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Determinant factors of vaccination timeliness and completeness for children under five in low and middle-income countries in the last fifteen years: A systematic review

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Abstract

Background: Vaccination is one of the most effective disease prevention efforts in reducing morbidity and mortality in infants and children. In achieving health status for all, the World Health Organization (WHO) launched a policy aimed at achieving universal vaccination for children. As a result, this program succeeded in significantly reducing global child deaths from 12.6 million in 1990 to 6.3 million in 2013.

Purpose: To explore the factors influencing of vaccination timeliness and completeness for children under five in low and middle-income countries in the last fifteen years.

Method: A systematic review of articles searched through PubMed and Google Scholar from 2009 to 2024. Retrieved articles were screened using selected items from a systematic review and flow diagram meta-analysis (PRISMA). The inclusion criteria in this review were articles in English or Indonesian that discussed factors that influence the completeness of basic vaccinations for children under five.

Results: Eight of the 244 articles were obtained from database searches. In general, the factors that influence the completeness of vaccination are divided into several levels, namely individual, family, community and country. At the individual and family level, the factors identified are knowledge, education, healthy living behavior, marital status, number of family members, number of children, child spacing, child birth order, economy, and family support. At the community and country level, several factors influence, among others, visits by health workers, providing information about vaccinations, officers' attitudes, living in poor, urban areas, illiterate communities, and the country's fertility rate.

Conclusion: Socioeconomics is still a factor influencing the completeness of vaccination in low and middle income countries in the last 15 years. Various existing factors should be evaluated and solutions sought that can be adapted and implemented, such as training for health workers, communication training for health workers, health education approaches for heads of families, increasing access to health services by utilizing technology, and so on.

Suggestion: Developing countries need innovative approaches to identify and understand factors associated with the social determinants of vaccination programs.

Keywords: Children Under Five; Completeness; Low Income Countries; Middle Income Countries; Timeliness; Vaccination.

INTRODUCTION

Vaccination is one of the most effective disease prevention efforts in reducing morbidity and mortality in infants and children (Hu, Chen, Guo, Tang, & Shen, 2014; de Cantuária Tauil, Sato, & Waldman, 2016). In achieving health status for all, the World Health Organization (WHO) launched a policy aimed at achieving universal vaccination for children.

Since 1974, WHO has launched various vaccination programs for children throughout the world, in 1999 WHO began to focus these programs on poor countries (Hartmann, Pagliusi, & Precioso, 2020; de Cantuária Tauil et al., 2016). As a result, this program succeeded in reducing global child deaths significantly from 12.6 million in 1990 to 6.3 million in 2013, so that vaccination is said to be the most influential prevention program in the world (Bustreo, Okwo-Bele, & Kamara, 2015).

After almost 50 years of running this program, coverage rates in developing countries are still below 85% of the 90% target of achieving herd immunity (Alam, Tasnim, Obaid, & Palit, 2018; de Cantuária Tauil et al., 2016). Although there has been a significant reduction in global morbidity and mortality due to vaccine-preventable diseases, low coverage allows the emergence of these infectious diseases, such as outbreaks that have occurred in the last 2 decades in various countries (Hu et al., 2014). In developing countries, as many as 22.6 million children still do not receive routine vaccination services. This could be an opportunity for worrying infectious disease outbreaks to occur (Bustreo et al., 2015).

Various studies around the world have attempted to explore factors influencing the completeness of basic vaccination in low- and middle-income countries. Several factors were found to have overlapping or even opposing influences on vaccination completeness. It is hoped that the results

of this research can be a reference for the government and related parties in preparing work plans to increase vaccination coverage.

RESEARCH METHOD

This research is a systematic review. Data was obtained from scientific publications via databases, namely PubMed and Google Scholar, published between 2009-2024. The keywords used were “vaccination AND factor associations AND low-income countries” “vaccination AND factor associations AND middle-income countries”, or “vaccination AND factors associated AND developing”.

The inclusion criteria in this review were articles in English or Indonesian that discussed factors that influence the completeness of basic vaccinations for children under five. The research subjects were children aged no more than 5 years and/or their parents, both or one of them. The independent variables are factors that influence whether basic vaccination is complete or not from various points of view, while the dependent variable is the completeness of basic vaccination. The research design used was observational research with a cross sectional approach and multivariate analysis. Articles that use languages other than English and Indonesian are subject to the age of more than 5 years, case studies, quasi-experiments, random control trials (RCT), case reports, and case-control designs.

Identified studies were assessed for suitability of title and abstract for review purposes. This process is carried out separately by the reviewer. Retrieved articles were screened using selected items from a systematic review and flow diagram meta-analysis (PRISMA) (Liberati, Altman, Tetzlaff, Mulrow, Gøtzsche, Ioannidis, & Moher, 2009; Moher,

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Shamseer, Clarke, Gherzi, Liberati, Petticrew, & Prisma-P 2015). Reviewers also carry out screening by analyzing population, intervention, comparison, outcome (PICO). Study quality was assessed using the Newcastle-Ottawa cross-sectional study quality assessment scale. Articles that were not included as main articles in this review were used as bibliographic sources.

A total of 244 articles were obtained from database searches. 184 articles were excluded during

the screening process because they were not available in full text (30 articles) and were not cross-sectional studies (154 articles). After a manual review process, 40 duplicate articles were excluded, as were articles that were not in English or Indonesian (3 articles), and studies that did not meet PICO analysis (9 articles). A total of 8 articles that met the inclusion and exclusion criteria were included in this review.

RESEARCH RESULTS

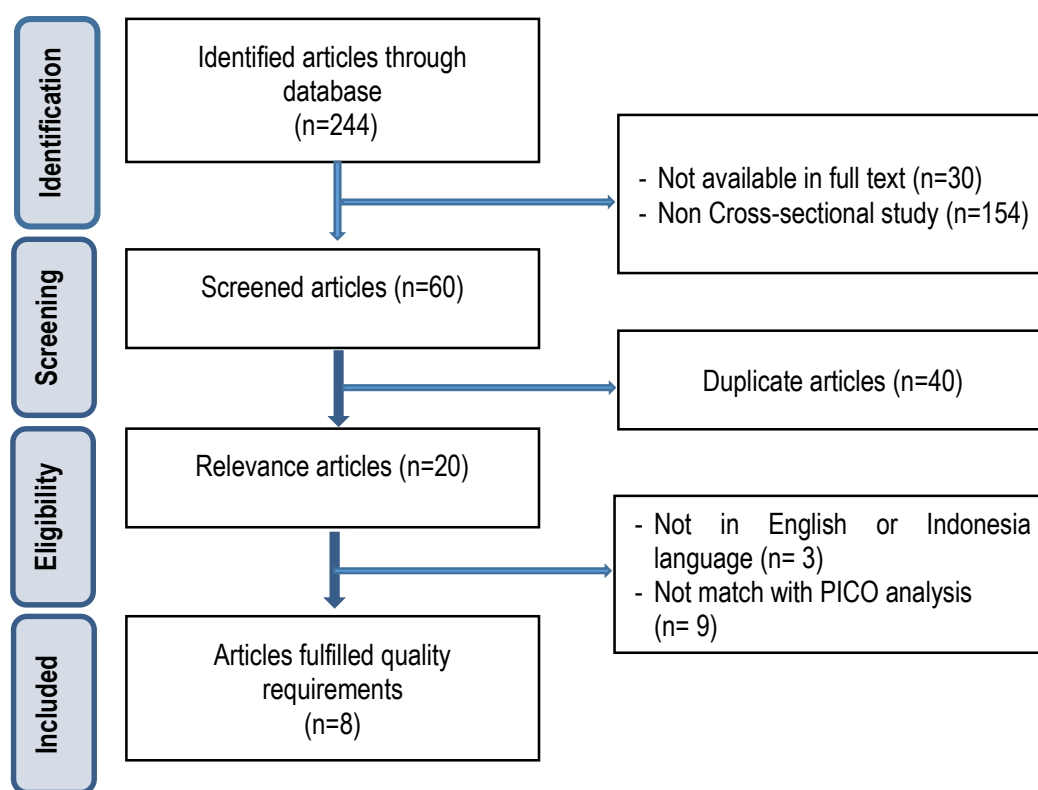


Figure of PRISMA Flow Diagram

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Results Analysis of the Selected Articles

Author	Country	Purpose	Method	Results
(Babirye, Engebretsen, Makumbi, Fadnes, Wamani, Tylleskar, & Nuwaha, 2012).	Uganda	To identify predictors of delayed vaccination in children aged 10-23 months in Kampala.	The research was conducted in Kampala from June to September 2010. Kampala is the capital and largest urban area in Uganda and 20% of the total population are children under 5 years of age. Sample collection uses the Bennett formula. The questionnaire designed and administered with OpenXdata version 1.3.4 was downloaded to the mobile phone.	Factors influencing incomplete vaccination were an increase in the number of children per woman (AHR1.84, 95% CI 1.29-2.64), not giving birth in a health facility (AHR 1.58, 95% CI 1.02-2.46), maternal status, being unmarried (AHR 1.49, 95% CI 1,151.94), or in difficult economic conditions (AHR 1.38, 95% CI 1.11-1.72).
(Kawakatsu, & Honda, 2012).	Kenya	To identify determinants of full vaccination status at individual, family and community levels in the most challenging areas of Kenya.	Cross-sectional study of children aged 12-23 months and their mothers. A total of 1,965 children were involved in this study and their mothers filled out questionnaires. The study was conducted in 64 sub-sites covered by community health workers (CHWs) in community units (CUs) identified as level one health systems in Kenya.	Factors influencing complete vaccination include maternal knowledge (AOR 2.69, 95% CI 2.01-3.60), high maternal knowledge (AOR 8.12, 95% CI 5.50-11.97), medium birth interval (AOR 2.46, 95% CI 1.29-4.69), the length of time to give birth, birth spacing (AOR 1.84, 95% CI 1.10-3.09), first birth (AOR 2.14, 95% CI 1.20-3.84), less than 5 children under five in one family (AOR 1.39, 95% CI 1,041.88), and

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			performance of public health workers (AOR 2.20, 95% CI 1.39-3.47).
(Kusuma, Kumari, Pandav, & Gupta, 2010).	India	To determine age-appropriate childhood vaccination coverage among socio-economically disadvantaged rural-urban migrants living in Delhi and to identify determinants of full vaccination uptake in such migrant children.	Cross-sectional survey study of 746 rural-urban migrant mothers with children aged up to 2 years. Research through interviews using a questionnaire that has been tested. The variables involved are receipt of various vaccines, migration history and some demographic and income details. Multiple logistic regression analysis was performed to identify determinants of vaccination status.
(Maina, Karanja, & Kombich, 2013).	Kenya	To determine complete vaccination coverage, antigen-specific coverage, and factors associated with incomplete vaccination.	A cross-sectional community-based survey was conducted between January and March 2011. Data collection was carried out using an interviewer-guided structured questionnaire through door-to-door visits. Data were analyzed with SPSS using descriptive, bivariate and multivariate logistic regression. Predictors of complete vaccination included the number of children in the family, the child's place of birth, the recommended date of the next visit for growth monitoring, and opinions about the health services offered.

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(Triana, 2016).	Indonesia	To determine the factors that influence the provision of complete basic vaccination	Cross sectional research design carried out in Kuranji District. The research sample of 80 people was taken by accidental sampling. Data collection was carried out by interviews and observations. Univariate, bivariate and multivariate data analysis.	The determining factors that influence the completeness of basic vaccination are parents' knowledge, attitudes and motivation, as well as the information obtained. Motivation is the most influential factor (p-value 0.0001).
(Rahmi, & Husna, 2018).	Indonesia	To examine the factors that influence the completeness of basic vaccinations for working area, Aceh Besar Regency.	Case control design survey research with a sample ratio of 1: 1, namely 40 cases and 40 controls. The research instrument used a questionnaire sheet. Chi Square analysis to determine the relationship between knowledge, number of children, attitude of health workers, family support and distance from home with completeness of basic vaccination.	Factors that influence the completeness of basic vaccination are the attitude of health workers (p-value 0.001, OR 9.471) and family support (p-value 0.001, OR 16.333). Family support (OR 12.73) was the most influential factor. There was no relationship between knowledge, number of children, and distance from home on completeness of basic vaccination.

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(Herliana, & Douiri, 2017).	Indonesia	To assess factors associated with low childhood vaccination coverage in Indonesia.	This research is the latest secondary data analysis DHS in Indonesia. Participants were randomly selected through a two-stage stratified sampling design. Data from 14.401 children aged 12–59 months in census blocks, totaling 1.832, were analyzed.	Several factors causing incomplete vaccination are children living in the Maluku and Papua regions (AOR 1.94; 95% CI 1.42-2.64), aged 36-47 months (AOR 1.39; 1.20-1.60), having a higher birth order (AOR 1.68; 1.28 - 2.19), having a larger number of family members (AOR 1.47; 1.11-1.93), uneducated mother (AOR 2.13; 1.22-3.72), coming from a poor household (AOR 1.58; 1.26-1.99), children who not having health insurance (AOR 1.16; 1.04 - 1.30), not getting ANC (AOR 3.28; 2.09-5.15), and PNC (AOR 1.50; 1.34-1.69).
(Wiysonge, Uthman, Ndumbe, & Hussey, 2012).	Afrika	To develop and test childhood vaccination models that include individual, community, and country level characteristics.	Multilevel logistic regression analysis of Demographic and Health Survey data on 27,094 children aged 12–23 months, spread across 8,546 communities from 24 countries in sub-Saharan Africa. According to the intra-country and intra-community correlation coefficients indicated by the variance estimates of the intercept components.	Factors influencing incomplete vaccination are children from mothers (OR 1.35, 95%CI 1.18-1.53) and fathers (OR 1.13, 95%CI 1.12-1.40) without formal education, mothers having less access to health services (OR 0.94, 95 % CI 0.94-0.99), children living in urban areas (OR 1.12, 95% CI 1.01-1.23), communities with high levels of illiteracy (OR 1.13, 95% CI 1.05-1.23), and countries with high fertility rates high (OR 4.43, 95% CI 1.04 -18.92).

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DISCUSSION

All research comes from low and lower middle income countries based on World Bank data (World Bank, 2022). Country income status is at the time the research was conducted. Four of them come from Africa and the other four come from Asia. All studies used children under five years as participants. Some studies also involve their parents. Based on the research objectives, these 8 studies were divided into two themes, namely research that focused on analyzing factors that influence the completeness of vaccination (5 studies) (Kawakatsu, & Honda, 2012; Kusuma et al., 2010; Maina et al., 2013; Rahmi, & Husna, 2018; Triana, 2016). Other studies focus on analyzing factors that influence incomplete basic vaccination (3 studies) (Babirye et al., 2012; Herliana, & Douiri, 2017; Wiysonge et al., 2012).

In this study, the reviewers explored factors influencing vaccination completeness in low- and middle-income countries. Four studies were from Africa, generally from low-income countries. Meanwhile, the other four studies came from Asia, all of which are lower middle income countries. The factors involved in fully vaccinating these two groups of countries are not very different. In general, social and economic factors are still the problems faced. These results are similar to those reported by previous research that factors associated with vaccination completeness can be similar in low- or middle-income countries (Glatman-Freedman, & Nichols, 2012). A country's socioeconomic status is still associated with incomplete or delayed vaccination, but the direction of the association may be different or paradoxical among the countries studied.

The main findings from this literature review show that the factors influencing vaccination coverage are very complex and driven by various aspects, including socio-economic conditions, heterogeneity and specificity of the population as well as low maternal education or inadequate information. Some studies use education level as a socioeconomic proxy.

However, the underlying explanation of this relationship has rarely been investigated. In a review it was explained that in LMICs around 44% of the reasons babies were not vaccinated were related to the health care system, and 28% were related to parental attitudes and knowledge (Rainey, Watkins, Ryman, Sandhu, Bo, & Banerjee, 2011).

Child age, number of children, birth distance between one child and another, and birth order are said to influence the completeness of vaccination (Babirye et al., 2012; Herliana, & Douiri, 2017; Kawakatsu, & Honda, 2012; Maina et al., 2012). Children aged 36-47 months are reported to have incomplete vaccination status (Herliana, & Douiri, 2017). The relationship between complete immunization and the number of children in a family is described in several forms, including the number of children under five in a household and the ratio of children to women. Children under five and a decreasing ratio of children to women are said to have a higher chance of obtaining complete vaccination status. Moderate and long intervals between births can also influence (Babirye et al., 2012; Kawakatsu, & Honda, 2012; Maina et al., 2013). A study also reported that the order of birth of children also has an effect. The first child has a greater potential to receive complete vaccination compared to children with a later birth order (Herliana, & Douiri, 2017; Kawakatsu, & Honda, 2012).

At the individual level, researchers also analyzed that fathers and mothers separately can play a role in influencing a child's vaccination status. In this review it was found that the mother was the most influential factor compared to the father. This is possible because mothers are research subjects who are more often involved than fathers. The mother's age, education level, knowledge about vaccinations, and the mother's healthy living behavior also have an influence. Maternal healthy living behavior that influences the use of health facilities includes

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antenatal care (ANC) and postnatal care (PNC). The older the mother, the higher the awareness of vaccinating her child. Likewise with higher education and science (Kusuma et al., 2010; Herliana, & Douiri, 2017; Kawakatsu, & Honda, 2012).

The more often a mother uses health facilities, the more frequently she is exposed to health information and education. This situation also shapes attitudes and motivation for vaccinating children (Herliana, & Douiri, 2017). A study shows that mothers who do not have ANC are less likely to vaccinate their children (Widyaningsih, & Murti, 2020). Likewise, for mothers who are not PNC, information regarding the vaccination schedule is generally given in stages and continuously. So, if a mother does not have ANC and does not give birth in a health facility, then important information regarding the vaccination schedule will be left behind (Cata-Preta, Santos, Mengistu, Hogan, Barros, & Victora, 2021).

A mother's marital status is one thing that is often forgotten. Marital status has an impact on the vaccination status of children in developing countries. Generally in developing countries, women who have children without marital status will be socially isolated. This should be of concern to local public health officials. In situations like this, health cadres play a role in providing information to health workers to find solutions (Jain, Shisler, Lane, Bagai, Brown, & Engelbert, 2022).

Only two studies out of the eight studies reviewed analyzed father involvement (Kusuma et al., 2010; Wiysonge et al., 2012). Even though it is not as high as the mother's, the father's education level also influences the completeness of the child's vaccination (Wiysonge et al., 2012). Fathers have greater influence in the family economy. Economic stability, employment, and father's salary influence children's vaccination status (Kusuma et al., 2010). There is a dominant role of fathers in households in developing countries. Most decisions in the family are taken by the father, including those related to health. Even

though children are more involved with their mothers, various studies also mention the importance of the mother's role in the child's vaccination status. Mothers were also participants who received health education more often than fathers. However, in the end, father and mother together form the motivation and attitude to vaccinate their children. In this case, the parents' attitude is dominated by the father. Therefore, apart from the father's educational level, efforts to broaden the father's knowledge in the field of health using various approaches are also an important agenda.

In contrast to developed countries, in developing countries families often do not only consist of father, mother and children. Grandparents or relatives often live in the same house. This can be a supporting factor as well as an obstacle to vaccination. Family support is said to be one of the determining factors in providing vaccinations in Indonesia (Rahmi, & Husna, 2018). Meanwhile, in other research, it was reported that the number of extended family members influenced children's incomplete vaccinations (Herliana, & Douiri, 2017).

Based on 8 main articles, 5 of them mention that health facilities and the role of public health workers have an influence on vaccination (Kawakatsu, & Honda, 2012; Kusuma et al., 2010; Maina et al., 2013; Rahmi, & Husna, 2018; Triana, 2016). The number of visits by staff, providing adequate education and information to mothers, and the attitude of health workers can influence parents' attitudes in vaccinating their children. These findings are an important note for health workers in developing countries to optimize their performance to increase vaccination coverage.

Settlement and regional characteristics also play a role in both social and economic aspects. People living in poor areas, many illiterate people and urban areas are reported to be affected by incomplete basic vaccination (Herliana, & Douiri, 2017; Wiysonge et al., 2012). Lack of parental knowledge, problems related to health access, and problems related to the economy are more frequently reported by people in

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urban areas than in rural areas (Glatman-Freedman, & Nichols, 2012). Geographical barriers and limited access to health facilities and programs are also other important agendas that need to be changed, as it has been reported that there are coverage gaps in several regions in Indonesia (Herliana, & Douiri, 2017). Apart from low human resources, the geographical characteristics of areas that are difficult for health workers to reach are also another challenge (Glatman-Freedman, & Nichols, 2012).

One of the problems faced by poor and developing countries is migration (Kusuma et al., 2010). Immigrant communities tend to have incomplete vaccination status. Social mobilization can be a route for the spread of disease, especially diseases that can be prevented by vaccines. A special approach is needed for this migrant community to monitor the vaccination status of their children (Awoh, & Plugge, 2015; Jalloh, Wilhelm, Abad, & Prybylski, 2020).

The presence of health cadres in the community really helps achieve program targets. Information in the community that is often ignored by health workers can be conveyed by the presence of health cadres. Vice versa, the information gap between health workers and the community can also be bridged by health cadres (Jain et al., 2022).

In the vaccination program, governance policies play an important role. Vaccination problems that cannot be resolved at the grassroots level will be resolved at the country level (Mihigo, Okeibunor, Cernuschi, Petu, Satoulou, & Zawaira, 2019; Portnoy, Jit, Helleringer, & Verguet, 2018; Restrepo-Méndez, Barros, Wong, Johnson, Pariyo, França, & Victora, 2016). Based on 8 articles, only 1 study mentioned the country as a direct factor in low vaccination coverage. Research in Sub-Saharan countries reports that people in countries with high levels of reproductive fertility are less likely to vaccinate their children (Wiysonge et al., 2012). High fertility rates generally occur in low-income countries. Low-income countries have difficulty providing sufficient vaccines for their

citizens, there needs to be a role at the state level to be able to solve this. The problems associated with vaccination in low- and middle-income countries are also similar. Recognizing each other's problems and learning from those closest to them who have successfully overcome them can be valuable input for increasing vaccination coverage (Machingaidze, Rehfuess, von Kries, Hussey, & Wiysonge, 2013; Mihigo et al., 2019).

CONCLUSION

Socioeconomics is still a factor influencing the completeness of vaccination in low and middle income countries in the last 15 years. Various existing factors should be evaluated and solutions sought that can be adapted and implemented, such as training for health workers, communication training for health workers, health education approaches for heads of families, increasing access to health services by utilizing technology, and so on.

SUGGESTION

Developing countries need innovative approaches to identify and understand factors associated with the social determinants of vaccination programs.

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