46.AU/I/2025. All participants provided informed consent prior to completing the questionnaires, and confidentiality procedures were applied to protect participants' privacy.

Artificial Intelligence-Assisted Technology

Artificial intelligence-assisted tools were used solely to support language editing and clarity of the manuscript. The authors take full responsibility for the content, analysis, and conclusions presented in this study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of interest Statement

The authors declare that they have no competing interests.

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Authors' contributions

Author1: Conceptualization, study design, data collection, data analysis, manuscript drafting, and final approval of the manuscript.

Author2: Supervision, methodological guidance, critical revision of the manuscript, and final approval of the version to be published.

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ADDITIONAL INFORMATION

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