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Maternal Knowledge and Attitude as Determinants of Booster Immunization Completeness in Toddlers

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Abstract

Background: Booster immunization with DPT-HB-Hib 4, MR dose 2, and Polio 4 maintains children's immunity after the basic series, yet coverage in several Indonesian regions remains below target.
Objective: This study analysed the association of maternal knowledge and attitude with the completeness of booster immunization in children aged 24 to 36 months in Banjar Village, Pandeglang Regency.
Methods: A cross-sectional study was conducted on 70 mothers selected by consecutive sampling. Knowledge and attitude were measured using validated questionnaires (r = 0.389 to 0.768; Cronbach's alpha 0.842 and 0.876), and immunization status was verified from the Maternal and Child Health book. Data were analysed using Chi-square, Fisher's exact test, and binary logistic regression; associations are reported as prevalence ratio (PR) and adjusted odds ratio (aOR) with 95% confidence intervals (CI).
Results: Complete booster immunization was found in 52 children (74.3%). Good maternal knowledge (PR = 5.17; 95% CI 1.45 to 18.41; risk difference 69.5%) and a positive maternal attitude (PR = 1.89; 95% CI 1.36 to 2.62; risk difference 45.7%) were both associated with completeness ($p < 0.001$). In practice, one additional child completed booster immunization for every two mothers with good knowledge. Both persisted after adjustment for maternal age, education, and occupation (aOR 24.6 and 26.1; $p < 0.01$).
Conclusion: Maternal knowledge and attitude are significantly associated with booster immunization completeness, so strengthening maternal health literacy should be a priority for immunization programmes at primary care level.

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INTRODUCTION

Immunization is one of the most effective and efficient public health interventions in preventing vaccine-preventable diseases (vaccine-preventable diseases). Regular immunization has been proven to reduce the rate of illness, disability, and death, especially in children. The World Health Organization (WHO) estimates that immunization saves about 3.5–5 million lives each year from diseases such as diphtheria, tetanus, pertussis, influenza, and measles (Bangura et al. 2020). In addition to providing individual protection, high immunization coverage also contributes to shaping Herd Immunity, to reduce disease transmission in the community and

protect groups who have not been able to receive vaccines due to certain medical conditions. The Expanded Programme on Immunization (EPI) program and the implementation of the Immunization Agenda 2030 (IA2030) further strengthen the global commitment to improving access, equity, and quality of immunization services around the world (World Health Organization 2021).

Advanced immunization is an important part of a series of immunizations aimed at maintaining and enhancing the immune response after the administration of basic immunization. Over time, antibody levels can decrease, so booster doses are needed to keep protection against the disease optimal. In Indonesia, the Ministry of Health of the Republic of Indonesia recommends the administration of the fourth dose of DPT-HB-Hib, the second dose of MR, and Polio immunization according to the national immunization schedule as an effort to maintain immunity against diphtheria, pertussis, tetanus, hepatitis B, *Haemophilus influenzae* Type B, measles, rubella, and poliomyelitis. Children who do not receive follow-up immunizations according to schedule are at risk of decreased immunity so that they are more susceptible to infections, extraordinary events (KLB), and complications of diseases that can actually be prevented through complete immunization (Lindstrand et al., 2024; World Health Organization, 2024).

Although the national immunization program has been running widely, the coverage of advanced immunization in various regions in Indonesia has still not reached the national and global targets set in the Immunization Agenda 2030. A report by the Ministry of Health of the Republic of Indonesia shows that the coverage of immunization of the fourth dose of DPT-HB-Hib, the second dose of MR, and Polio still varies between regions, which reflects that there are still gaps in access to health services, resource distribution, and utilization of immunization services (Pandeglang Regency Health Office 2022; Banten Provincial Health Office 2024).

This condition has the potential to increase the number of children who are susceptible to diseases that can be prevented by immunization, so that the risk of transmission, extraordinary events, hospitalization, and death from infectious diseases remains high if immunization coverage cannot be maintained optimally World Health Organization (2024) At the sub-district level, the coverage report of Puskesmas Banjar for 2025 recorded booster immunization coverage of 68.2% for DPT-HB-Hib 4, 65.7% for MR dose 2, and 63.9% for Polio 4. All three figures remain below the achievement of Pandeglang Regency (72.4%) and Banten Province (75.1%), and are 12 to 16 percentage points short of the national booster immunization target of 80% (Pandeglang Regency Health Office, 2022; Banten Provincial Health Office, 2024). This gap indicates that a substantial proportion of children in the working area of Puskesmas Banjar are at risk of waning immunity before they reach school age, which makes the working area of this health centre a relevant setting for examining the determinants of booster immunization completeness.

Various studies show that the completeness of childhood immunization is influenced by multidimensional factors, including the characteristics of individuals, families, environments, and health care systems. Barriers to accessing health services, low family support, limited access to information, and sociodemographic characteristics of parents are factors that are often associated with low immunization coverage. In the framework of the PRECEDE–PROCEED Model developed by Green and Kreuter, health behaviors are influenced by three main groups of factors, namely predisposing factors, enabling factors, and reinforcing factors. These three factors interact with each other in shaping a person's behavior in utilizing health services, including compliance with the child immunization program (Adedire EB 2021).

Nevertheless, the existing evidence base still leaves at least three gaps. First, most national and international studies place complete basic immunization in infants aged 0 to 11 months as the outcome, whereas booster doses given in the second and third years of life are rarely analysed as a separate outcome, even though the largest dropout occurs precisely at this transition (Sinuraya et al., 2024). Second, most previous Indonesian studies report the strength of association only as an odds ratio, which overestimates the magnitude of the association when the prevalence of the outcome exceeds 10% (Tamhane et al., 2016). Third, studies that analyse maternal knowledge and attitude simultaneously while controlling for sociodemographic confounders through multivariable modelling are still limited, so the independent contribution of each predisposing factor has not been firmly established.

Maternal knowledge is one of the predisposing factors that has an important role in

shaping health behaviors. As the party generally responsible for making decisions related to children's health, mothers play a central role in determining whether children receive immunizations according to the recommended schedule. Adequate knowledge about the benefits of immunization, vaccine administration schedule, diseases that can be prevented through immunization, and the consequences if immunization is not given completely will increase the confidence of mothers to take advantage of immunization services. On the other hand, limited knowledge can lead to misunderstandings, doubts about the safety and effectiveness of vaccines, and decreased adherence to the set immunization schedule. A number of studies report that a better level of maternal knowledge is significantly associated with increased immunization completeness in children (Betsch C 2021; Dyda et al. 2020; Yuda and Nurmala 2018).

In addition to knowledge, maternal attitudes are also important determinants that influence behavior in the use of immunization services (Betsch et al. 2021). Attitude is an individual's tendency to give a positive or negative response to an object based on their experiences, knowledge, values, and beliefs (Betsch et al. 2021). Mothers who have a positive attitude towards immunization tend to be more obedient in completing their children's immunization schedule than mothers who have a negative attitude (Chen et al. 2023). On the other hand, concerns about vaccine side effects, exposure to misinformation or disinformation, low trust in the safety of vaccines and health care systems, and the influence of the social environment can form a less supportive attitude towards immunization (Larson, 2021). This condition has the potential to cause delays or incompleteness of immunization in children (Chen et al. 2023).

Banjar Village, which is in the work area of the Banjar Health Center, was chosen as the research location because there are still variations in the level of knowledge, attitudes, and perceptions of mothers towards child immunization that have the potential to affect compliance with the follow-up immunization schedule (Elbert et al., 2023). In addition, previous research has shown that predisposing factors, especially parental knowledge and attitudes, are important determinants that contribute to the completeness of children's immunizations (Adedire EB 2021). Therefore, the identification of factors that affect the completeness of immunization at the community level is needed as a basis for the preparation of more effective interventions, both through strengthening health education, improving communication of behavior changes, and developing community-based immunization programs tailored to local characteristics (Ministry of Health of the Republic of Indonesia 2024).

Previous studies in Indonesia, including those of Azhura (2023) and Chairani (2020), have shown an association between maternal knowledge and attitude and immunization completeness, but were confined to basic immunization, relied on maternal recall without documentary verification, and did not adjust for sociodemographic variables. A comparable limitation applies to Elbert et al. (2023), who measured knowledge, attitude, and behavior in an urban setting during the COVID-19 pandemic, so that the findings cannot be extrapolated directly to rural communities with different service access characteristics. These shortcomings leave open the question of whether the association between predisposing factors and booster immunization completeness persists when the outcome is verified against immunization records and when sociodemographic factors are controlled for.

This study offers three novel contributions. First, it positions the completeness of booster immunization, namely DPT-HB-Hib 4, MR dose 2, and Polio 4, as a single composite outcome in children aged 24 to 36 months, a segment that has rarely been examined separately from basic immunization in the Indonesian literature. Second, immunization status is verified against records in the Maternal and Child Health book rather than relying on maternal recall, so that outcome measurement is more robust to recall and misclassification bias. Third, the strength of association is reported as a prevalence ratio accompanied by risk difference and adjusted estimates from binary logistic regression, so that the magnitude of the association can be interpreted directly and is not overestimated as it would be if only odds ratios were reported (Tamhane et al., 2016). To the best of the authors' knowledge, no previous study has reported these three elements simultaneously in the working area of Puskesmas Banjar, Pandeglang Regency.

Based on this description, this study aims to analyze the relationship between maternal knowledge and attitudes with the completeness of DPT-HB-Hib 4, MR dose 2 and Polio 4

immunization in children aged 24–36 months in Banjar Village, Pandeglang Regency, Indonesia.

METHOD

This study used a quantitative approach with a cross-sectional design, which is an observational design that measures independent and dependent variables at the same time to analyze the relationships between variables without determining causal relationships. The research was carried out in January-March 2026 in all Integrated Service Posts (Posyandu) located in Banjar Village, the working area of the Banjar Health Center, Pandeglang Regency, Banten Province, Indonesia.

The study population consisted of all mothers who had children aged 24–36 months and lived in Banjar Village. Based on data from the Banjar Health Center, the number of people who meet the criteria is 82 people. The sample size was calculated using the proportional estimation formula for the cross-sectional study as explained by (Sastroasmoro, 2023). Initial calculations show a minimum need of 269 respondents. However, because the number of the study population was less than 10,000, limited population corrections were made (*finite population correction*), so that a minimum sample requirement of 63 respondents was obtained. To anticipate the possibility of non-response or incomplete data, the number of samples was increased by 10%, so that the number of targeted final samples was 70 respondents. In detail, the minimum sample size was calculated using the single proportion estimation formula for a cross-sectional design, $n_0 = Z^2_{1-\alpha/2} \times P(1-P) / d^2$, with a confidence level of 95% ($Z_{1-\alpha/2} = 1.96$), an assumed proportion of booster immunization completeness of P = 0.774 taken from the provincial coverage report, and an absolute precision of d = 0.05. This calculation yields $n_0 = 269$ respondents. Because the source population comprised only 82 mothers, a finite population correction was applied, $n = n_0 / (1 + n_0/N) = 269 / (1 + 269/82) = 63$ respondents. The addition of 10% to anticipate non-response produced a final target of 70 respondents, equivalent to 85.4% of the source population.

Sampling was carried out using consecutive sampling technique, namely all mothers who met the inclusion criteria and were found during Posyandu activities during the research period were recruited as respondents until the specified number of samples was met. Consecutive sampling was selected because the source population was small, only 82 mothers, so that recruiting every eligible mother encountered across the whole study period covered 85.4% of the source population and produced a sample that closely approaches total sampling. This approach minimizes the selection bias that would arise if respondents were chosen solely based on chance encounters.

The inclusion criteria for the study included mothers who have children aged 24–36 months, have a Maternal and Child Health Book (KIA), are willing to participate in the research, and have given written *informed consent*. Exclusion criteria included mothers who could not communicate well during the data collection process and respondents who returned questionnaires with incomplete answers.

Data were collected using a structured questionnaire consisting of respondent characteristics, maternal knowledge of the fourth dose of DPT-HB-Hib, second dose MR, and Polio, as well as maternal attitudes towards follow-up immunization. Knowledge was measured using closed-ended questions that included aspects of definition, goals, benefits, timing of administration, and diseases that could be prevented through immunization. Meanwhile, attitudes were measured using an instrument with a five-level Likert scale, which describes respondents' level of approval of statements about immunization (Essoh, 2023)**.** The status of children's immunization completeness is verified through recording in the KIA Book to increase data validity and minimize information bias. Before use, both instruments were tested on 30 mothers with comparable characteristics in Kadumerak Village, outside the study area.

The validity test using the Pearson product moment correlation showed that all 20 knowledge items and all 15 attitude items were valid, with correlation coefficients of 0.412 to 0.768 and 0.389 to 0.741 respectively, all exceeding the r table value of 0.361 (n = 30, α = 0.05). The reliability test produced a Cronbach's alpha of 0.842 for the knowledge instrument and 0.876 for the attitude instrument, both above the 0.70 threshold, so that both instruments were declared reliable. Maternal knowledge was scored on a scale of 0 to 100 and categorized as good when the score reached at least 76% of the maximum score, following the Bloom cut off point widely used

in health behavior research, and as poor when the score fell below that threshold. Maternal attitude was scored on a scale of 15 to 75 from 15 statements on a five-level Likert scale. Because the attitude score distribution was not normal on the Shapiro Wilk test ($p < 0.05$), categorization used the median score as the cutoff point, namely positive when the score was greater than or equal to the median and negative when it fell below the median.

This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Muhammadiyah Prof. Dr. HAMKA, under approval number. All respondents received an explanation of the objectives, benefits, and procedures of the study and signed a written informed consent form before data collection. Respondent identities were coded, the data were used solely for research purposes, and participation was voluntary with the right to withdraw at any time without any consequence for the health services received.

Data analysis was carried out using the Statistical Package for the Social Sciences (SPSS). Univariate analysis was used to describe the characteristics of respondents and the distribution of each research variable. Bivariate analysis was conducted to evaluate the relationship between maternal knowledge and attitudes and the completeness of child immunization. The relationship between variables is analyzed using the Chi-square test, while Fisher's Exact Test is used when there are cells with an expected count value of less than five. The magnitude of the relationship is expressed as the prevalence ratio (PR) with a 95% confidence interval (95% CI). All tests used a statistical significance level of $p < 0.05$.

Before the Chi-square test was applied, the assumption of expected cell count was examined. In the knowledge cross tabulation one cell had an expected count below five (3.09), so Fisher's exact test was used, whereas in the attitude cross tabulation all expected counts were at least five (minimum 9.00), so the Pearson Chi-square test was applied. In addition to the prevalence ratio, the magnitude of the association was expressed as risk difference and attributable fraction among the exposed to describe the practical significance of the findings. Multivariable analysis used binary logistic regression, into which all variables with a p value below 0.25 in the bivariate analysis were entered, to control for the potential confounding effect of maternal age, maternal education, and maternal occupation. The results of the multivariable analysis are reported as adjusted odds ratio (aOR) with a 95% confidence interval, accompanied by the adjusted prevalence ratio (aPR) estimated through log binomial regression, because the outcome prevalence exceeded 10% so that the odds ratio would overestimate the magnitude of the association (Tamhane et al., 2016). Model fit was assessed using the Hosmer and Lemeshow test.

RESULTS AND DISCUSSION

Results

A total of 70 mothers with children aged 24–36 months participated in the study, and all met the criteria for analysis. The analysis was carried out descriptively to describe the characteristics of the respondents and the distribution of each study variable, then followed by bivariate analysis to evaluate the relationship between the level of knowledge and maternal attitudes with the completeness of the fourth dose of DPT-HB-Hib, the second dose of MR, and Polio immunizations.

Respondent Characteristics

Table 1 presents the sociodemographic characteristics of the respondents. Most of the mothers are in the age group of 26–36 years, have a secondary level of education, and have the status of housewives. Based on the child's immunization status, most children have received the fourth dose of DPT-HB-Hib, the second dose of MR, and Polio immunizations in accordance with the recommended national immunization schedule.

Table 1
Maternal and Child Characteristics in Research (n = 70)

Variable	n	%
Mother's Age		
≤25	15	21.43

26–35	40	57.14
>35	15	21.43
Red ± SD	32.47	
Child's Age		
24-27	22	31.43
28-31	25	35.71
32-36	23	32.96
Red ± SD	29.36	
Education Level		
SD	21	30.00
Junior High School	34	48.57
High School	15	21.43
Mother's Work		
IRT	64	91.43
Merchant	6	8.57
Mother's Knowledge		
Good	58	82.86
Less	12	17.14
Mother's Attitude		
Positive	35	50.00
Negatives	35	50.00
Booster Immunization		
Given	52	74.29
Not Granted	18	25.71
Total	70	100.00

Source: Primary data processed by researchers, 2026.

Table 1 shows the sociodemographic characteristics of the respondents and the distribution of the study variables. Most of the respondents were in the age group of 26–35 years (57.14%) with an average age of 32.47 years. The average age of children is 29.36 months, with the largest proportion being in the age group of 28–31 months (35.71%). Based on education level, almost half of the respondents were junior high school graduates (48.57%), followed by elementary school (30.00%) and high school (21.43%). Most respondents had the status of housewives (91.43%).

Based on the main variables of the study, most mothers had a good level of knowledge regarding the fourth dose of DPT-HB-Hib immunization, the second dose of MR, and Polio (82.86%). Meanwhile, the proportion of mothers with a positive attitude and a negative attitude towards immunization is the same, at 50.00% each. Based on the child's immunization status, as many as 74.29% of children have received the fourth dose of DPT-HB-Hib, the second dose of MR, and complete Polio.

Table 2
Distribution of Maternal Knowledge and Attitude Scores (n = 70)

Variable	Mean ± SD	Median (Min–Max)	Category (cut off)	n (%)
Knowledge score (0–100)	84.7 ± 9.6	85.0 (55–100)	Good (≥ 76)	58 (82.86)
			Poor (< 76)	12 (17.14)
Attitude score (15–75)	54.3 ± 8.7	55.0 (33–72)	Positive (≥ 55)	35 (50.00)
			Negative (< 55)	35 (50.00)

Note: Primary data processed by researchers, 2026.

Table 2 presents the distribution of knowledge and attitude scores together with the cut off points used for categorization. The mean maternal knowledge score was 84.7 ± 9.6 with a median of 85.0, so that 58 respondents (82.86%) reached the good category at the 76% threshold.

The mean maternal attitude score was 54.3 ± 8.7 with a median of 55.0, and because the median was used as the cutoff point the positive and negative categories each contained 35 respondents (50.00%).

Bivariate Analysis

Table 3
The Relationship of Maternal Knowledge with Immunization Completeness

Mother's Knowledge	Complete n (%)	Incomplete n (%)	PR (CI95%)	Value p
Good	50 (86.21%)	8 (13.79%)	5.17 (1.45-18.41)	<0.001
Less	2 (16.67%)	10 (83.33%)	Ref	

Source: Primary data processed by researchers, 2026.

Table 3 shows a statistically significant relationship between maternal knowledge level and completeness of the fourth dose of DPT-HB-Hib, second dose MR, and Polio immunization in children ($p < 0.001$). The proportion of children who received complete immunization was higher in mothers with a good level of knowledge (86.21%) than in mothers with a low level of knowledge (16.67%). Bivariate analysis showed that mothers with a good level of knowledge had a 5.17 times greater chance of having a child with complete immunization than mothers with a low level of knowledge (PR = 5.17; 95% CI95%: 1.45–18.41). The confidence interval of this estimate is wide (1.45 to 18.41) because the reference group contains only 12 mothers with poor knowledge, of whom just 2 had children with complete immunization, so that the variance of the estimate is large. The direction and statistical significance of the association are therefore robust, but the exact magnitude requires confirmation in a larger sample. Fisher's exact test was applied to this cross tabulation because one cell had an expected count below five (3.09).

Table 4
The Relationship between Maternal Attitudes and Immunization Completeness

Mother's Attitude	Complete n (%)	Incomplete n (%)	PR (CI95%)	Value p
Positive	34 (97.14%)	1 (2.86%)	1.89 (1.36-2.62)	<0.001
Negatives	18 (51.43%)	17 (48.57%)	Ref	

Source: Primary data processed by researchers, 2026

Table 4 shows a statistically significant relationship between maternal attitudes and completeness of the fourth dose of DPT-HB-Hib, the second dose of MR, and Polio immunization in children ($p < 0.001$). The proportion of children who received complete immunization was higher in mothers with a positive attitude (97.14%) than in mothers with a negative attitude (51.43%). The results of the analysis showed that mothers who had a positive attitude had a 1.89 times greater chance of having a child with complete immunization than mothers who had a negative attitude (PR = 1.89; 95% CI: 1.36–2.62). All expected counts in this cross tabulation were at least five (minimum 9.00), so that the assumption of the Pearson Chi-square test was met ($\chi^2 = 19.15$; df = 1; $p < 0.001$).

Table 5
Measures of Effect Size for Maternal Knowledge and Attitude on Booster Immunization Completeness

Variable	PR (95% CI)	Risk difference % (95% CI)	Attributable fraction among the exposed (%)
Good maternal knowledge	5.17 (1.45–18.41)	69.54 (46.66–92.42)	80.67
Positive maternal attitude	1.89 (1.36–2.62)	45.71 (28.26–63.17)	47.06

Source: Primary data processed by researchers, 2026

Table 5 presents the magnitude of the association on the absolute scale. The risk difference for maternal knowledge was 69.54 percentage points (95% CI 46.66 to 92.42), meaning that

approximately two mothers need to move from the poor to the good knowledge category for one additional child to complete booster immunization. The risk difference for maternal attitude was 45.71 percentage points (95% CI 28.26 to 63.17), equivalent to approximately two to three mothers. The attributable fraction among the exposed of 80.67% for knowledge and 47.06% for attitude indicates that a substantial share of complete booster immunization in this population can be attributed to these two predisposing factors.

Table 6
Multivariable Binary Logistic Regression of Determinants of Booster Immunization Completeness (n = 70)

Variable	B	aOR (95% CI)	aPR (95% CI)	p
Maternal knowledge (good vs poor)	3.203	24.60 (4.18–144.90)	4.62 (1.29–16.54)	< 0.001
Maternal attitude (positive vs negative)	3.262	26.10 (2.96–230.10)	1.76 (1.26–2.46)	0.003
Maternal age (> 25 vs ≤ 25 years)	0.351	1.42 (0.36–5.63)	1.08 (0.79–1.48)	0.618
Maternal education (≥ junior high vs elementary)	0.615	1.85 (0.47–7.28)	1.13 (0.83–1.54)	0.378
Maternal occupation (housewife vs working)	−0.139	0.87 (0.13–5.94)	0.97 (0.63–1.49)	0.888
Constant	−3.845	–	–	0.002

Note: Hosmer and Lemeshow test $\chi^2 = 4.62$; $p = 0.707$; Nagelkerke $R^2 = 0.615$; overall classification accuracy 88.6%. Primary data processed by researchers, 2026.

Table 6 shows that after simultaneous adjustment for maternal age, education, and occupation, maternal knowledge (aOR = 24.60; 95% CI 4.18 to 144.90; p < 0.001) and maternal attitude (aOR = 26.10; 95% CI 2.96 to 230.10; p = 0.003) remained significantly associated with booster immunization completeness, whereas the three sociodemographic variables were not significant. The adjusted prevalence ratio, which is not inflated by a high outcome prevalence, was 4.62 (95% CI 1.29 to 16.54) for knowledge and 1.76 (95% CI 1.26 to 2.46) for attitude, both slightly attenuated relative to the crude estimates. The model fitted the data adequately (Hosmer and Lemeshow p = 0.707) and explained 61.5% of the variance in the outcome, with an overall classification accuracy of 88.6%. The very wide confidence intervals of the adjusted odds ratios reflect the small number of respondents in the reference cells, so these estimates should be read as confirming the direction and significance of the association rather than as precise point estimates.

Discussion

Maternal Knowledge and Completeness of Immunization of the fourth dose of DPT-HB-Hib, MR second dose, and Polio

This study showed a statistically significant relationship between maternal knowledge level and completeness of the fourth dose of DPT-HB-Hib immunization, second dose MR, and Polio in children aged 24–36 months (p < 0.001). Mothers with a good level of knowledge were 5.17 times more likely to have a child with complete immunization status than mothers with a low level of knowledge (PR = 5.17; 95% CI95%: 1.45–18.41). These findings show that knowledge is an important determinant that influences a mother's decision to use immunization services and ensure that children receive follow-up immunizations as recommended.

According to the PRECEDE–PROCEED model developed by Green and Kreuter, knowledge is one of the predisposing factors that play a role in shaping health behaviors. Individuals who have adequate knowledge of the benefits of a health intervention tend to have a better perception of risk, are able to rationally evaluate the benefits and consequences of an action, and are more motivated to adopt health-supporting behaviors (Adedire EB 2021). In the context of immunization, understanding the purpose of immunization, immunization schedules, preventable diseases, and the benefits of follow-up doses can increase maternal confidence to bring children

to receive immunizations according to the recommended schedule.

The results of this study are in line with Azhura's research which reported that maternal knowledge is significantly related to the completeness of basic and advanced immunizations in children (Azhura 2023). Similar findings were also reported by Chairani which showed that mothers with better levels of health knowledge had a higher tendency to engage in disease-preventing behaviors, including completing child immunizations. The consistency of these results shows that increasing knowledge is one of the effective strategies in increasing immunization coverage (Chairani et al., 2020).

The results of this study are also supported by international research. Dyda et al. (2020) In its systematic review, it was reported that low parental knowledge about the benefits of vaccines, immunization schedules, and preventable diseases is one of the main determinants of immunization incompleteness in children. In addition, Betsch et al. (2021) explained that good knowledge contributes to increasing vaccine confidence, so that it can reduce vaccine hesitancy which is one of the causes of delay and rejection of immunization. The findings show that improving health literacy is an important component in the success of immunization programs.

Beyond confirming previous findings, the pattern observed in this study population warrants a more critical reading. The very wide confidence interval for the knowledge variable, 1.45 to 18.41, indicates that the point estimate of 5.17 must be interpreted with caution. The principal cause is the small size of the poor knowledge group, only 12 respondents, of whom just 2 had children with complete immunization, so that the denominator of the reference group is very small and the variance of the estimate becomes large.

The same pattern appears in the attitude variable, where only one child of a mother with a positive attitude did not receive complete immunization. A second consideration is that maternal knowledge in this population may function partly as a proxy for exposure to Posyandu services, because mothers who attend regularly receive repeated counselling and at the same time have easier access to booster doses, so that part of the association observed may reflect service contact rather than knowledge as an isolated cognitive attribute. After adjustment for maternal age, education, and occupation, however, both variables remained significant, which suggests that the association is not merely a reflection of the sociodemographic composition of the respondents.

Maternal Attitude and Completeness of Immunization of the fourth dose of DPT-HB-Hib, the second dose of MR, and Polio

This study shows a statistically significant relationship between maternal attitudes and completeness of the fourth dose of DPT-HB-Hib, the second dose of MR, and Polio in children aged 24–36 months ($p < 0.001$). Mothers who have a positive attitude towards immunization have a 1.89 times greater chance of having a child with complete immunization status than mothers who have a negative attitude (PR = 1.89; 95% CI: 1.36–2.62). These findings indicate that in addition to knowledge, attitudes are an important determinant that influences mothers' decisions to utilize immunization services and complete follow-up immunization schedules as recommended.

In health behavioral theory, attitudes are the tendency of individuals to respond favorably or unfavorably to a health object, behavior, or program. A positive attitude is generally formed through a combination of adequate knowledge, personal experience, trust in health workers, and perceptions of the benefits and safety of immunization. On the other hand, negative attitudes can be influenced by concerns about post-immunization adverse events (AEFIs), exposure to misinformation or disinformation about vaccines, previous negative experiences, or low trust in health services (Betsch C; 2021; Larson et al., 2021). These factors can lead to doubt (vaccine hesitancy) so that the mother delays or does not complete the child's immunization.

The results of this study are in line with Chen's research et al. (2023) who reported that parents' positive attitudes towards immunization were associated with increased vaccination coverage in children. Similar findings were also reported by Essoh (2023), which suggests that good acceptance of the vaccine contributes to parental adherence in following the recommended immunization schedule. The consistency of these findings shows that attitude is one of the psychological factors that play an important role in determining the behavior of seeking health services, including the use of immunization services.

The higher proportion of immunization completeness in the group of mothers with a

positive attitude in this study is suspected to be related to high trust in the benefits of immunization as a disease prevention effort. Mothers who believe that immunization is effective and safe tend to be more willing to follow the recommendations of health workers, attend Posyandu activities, and ensure that children receive immunizations according to the national schedule. Conversely, mothers with negative attitudes are more susceptible to being influenced by inaccurate information about vaccine safety or the notion that follow-up immunizations are no longer needed after basic immunizations are completed, potentially lowering adherence to immunization schedules (World Health Organization 2024).

The magnitude of the effect measured on the absolute scale gives a clearer picture for program purposes than the ratio measure alone. A risk difference of 69.54 percentage points for knowledge means that approximately two mothers need to be moved from the poor to the good knowledge category for one additional child to complete booster immunization, while for attitude the figure is approximately two to three mothers. The attributable fraction among the exposed of 80.67% for knowledge and 47.06% for attitude indicates that a substantial share of complete booster immunization in this population can be attributed to these two predisposing factors. This finding positions health education and behavior change communication not as a supporting activity but as a core intervention with a large potential yield at the community level (World Health Organization, 2022).

Several factors that were not measured may also contribute to the pattern observed. Distance to the Posyandu and to the health center, family income, husband and extended family support, the quality of communication by health workers, vaccine availability, and exposure to information through social media are consistently reported as determinants of immunization completeness (Sinuraya et al., 2024). Maternal education, which in this population is dominated by elementary and junior high school graduates, may also operate as an upstream determinant that shapes knowledge and attitude simultaneously, a pattern also reported at the national level by (Hermawan et al., 2025). Because these variables were not included in the model, the possibility of residual confounding cannot be ruled out, and the adjusted estimates in this study should be read as an approximation rather than a definitive estimate of the independent effect of each factor.

From a policy standpoint, these findings support three priorities at the primary care level. First, health education on booster immunization should be delivered at the time of the final basic immunization visit, because the dropout between the basic series and the booster dose is the largest single leak in the coverage chain (Golla et al., 2025). Second, a reminder system based on the Maternal and Child Health book, supported by Posyandu cadres and messaging applications, can convert a positive maternal attitude into actual attendance. Third, mapping mothers with poor knowledge as a priority target group is more efficient than a uniform approach to all mothers, and is consistent with the risk stratification strategy recommended for the Indonesian context (Alfian et al., 2025). These three measures are also aligned with the behavioral and social driver's framework issued by the World Health Organization, which places what people think and feel as one of the four main domains determining vaccine uptake (World Health Organization, 2022).

Research Strengths and Limitations

This study has several strengths to consider in interpreting the results. First, this study provides empirical evidence regarding the relationship between maternal knowledge and attitudes with the completeness of the fourth dose of DPT-HB-Hib, the second dose of MR, and Polio immunization in children aged 24–36 months in Banjar Village, Pandeglang Regency. Until now, research that specifically examines the determinants of advanced immunization at the community level in the region is still limited, so this finding can be baseline evidence for the development of immunization programs at the health center and local government levels. Second, the status of immunization completeness is not only based on respondents' reports, but is verified through recording in the Maternal and Child Health Book (KIA). This approach improves the validity of the data and reduces the potential for recall bias and bias misclassification often found in interview-based research. In addition, the use of structured questionnaire instruments allows the data collection process to be carried out uniformly among all respondents to increase the consistency of the measurement of research variables.

On the other hand, this research also has some limitations. The cross-sectional design only measures exposure and output variables at a single observation time so that the temporal relationship between immunization knowledge, attitudes, and completeness cannot be ascertained. Therefore, the results of this study only show the existence of a relationship or association and cannot be used to conclude a causal relationship. In addition, the consecutive sampling technique as one of the non-probability sampling methods has the potential to cause selection bias, because respondents are selected based on the ease of encounter during Posyandu activities. This condition can limit the representation of the sample to the entire population of mothers who have children aged 24-36 months in Banjar Village, so the results of the study need to be interpreted carefully when generalized to a wider population. Although consecutive recruitment covered 85.4% of the source population so that the residual selection bias is small, the technique remains non-probability in nature, so that generalization beyond Banjar Village should still be made with care.

Another limitation is that the variables analyzed only focus on the mother's knowledge and attitude. In fact, the completeness of immunization is influenced by various other factors, such as access to health service facilities, family income levels, husband and family support, quality of communication of health workers, availability of vaccines, distance to health facilities, exposure to information through mass media and social media, and the level of trust in immunization programs. The exclusion of these factors allows residual confounding to still exist which can affect the relationship between independent variables and research outputs. A further limitation is that the measurement of knowledge and attitude relied on self-reported answers to a structured questionnaire, so that the potential for information bias in the form of social desirability bias cannot be eliminated. Mothers may have given answers they considered socially acceptable, particularly on attitude items, which could inflate the proportion of respondents in the good knowledge and positive attitude categories and bias the estimate of association away from the null. Verification of immunization status through the Maternal and Child Health book limits this bias on the outcome side, but not on the exposure side.

Based on these limitations, further studies are recommended to use prospective or longitudinal cohort designs so that the temporal relationship between the factors studied and immunization completeness can be better evaluated. The use of probability sampling techniques, such as simple random sampling or stratified random sampling, is also recommended to increase the representativeness of the sample and the external validity of the research. In addition, the next study is expected to involve a larger number of respondents and include individual, family, social, and health service system factors more comprehensively to obtain a more complete picture of the determinants of immunization completeness in children in Indonesia.

CONCLUSION

This study shows that maternal knowledge and attitudes are significantly associated with the completeness of the fourth dose of DPT-HB-Hib, the second dose of MR, and Polio immunization in children aged 24–36 months in Banjar Village, Pandeglang Regency. Mothers who have a good level of knowledge and a positive attitude towards immunization showed a higher proportion of complete immunization than mothers with poor knowledge and attitudes. These findings indicate that behavioral factors, especially maternal knowledge and attitudes, are associated with the completeness of booster immunization in children. Because this study used a cross-sectional design that measures exposure and outcome at a single point in time, these findings describe an association and cannot be interpreted as a causal relationship.

The implications of this study show that efforts to increase immunization coverage need to be focused not only on the provision of vaccination services, but also on strengthening educational interventions and communication of behavior change. Health workers and Posyandu cadres are expected to intensify communication, information, and education (KIE) activities regarding the benefits of immunization, the timing of administration, and the risks that can arise if immunizations are not given completely. The education can be carried out through routine counseling at the Posyandu, individual counseling, the use of educational media, and a reminder system for immunization schedules to parents. In addition, Puskesmas needs to strengthen the monitoring and follow-up system for children who have not received complete immunization

through optimizing the role of Posyandu cadres and the use of the Maternal and Child Health Book (KIA) as a medium for recording as well as education for families.

Further research is recommended to use a cohort or longitudinal design with probability sampling techniques to produce stronger evidence regarding the temporal relationship between behavioral factors and immunization completeness. Future research also needs to consider other factors that have the potential to affect immunization completeness, such as access to health facilities, family support, socioeconomic conditions, trust in vaccines, and the quality of communication of health workers, so as to obtain a more comprehensive understanding of the determinants of immunization completeness in children.

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