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The Relationship Between Immunization Status and Infectious Diseases in Children: A Literature Review

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Abstract

Background: Infectious diseases remain the leading cause of morbidity and mortality among children. WHO data from 2023 indicate that approximately 14.5 million children worldwide are not immunized, including a significant number in Indonesia.

Objective: This study aims to analyze the relationship between immunization status and the incidence of infections in children through a *literature review*.

Methods: This study employed a *systematic literature review* approach. The literature search focused on publications from the past 10 years that were available in *full text*. Most of the analyzed studies used an analytical observational design. Data were collected from primary studies. Data analysis in the reviewed studies generally employed statistical tests such as *the chi-square test*, logistic regression, and multivariate analysis to determine the relationship between immunization status and the incidence of infections. Several large-scale studies also used logistic regression and multilevel models to control for confounding factors such as nutritional status, parental education, and access to health care.

Results: The findings indicate that the majority of studies report an association between immunization status and the incidence of infectious diseases. Children with incomplete immunizations have a higher risk of developing infections such as acute respiratory infections (ARIs) and pneumonia. Variations in results are influenced by other factors such as nutritional status, environment, and access to health care. The conclusions indicate that immunization status plays a crucial role in reducing the incidence of infectious diseases in children, although this association is influenced by various other factors.

Conclusion: The results of this analysis underscore the importance of increasing immunization coverage and adopting a comprehensive approach to the prevention of infectious diseases in children.

Keywords: Children, Immunization, Immunization Status, Infection,

INTRODUCTION

Infectious diseases remain one of the leading causes of morbidity and mortality among children worldwide, particularly among those under five years of age whose immune systems are still developing. Respiratory tract infections, diarrheal diseases, and vaccine-preventable diseases (VPDs) continue to impose a substantial public health burden, especially in low- and middle-income countries (1). According to the World Health Organization (WHO), vaccine-preventable infectious diseases are responsible for hundreds of thousands of child deaths annually despite the widespread availability of effective vaccines (2). These findings indicate that infectious diseases remain a major challenge to child health globally.

Indonesia continues to face similar challenges. Although considerable progress has been achieved through national immunization programs, infectious diseases remain an important cause of illness among children. Preventive efforts emphasize not only treatment but also health promotion and disease prevention, with immunization recognized as one of the most effective public health interventions. Immunization has significantly reduced the incidence of diseases such as measles, polio, diphtheria, and other vaccine-preventable diseases while contributing to lower child morbidity, disability, and mortality (3).

Despite these achievements, optimal immunization coverage has not yet been attained (4). WHO reported that approximately 14.5 million children worldwide had not received any routine vaccination (zero-dose children) in 2023 (5). Indonesia ranked sixth globally, with more than 1.3 million children failing to receive complete basic immunization during the 2019–2023 period (6). Declining immunization coverage has also been reported in several regions of Indonesia, suggesting persistent challenges in maintaining successful immunization programs (7).

A decline in immunization coverage has also been reported in several regions of Indonesia, indicating challenges in sustaining the success of immunization programs (8). Low immunization coverage is influenced by various factors, such as a lack of public knowledge, misconceptions about immunization, and limited access to health services (9). In addition, socioeconomic factors, parental education, and geographic conditions

also play a role in determining the completeness of children's immunization (10).

Behavioral factors also contribute to low immunization coverage. Concerns about vaccine side effects, a lack of trust in health services, and *vaccine hesitancy* pose barriers to immunization implementation (11). These conditions result in many children still not receiving immunizations according to the recommended schedule.

Previous studies have consistently shown that children with incomplete immunization are more likely to develop infectious diseases than those who receive complete immunization (12). Nevertheless, the strength of this association has varied across studies. Some investigations have reported a significant protective effect of complete immunization against infectious diseases (13), whereas others have demonstrated inconsistent findings depending on vaccine type, study population, epidemiological setting, and environmental conditions. These inconsistencies suggest that the relationship between immunization status and childhood infectious diseases is complex and influenced by multiple biological, behavioral, and contextual factors (14).

Although numerous primary studies have investigated immunization coverage, determinants of vaccine uptake, and childhood infectious diseases, comprehensive evidence synthesizing the association between immunization status and the incidence of infectious diseases among children remains limited. Furthermore, variations in study design, vaccine schedules, population characteristics, and outcome measurements have made direct comparisons across studies difficult (15). A comprehensive synthesis of the available evidence is therefore needed to provide a clearer understanding of the protective role of immunization against childhood infectious diseases and to identify consistent patterns across different settings (16).

Therefore, this study aimed to analyze the association between immunization status and the incidence of infectious diseases among children by synthesizing evidence from published studies. The findings are expected to strengthen the evidence base regarding the protective role of immunization and provide valuable information for policymakers, healthcare professionals, and public health programs to improve childhood immunization strategies.

METHODS

Study Design

This study employed a literature review design to synthesize published evidence regarding the relationship between immunization status and the incidence of infectious diseases among children. The review was conducted systematically through the processes of literature identification, article screening, eligibility assessment, and evidence synthesis.

Literature Search Strategy

The literature search was conducted using Google Scholar through the Publish or Perish software. The search employed the following keywords: "immunization status and infection in children," "vaccination coverage and infectious diseases in children," and "effect of immunization on child morbidity." Only articles published between 2015 and 2025 were included. The search was limited to full-text articles published in English or Indonesian.

Eligibility Criteria

Studies were included if they:

- investigated children as the study population;
- assessed immunization status as the exposure variable;
- reported infectious diseases or infection-related health outcomes;
- examined the association between immunization status and infectious disease incidence;
- employed observational study designs, including cross-sectional, case-control, or cohort studies; and
- were available in full text..

Studies were excluded if they:

- were duplicate publications;
- focused on adult populations;
- were review articles, editorials, conference abstracts, or case reports; or
- did not meet the predetermined inclusion criteria.

Study Selection

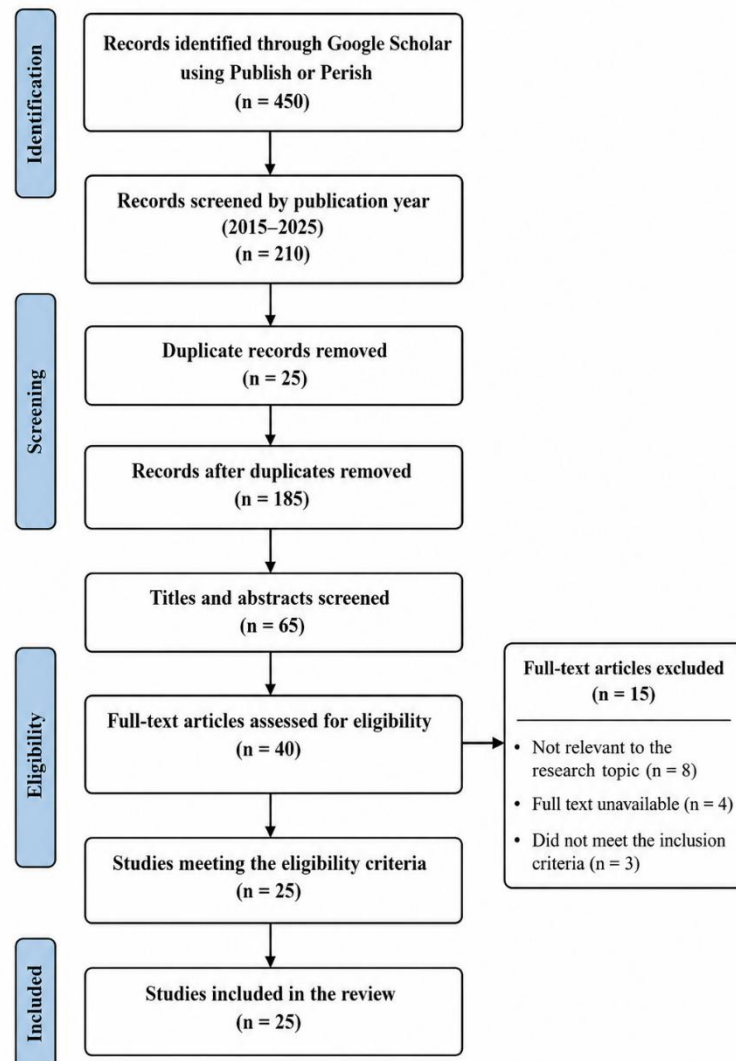
The study selection process is illustrated in Figure 1. A total of 450 records were identified through Google Scholar using Publish or Perish. After screening by publication year (2015–2025), 210 records remained. Following the removal of 25 duplicate records, 185 articles were retained. Screening of titles and abstracts resulted in 65 potentially relevant articles. Subsequently, 40 full-text articles were assessed for eligibility. Fifteen articles were excluded because they were not relevant to the research topic ($n = 8$), the full text was unavailable ($n = 4$), or they did not meet the inclusion criteria ($n = 3$). Finally, 25 articles were included in the review.

Data Extraction

Relevant information from each included study was extracted using a standardized data extraction table developed by the researchers. The extracted data included the author's name, publication year, study location, study design, sample characteristics, sampling technique, assessment of immunization status, infectious disease outcomes, statistical methods, and the principal findings related to the association between immunization status and childhood infectious diseases.

Data Analysis

The extracted data were analyzed using descriptive narrative synthesis. The characteristics and findings of the included studies were summarized and categorized according to study design, type of infectious disease, immunization status, and reported outcomes. The evidence was then compared to identify similarities, differences, and overall trends regarding the relationship between immunization status and infectious diseases among children. The synthesis focused on studies reporting significant associations as well as those reporting no significant association to provide a balanced interpretation of the available evidence.



RESULTS

Table 1. Research Synthesis Results

Research Findings	Number of Articles
Immunization is associated with infection	19
No significant association	4
Reviews supporting the benefits of immunization	2

Based on Table 1, most of the reviewed articles showed an association between immunization status and the incidence of infectious diseases in children. A total of 19 articles reported that children with incomplete immunization had a higher risk of developing infectious diseases, such as acute respiratory infections (ARIs), pneumonia, tuberculosis, and other infectious

diseases. A total of 4 articles showed nonsignificant results or found no direct association between immunization status and the outcomes studied. In addition, two review articles reported that immunization has broad benefits in reducing childhood morbidity and mortality, both through specific protection against certain diseases and through nonspecific

effects on the immune system. These results indicate that immunization status plays a crucial role in efforts to prevent infectious diseases in children, although its impact may be influenced by other factors such as nutritional status, environment, socioeconomic conditions, and access to health care.

Analysis of various studies shows that immunization status is associated with the incidence of infectious diseases in children, although the level of significance of this association varies across studies. In general, the majority of studies indicate that children with incomplete immunization have a higher risk of developing infectious diseases compared to those with complete immunization. This reinforces the assumption that immunization acts as a protective factor in reducing the incidence of infectious diseases in children.

Studies on the relationship between immunization and acute respiratory infections (ARIs) show a significant association between immunization status and the incidence of ARIs in toddlers. Children with incomplete immunization tend to have a higher risk of developing ARIs compared to those who have received complete immunization (17). These findings are consistent with other studies showing that immunization completeness is associated with the incidence of pneumonia in children, with children who are not fully immunized being more susceptible to pneumonia (18). This indicates that immunization not only provides specific protection against certain diseases but also contributes to an overall increase in the body's resistance to respiratory tract infections.

Other studies have also shown that incomplete primary immunization significantly increases the likelihood of ARI in toddlers (19). Based on these findings, it can be concluded that incomplete immunization results in suboptimal antibody production against specific pathogens, thereby making children more susceptible to infection. Furthermore, this condition can be exacerbated by other factors such as overcrowding, exposure to pollution, and parents' lack of knowledge regarding disease prevention.

Research on risk factors for ARI also indicates that immunization status is a key determinant of infection incidence, alongside environmental factors and family health behaviors (20). This suggests that immunization does not act as the

sole protective factor but rather interacts with various other factors in determining a child's risk of infection.

Although most studies show a significant association, there are also inconsistent findings. A study on the association between BCG vaccination and the incidence of pulmonary tuberculosis in toddlers showed no statistically significant association (21). This discrepancy can be attributed to the complexity of tuberculosis transmission, which is influenced not only by immunization status but also by environmental factors such as housing density, home ventilation, and exposure to individuals with active TB. Furthermore, the effectiveness of the BCG vaccine against pulmonary tuberculosis in children has been reported to vary, so non-significant study results remain scientifically acceptable.

Studies examining the relationship between immunization and health conditions indirectly indicate that incomplete immunization status is associated with an increased risk of wasting in infants and toddlers (22). This can be explained by the fact that children who frequently experience infections due to suboptimal immunization protection will experience impaired nutrient absorption, thereby affecting their nutritional status. A similar association has also been found regarding the incidence of stunting, where a history of infectious diseases and immunization status contribute to growth impairment (23).

However, some studies indicate that immunization status is not directly associated with the incidence of stunting (24). This can be interpreted to mean that stunting is a chronic condition influenced by various long-term factors such as nutritional intake, parenting practices, and socioeconomic conditions; thus, the effect of immunization on stunting is indirect, mediated through a reduction in the incidence of infections. Other studies involving additional variables, such as vitamin A supplementation, indicate that immunization is not the sole factor determining a child's health status (25). These findings suggest that child health interventions must be comprehensive, encompassing immunization, nutritional improvement, and the promotion of clean and healthy living behaviors.

Globally, research indicates that low immunization coverage remains a problem in many developing countries and contributes to

high rates of infectious diseases among children (26). This suggests that immunization issues are not merely individual in nature but are also influenced by a country's health system and public policies. Further analysis reveals that socioeconomic factors, parental education, and access to health services play a crucial role in determining children's immunization status (27). Inequalities in immunization distribution have also been identified, with children from low-income families having a lower likelihood of receiving a complete immunization series (28). This demonstrates that increasing immunization coverage requires an approach that focuses not only on medical aspects but also on social and economic factors.

Other studies show that low immunization coverage contributes to high rates of morbidity and mortality from infectious diseases that are actually preventable through vaccination (29,30). This reinforces the fact that immunization is one of the most effective public health interventions for reducing the burden of infectious diseases in children.

Furthermore, cross-national analyses indicate that children with incomplete immunization status tend to have poorer health outcomes, including an increased risk of malnutrition (31). This suggests a complex relationship between immunization, nutritional status, and the incidence of infections, in which these three factors influence one another. Access to health care services is also a key determinant in achieving complete immunization. Barriers such as distance to health facilities, limited service hours, and a lack of information are the main causes of low immunization coverage (32). These conditions indicate that interventions to improve immunization must take into account ease of access and public education.

The effects of immunization are not limited to the prevention of specific diseases but also have nonspecific effects on the immune system. Vaccines such as BCG and measles are reported to enhance the immune response against various other pathogens (33). This indicates that immunization has broader benefits in enhancing children's resistance to various infectious diseases.

Overall, the analysis results show that immunization status plays a significant role in reducing the incidence of infectious diseases in children. However, this relationship is not singular; it is influenced by various other factors

such as nutritional status, environmental conditions, and access to health services. Therefore, efforts to prevent infectious diseases in children do not rely solely on immunization but also require an integrated and comprehensive approach.

DISCUSSION

The main conclusion of this review is that complete immunization tends to act as a protective factor against the incidence of infections in children. Of the 25 articles analyzed, 19 showed an association between immunization status and the incidence of infections or infection-related health conditions, 4 found no significant association, and 2 review articles supported the benefits of immunization in reducing childhood morbidity and mortality. These findings suggest that children with incomplete immunization are generally more susceptible to ARI, pneumonia, and other infectious diseases. However, the strength of the association varies across studies due to differences in vaccine type, outcomes assessed, population characteristics, nutritional status, environmental exposure, and access to health care.

Theoretically, vaccines provide safe antigenic exposure to activate the adaptive immune response. Antigens are processed by antigen-presenting cells, which then stimulate the activation of B and T lymphocytes, antibody production, and the formation of immunological memory cells. When a child is exposed to the same pathogen at a later time, the memory response occurs more rapidly and is stronger, thereby preventing infection, reducing disease severity, or minimizing complications. Antibodies in serum and mucosal secretions are one of the primary correlates of protection for many vaccines, while cellular immunity plays a crucial role against intracellular pathogens (34,35).

Vaccine protection does not operate solely at the individual level. When immunization coverage is high, the number of susceptible individuals decreases, and the likelihood of pathogen transmission in the community also declines. This mechanism of indirect protection is known as herd protection or herd immunity. The extent of population protection depends on the vaccine's ability to prevent infection and transmission, the disease's transmission rate, community contact patterns, and the equity of immunization coverage (36).

Some vaccines have also been reported to have nonspecific effects on the immune response. One mechanism under study is “trained immunity,” which refers to medium-term functional changes in the innate immune system following specific stimulation, resulting in altered responses to subsequent triggers. Although this mechanism may help explain findings regarding the BCG and measles vaccines beyond their target diseases, clinical evidence regarding the direction and magnitude of these nonspecific effects remains inconsistent and must therefore be interpreted with caution (3,15,33).

Research on the relationship between immunization and acute respiratory infections (ARIs) indicates a significant association between immunization status and the incidence of ARIs in toddlers. Children with incomplete immunization tend to have a higher risk of developing ARIs compared to those who have received complete immunization (17). These findings are consistent with other studies showing that immunization completeness is associated with the incidence of pneumonia in children, with those who are not fully immunized being more susceptible to pneumonia (37). This suggests that immunization not only provides specific protection against certain diseases but also contributes to an overall increase in the body's resistance to respiratory tract infections.

Other studies have also shown that incomplete primary immunization significantly increases the likelihood of ARI in toddlers (38). Based on these results, it can be concluded that incomplete immunization results in suboptimal antibody production against specific pathogens, making children more susceptible to infection. Furthermore, this condition can be exacerbated by other factors such as overcrowding, exposure to pollution, and a lack of parental knowledge regarding disease prevention.

Research on risk factors for acute respiratory infections (ARIs) also indicates that immunization status is one of the key determinants of infection incidence, in addition to environmental factors and family health behaviors (19). This suggests that immunization does not act in isolation as the sole protective factor but rather interacts with various other factors in determining a child's risk of infection.

Although most studies show a significant association, there are also inconsistent results. A study on the relationship between BCG

vaccination and the incidence of pulmonary tuberculosis in toddlers showed no statistically significant association (20). These discrepancies can be attributed to the complexity of tuberculosis transmission, which is influenced not only by immunization status but also by environmental factors such as housing density, home ventilation, and exposure to individuals with active TB. Furthermore, the effectiveness of the BCG vaccine against pulmonary tuberculosis in children has been reported to vary, so non-significant study results remain scientifically acceptable.

Studies examining the relationship between immunization and health conditions indirectly indicate that incomplete immunization status is associated with an increased risk of wasting in infants and toddlers (21). This can be explained by the fact that children who frequently experience infections due to suboptimal immunization protection will experience impaired nutrient absorption, thereby affecting their nutritional status. A similar association has also been found regarding stunting, where a history of infectious diseases and immunization status contribute to growth impairment (22).

However, some studies indicate that immunization status is not directly associated with the incidence of stunting (23). This can be interpreted to mean that stunting is a chronic condition influenced by various long-term factors such as nutritional intake, parenting practices, and socioeconomic conditions; thus, the effect of immunization on stunting is indirect, mediated through a reduction in the incidence of infections. Other studies involving additional variables, such as vitamin A supplementation, indicate that immunization is not the sole factor determining a child's health status (Putri et al., 2021). These findings suggest that child health interventions must be comprehensive, encompassing immunization, nutritional improvement, and the promotion of clean and healthy living behaviors.

Globally, research indicates that low immunization coverage remains a problem in many developing countries and contributes to high rates of infectious diseases among children (Ahmed et al., 2024; Gebeyehu et al., 2023). This suggests that immunization issues are not merely individual in nature but are also influenced by a country's health system and public policies. Further analysis shows that socioeconomic factors, parental education, and

access to health services play a crucial role in determining a child's immunization status (27). Inequalities in immunization distribution have also been identified, with children from low-income families having a lower likelihood of receiving a complete immunization series (28). This demonstrates that increasing immunization coverage requires an approach that focuses not only on medical aspects but also on social and economic factors.

Other studies show that low immunization coverage contributes to high rates of morbidity and mortality from infectious diseases that are actually preventable through vaccination (29,30). This reinforces the fact that immunization is one of the most effective public health interventions for reducing the burden of infectious diseases in children.

Furthermore, cross-national analyses indicate that children with incomplete immunization status tend to have poorer health outcomes, including an increased risk of malnutrition (31). This suggests a complex relationship between immunization, nutritional status, and the incidence of infections, in which these three factors influence one another. Access to health care services is also a key determinant in achieving full immunization coverage. Barriers such as distance to health facilities, limited service hours, and a lack of information are the main causes of low immunization coverage (Kurkuri & Subramanian, 2024). These conditions indicate that interventions to improve immunization must consider ease of access and public education.

The effects of immunization are not limited to the prevention of specific diseases but also have nonspecific effects on the immune system. Vaccines such as BCG and measles are reported to enhance the immune response against various other pathogens (13). This suggests that immunization has broader benefits in enhancing children's resistance to various infectious diseases.

The practical implications of this review's findings include the need to verify immunization status during every child's contact with health services, to track down children who are behind schedule or have interrupted their immunization series, and to provide education that specifically explains the benefits and safety of vaccines. At the policy level, increasing coverage must be accompanied by equitable access, vaccine availability, strengthened record-keeping,

outreach services, and communication strategies tailored to social and geographic barriers. Infection prevention must also be integrated with improvements in nutrition, home environmental quality, smoke exposure control, and early disease detection.

Future research needs to more clearly distinguish between vaccine types and target diseases, use a uniform definition of immunization completeness, and control for confounding factors such as age, nutritional status, socioeconomic conditions, housing density, exposure to infected individuals, and access to health services. Prospective cohort studies or registry-based analyses are also needed to clarify the temporal sequence and strengthen inferences regarding the relationship between immunization status and the incidence of infection.

This review has several limitations. The literature search was conducted exclusively using Google Scholar via Publish or Perish; therefore, articles indexed in other databases may not have been identified. The study designs, populations, definitions of immunization status, vaccine types, and outcomes varied significantly across articles, making it impossible to directly compare results or combine them in a meta-analysis. Some studies used cross-sectional designs and retrospective data, which are at risk of information bias, while the predominance of articles with significant results may indicate publication bias. Therefore, the conclusions of this review primarily describe trends in associations and cannot yet be interpreted as uniform causal effects for all vaccines and all types of infections.

CONCLUSION

This literature review demonstrates that complete immunization plays an important role in reducing the incidence of infectious diseases among children. Most of the included studies consistently showed that incomplete immunization was associated with a higher risk of infections, particularly acute respiratory infections, pneumonia, and tuberculosis. However, the relationship between immunization status and childhood infections is influenced by other determinants, including nutritional status, environmental conditions, socioeconomic factors, parental education, and access to healthcare services.

These findings highlight the importance of maintaining high immunization coverage as part of comprehensive child health programs. In addition to strengthening immunization services, policymakers and healthcare providers should integrate immunization programs with health education, nutritional improvement, and equitable access to healthcare to maximize disease prevention among children. Future research using more robust study designs is recommended to clarify the effects of specific vaccines on specific infectious diseases while adequately controlling for potential confounding variables.

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Author Contributions

FAAM: Conceptualization, literature search, data collection, data analysis, manuscript drafting, and final approval of the manuscript.

AFAPS: Literature screening, data extraction, data interpretation, manuscript writing, and critical revision.

SRM: Data extraction, evidence synthesis, manuscript editing, and critical review of the manuscript.

MEI: Methodological guidance, supervision of the literature review process, interpretation of findings, and manuscript revision.

SP: Study conception and design, supervision, critical review of the manuscript, and final approval of the version to be published

CONFLICT OF INTEREST

The author declares that there are no financial, personal, or professional relationships that could be considered to influence the conduct, analysis, or reporting of this study. Therefore,

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