A Meta-Analisis of Correlation between Diarrhea and Stunting in Children Under Five

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ABSTRACT

Background: Diarrhea is an infectious disease that can cause children to experience appetite disturbances, resulting in reduced nutritional intake, while the nutrients consumed also fail to be properly absorbed by the body. If this condition is not balanced with appropriate food intake, it can have an impact on cognitive development disorders and height growth, namely stunting. This study aimed to determine whether there was a relationship between a history of diarrhea and the incidence of stunting in toddlers, through a meta-analysis of primary studies conducted by previous authors.

Subjects and Method: This study was conducted using a systematic review and meta-analysis with PICO namely, Population: under five, Intervention; diarrhea, comparison: no diarrhea, outcome: stunting. By searching for articles in 2 databases, namely PubMed and Google Scholar, which were published from 2017 to 2022, following keywords "Diarrhea" AND "Stunting" AND "adjusted Odds Ratio" OR "aOR". The included article is a full-text cross-sectional study design for 2017-2022 and reports the adjusted odds ratio (aOR) in multivariate analysis. Articles were selected using prism flow with inclusion criteria, namely, and data analysis using the Review Manager 5.3 application.

Results: In total there were 9 articles using a cross-sectional study design with a total sample of 69,549 children under five from Ethiopia, Uganda, Indonesia, Pakistan which had been carried out systematic review and meta-analysis. The data that has been processed shows that toddlers with a history of diarrhea have a risk of experiencing stunting 1.21 times compared to toddlers without a history of diarrhea (aOR= 1.57; 95% CI= 1.20 to 2.05; p< 0.001).

Conclusion: Toddlers with a history of diarrhea have a risk of experiencing stunting compared to toddlers without a history of diarrhea.

Keywords: diarrhea, stunting, toddlers

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BACKGROUND

Stunting or chronic malnutrition is another form of growth failure. Stunting is still one of the most common public health problems among children under the age of five world-wide (Sema et al., 2021). Children who are stunted often appear to have proportional normal bodies, but in fact their height is shorter than the normal height of children of their age (Lukman et al., 2021). According to WHO (2021), the prevalence of stunting in children under five worldwide in 2020 will

reach 22% or as many as 149.2 million children under five. Meanwhile in the Southeast Asia region, the prevalence of stunting in children under five in 2020 was reported at 30.1%. This figure needs to be watched out for because it is close to the 40% threshold which marks a serious public health problem. Then thanks to the National Movement to Accelerate Nutrition Improvement which has been promoted since 2013, in 2018 the prevalence of stunting in Indonesia has decreased to 30.8% or around 7 million children under five (Kemenkes RI, 2021). The latest data for 2021 according to the Indonesian Nutrition Status Study (SSGI) report, the prevalence of stunting in Indonesia has decreased again to 24.4%. Meanwhile, based on the data obtained by the Indonesian Toddler Nutritional Status Survey (SSGBI) team in 2021, it was found that the prevalence of stunting is currently still 24.4 percent, or 5.33 million children under the age of five are stunted. The prevalence of stunting has decreased compared to previous years, besides that Indonesian president Joko Widodo on the other hand wants the stunting rate to drop to 14% in 2024 (KemenkoPMK, 2022).

Incidence of stunting in toddlers can be caused by direct factors and indirect factors. Direct factors include: food intake and infectious diseases, while indirect factors include: the condition of household food security, parenting style, and the economic conditions of families of toddlers. One of the causes of stunting in toddlers is an infectious disease. Diarrhea is an infectious disease that can cause impaired absorption and even loss of nutrients. When a child has diarrhea, he will lose his appetite, so that the intake of nutrients is reduced, while the nutrients consumed also fail to be properly absorbed by the body. These conditions cause the child's weight to begin to slowly decrease

and this is followed by stunted growth in height (Choiroh et al., 2020).

If this condition is not balanced with appropriate food intake, it can impact on cognitive development disorders and height growth, namely stunting (Lestari and Siwiendrayanti, 2021). The results of research conducted by Dake et al. (2019) on toddlers in Sodo Zuria, South Ethiopia showed 24.9% of toddlers experienced stunting, where one of the contributing factors was the incidence of diarrhea.

Based on the background, the researcher is interested in conducting a study using a meta-analysis approach on the relationship between diarrhea and stunting in toddlers, with the aim of knowing the relationship between diarrhea and stunting in toddlers based on previous studies. In this study there were no regional restrictions, so the range of analysis was quite broad while taking into account its relevance. This study aimed to determine whether there was a relationship between a history of diarrhea and the incidence of stunting in toddlers, through a meta-analysis of primary studies conducted by previous authors.

SUBJECTS AND METHOD

1. Study Design
This research is a systematic review and meta-analysis, using PRISMA diagrams by searching for articles on 2 databases, namely PubMed and Google Scholar, which were published from 2017 to 2022, entering the following keywords "Diarrhea" AND "Stunting" AND "adjusted Odds Ratio" OR "aOR". Analysis was performed with Review Manager (RevMan) 5.3.

2. Steps of Meta-Analysis
Meta-analysis is carried out through 5 steps as follows:
1) Formulate research questions with the PICO model (Population= toddlers. Inter-

vention= diarrhea. Comparison= no diarrhea. Outcome: Stunting).

2) Search for primary study research articles from 2 online databases, namely PubMed and Google Scholar.

3) Conduct screening and quality assessment of primary research articles.

4) Extracting and analyzing data into the RevMan 5.3 application.

5) Interpret results and draw conclusions.

3. Inclusion Criteria

The inclusion criteria of this study were full text articles and used a cross-sectional study design, research subjects were toddlers with a history of diarrhea, multivariate analysis with adjusted odds ratio (aOR), the year of the article used ranged from 2017 to 2022 with English or Indonesia language and the outcome of the study was stunting.

4. Exclusion Criteria

The exclusion criteria were articles with size incomplete results study or did not clearly describe the results, the year of publication was more than 5 years since the study was conducted, the intervention and study population were different.

5. Operational Definition of Variables

Article search was carried out by considering the eligibility criteria determined using the PICO model. Population= toddlers. Intervention= diarrhea.Comparison: no diarrhea. Outcome: Stunting

Diarrhea is a disease characterized by changes in the form and consistency of liquid stools and the frequency of bowel movements more than usual (more than 2 times a day). The instrument used was a medical record document from a health center related to a history of diarrhea.

Stunting itself is a condition of failure to thrive in toddlers with a z-score <-2 for HFA (height for age)/height for age. The instrument used was an anthropometric measurement of TB/BB.

6. Study Instruments

The instrument in this study was an article on the relationship between history of diarrhea and the incidence of stunting in toddlers. This research using a checklist for critical assessment from a cross-sectional study (survey) sourced from the Center for Evidence Based Management (CEBMa) (2014).

7. Data Analysis

The research that has been collected is selected with predetermined criteria and then the results of the research will be analyzed based on variations between studies with the fixed effect model analysis model and random effect model using RevMan 5.4 software released by the Cochrane collaboration to calculate the overall OR value by describing the 95% Confidence Interval (CI) using the effects model and also data heterogeneity.

RESULTS

The process of searching articles is carried out through several journal databases, namely Google Scholar and PubMed. With keywords including: "Diarrhea" AND "Stunting" AND "adjusted Odds Ratio" OR "aOR" in the period 2017-2022. The process of reviewing related articles can be seen in the PRISMA flow in Figure 1. The selected research articles can be seen in Figure 2 that the research articles came from 2 continents, namely 4 articles from the continent of Asia (Indonesia, Pakistan), and 5 articles from the continent of Africa (Ethiopia and Uganda).

After conducting an initial search on the database, 1,079 articles were found, then 266 published multiple articles were deleted to obtain 813 articles. Followed by the process of selecting articles by issuing 360 so that there are still 453 full text articles that are considered feasible. Then as many as 444 full text articles were published, leaving 9 final articles which will be followed by a qualitative synthesis

Figure 2 shows the area of distribution of primary articles spread over 2 continents, namely 4 articles from the Asian Continent (Indonesia and Pakistan), 5 articles from the African continent (Ethiopia and Uganda).
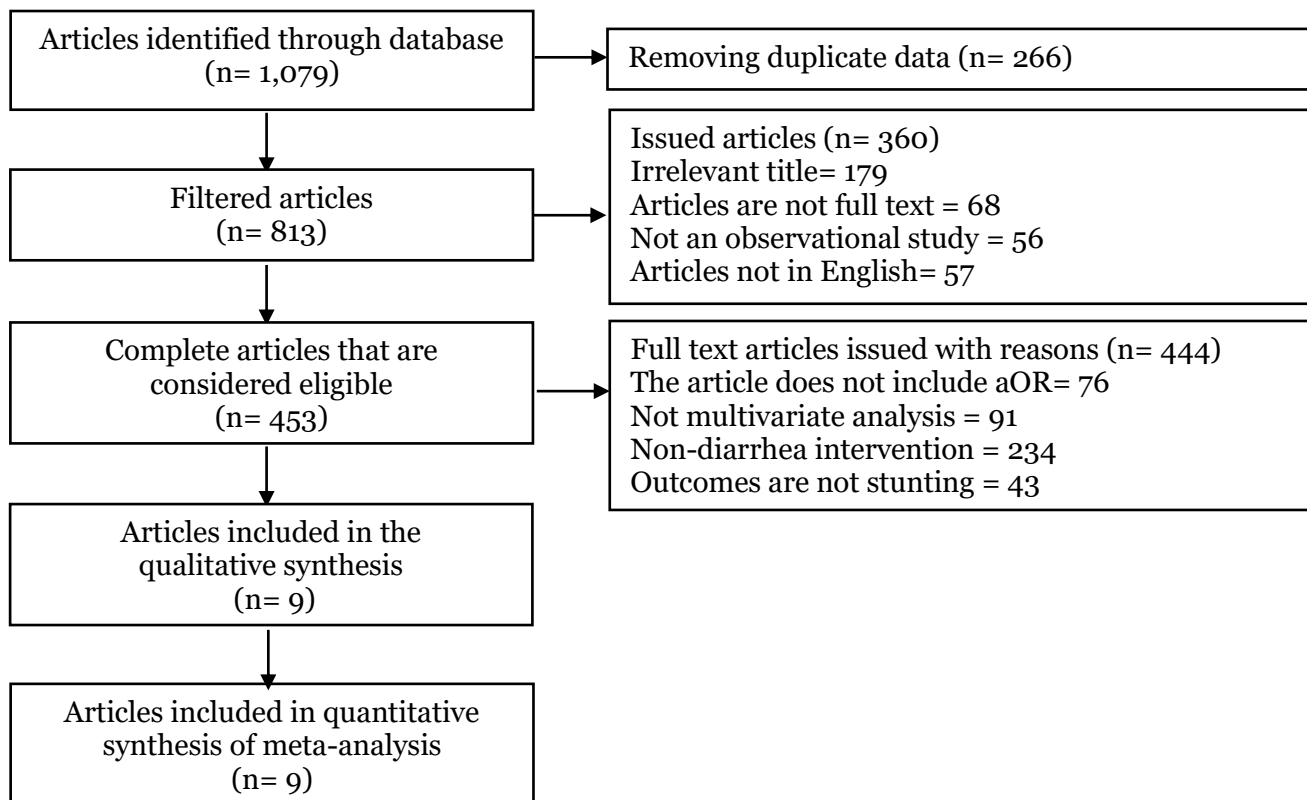
| Articles identified through database (n= 1,079) | → | Removing duplicate data (n= 266) |

| Filtered articles (n= 813) | → | Issued articles (n= 360)
Irrelevant title= 179
Articles are not full text = 68
Not an observational study = 56
Articles not in English= 57 |

| Complete articles that are considered eligible (n= 453) | → | Full text articles issued with reasons (n= 444)
The article does not include aOR= 76
Not multivariate analysis = 91
Non-diarrhea intervention = 234
Outcomes are not stunting = 43 |

Articles included in the qualitative synthesis (n= 9)

Articles included in quantitative synthesis of meta-analysis (n= 9)

Figure 1. PRISMA Flowchart

Figure 2. Research areas on the effect of vaccination on covid-19 infection

Table 1, researchers conducted an assessment of the quality of the study. The nine articles that have been obtained from Pubmed and Google scholar, need to be critically

assessed to determine the quality of the articles before being used as material for processing meta-analyses. This research was conducted using a checklist for critical assessment from a cross-sectional study (survey) sourced from the Center for evidence based management (CEBMa) (2014). This assessment criterion consists of 12 question criteria with each given a score of 2= if the answer is yes, 1= if the answer is uncertain, and 0= if no answer, then added up. The results of the summation of the scores that have been carried out get a total score of 24 answers, namely Ademas et al. (2021), Abeway et al. (2018), Amoako et al. (2020), and Sartika et al. (2021), Khan et al. (2019). In addition, there are 3 articles with a total answer score of 23, namely Mekonen et al. (2019), Desyanti and Nindya (2017), Badriyah and Syafiq (2017), as well as one article with a total score of 22, namely Dake et al. (2019).

Table 1. Critical appraisal checklist for cross-sectional studies on correlation between diarrhea and stunting in children under five

Author (Year)	Question Criteria												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
Dake et al (2019)	2	2	2	1	2	2	2	2	2	2	2	1	22
Mekonen et al. (2019)	2	2	2	1	2	2	2	2	2	2	2	2	23
Ademas et al. (2021)	2	2	2	2	2	2	2	2	2	2	2	2	24
Abeway et al. (2018)	2	2	2	2	2	2	2	2	2	2	2	2	24
Amoako et al. (2020)	2	2	2	2	2	2	2	2	2	2	2	2	24
Sartika et al. (2021)	2	2	2	2	2	2	2	2	2	2	2	2	24
Desyanti and Nindya (2017)	2	2	2	1	2	2	2	2	2	2	2	2	23
Badriyah and Syafiq (2017)	2	2	2	2	2	2	2	2	2	2	2	1	23
Khan et al. (2019)	2	2	2	2	2	2	2	2	2	2	2	2	24

Description of the question criteria:

1 = Does the study address clearly focused questions/problems?
2 = Is the research method appropriate to answer the research questions?
3 = Was the subject selection method clearly explained?
4 = Could the way the sample was obtained introduce selection bias?
5 = Does the subject sample represent the population to which the findings will refer?
6 = Was the sample size based on pre-study considerations of statistical power?
7 = Was a satisfactory response rate achieved?
8 = Are the questionnaire measurements likely to be valid and reliable?
9 = Was statistical significance assessed?
10 = Are confidence intervals given for the main outcome?
11 = Could there be any confounding factors that have not been recorded?
12 = Can the results be applied in your organization?

Answer score description:

0 = No
1 = Hesistant
2 = Yes

Table 2 shows 9 cross-sectional articles provide evidence of the association between history of diarrhea and the incidence of stunting in toddlers, with a total sample of 69,549 toddlers with an age range of 0-65 months.

Table 2. Summary of primary cross-sectional study articles with each PICO (N=69,549)

Author (Year)	Country	Total Sampel	P	I	C	O
Dake et al. (2019)	Ethiopia	342	Children aged 6-59 months	HAZ score <-2SD	HAZ scores between -2SD to +2SD	Stunting
Mekonen et al. (2019)	Ethiopia	616	Parents of toddlers.	HAZ score <-2SD	HAZ scores between -2SD to +2SD	Stunting
Ademas et al. (2021)	Ethiopia	630	Toddler	HAZ score < -2SD or <-3SD.	HAZ scores between -2SD to +2SD	Stunting
Abeway et al. (2018)	Ethiopia	410	Children aged 6 to 59 months	HAZ score < -2SD	HAZ scores between -2SD to +2SD	Stunting
Amoako et al. (2020)	Uganda	33,054	Children aged 6 to 59 months	WHO Child Growth Score < -2SD	The WHO Child Growth score -2 SD to +2SD	Stunting
Sartika et al. (2021)	Indonesia	559	Infants aged 0 to 11 months.	WHO Child Growth Score < -2SD	The WHO Child Growth score ranges from -2SD to +2SD	Stunting
Desyanti and Nindya (2017)	Indonesia	66	Toddler	HAZ score < -2SD	HAZ scores between -2SD to +2SD	Stunting
Badriyah and Syafiq (2017)	Indonesia	30,801	Toddlers under 2 years	WHO Child Growth Score < -2SD	The WHO Child Growth score ranges from -2SD to +2SD	Stunting
Khan et al. (2019)	Pakistan	3,071	Toddler	WHO Child Growth Score < -2SD	The WHO Child Growth score ranges from -2SD to +2SD	Stunting

Tabel 3. Adjusted Odds Ratio (aOR) of correlation between diarrhea and stunting in children under five (N=69,549)

Studies	aOR	95%CI	
		Lower Limit	Upper Limit
Dake et al (2019)	2.50	1.20	5.30
Mekonen et al. (2019)	1.25	1.06	1.48
Ademas et al. (2021)	1.79	1.13	2.83
Abeway et al. (2018)	2.79	0.99	7.90
Amoako et al. (2020)	2.90	1.50	2.91
Sartika et al. (2021)	1.06	0.79	1.40
Desyanti and Nindya (2017)	3.62	1.29	10.15
Badriyah and Syafiq (2017)	1.02	0.89	1.17
Khan et al. (2019)	1.10	0.45	2.60

Table 3 displays the amount of aOR in each selected article. It is necessary to pay attention to the collection of articles by selecting articles that have controlled for confounding factors, which can be seen from the study inclusion requirements, namely the adjusted odds ratio (aOR). According to Murti (2018), the confounding factor is the mixing of estimates of the relationship between exposure to the disease under study, and other factors that are related, both to disease and exposure.
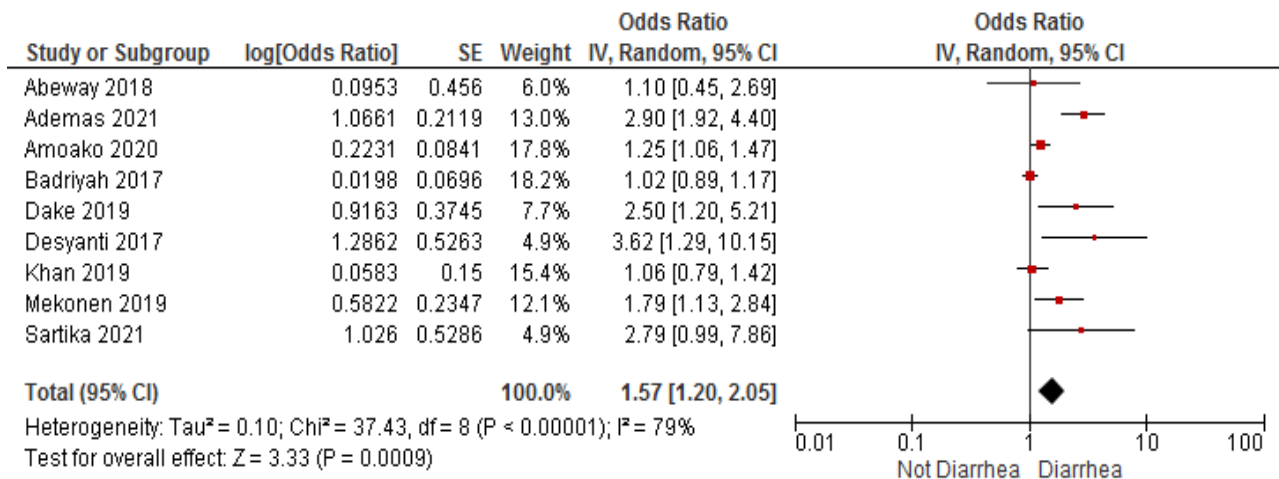
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Abeway 2018	0.0953	0.456	6.0%	1.10 [0.45, 2.69]
Ademas 2021	1.0661	0.2119	13.0%	2.90 [1.92, 4.40]
Amoako 2020	0.2231	0.0841	17.8%	1.25 [1.06, 1.47]
Badriyah 2017	0.0198	0.0696	18.2%	1.02 [0.89, 1.17]
Dake 2019	0.9163	0.3745	7.7%	2.50 [1.20, 5.21]
Desyanti 2017	1.2862	0.5263	4.9%	3.62 [1.29, 10.15]
Khan 2019	0.0583	0.15	15.4%	1.06 [0.79, 1.42]
Mekonen 2019	0.5822	0.2347	12.1%	1.79 [1.13, 2.84]
Sartika 2021	1.026	0.5286	4.9%	2.79 [0.99, 7.86]
Total (95% CI)			100.0%	1.57 [1.20, 2.05]

Heterogeneity: Tau² = 0.10; Chi² = 37.43, df = 8 (P < 0.00001); I² = 79%
Test for overall effect: Z = 3.33 (P = 0.0009)

Figure 3. Forest plot of meta-analysis the relationship between diarrhea and the incidence of stunting in toddlers
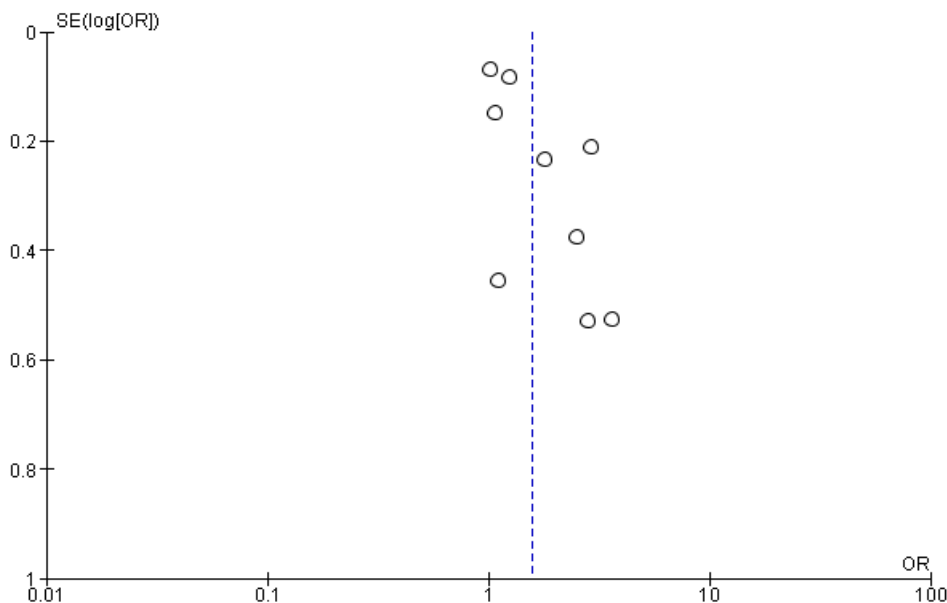
Figure 4. plot meta-analysis of the relationship between diarrhea and the incidence of stunting in toddlers

The forest plot in Figure 3 shows that there is a relationship between a history of diarrhea and the incidence of stunting in toddlers, and this relationship is statistically significant. Toddlers with a history of diarrhea have a risk of experiencing stunt-

ing 1.57 times compared to toddlers without a history of diarrhea (aOR= 1.57; 95% CI= 1.20 to 2.05; p< 0.001). The forest plot also shows high heterogeneity of effect estimates between studies (I2 = 79%; p <0.001) thus the calculation of the average effect estimate was carried out using the random effect model (REM) approach.

The funnel plot in Figure 4 shows that the distribution of effect estimates is asymetric to the right and left of the estimated mean vertical line. The effect estimates are more distributed to the right of the vertical line, thus identifying publication bias. Because the distribution of effects in the funnel plot lies to the right of the vertical line in the same direction as the average estimated effect (diamond shape) in the forest plot image which is also to the right of the vertical line, the publication bias tends to overstate the true effect (over-estimated).

DISCUSSION

This systematic study and meta-analysis research raised the relationship between a history of diarrhea in toddlers and the incidence of stunting. This research is considered important because there is a relationship between a history of diarrhea in toddlers and an increased risk of stunting. The results of a meta-analysis from 9 cross-sectional articles containing the relationship between diarrhea and the incidence of stunting showed that toddlers with a history of diarrhea were shown to have a 1.21 times the risk of experiencing stunting compared to toddlers who did not have a history of diarrhea (aOR = 1.57; 95% CI = 1.20 to 2.05; p < 0.001).

Several studies have shown a relationship between a history of diarrhea in toddlers and the incidence of stunting, one of which is the study by Dake et al. (2019) on toddlers in the city of Sodo Zuria, South

Ethiopia showed that 24.9% of toddlers experienced stunting, where one of the contributing factors was the incidence of diarrhea. Toddlers with diarrhea for a long time have a 2.5 times greater risk of experiencing stunting than toddlers who don't experience it. The results of Soboksa et al. (2021) on toddlers in the city of Jimma showed that toddlers with a history of diarrhea had a 9.22 times greater risk of experiencing stunting than normal toddlers.

The results of the study by Mekonen et al. (2019) in the city of Adama, Ethiopia found that of a total sample of children under five with undernourished and malnourished conditions, 34.1% had diarrhea in the last 2 weeks and 32.2% had three to four episodes of diarrhea in the past year. Furthermore, the results of the meta-analysis conducted by Danaei et al. (2016) covering toddlers in 137 developing countries in the world shows the fact that out of a total of 10.8 million cases of stunting in toddlers analyzed, as many as 5.8 million toddlers have a history of infection with diarrhea. While in a study by Verma (2017) it was reported that there was no significant relationship between stunting and the severity and duaration of diarrhea, however there was a significant relationship between wasted children and the severity and duration of diarrhea. The conclusion in this study is that there is a relationship between a history of diarrhea and the incidence of stunting in toddlers. The limitations of this study are the publication bias shown in the funnel plot results due to the varying number of samples from each study, as well as search bias because it only uses two databases, namely Pubmed and Google Scholar.

AUTHOR CONTRIBUTION

Reza Ramadhana Tahta Firmansyah is the main researcher in this study who chooses

topics, searches for and collects research data. Bhisma Murti and Hanung Prasetya analyzed the data and provided input throughout the research process to the end.

CONFLICT OF INTEREST
There is no conflict of interest in this study.

REFERENCES

Abeway S, Gebremichael, Murugan R, Assefa M, Adinew YM (2018). Stunting and its determinants among children aged 6–59 months in northern ethiopia: a cross sectional study. J Nutr Metab. 2: 1-8. doi: 10.1155/2018-/1078480.

Ademas A, Adane M, Keleb A, Berihun G, Tesfaw G (2021). Water, sanitation, and hygiene as a priority intervention for stunting in under-five children in northwest ethiopia: a community-based cross-sectional study. Ital J Pediatr. 47(174): 1-11. doi: 10.1186/s1-3052-021-01128-y.

Amoako GA, Karamagi C, Nangendo J, Okiring J, Kiirya Y, Aryeetey R, Mupere E, et al. (2020). Factors associated with concurrent wasting and stunting among children 6–59 months in karamoja, uganda. Child Care Health Dev. doi: 10.1111-/mcn.1-3074.

Badriyah L, Syafiq A (2017). The association between sanitation, hygiene, and stunting in children under two-years. Makara J Health Res. 21(2): 35-41. doi: 10.7454-/msk.v21i2.6002.

Desyanti C, Nindya TS (2017). Hubungan riwayat penyakit diare dan praktik higiene dengan kejadian stunting pada balita usia 24-59 bulan di wilayah kerja puskesmas simolawang, Surabaya. Amerta Nutrition J. 2(1):243-251. doi: 10.20473/amnt.v1i3.6251.

Choiroh ZM, Windari EN, Proborini A (2020). Hubungan antara frekuensi dan durasi diare dengan kejadian stunting pada balita usia 24-36 bulan di desa Kedungrejo kecamatan Pakis (The relationship between the frequency and duration of diarrhea and the incidence of stunting in toddlers aged 24-36 months in Kedungrejo village, Pakis sub-district). J Issue Midwifery. 4 (3):131-141. doi: 10.21-7-76/ub.JOIM.2020.004.03.4.

Dake SK, Solomon FB, Bobe K, Tesfahun M, Tekle HA, Tufa EG (2019). Predictors of stunting among children 6–59 months of age in sodo zuria district, south Ethiopia: a community based cross sectional study. BMC Nutr. 5 (23). doi:10.1186/s40795-019-0287-6.

Danaei G, Andrews KG, Sudfeld CR, Fink G, McCoy DC, Peet E, Sania A, et al. (2016). Risk factors for childhood stunting in 137 developing countries: a comparative risk assessment analysis at global, regional, and country levels. PLoS Med. 13(11): 1-18. doi: 10.1371/-journal.pmed.1002164.

Kemenkes RI (2021). Buku saku hasil studi status gizi indonesia (ssgi). Jakarta: Litbang Kemenkes RI.

Kemenko PMK (2022) Kejar target! per tahun prevalensi stunting harus turun 3 persen, Kementerian Koordinator Bidang Pembangunan Manusia dan Kebudayaan.

Khan S, Zaheer S, Safdar NF (2019). Determinants of stunting, underweight and wasting among children <5 years of

age: evidence from 2012-2013 pakistan demographic and health survey. BMC Nutr. 19(358): 1-15. doi: 10.1186/s12889-019-6688-2.

Lestari MEP, Siwiendrayanti A (2021). Kontribusi kondisi fisik lingkungan rumah dengan kejadian diare dan hubungannya terhadap kejadian stunting. Indones J Hum Nutr. 1(3): 355-361. doi: 10.15294/IJPHN.V1I3.47482.

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 Pangan, Gizi dan Kesehatan. 16(1): 99–108.

Mekonen J, Addisu S, Mekonnen H (2019). Prevalence and associated factors of chronic undernutrition among under five children in Adama town, central Ethiopia: a cross sectional study design. BMC Res Notes. 12(532): 1-6. doi: 10.1186/s13104-019-4552-1.

Murti B (2018). Prinsip dan metode riset epidemiologi (5th ed). Program Studi Ilmu Kesehatan Masyarakat, Program Pascasarjana, Universitas Sebelas Maret.

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

Sema B, Azage M, Tirfie M. Childhood stunting and associated factors among irrigation and non-irrigation user northwest, Ethiopia: a comparative cross-sectional study. Ital J Pediatr. 47(1). doi: 10.1186/s13052-021-01048-x.

Soboksa NE, Gari SR, Hailu AB, Alemu BM (2021). Childhood malnutrition and the association with diarrhea, water supply, sanitation, and hygiene practices in kersa and omo nada districts of jimma zone, Ethiopia. SAGE Open. doi: 10.1177/1178630221999635

Verma S, Zaheer S, Safdar NF (2019). Determinants of stunting, underweight and wasting among children <5 years of age: evidence from 2012-2013 pakistan demographic and health survey. BMC Nutr. 19(358): 1-15. doi: 10.1186/s12889-019-6688-2.

WHO (2021). Stunting prevalence among children under 5 years of age (%) (model-based estimates). World Health Organization.