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Meta-Analysis

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Meta-Analysis of the Effect of Protected Well and Measles Vaccination on Stunting in Children Under Five

Edi Pramono[1)], Bhisma Murti[1)], Hanung Prasetya[2)]

[1)]Master's Program in Public Health, Universitas Sebelas Maret
[2)]Study Program in Acupuncture, Health Polytechnics, Ministry of Health Surakarta

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ABSTRACT

Background: Stunting is a condition where children's growth fails (body and brain growth) due to malnutrition for a long time. The incidence of stunting in toddlers needs special attention because it can hinder children's physical and mental development. This study aims to analyze and estimate the effect of protected wells and the measles vaccine on the incidence of stunting in children under five, with a meta-analysis based on primary studies conducted previously.
Subjects and Method: Meta-analysis was carried out in PICO format. Population: Children under five. Intervention: Protected Wells and Measles vaccine status. Comparison: Unprotected Well and Status not vaccinated against measles. Outcome: Stunting incidence. Article searches were carried out using several databases such as Google Scholar, PubMed, Science Direct, and Springerlink. The keywords used are "Protected well" AND Measles vaccine" AND "Stunting in toddlers". Inclusion criteria for the included articles were full-text articles with a cross-sectional design from 2015 to 2023. This study was conducted following PRISMA flow diagram guidelines. Data was analyzed using the Review Manager 5.3 application.
Results: 12 cross-sectional studies from Asia and Africa were selected for meta-analysis. the total sample was 48,128 toddlers. Protected well (aOR= 0.86; 95% CI= 0.75 to 1.00; p= 0.040) and measles vaccine (aOR= 0.59; 95% CI= 0.27 to 1.29; p= 0.190) reduce the risk of stunting in children under five.
Conclusion: Protected wells and administering the measles vaccine reduce the incidence of stunting in toddlers.

Keywords: protected wells, measles vaccine, stunting, toddlers.

Correspondence:
Edi Pramono. Master's Program in Public Health, Universitas Sebelas Maret. Jl. Ir. Sutami 36A, Surakarta 57126, Central Java, Indonesia. Email: pintudoa@gmail.com. Mobile: +6281329809090.

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BACKGROUND

Nutrition is the foundation for a child's survival and development. Children who have adequate nutrition will have better growth, development, and ability to learn, play, be resilient, and participate in their environment than those who experience malnutrition. Currently, many children do not get the nutrition they need to survive and thrive, especially the poor and most vulnerable children. There are 1 in 3 children under 5 years old experiencing malnutrition such as stunting. Around 144 million children under 5 years old have a height (short) inappropriate for their age and low cognitive abilities (UNICEF, 2021).

The incidence of stunting in toddlers needs special attention because it can hinder children's physical and mental development. Stunting is associated with an increased risk of morbidity and death as well as hampered growth of motor and mental abilities. Toddlers or toddlers who are stunted will have a lower level of intelligence, making them more susceptible to disease and potentially reducing production levels in the future (Beal et al., 2018).

Toddlers who experience stunting have a risk of decreased intellectual ability, and productivity and an increased risk of degenerative diseases in the future. Stunting remains one of the most common public health problems among children under five years of age worldwide (Shegaw et al., 2020).

The Global Nutrition Targets 2025 report estimates that around 171 million to 314 million children under five years old experience stunting and 90% of them are in Asian countries. Indonesia is included in 17 countries out of 117 countries that have nutritional problems, namely stunting, wasting, and overweight in children under five. Riskesdas results show that the proportion of stunting in Indonesia in 2007 decreased from 37.6% in 2010 to 35.8%, which decreased by 1.2%, but in 2013 it increased again to 37.2% and decreased to 30.8% in 2018 (Lukman, 2021).

Stunting in children under five years of age is one of the most common nutritional problems faced by toddlers today. Stunting affects 21.6% of children under five years of age in 2022. This is different from 2019 when stunting was 27.7% (Ministry of Health of the Republic of Indonesia, 2022).

Several factors cause stunting in children under five years of age, such as maternal knowledge, LBW, the number of more than 4 children in a household, and a history of disease infection (Sulaiman et al., 2021). One of the diseases that can cause stunting that often attacks toddlers is diarrhea. According to Pratama et al. (2023), several factors that cause diarrhea are not getting the rotavirus vaccine, exclusive breast milk, and the mother's low education level. Toddlers who have a history of diarrhea have a greater risk of experiencing stunting compared to children who do not have a history of diarrhea (Firmansyah et al., 2023).

Stunting is associated with a higher risk of morbidity and mortality, as well as impaired motor and brain development. Because short people have a low optimal body weight, stunting increases the risk of obesity. an increase in weight of several kilograms can cause a person's body mass index (BMI) to rise above the normal range, conditions of overweight and obesity that persist for a long time will increase the risk of degenerative diseases (Maywita, 2018). Based on this background, this research aims to analyze and estimate the effect of protected wells and the measles vaccine on the incidence of stunting in children under five, with a meta-analysis based on previously conducted primary studies.

SUBJECTS AND METHOD

1. Study Design

Meta-analysis was performed with PRISMA flowcharts using PubMed, Google Scholar, ScienceDirect, and Spiringer Link databases. The keywords used are "Protected well" AND Measles vaccine" AND "Stunting in toddlers". There were 12 studies with a cross-sectional research design that met the inclusion criteria. This study was conducted by PRISMA (Preferred Reporting Item for

Systematic Reviews and Meta-Analysis) guidelines.

2. Steps of Meta-Analysis

1) Create research questions using the PICO format, which involves defining the Population, Intervention, Comparison, and Outcome.
2) Searching for review of main articles from various electronic and non-electronic databases
3) Screening articles with Critical Appraisal assessment of primary research.
4) Performing data extraction and synthesize effect estimates using RevMan 5.4
5) Conducting interpretation and conclusion of study results.

3. Inclusion Criteria

This research article is a full-text paper with a cross-sectional study design that analyzes the effect of protected wells and the measles vaccine on the incidence of stunting. Analysis used multivariate with adjusted odds ratio (aOR) and a confidence level of 95%. The research subjects were toddlers.

4. Exclusion Criteria

Articles published other than in English, non-cross-sectional study designs, and articles published before 2015.

5. Operational Definition of Variables

Stunting: is a condition of growth failure in children (body and brain growth) due to malnutrition for a long time.

Protected well: is a means to tap and contain groundwater and aquifers that are used as a source of raw water for clean water or drinking water.

Measles vaccine: is an effort to increase a person's immunity actively against a disease so that at any time.

6. Study Instruments

The quality assessment in this study was conducted using critical Appraisal sheet for a cross-sectional study published by Murti in 2023.

7. Data Analysis

Data analysis using a RevMan 5.3. Forest plots and funnel plots are used to determine the size of relationships and heterogeneity of data. Fixed effect models are used for homogeneous data, while random effect models are used for heterogeneous data across studies.

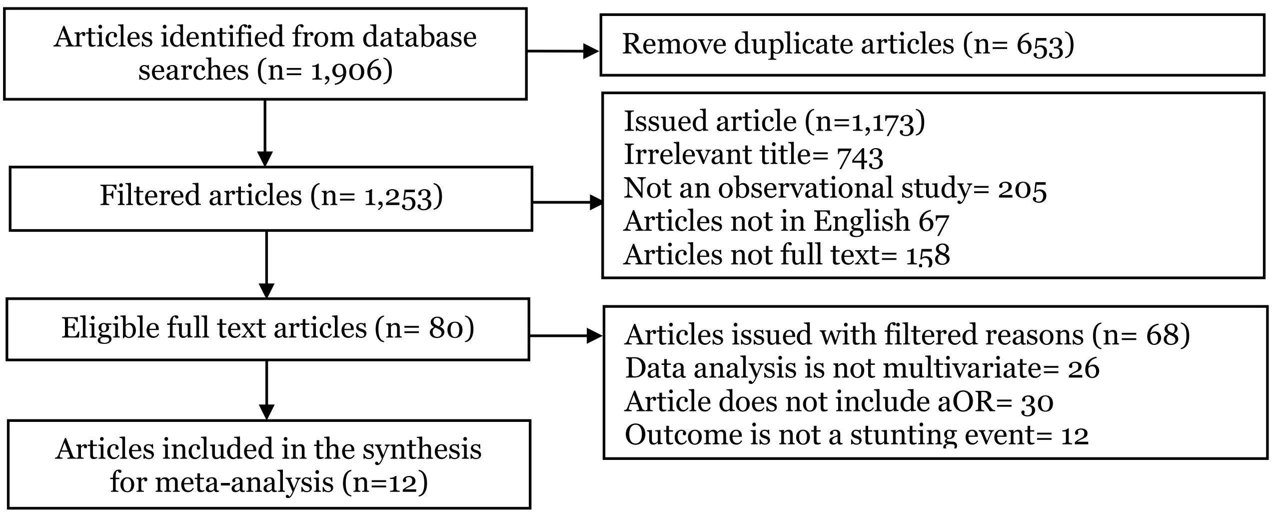

Figure 1. PRISMA flowchart

Figure 2. Map of the study area of the influence of protected wells and Measles vaccine against stunting in children under five

RESULTS

The article search process is carried out through databases which include PubMed, Google Scholar, ScienceDirect, and Springer Link. The article review process can be seen in the PRISMA flow diagram in Figure 1. Research related to the effect of protected wells and the measles vaccine on the incidence of diarrhea in toddlers consists of 12 articles. In Figure 2. that the research articles taken as meta-analysis sources came from the African Continent as many as 11 articles and from the Asian Continent as many as 1 articles.

Table 1. The Critical Appraisal of Articles with a Cross-Sectional Study

Authors (Year)	Criteria													total
	1a	1b	1c	1d	2a	2b	3a	3b	4	5	6a	6b	7	
Afework et al. (2021)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Azmeraw et al. (2021)	2	2	2	1	2	2	2	2	2	2	2	2	2	25
Chirande et al. (2015)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Danso dan Appiah (2023)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Derso et al. (2015)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Mazengia at al. (2018)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Sahiledengle et al. (2023)	2	2	2	2	1	2	2	2	2	2	2	2	2	25
Sartika et al. (2021)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Sewnet at al. (2021)	2	2	2	1	1	2	2	2	2	2	2	2	2	24
Tariku et al. (2017)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Toma et al. (2023)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Woldeamanuel et al. (2019)	2	2	2	2	2	2	2	2	2	2	2	2	2	26

Description of question criteria:

1a. Is the population in the primary study the same as the population in the PICO meta-analysis?

1b. Is the operational definition of the intervention, i.e. exposed status in the primary study the same as the definition intended in the meta-analysis?

1c. Is the comparison, i.e. unexposed status used by the primary study the same as the definition intended in the meta-analysis?
1d. Are the outcome variables studied in the primary study the same as the definitions intended in the meta-analysis?
2a. In analytical cross-sectional studies, did researchers randomly select samples from the population (random sampling)?
2b. Alternatively, if in an analytically cross-sectional study, the sample was not randomly selected, did researchers select the sample based on outcome status or based on intervention status?
3a. Were both exposure and outcome variables measured with the same instruments in all primary studies?
3b. If variables were measured on a categorical scale, were the cutoffs or categories used the same across primary studies?
4. If the sample was not randomly selected, had the researcher made efforts to prevent bias in choosing the study subject? For example, selecting subjects based on outcome status was not affected by exposure status (intervention), or in selecting subjects based on exposure status (intervention) was not affected by outcome status.
5. Whether the primary study researcher has made efforts to control for the influence of confusion (e.g., performing a multivariate analysis to control for the influence of several confounding factors)
6a. Did the researchers analyze the data in this primary study with multivariate analysis models (e.g., multiple linear regression analysis, multiple logistic regression analysis)
6b. Whether the primary study reports effect size or the association of the results of the multivariate analysis (e.g., adjusted OR, adjusted regression coefficient)
7. Is there no possibility of a conflict of interest with the research sponsor, which causes bias in concluding research results?

Description of Scoring:
Yes=2; Hesitate=1; No=0

Table 2. PICO table summary of cross-sectional articles of primary study sources with sample size (n= 48,128)

Author (year)	Country	Sample	P	I	C	O
Afework et al. (2021)	Ethiopia	767	Toddler	Vaccine Status	Not Vaccinated Status	Stunting
Azmeraw et al. (2021)	Ethiopia	845	Children aged 6 to 59 months	Protected Wells and Vaccines	Unprotected Wells and Unvaccinated	Stunting
Chirade et al. (2015)	Ethiopia	7,324	Children 0 to 59 months	Protected Wells	Unprotected Wells	Stunting
Derso et al. (2015)	Ethiopia	587	Children aged 6 to 24 months	Protected Wells	Unprotected Wells	Stunting
Danso and Appiah (2023)	Ghana	240	Children aged 1 to 5 years	Vaccine Status	Not Vaccinated	Stunting
Mazengia et al. (2018)	Ethiopia	802	Children aged 5 to 15 years	Protected Wells	Unprotected Wells	Stunting
Sahiledengle et al. (2023)	Ethiopia	33,650	Age child 0 to 59 months	Protected Wells and Vaccines	Unprotected Wells and Unvaccinated	Stunting

Author (year)	Country	Sample	P	I	C	O
Sartika et al. (2021)	Indonesia	599	Children aged 0 to 15 months	Vaccine Status	Not Vaccinated	Stunting
Sewnet et al. (2021)	Ethiopia	275	Toddler	Vaccine Status	Not Vaccinated	Stunting
Tariku et al. (2017)	Ethiopia	1,295	Mother and Child aged 6 to 59 months	Protected Wells	Unprotected Wells	Stunting
Toma et al. (2023)	Ethiopia	717	Children aged 6 to 59 months with stunting	Protected Wells	Unprotected Wells	Stunting
Woldeamanuel et al. (2019)	Ethiopia	1077	Children aged 5 years	Protected Wells	Unprotected Wells	Stunting

Table 3. Adjusted odds ratio data on the effect of protected wells on stunting

Author (Year)	aOR	CI 95%	
		Lower Limit	Upper Limit
Azmeraw et al. (2021)	0.71	0.35	1.44
Chirade et al. (2015)	0.79	0.68	0.92
Derso et al. (2015)	0.82	0.54	1.25
Mazengia et al. (2017)	0.71	0.54	0.93
Sahiledengle et al. (2023)	1.11	0.90	1.37
Tariku et al. (2017)	1.08	0.85	1.37
Toma et al. (2023)	0.91	0.64	1.29
Woldeamanuel et al. (2019)	0.68	0.50	0.92

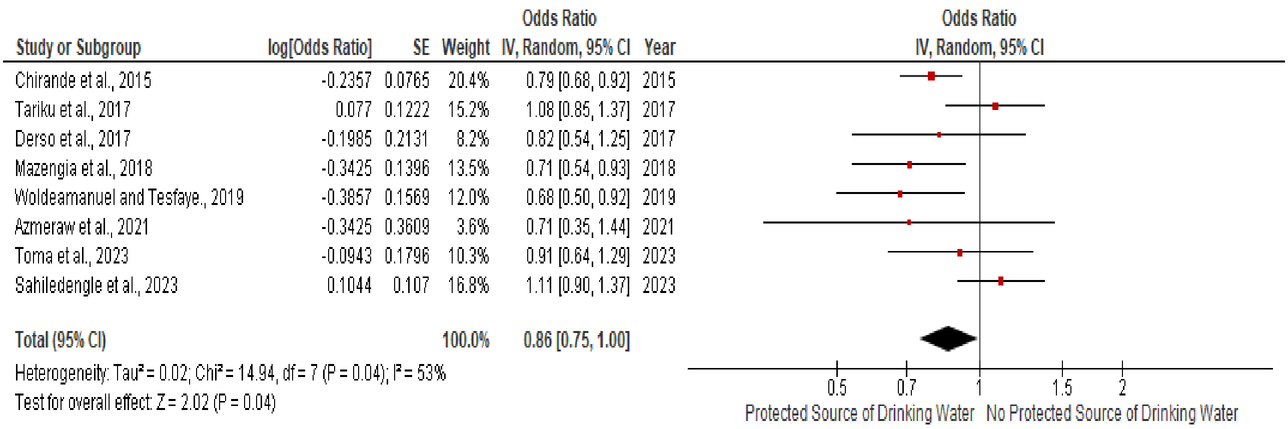

Figure 3. Forest well plots protected against stunting

Figure 3 shows protected wells reduce the risk of stunting in children under five by 0.86 times compared to unprotected wells, and the effect was statistically significant (aOR= 0.86; CI 95%= 0.75 to 1.00; p= 0.040). The heterogeneity of effect estimates between studies is quite large (I^2 = 53%). Thus, the calculation of the average effect estimation is carried out with the Random Effect Model (REM) approach.

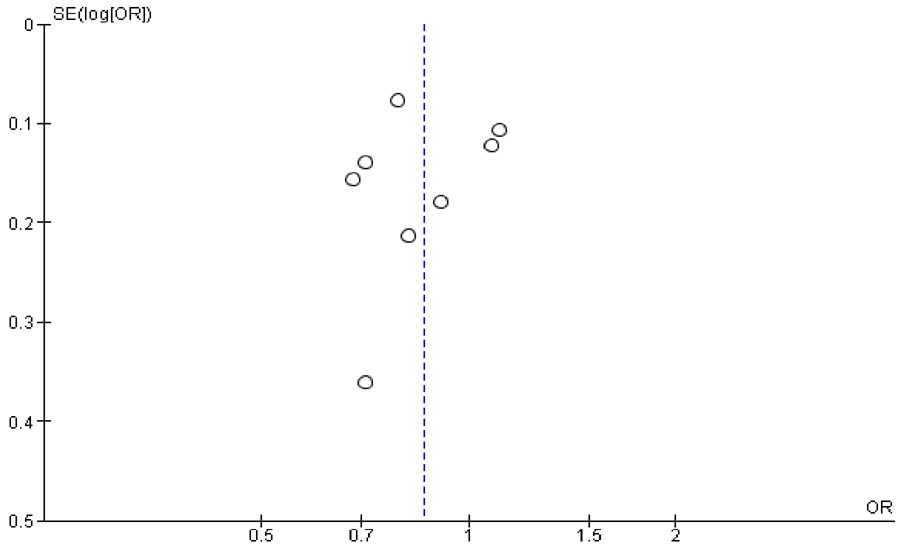

Figure 4. Funnel plot of the effect of protected wells on stunting events

Figure 4 shows a slightly greater distribution of effect estimates located on the left than to the right of the average vertical line of effect estimates, thus indicating a slight publication bias. Because the distribution of the effect estimate is more to the left of the average vertical line which is also the same as the location of the diamond in the forest plot which is also located on the left, the publication bias somewhat overestimates.

Table 4. Adjusted odds ratio data on the effect of measles vaccine on stunting incidence

Author (Years)	aOR	95% CI	
		Lower Limit	Upper Limit
Afework et al. (2021)	0.57	0.57	0.37
Azmeraw et al. (2023)	0.80	0.80	0.23
Danso and Appiah (2023)	1.19	1.19	0.89
Mazengia et al. (2018)	0.18	0.18	0.09
Sahiledengle et al. (2023)	0.18	0.18	0.09
Sartika et al. (2021)	0.41	0.41	0.17
Sewnet at al. (2021)	2.86	2.86	2.07

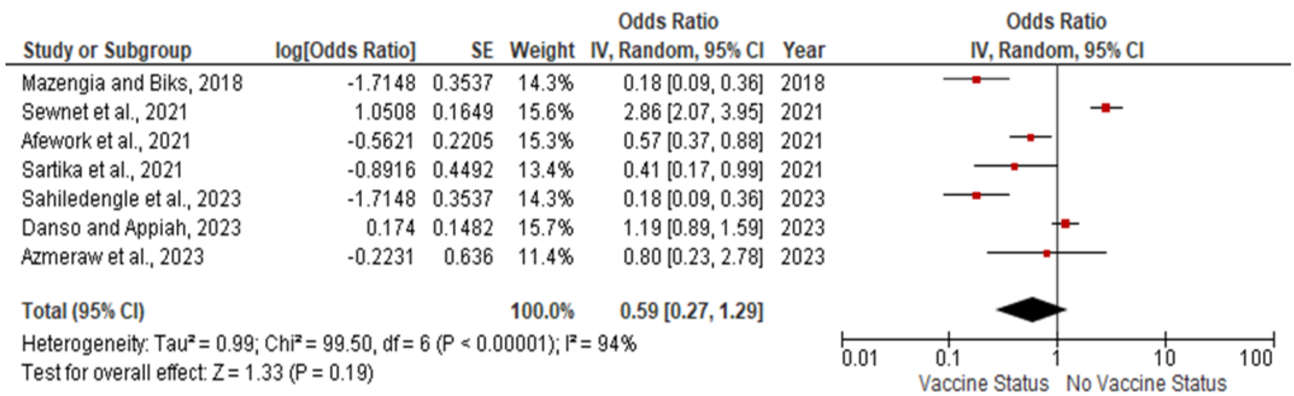

Figure 5. Forest Plot of the effect of measles vaccine on stunting

Figure 5 shows the effect of the measles vaccine on stunting risk in children under five. Vaccine administration reduces the risk of stunting in children under five although it is not statistically significant. Children under five who were vaccinated at the time of infancy had a risk of stunting by 0.59 times compared to not being vaccinated (aOR= 0.59; CI 95%= 0.27 to 1.29; p=0.190). The forest plot showed a considerable heterogeneity of effect estimates between studies (I^2= 94%). Thus, the calculation of the average effect estimation is carried out with the Random Effect Model (REM) approach).

The funnel plot in Figure 6. shows the effect of vaccination on stunting in children under five. The distribution of effect estimates is more or less balanced to the right and left of the vertical line of the effect. This meta-analysis does not show publication bias.

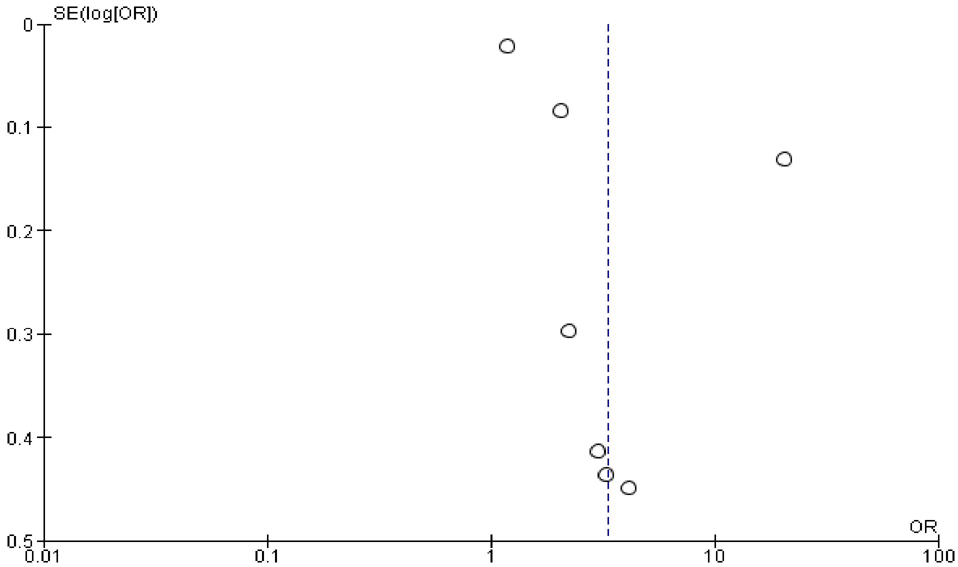

Figure 1. Funnel plot of alcohol consumption and osteoporosis in adults

DISCUSSION

Stunting is a condition of children who experience failure to grow in toddlers due to repeated infections, chronic malnutrition, and lack of stimulation, especially in the golden age so that children become short for their age (Aryastami et al., 2017). In addition, children who are stunted may continue and are at risk of having a short body when growing into adolescents (Mangesha et al., 2020).

Globally, the prevalence of stunting is 22.9% or around 154.8 million children under the age of 5 years suffer from stunting. Stunting is mostly experienced by children in poor and developing countries, such as in South Africa at 18.6%, in Ethiopia at 26.4%, and in Nigeria at 22.2%. As many as 6 million children in Latin America and the Caribbean are stunted. The prevalence of stunting in Asian countries also shows a high prevalence such as India at 38.4%, Pakistan at 45%, Bangladesh at 36.1%, Malaysia at 20.7%, the Philippines and Thailand at 10.5%, then Indonesia at 30.8% (Sartika et al., 2021).

Stunting is defined as the condition of nutritional status of toddlers who have less length or height according to their age. The measurement is carried out using child growth standards from WHO, if the z-score value is less than -2 standard deviations (SD) then it is categorized as stunting. From various previous studies, it is stated that the determinants of stunting are very complex such as economic conditions, sources of drinking water, the number of children in a family, low birthweight, vaccine administration, care visits to health care centers, food intake, breastfeeding, infant pain, maternal nutrition during pregnancy. Generally, these various causes last for a long time (Ministry of Health, 2016).

This systematic study and meta-analysis raised the theme of the effect of protected wells and measles vaccine on stunting in toddlers. The dependent variable analyzed is the incidence of stunting. The independent variables analyzed were the effect of protected wells and measles vaccine.

1. The effect of protected wells on stunting

A total of 8 cross-sectional observational study articles as a source of meta-analysis of the effect of protected wells on the incidence of stunting in children under five. This study showed protected drinking water sources reduced the risk of stunting in children under five by 0.86 times compared to unprotected drinking water sources, and the effect was statistically significant (aOR= 0.86; CI 95%= 0.75 to 1.00; p= 0.040). Effect estimation between studies showed high heterogeneity (I^2= 53%; p= 0.040), with the calculation of the average effect estimation using the Random Effect Model (REM) approach.

Children who get unprotected springs are at risk of stunting. This is supported by the study of Toma et al. (2015) in Ethiopia in children aged 6 to 59 months, which found that the factors causing stunting are unprotected springs, protected water sources will reduce the risk of stunting in children (aOR= 0.91; CI95%= 0.64 to 1.29; p= 0.040).

The results of this study are in line with the study of Tariku et al. (2017), showing that protected springs reduce the risk of stunting by 1.08 times compared to unprotected springs (aOR= 1.08; CI 95%= 0.85 to 1.37; p= 0.040).

Sanitation and the availability of clean water are very important in the growth of children under five. The activity of microbial pollutants in water will cause health problems in humans who consume it. Garbage is one of the causes of water pollutants type of dissolved or suspended solid material pollutants, if the garbage disposal is close to the water source it can pollute the water there by reducing the physical value of the water quality. Polluted water may contain aged substances that cause diseases transmitted indirectly, one of which is diarrhea (Afework et al., 2021).

Puddles on the well floor can be a nesting place for vectors, such as Aedes aegypti mosquitoes which are intermediaries or carriers of the dengue virus against the human body to become dengue fever. Toddlers who suffer from infectious diseases such as dengue fever have a greater chance of stunting (Sumarno and Syafiuddin, 2023).

2. The effect of measles vaccine on the incidence of stunting

A total of 7 (seven) cross-sectional observational study articles as a source of meta-analysis of the effect of Measles Vaccine on the incidence of stunting in children under five. Vaccine administration reduces the risk of stunting in children under five although it is not statistically significant. Children under five who were vaccinated at the time of infancy had a risk of stunting by 0.59 times compared to not being vaccinated (aOR= 0.59; CI 95%= 0.27 to 1.29; p= 0.190). Forest plots in this study showed a considerable heterogeneity of effect estimates between studies (I^2= 94%; p = 0.190). Thus, the calculation of the average effect estimation is carried out with the Random Effect Model (REM) approach.

Children who are not vaccinated in their growth will increase the risk of stunting at that age, this is in line with a study conducted by Sewnet et al. (2021), that giving vaccines will reduce the risk of stunting in children by 2.86 times compared to children who are not given vaccines (aOR= 2.86; CI 95%= 2.07 to 3.95; p= 0.050).

According to Dasalegn et al. (2016) also conveyed the importance of vaccines in child growth and development, that vaccination is an effort to cause and increase immunity to diseases in infants, done by injection. Incomplete immunization causes immunity. Toddlers become weak, making it easy to get infectious diseases. Children who have infections if left unchecked can be at risk of becoming stunted.

AUTHOR CONTRIBUTION

Edi Pramono as a researcher who selects topics, searches and collects study data. Bhisma Murti and Hanung Prasetya analyzed the data and reviewed the study documents.

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CONFLICT OF INTEREST

There is no conflict of interest in this study.

REFERENCES

Afework E, Mengesha S, Wachamo D (2021). Stunting and Associated Factors among Under-Five-Age Children in West Guji Zone, Oromia, Ethiopia. J Nutr Metab, 2021: 1-8. doi: 10.1155/2021/8890725.

Aryastami NK, Shankar A, Kusumawardani N, Besral B, Jahari AB, Achadi E (2017). Low birth weight was the most dominant predictor associated with stunting among children aged 12-23 months in Indonesia. BMC Nutr, 3(1): 1–6. doi: 10.1186/s40795-017-0130-x.

Azmeraw Y, Amegbor PM, Essah M (2021). The Effect of Socioeconomic and Environmental Factors on Obesity. J of Applied Geos Res. 12(4): 58–74. doi: 10.4018/ijagr.2021100104.

Beal T, Tumilowicz A , Sutrisna A, Izwardy D, Neufeld LM (2018) A review of child stunting determinants in Indonesia. Matern. Child Nutr. 14(4): 1–10. doi: 10.1111/mcn.12617.

Chirande L, Victor R, Kimboka S, Issaka AI, Baines SK, Dibley MJ, Agho KE (2015). Determinants of stunting and severe stunting among under-fives in Tanzania: evidence from the 2010 cross-sectional household survey. BMC Pediatr. 15(165): 1–13. doi: 10.1186/s-12887-0150482-9.

Danso F, Appiah MA (2023). Prevalence and associated factors influencing stunting and wasting among children of ages 1 to 5 years in Nkwanta South Municipality, Ghana. Nutr. 110. doi: 10.1016-/j.nut.2023.111996.

Desalegn BB, Kinfe E, Fikre K, Bosha T (2016). Stunting and Its Associated Factors in Under Five Years Old Children: The Case of Hawassa University Technology Villages, Southern Ethiopia. J Environ Sci Toxicol Food Technol. 10(11): 25-31. doi: 10.9790/-2402-1011022531.

Derso T, Amare T, Biks GA, Bashaw AB, Molla MW. (2015). Stunting, wasting and associated factors among children aged 6–24 months in Dabat health and demographic surveillance system site: A community based cross sectional study in Ethiopia. BMC Pediatr.

17(96): 1-9. doi: 10.1186/s12887-017-0848-2.

Firmansyah RRT, Murti B, Prasetya H (2023). A Meta-Analisis of Correlation between Diarrhea and Stunting in Children Under Five. J Epidemiol Public Health. 8(1): 88-97. doi: 10.26-911/jepublichealth.2023.08.01.08.

Pratama GA, Rahardjo SS, Murti B (2023). Meta-Analysis the Effects of Rotavirus Vaccine, Exclusive Breastfeeding, and Maternal Education on Diarrhea in Children Under Five. J Epidemiol Public Health. 8(3): 298-311. doi: 10.2-6911/jepublichealth.2023.08.03.02.

Kementrian Kesehatan RI (2016). Situation of Short Toddlers in Indonesia. (Situasi Balita Pendek di Indonesia). Jakarta: Kementerian Kesehatan Republik Indonesia.

Kementrian Kesehatan RI (2022). Pocket Book of 2022 Indonesian Nutritional Status Study Results (SSGI) (Buku Saku Hasil Studi Status Gizi Indonesia (SSGI) Tahun 2022). Jakarta: Kementrian Kesehatan Republik Indonsia.

Lukman TNE, Anwar F, Riyadi H, Harjomidjojo H, Martianto D (2021). Birth Weight and Length Associated with Stunting Among Children Under-Five in Indonesia. J Gizi Pangan. 16(1): 99–108.

Maywita E (2018). Risk Factors Causing Stunting in Toddlers Aged 12-59 Months in Kampung Baru Village, Kec. Lubuk Begalung in 2015 (Faktor Risiko Penyebab Terjadinya Stunting Pada Balita Umur 12-59 Bulan Di Kelurahan Kampung Baru Kec. Lubuk Begalung Tahun 2015). Jurnal Riset Hesti Medan Akper Kesdam I/BB Medan. 3(1): 56. doi: 10.34008/jurhesti.v3i1.24.

Mazengia AL, Biks GA (2018). Predictors of Stunting among School-Age Chil-dren in Northwestern Ethiopia. J Nutr Metab. 2018: 1-7. 10.1155/2018/75217-51 doi: 10.1155/2018/7521751.

Mengesha A,Hailu S, Birhane M, Belay MM (2021). The prevalence of stunting and associated factors among children under five years of age in southern ethiopia: Community based cross-sectional study. Ann Glob Health. 87(1): 1–14. doi: 10.5334/aogh.3432.

Sahiledengle B, Agho KE, Petrucka P, Kumie A, Beressa G, Atlaw D, Tekalegn Y, et al. (2023). Concurrent wasting and stunting among under-five children in the context of Ethiopia: A generalised mixed-effects modelling. Maternal n Child Nutri. 19(2): 1-20. doi: 10.1111/-mcn.13483.

Sartika AN, Khoirunnisa M, Meiyetriani E, Ermayani E, Pramesthi IL, Nur AA (2021). Prenatal and postnatal determinants of stunting at age 0–11 months: A cross-sectional study in Indonesia. PLoS ONE, 16(7): 1–14. doi: 10.1371/journal.pone.0254662.

Sewnet SS, Derseh HA, Desyibelew HD, Fentahun N (2021). Undernutrition and associated factors among under-five orphan children in Addis Ababa, Ethiopia 2020: A cross-sectional study. J Nutr Metab. 2021: 1-9. doi: 10.1155/2021/6728497.

Shegaw SS, Hunegnaw AD, Hanna DD, Netsanet F (2020) Undernutrition and associated factors among under-five orphan children in addis abada, Etiopia, 2020: a cross-sectional study. J Nutr Metab. doi: 10.1155/2021/6728-497.

Sulaiman Z, Febrianti D, Said S, Adri K (2021). Risk Factor Analysis of Family Characteristics and Health History of Children Under Five on the Incidence of Stunting in Sidenreng Rappang, South Sulawesi, Indonesia. J Epidemiol Public Health. 6(3): 291-298. doi: 10.26911/jepublichealth.2021.06.-03.03.

Sumarno TI, Syafiuddin A (2023). Analysis of Well Water Quality and Sanitation Facilities with Stunting Incidents in Lokus Stunting Village, Driyorejo District (Analisis Kualitas Air Sumur dan Sarana Sanitasi Dengan Kejadian Stunting di Desa Lokus Stunting Kecamatan Driyorejo). J Ilmu Kes. 1(1): 21–39. doi: 10.9644-/scp.v1i1.332.

Toma TM, Andargie KT, Alula RA, Kebede BM, Gujo MM (2023). Factors associated with wasting and stunting among children aged 06–59 months in South Ari District, Southern Ethiopia: a community-based cross-sectional study. BMC Nutr. 9(1) : 1–16. doi: 10.11-86/s40795-023-00683-3.

Tariku A, Biks GA, Derso T, Wassie MM, Abebe SM (2017). Stunting and its determinant factors among children aged 6-59 months in Ethiopia. Ital. J. Pediatr. 43(1): 1–9. doi: 10.1186/s13-052-017-0433-1

UNICEF (2021) Early childhood nutrition. United Nations International Children's Emergency Fund

Woldeamanuel BT, Tesfaye TT (2019). Risk factors associated with under-five stunting, wasting, and underweight based on ethiopian demographic health survey datasets in Tigray Region, Ethiopia. J Nutr Metab. 2019: 1-11. doi: 10.115520196967170.