DRINKING WATER QUALITY AS A RISK FACTOR OF STUNTING : SYSTEMATIC REVIEWS

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ABSTRACT

Stunting is a nutritional problem that needs attention because of its risk to future generations. The causes of stunting are related to environmental factors such as sanitation and drinking water quality. Intervention efforts are carried out to improve sanitation and drinking water quality, which is regarded as a risk factor. This article reviewed literature relevant to the topic from Science Direct, Scopus, EBSCO (CINAHL, MEDLINE), and Proquest databases from 2020-2024 publications with the keywords Water Quality and Stunting, then analyzed using a synthesis matrix. The inclusion criteria for this study were articles in English with a correlational design and full text. The results of the journal review found six articles that stated that sanitation factors, especially the quality of drinking water, were the cause of the stunting problem. The quality of drinking water is related to bacterial contamination due to disasters (floods), risk factors for unhealthy behavior, and open toilets. Poor water quality causes infection, which indirectly affects other factors that affect linear growth (weight and height), which are indicators of stunting. Interventions reduce the prevalence of stunting by improving sanitation, especially the quality of proper drinking water, and improving clean living behavior in the community.

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INTRODUCTION

Stunting (short children) is a nutritional problem faced in the world, especially in poor and developing countries. Stunting is associated with an increased risk of morbidity and mortality and sub-optimal brain development, resulting in delayed motor development and retarded mental growth.[1] Stunting incidence factors include changes in behavior and practices for stunting prevention.[2] Behavior change is carried out at the individual, family, group,

organizational, and policy levels.[3]

Epidemiologically, the cause of stunting is related to environmental factors such as proper sanitation and drinking water.[4] Adequate drinking water has physical and chemical requirements that are safe from microbiology, chemistry, and radioactivity contaminants. Parameters of good physical quality of water that meet the requirements are not turbid, tasteless, odorless, or colorless.[5] Many households have access to proper facilities but produce low-quality water.[6]

The results of the Water Quality Survey found that almost 67% of households consumed water contaminated with *Escherichia coli* (*E.coli*) bacteria, which is indicated by waste or animal waste.[7] Research states that water sources contain coliforms that do not meet standards and contain *E.coli* bacteria.[8] Research in Jakarta found that drinking water quality from the physical, chemical, and microbiological parameters exceeded the standard threshold due to exposure to organic compounds and microorganisms at risk of infection.[9]

According to a research by the Ministry of Health, Republic of Indonesia, stunting is caused by the absence of clean water and poor sanitation at 60%, while malnutrition is at 40%. The implementation of the Household Drinking Water Quality Study (*Studi Kualitas Air Minum Rumah Tangga* / SKAMRT) is a form of Indonesia's support to achieve SDGs Goal 6 and the 2030 National Medium Term Development Plan (*Rencana Pembangunan Jangka Menengah Nasional* / RPJMN).[10] The crisis of proper drinking water is the cause of children's growth problems because of poor waste management, which affects the contamination of water sources.[11]

Adequate drinking water is a factor in infectious diseases that have an impact on children's growth and development problems, including stunting.[12] People who do not have access to proper drinking water are at risk of health problems, especially stunting. Clean water prevents the development of diseases that, together with sanitation and hygiene, affect poor nutritional status.[13] Studies mention sanitation (one of which is the category of access to clean water and behavior in drinking water treatment) as a predictor of stunting.[14]

Rezki's research also found that stunting is caused by a lack of proper drinking water sources and poor physical quality of drinking water.[15] The quality of drinking water includes the source of clean water and the behavior of using water or habits in treating this clean water. Communities store drinking water in gallons, buckets, or other storage areas, which is an important indicator in assessing patterns of community drinking water consumption. Storage of drinking water that is not clean and proper causes the risk of drinking water contaminated with bacteria, so it is at risk of experiencing diarrhea.[16]

Contamination of drinking water often occurs not because of the source of the drinking water but due to habits in water storing and dirty place and environments which makes it easier for bacteria to enter the drinking water.[17] Hasan's research explains that there is a relationship between the physical quality of water and the incidence of stunting.[18] Families without adequate water sources are 2,182 times more at risk of stunting in their toddlers than families with adequate water sources.[19] Requirements for drinking water are appropriate if it meets the

physical quality, including not being cloudy, colorless, odorless, does not contain solids, and tastes fresh and the processing method is cooked before consumption.[20] Lack of clean water for daily use causes infectious diseases such as diarrhea and intestinal worms, sotoddlers experience impaired absorption of nutrients in the digestive process, which results in decreased toddler weight.[21]

Drinking water management behavior as a pattern of water consumption has a relationship with stunting, underweight, and wasting. Inappropriate water management behavior has the risk of causing water to be contaminated with diarrhea-causing bacteria, which can cause nutritional problems in children.[22] Water used for everyday life should be provided from water sources that meet the quality and quantity of clean water.[23] Access to clean water sources is related to the incidence ofstunting. Families who do not have access to clean water sources for their toddlers have a 5.99 risk of suffering from stunting. The pattern of drinking water consumption, including storing, serving, and using container for drinking water, also pose a risk of water contamination.[24] The purpose of this review was to determine the risk factors of drinking water quality that may cause stunting.

METHOD

Methods of literature review and knowledge synthesis, which identify trends and gaps in an existing knowledgebase or scope of knowledge, for the purpose of informing research, policy,and practice.[25] Literature review is anintegrated analysis of scientific writing related to research questions. How tocollect data about themes taken from database sources on the internet.[26]

The stages of compiling a literature review refer to Arksey and O'Malley regarding the framework for compiling a scoping review, then modified by Levac, Colquhoun, and O'Brien.[27] These stages are explained as follows:

Stage 1: Research questions identification.

The research question for this literature review was "Are there any risk factors for drinking water quality with stunting?"

Stage 2: Relevant research identification.

The inclusion criteria of the literature were as follows: articles with cross-sectional studies, cohorts, and meta-analyses, published in 2020, and in English. The databases used were Science Direct, Scopus, EBSCO, CHINAHL, MEDLINE, and Proquest. The literature search was conducted in May 2023. Keywords adjusted to the Medical Subject Heading (MeSH), namely Water Quality and Stunting.

Stage 3: Research selection.

The first selection was by searching relevant titles. Irrelevant titles were excluded, while the duplicated articles were managed using the reference manager Mendeley.The selection of studies from the database identified 35.745 articles. After screening, 4.465 articles were obtained. The screening was done by excluding unsuitable themes so that six articles were obtained. Then the abstracts of the articles were reviewed and those that matched the established inclusion criteria were identified.

Stage 4: Data mapping

The selection was carried out using PRISMA, and six articles were selected (Figure 1). Data extraction was carried out in Microsoft Word by creating a table containing the following components: title, researchers (year), methods, results, and conclusions (Table 1).

Stage 5: Result, compiling, summarizing, and reporting

The articles were summarized descriptively and compared to those reviewed. A more specificsummary included significant and non-significant results.

Stage 6: Consultation with competent parties

Results of the analysis (review) were consulted with experts to obtain feedback that can be integrated with knowledge that may not be accessible through academic literature.

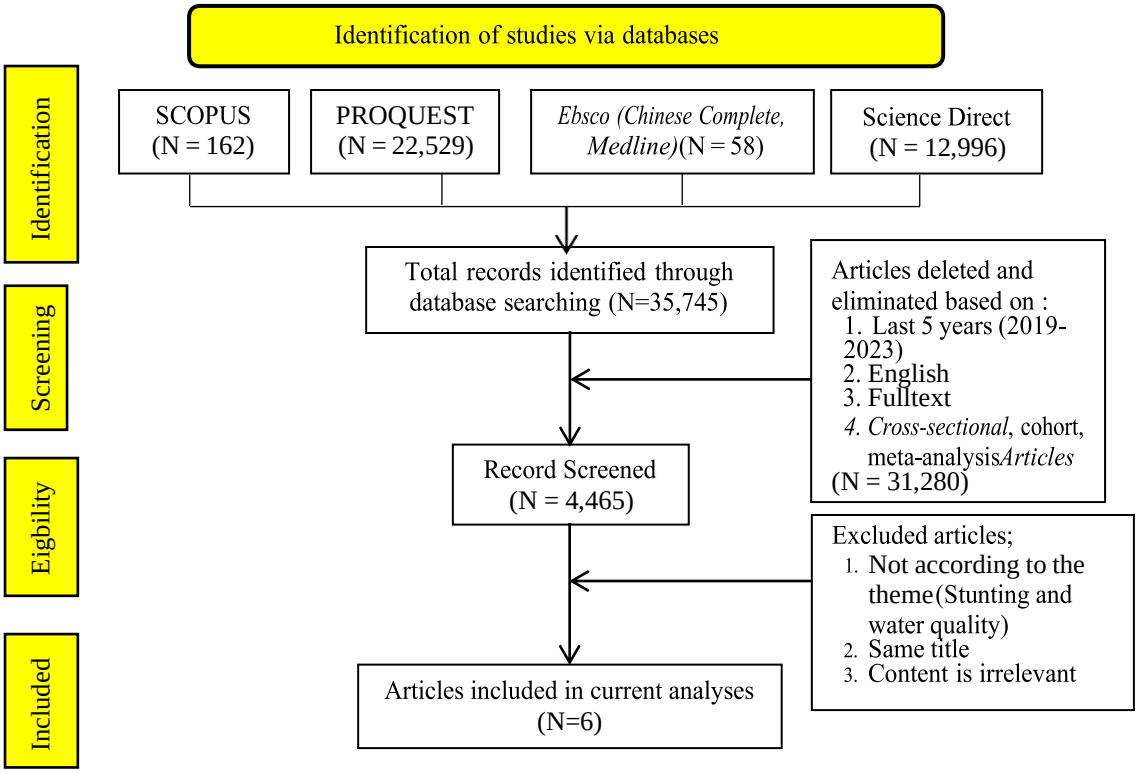

Figure 1: PRISMA Flowchart

Table 1 Article Search Results

No	Title	Researcher (Year)	Method	Results	Conclusion
Science Direct					
1.	Environmental factors related to children diagnosed with stunting 3 years ago in Salatiga City, Central Java, Indonesia,	Nurjazuli, Budiyono, Mursid Raharjo, Nur Endah Wahyuningsih , 2023.	Cross-sectional observational study design.	Stunting (22%) with a z score of 3 to 2 standard deviations (SD), followed by severe stunting (8%) with an az score of 3 SD, dominates the assessment of stunting status for toddlers in 2021. The study shows that environmental factors do not contribute to stunting. However, boiled water is considered a risk factor for stunting. Furthermore, our analysis shows that exclusivebreastfeeding is correlated with stunting and provides a protective factor for stunting in toddlers.	Exclusive breastfeeding correlates with the incidence of stunting. The environment is not related to stunting, but boiled water is related to stunting.
2.	Lead exposure and stunting incidents in children aged 3–5 years in Pontianak City, West Kalimantan, Indonesia,	Slamet Wardoyo, Nurjazuli Nurjazuli, Yusniar Hanani Darundiati, 2022.	The research method used a case-control approach with a sample of 60 children aged 3-5 years. Data collection was carried out from August to November 2021.	The results showed that there were differences in the urinary Pb levels of affected children compared to healthy toddlers ($P \leq 0.001$), while the Pb levels in drinking water sources were not significantly different. on the incidence of stunting in toddlers (P=0.068).	It was concluded that there were differences in the Pb content of urine, but there was no significant relationship between Pb levels in drinking water sources and the incidence of stunting in children.
EBSCO					
3.	Nutritional and health status of children 15 months after integrated school garden, nutrition, and water, sanitation, and hygiene interventions: a cluster randomized	Shrestha, A., Schindler, C., Odermatt, P., Gerold, J., Erismann, S., Sharma, S., Koju, R., Utzinger, J., Cissé, G, 2020	Cluster-randomized controlled trial involving 682 children aged 8-17 years from 12 schools. Schools were randomly allocated to one of three interventions: (a) school garden program (SG; 4 schools, n=172 children); (b) school garden program with complementary WASH, health, and nutrition Interventions (SG+; 4 schools, n=197 children); and (c) no specific intervention (control; 4	Stunting decreased slightly at SG+ (19.9 to 18.3%; p= 0.92) and in controls (19.7 to 18.9%). Anemia decreased slightly in SG+ (33.0 to 32.0%; p< 0.01) and increased markedly in the control (22.7 to 41.3%; p<0.01). A small decrease was found in the control (43.9 to 42.4%). Washing hands with soap before eating greatly increased SG+ (from 74.1 to 96.9%; p=0. 01, compared to controls, where only a	Integrated interventions consisting of school gardens, WASH, nutrition, and health components (SG+) increase children's fruit and vegetable consumption, reduce intestinal parasite infections, and improve hygiene behavior.

	a controlled trial in Nepal		schools, n=313 children). The same field and laboratory procedures were used for the initial survey (March 2015) and the final survey (June 2016). Questionnaires were administered to evaluate WASH conditions in schools and households. Water quality was assessed using the Delaguakit. Food intake with food frequency and a 24-hour recall questionnaire. Hemoglobin levelwith the HemoCue digital device and used as a proxy for anemia. Stool samples with a range of copro-microscopic diagnostic methods are used to detect intestinal protozoa and helminths. Changes in key indicators between the baseline and end-line surveys wereanalyzed by linear and mixed logistic regression.	slight increase was observed from 78.0 to 84.0%). Similar observations were made for hand washing after defecation (increased from 77.2 to 99.0% in SG+ versus 78.0 to 91.9% in controls, p=0.15).	
4.	Association between water, sanitation and hygiene (WASH) and child undernutrition in Ethiopia: a hierarchical approach	Sahiledengle, Biniyam Petrucka, Pammla Kumie, Abera Mwanri, Lillian Beressa, Girma Atlaw, Daniel Tekalegn, Yohannes Zen baba, Demisu Desta, FikreabAgho, Kingsley Emwinyore, 2022	Secondary data analysis was performed based on the Ethiopian Demographic and Health Survey (EDHS) conducted from 2000 to 2016. A total of 33,763 recent live births extracted from the EDHS reports were included in the current analysis. Multilevel logistic regression model to investigate the relationship between WASH and child malnutrition. Relevant factors from the EDHS data were identified after an extensive literature review.	The overall prevalence of stunting and wasting were 47.29% [95% CI: (46.75, 47.82%)] and 10.98% [95% CI: (10.65, 11.32%)]. Children from households with inadequate toilets facilities [AOR: 1.20, 95% CI: (1.05,1.39)], open defecation [AOR: 1.29, 95% CI: (1.11,1.51)], and live in Households with dirt floors [AOR: 1.32, 95% CI: (1.12,1.57)] were associated with a higher likelihood of being stunted. Children from households with inadequate drinking water sources were significantly less likely to be wasted [AOR: 0.85, 95% CI: (0.76,0.95)] and stunted [AOR: 0.91, 95% CI: (0.83, 0.99)]. It found no difference between better sanitation, safe disposal of children's feces, or better household flooring and child wastage.	The quality of access to sanitation and housing conditions affects children's linear growth indicators. The source of household drinking water does not predict wasting or stunting. Further longitudinal studies and interventions are needed to determine whether individual and shared access to WASH facilities are strongly associated with stunting and wasting in children.

Scopus					
5.	Water, hygiene and sanitation practices are associated with stunting among children of age 24-59 months in Lemo district, South Ethiopia, in 2021: community based cross sectional study	Woldesenbet, Biruk., Tolcha, Alemu., Tsegaye, Berhan, 2023	A community-based cross-sectional study was conducted from January 1-30 2021. Data was collected from a total of 415 children and their mothers, guardians, or randomly selected. Logistic regression analysis was performed to identify factors associated with stunting in children. In the binary logistic regression analysis, independent variables with a p-value <0.25 were included in the multivariable logistic regression analysis to explore the final predictors of stunting or thinness. Independent variables with an AOR of 95% CI and a P value <0.05 were calculated and reported as predictors of stunting in children in this study.	Out of a total of 450 children, only 415 were included in the final analysis, with a response rate of 92.2%. The prevalence of stunting in children was 33.5% (95% CI: 30.4 and 36.6%) in this study. Children aged 48-59 months (AOR = 2.8, 95% CI: 2.1, 12.1), children aged 36-47 months (AOR = 1.6, 95% CI: 1.1, 7.1), children of uneducated mothers (AOR = 1.8, 95% CI: 1.5, 4.2), children who live near inadequate toilets (AOR = 1.7, 95% CI: 1.2, 2.6), children whose feces were disposed of unsafely (AOR = 2.8, 95% CI: 1.57, 5.31), and children whose mothers did not wash their hands before feeding their children (AOR = 6.2, 95% CI: 2.0, 19.1) were factors that were positively related to stunting in children aged 24 months to 59 months.	The prevalence of stunting is relatively high compared to the national prevalence of stunting in food-insecure areas. Policymakers, local leaders, and public health educators should improve environmental sanitation and create awareness about personal hygiene. In addition, the construction of better toilets and their proper utilization should be encouraged. In addition, local government must work to improve the socioeconomic status of poor households.
ProQuest					
6.	Prevalence and determinants of stunting among preschool and school-going children in the flood-affected areas of Pakistan	I. ul Haq, Z. Mehmood, T. Afzal, N. Khand, B. Ahmede Nawsherwanf L. Alig, A. Khana, J. Muhammadh, EA Khani, J. Khani, SA Zakki J. Xuk And Y, Shu, (2021)	A cross-sectional study was conducted by visiting 656 households through multi-stage sampling. Respondents' anthropometric measurements, socio-demographic information, and facility sanitation were explored. The logistic regression model was used to determine the determinants of stunting, controlling for all possible confounders.	The overall prevalence of stunting in children is 40.5%, in boys 36.1%, and in girls 46.3%. The prevalence of stunting in toddlers is 50.7%. Girls (OR=1.35, 95% CI: 0.94 – 2.0), children aged 13-24 months (OR=6.5, 95% CI: 3.0 – 13.9) mothers aged 15-24 years (OR=4.4, 95% CI: 2.6 – 7.2) joint families (OR=2.1, 95% CI: 1.4 – 3.0) do not have access to proper drinking water (OR=3.3, 95% CI: 1.9 – 5.9) and toilet facilities (OR=2.8, 95% CI: 1.9 – 4.3), whereas children from Nowshera district (OR=1.7, 95% CI: 0.9 – 3.2) were significantly related (P<0.05) in univariate analysis.	The regression model revealed that the child's mother's age, type of family, water quality, and toilet facilities were significant factors (P<0.05) contributing to child stunting in flood-affected areas. Identification of key factors may be useful for policymakers in designing a comprehensive community-based program for stunting reduction in flood-affected areas.

RESULTS

An article search using the keywords water quality and stunting yielded 35,745 articles. Then, the selection process was based on inclusion criteria, obtaining 4,465 articles, then 4,459 articles were excluded with relevant themes, so six articles were obtained.

A review of the six articles found that stunting is a national problem that must be considered by all elements of society. Stunting is a nutritional problem in children caused by four major categories, i.e. family and household; inadequate supplementary and complementary foods; breastfeeding; and infection.[28] Environmental factors related to sanitation, especially the quality of drinking water, are the cause of the stunting problem.[29] The quality of proper drinking water has a correlation with the high incidence of stunting, as research has found that the risk factor for consumption patterns (boiled water) is correlated with the incidence of stunting.[30] Children's growth is linearly influenced by sanitation conditions, but a study in Ethiopia did not find water quality to be significantly related to the incidence of stunting.[31] The quality of drinking water is poor due to lead contamination, but lead levels are not related to the incidence of stunting. Water contamination is related to the content of bacteria in the water consumed by the public.[32]

A research in Pakistan found that family habits related to poor cleanliness (bacterial contamination) and lack of toilet facilities results in poor water quality that leads to the high prevalence of stunting.[33] Nurjazuli et al. found that the risk factors for stunting based on environmental conditions were the quality of drinking water and people's habits of storing and processing the drinking water.[34]

Poor sanitation (inadequate water) caused by exposure to bacteria in the environment and risky behavior is associated with a high prevalence of stunting in children aged 24-59 months in Ethiopia.[35] The effort to eliminate stunting is to suppress risk factors, one of which is access to proper drinking water. Sanitation improvement interventions (including drinking water quality) are effective steps in reducing the incidence of stunting, decreasing intestinal bacterial infections, and increasing hygiene behavior.[36]

DISCUSSION

The purpose of this literature review was to identify the relationship between risk factors for drinking water quality and the incidence of stunting. Drinking water must meet the principles of hygiene and sanitation by ensuring the quality of the water does not contain microbiological, physical, chemical, or radioactive elements that can endanger health.[37] Physically, water must be clean and not cloudy, colorless, tasteless, or odorless; the temperature must not be more than 3°C above the air temperature and there must be no precipitate. The chemical requirements of the drinking water include the absence of chemicals above the threshold, the pH of the water 6.5-8.5, and the hardness value not exceeding normal limits. Hard water contains essential minerals that the body needs, namely the elements of Mg, Ca, Fe, and Mn.[38]

Sanitation with water quality indicators in the population of children

aged < 2 years can prevent stunting five times. This study also states that the quality of drinking wateris poor because it is often contaminated due to the habit of defecating in the open. This is 10 times more likely to cause infection problems and developmental disorders in children. Community habits are a risk factor for stunting, such as cleanliness and drinking water treatment.[39]

The requirements for drinking water are good if it meets the requirements for the physical quality of drinking water, including not being cloudy, colorless, odorless, not containing solids, tasting fresh, and how it is processed and cooked before consumption.[20] The importance of the use of water must be balanced with the provision of water sources that can provide water with good quality and quantity.[23]Access to clean drinking water containing essential minerals is very important in preventing stunting because mineral water supports the fulfillment of children's nutrition, especially the need for minerals for growth.[40]

Lack of cleanliness of the water used daily causes infectious diseases such as diarrhea and intestinal worms, so toddlers will experience impaired absorption of nutrients in the digestive process, which results in a decrease in toddler weight.[21] Drinking water management behavior has a relationship with stunting, underweight, and wasting. Water containing chemicals reduces the absorption of calcium and iodine, while water contaminated with bacteria causes diarrhea and disrupts intestinal absorption, causing nutritional problems in children.[22]

A research in India proved that improving the quality of drinking water can help reduce the proportion of underweight children.[41]Water is a vital human need, where access to clean water in terms of quality, quantity, and continuity indicates water borne diseases such as diarrhea and the accumulation of chemicals in the body. Children with diarrhea cause the body's essential substances (macro andmicrominerals) to come out, thereby disrupting the growth process. Chemicals such as lead can damage the process of intestinal absorption of iron, which is important for growing children.[29]

Clean water quality is a protective factor for waterborne diseases. This factor does not stand alone but acts as an indirect factor that, together with the parenting style and habits of parents in providing food and drinks to their children, causes fecal-oral infections to occur, which causes stunting problems.[30] A research in Ethiopia reported that problems with sanitation and access to drinking water in quality and quantity, together with clean living behavior (especially the habit of providing drinking water), are factors that cause stunting.[42]

The need for clean water is increasing as a consequence of an increase in population. The river, which is its source, has been polluted with various kinds of waste ranging from organic, household waste, to industrial toxic waste.[43] The lack of proper drinking water is due to the poor waste management process, which causes waste substances to enter drinking water sources.[44] Water pollution causes high casesof infection, and chemicals reduce the mineral content of water which results in poor drinking water, quality.[45]

The hardness of drinking water at a

certain level is beneficial, but when the hardness becomes high and is consumed by humans for a long time, it can be detrimental to health.[46] Research states that chemical pollution due to the environment and people's behavior in drinking water causes a decrease in the amount of iodine in the body and has a direct impact on the production ofgrowth hormones (thyroid hormone, growth hormone).[47] Contamination that exceeds the threshold causes stunting problems dueto reduced serum insulin-like growth factor-1 (IGF-1) and Growth Hormone Deficiency (GHD) as growth hormones.[48]

Sanitary measures to improve water quality by preventing contamination of drinking water through piped water supply chlorination programs, the use of water filters, and clean water containers will prevent environmental-based infections and prevent child growth problems, including stunting.[49] Programs in India also prioritize improving nutrition and sanitation, especially the quality of drinking water, to reduce stunting.[50]

CONCLUSION

The quality of drinking water is a risk factor associated with the incidence of stunting.

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CONFLICT OF INTEREST

All authors in this literature review do not have any conflict of interest.

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AUTHOR CONTRIBUTION

All authors have contributed to all processes in this literature review, including preparation, data collection and analysis, preparation, and approval for publication of this manuscript.

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