ISSN: 3032-3134 (ONLINE)
InaJBCS | Indonesian Journal of Biomedicine and Clinical Sciences

Association between undernutrition and language delay in children under 5 years old: a systematic review

Lulus Hardiyanti[1]*, Anindya Khairunnisa Zahra[1], Fara Azmiarrizqi[2], Amelia Nur Khasanah[2], Sheila Agustika Herliv[2], Ardiyuga Pratitapraya[2], Puguh Oktavian[3]

[1]Faculty of Medicine, Nursing, and Public Health Universitas Gadjah Mada/Dr. Sardjito General Hospital, Yogyakarta, Indonesia, [2]Faculty of Medicine, Nursing, and Public Health Universitas Gadjah Mada, Yogyakarta, Indonesia, [3]Faculty of Medicine Universitas Airlangga, Surabaya, East Java, Indonesia

https://doi.org/10.22146/inajbcs.v57i2.19291

Submitted: 2025-01-12
Accepted : 2025-04-16

ABSTRACT

In 2022, global statistics of the WHO (World Health Organization) reported 148.1 million children under 5 years old were too short for their age (stunting), 45.0 million were too thin for their height (wasting), and 37.0 million were too heavy for their height (overweight). Solving the problem of undernutrition is included in the second goal of the Sustainable Development Goals. Language skills are one of the important aspects of development in children. This study aimed to assess the association between undernutrition and language delay in children under 5 years old. We searched PubMed, Scopus, and Web of Science for relevant studies published in 2014-2024. We identified studies that analyzed children under 5 years old with undernutrition and screenings for language delay, full-text, Indonesian, and English language studies, used cross-sectional studies, case-control studies, cohort studies, and RCT study designs. The risk of bias was assessed using the ROBINS-E tool. There were 4,865 articles of search results in 3 databases consisting of PubMed, Web of Science, and Scopus. A total of 16 articles, including 11 cross-sectional studies and 5 cohorts, were analyzed. An association was observed between undernutrition and language delay. Other factors that significantly influenced language delay were paternal education, maternal education, and stimulation. Most studies report that the more severe the conditions of wasting, stunting and underweight will cause more severe conditions of language delay.

ABSTRAK

Pada tahun 2022, statistik global WHO (*World Health Organization*) melaporkan 148,1 juta anak di bawah usia 5 tahun terlalu pendek untuk usianya (stunting), 45,0 juta terlalu kurus untuk tinggi badannya (*wasting*), dan 37,0 juta terlalu berat untuk tinggi badannya (*overweight*). Penyelesaian masalah kekurangan gizi termasuk dalam tujuan kedua dari *Sustainable Development Goals*. Keterampilan bahasa merupakan salah satu aspek penting dalam tumbuh kembang anak. Penelitian ini bertujuan untuk mengkaji hubungan antara kekurangan gizi dengan keterlambatan bahasa pada anak usia di bawah 5 tahun. Kami menelusuri PubMed, Scopus, dan Web of Science untuk penelitian relevan yang diterbitkan pada tahun 2014-2024. Kami mengidentifikasi penelitian yang menganalisis anak usia di bawah 5 tahun dengan kekurangan gizi dan skrining untuk keterlambatan berbahasa, studi teks lengkap, bahasa Indonesia, dan bahasa Inggris, menggunakan rancangan studi potong lintang, studi kasus-kontrol, studi kohort, dan studi RCT. Risiko bias dinilai menggunakan alat ROBINS-E. Terdapat 4.865 artikel hasil penelusuran dalam 3 basis data yang terdiri dari PubMed, *Web of Science*, dan Scopus. Sebanyak 16 artikel yang dianalisis meliputi 11 studi potong lintang dan 5 kohort. Ditemukan hubungan antara gizi kurang dengan keterlambatan berbahasa. Faktor lain yang berpengaruh nyata terhadap keterlambatan berbahasa adalah tingkat pendidikan ayah, tingkat pendidikan ibu, dan stimulasi. Sebagian besar studi melaporkan bahwa semakin berat kondisi *wasting*, stunting, dan *underweight* akan menyebabkan kondisi keterlambatan berbahasa yang lebih berat.

Keywords:
delay;
disorder;
impairment;
language;
undernutrition

*corresponding author: lulus.hardianti@ugm.ac.id

INTRODUCTION

In 2022, global statistics of the WHO reported that148.1 million children under 5 years old were too short for their age (stunting), 45.0 million were too thin for their height (wasting), and 37.0 million were too heavy for their height (overweight).[1] The prevalence of stunting in children under 5 yo. was 22.3% in 2022.[1] In addition, solving the problem of undernutrition is included in the second goal of the Sustainable Development Goals, namely end hunger, achieve food security and improved nutrition and promote sustainable agriculture.[2]

Malnutrition is a condition that can result from either a lack or an excess of energy and nutrient intake. It includes undernutrition, deficiency or excess of essential micronutrients, and overweight or obesity. Undernutrition refers to a condition where body weight is low for one's height, stunting is characterized by short stature relative to age and gender, and underweight is where body weight is low for one's age and sex.[3]

There are no specific studies showing that malnutrition causes disorders in certain parts of the brain, that directly result in language delays. However, studies showed that severe malnutrition can cause abnormalities in the brain structure in the form of cerebral atrophy, especially in the frontal and prefrontal lobes.[4] In the frontal lobe there is Broca's area which plays an important role in language production.[5] In addition, undernutrition conditions such as stunting can inhibit the nerve myelination system, causing cognitive disorders.[6] The first 2000 days of a child's life up to around 5 years, is a period of rapid brain development and a critical window that influences the child's future therefore, this study focuses on children under 5 years old.[7]

Language skills are one of the important aspects of development in children. Verbal communication depends on the ability to speak and understand language. The prevalence of speech and language delay in the world varies in the range of 3-20% depending on the age of the child.[8] In 2017, the prevalence of language delay in Saudi Arabia children was 24.5 percent based on a previous study.[9] Language and speech are two distinct terms. Language ability refers to a system for expressing thoughts, emotions, ideas, and intentions while speech is the verbal expression of language.[10] This study focuses on language delays.

Language ability is influenced by both environmental and genetic factors. Environmental factors are modifiable factors, and therapeutic intervention can be provided to achieve better outcomes. In this study, the author focus on undernutrition because it is a modifiable factor.[9]

Undernutrition and language delay are common issues in many regions worldwide, significantly affecting a child's overall quality of life. Currently, there are many studies discussing undernutrition and language delay, but there has not been a conclusive summary from various studies. This study aimed to evaluate the association between undernutrition and language delay in children under 5 yo.

MATERIAL AND METHODS

Eligibility Criteria

The inclusion criteria applied are studies that exhibit the following characteristics: (1) subject population under 5 years old; (2) have nutritional status [height/length-for-age z-score (HLZ), weight-for-age z-score (WAZ), weight-for-height/length (WHZ)] data; (3) Indonesian or English language; (4) full text access; (5) have language development measurement; (6) published from 2014-2024; and (7) used

cross-sectional case-control cohort or RCT study designs. The exclusion criteria were: (1) children with congenital disease, (2) children with neurological disease, (3) children with chromosomal abnormalities, and (4) children with physical disabilities (e.g., deafness, anatomical abnormalities).

Data sources and search strategy

This systematic review was conducted and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement.[11] In order to identify potential literature, a search was conducted through three databases: PubMed, Web of Science, and Scopus with specific keywords. The search process used keywords and Boolean operators "AND" or "OR" to diversify the scope and identify important sources. The following keyword were used for this study (length-for-age, height-for-age, weight-for-age, weight-for-length, weight-for-height, LAZ, WAZ, HAZ, WHZ, stunt*, wast*, underweight, short stature, undernutrition, malnutrition, language, delay*, disorder*, impairment). This study was registered in Prospero with ID Number CRD420251011916.

Study selection

Reviewers conducted screening based on the titles and abstracts independently to examine eligibility. The articles were collected in Microsoft Excel and the duplicate articles were removed. After final determination of articles, three authors (FA, ANK, and PO) independently searched relevant studies and extracted the data using a standardized form. Disagreements were settled by consensus or by consulting with other authors (LH and AKZ).

Data synthesis and risk of bias assessment

Authors' name, year, design, population, language development tools, study objectives, age, outcomes and settings were acquired for data synthesis. The main outcome of this review was speech development screening results. To enhance the quality of included studies, a risk of bias assessment was performed using the ROBINS-E tool and judged for low, moderate, or high risk by two authors (FA, ANK). A consensus meeting was conducted if there was some disagreement.

RESULTS

Selection of studies

There were 4,865 articles identified in 3 databases PubMed (n = 456), Web of Science (n = 370), and Scopus (n = 4,039). There were 339 duplicate articles. There were 4,526 articles screened for title and abstract and 4,413 were excluded (4,412 inappropriate topic and 1 protocol). There were 113 articles checked for eligibility and 97 articles were excluded: 87 articles (no analysis related to language delay), 2 articles (age > 5 years), and 8 articles had no full access. In total 16 articles were included in this review (FIGURE 1).

Characteristic of studies

Total of 16 articles included in this review were published from 2014-2024. The age range of subjects in the article was 0-5 years. The articles were conducted in Pakistan (n=1), Uganda (n=2), Nigerian (n=1), Ethiopia (n=1), Tanzania (n=2), Vietnam (n=1), Bangladesh (n=2), India (n=2), Ghana (n=1), Asia Pacific (n=1), Brazil (n=1), and Burkina Faso, Africa (n=1). The study

was conducted in developing or lower-middle income countries. The included studies were observational, with 11 cross-sectional and 5 cohort studies. The tools used in included studies were not all the same: Denver-II (n=3), MDAT (Malawi Development Assessment Tool) (n=2), BSID-III (Bayley Scales of Infant Development) III (n=8), SGS-II (Schedule of Growing Skills) (n=1), DMC-II (n=1), and EAP-ECDS (n=1). Different screening tools may result in different severity assessment. Risk of bias assessment of included studies showed most studies were of some concern. The summary of data extraction and risk of bias assessment can be seen in TABLE 1 and FIGURE 3. From synthesized data, the research found that there is a relationship between undernutrition and language delay, and several other factors can influence it, including socioeconomic status, stimulation, environment and dietary diversity (FIGURE 2).

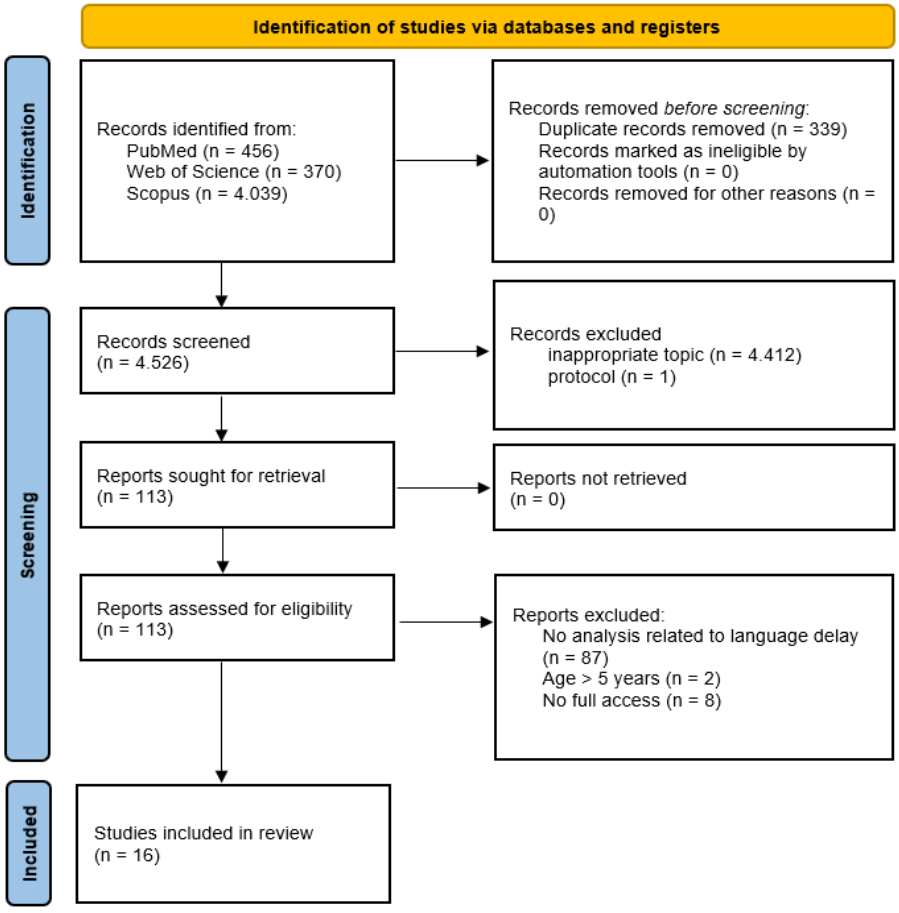

FIGURE 1. PRISMA 2020 flow diagram

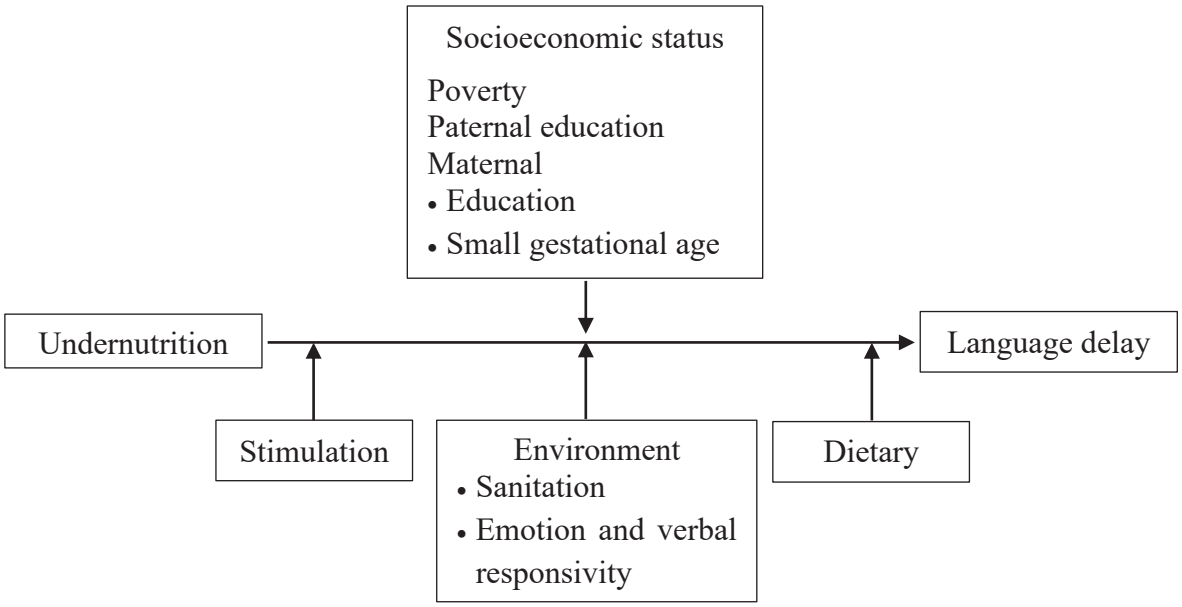

FIGURE 2. Relationship undernutrition with language delay

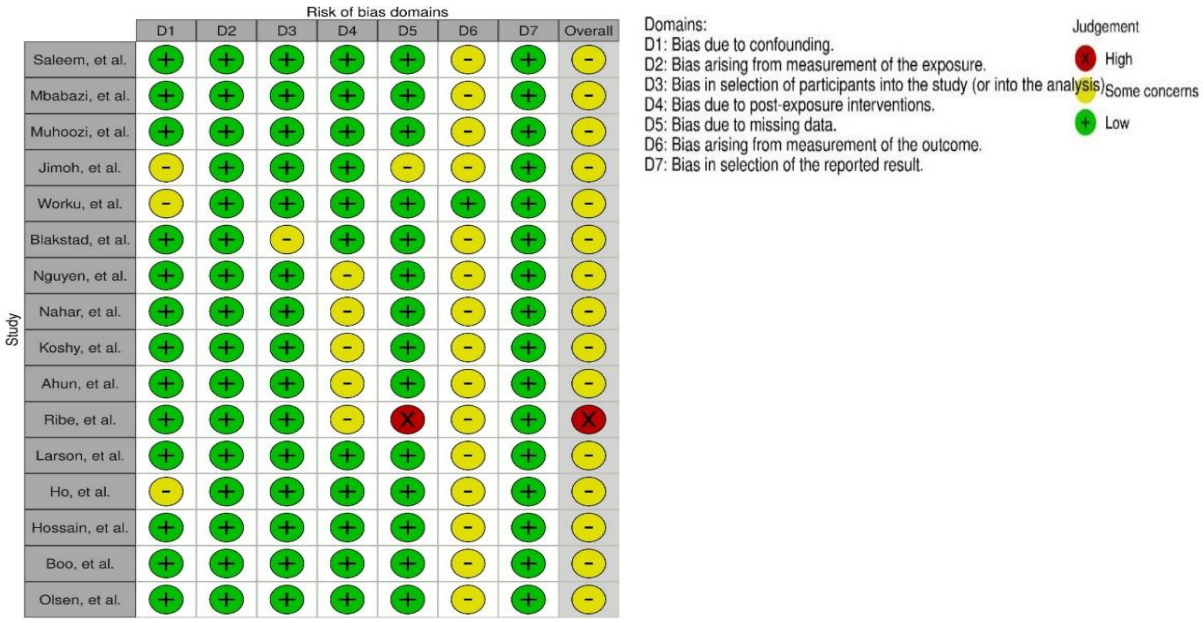

FIGURE 3. Risk of bias assessment (ROBINS-E)

TABLE 1. Summary of findings

Authors	Year	Design	Age	Population	Language development tools	Study objectives	Summary findings	Settings
Saleem, *et al.*[12]	2021	Cross-Sectional	6-59 months	200	Denver-II	Compare the developmental profile of SAM and normal under 5 years old and to find sociodemographic determinants accountable for their developmental disabilities.	SAM serves as a risk factor for delayed language development [OR (95%CI)=5.4 (2.35 - 12.48)]	Pakistan
Mbabazi *et al.*[13]	2024	Cross-Sectional	12-59 months	750	MDAT	Assesses correlates of development in the four domains and total MDAT score.	HAZ [OR (95%CI) = 0.24 (0.14 - 0.33)] and head circumference (OR (95%CI)=0.07 (0.02 - 0.12)] were positively correlated total MDAT score, whereas WHZ was not.	Uganda
Muhoozi, *et al.*[14]	2016	Cross-Sectional	6-8 months	456	BSID-III and ASQ	Assessed the nutritional status and milestone development of 6 - 8 month-old children and associated factors in 2 districts of South Western, Uganda.	All nutritional status indicators except HCZ were significantly positively associated with development domains. WAZ was the main predictor for all development domains	Uganda
Ribe, *et al.*[15]	2018	Cohort	6-15 months	262	BSID-III	Examine the determinants of cognitive development in north-central Tanzania	LAZ, WAZ, and WLZ had no significant correlation with language score ($p>0.05$).	Tanzania
Hossain, et al.[16]	2024	Cross-Sectional	6-16 months	599	BSID-III	Determine factors associated with children's cognitive, language, and motor development <2 yo.	LAZ, WAZ, and WLZ were positively associated [($\beta=2.01$; $p<0.001$); ($\beta=1.45$; $p=0.003$); ($\beta=0.5$; $p= 0.025$)].	Bangladesh

TABLE 1. Cont.

Authors	Year	Design	Age	Population	Language development tools	Study objectives	Summary findings	Settings
Olsen, *et al.*[17]	2018	Cross-Sectional	6-23 months	1,608	MDAT	Describe motor and language development of 6-23 month-old children with MAM and to explore nutrition and health-related correlates including socioeconomic status, anthropometry, MAM-defining criteria, body composition, LC-PUFA, hemoglobin, iron status, illness, and inflammation.	WHZ had no significant effect for language (β= 0.16; p=0.10). HAZ had a significant association with language (β= 0.12; p< 0.001).	Burkina Faso
Worku, *et al.*[19]	2018	Cross-Sectional	3-61 months	819	Denver-II-Jimma and ASQ	Ascertain the association of developmental outcomes and psychosocial factors after controlling for nutritional indices.	Stunting was negatively related to language [β= −0.178; t (816)= −5.030; p<0.001] and so underweight to language [β= −0.157; t(816)= −4.443; p<0.001]	Ethiopia
Nguyen, *et al.*[20]	2018	Cohort	1-2 years	1458	BSID-III	Examines the influences of quality of the home learning environment and child stunting in the first year of life on child development.	Children who were stunted at 1 yr had lower developmental scores at 2 yr for language (β= −0.23; 95%CI= −0.33 - −0.13; p = 0.001) when compared to those who were not stunted.	Vietnam
Nahar, et al.[21]	2020	Cohort	6-24 months	265	BSID-III	Explore differences in ECD between stunted (LAZ < −2) and no-stunted (LAZ ≥ −2) children in Bangladesh.	Stunted children had significantly lower ECD scores than their non-stunted peers on language scales (p< 0.001). Underweight children had developmental deficits in all domains (cognitive, fine motor, gross motor and total motor, expressive communication, total language, socioemotional development: p< 0.05).	Bangladesh

TABLE 1. Cont.

Authors	Year	Design	Age	Population	Language development tools	Study objectives	Summary findings	Settings
Koshy, *et al.*[22]	2021	Cohort	6-36 months	251	BSID-III	Evaluates developmental trends in the first 3 yr of life and their predictors in a low- and middle-income country setting	Child development domains of cognition, language, motor and social skills showed a significant decline in scores between 6 and 36 mo of age. Stunted (HAZ <-2 SD) have positive influence to language domain with adjusted β coefficient 95%CI=0.13 (-1.41-1.66) and underweight (WAZ < -2 SD) have negative influence to language domain with adjusted β coefficient 95% CI= -1.34 (-2.80-0.13)	India
Blakstad, *et al.*[26]	2019	Cohort	6-15 months	453	BSID-III	Evaluate the hypothesis that various maternal, socioeconomic, delivery and infant nutritional characteristics are associated with early childhood development in young Tanzanian children	Among infant growth outcomes, stunting, or alternatively LAZ and WLZ, at 6 wk were independently associated with ECD across the cognitive (HIV-exposed only), language (both HIV-exposed and -unexposed) and motor domains (HIV-unexposed only) of the BSID-III at 15 mo.	Tanzanian
Ahun, *et al.*[27]	2017	Cross-Sectional	10–24 months	330	BSID-III	Find the associations between children's nutrition and psychosocial stimulation and mental development	LAZ had significant correlation with receptive milestones (r= 0.14; p= 0.01) and expressive milestones (r= 0.20; p= 0.0003). WAZ had significant correlation with expressive milestones (r = 0.13; p = 0.01). LAZ (higher score) was associated to higher expressive milestones (β= 0.48; p = 0.003).	Ghana

TABLE 1. Cont.

Authors	Year	Design	Age	Population	Language development tools	Study objectives	Summary findings	Settings
Larson, *et al.*[28]	2018	Cross-Sectional	12-18 months	1,079	DMC-II	Determine the relations among diet, hemoglobin, nutritional status, child engagement, and child development.	LAZ had significant predictors of language development (β= 0.37; p< 0.001). LAZ had positively correlated to language development (r= 0.18; p < .0001)	India
Jimoh, *et al.*[29]	2018	Cross-Sectional	6-59 months	415	SGS-II	Assess the nutritional status of children under 5 years old and determine the relationship between the nutritional status and their developmental quotient	An underweight child had delayed hearing and language skills compared with his/her well-nourished counterpart [OR (95%)=3.25 (1.09–9.72)]. The odds of delay for the underweight child in speech and language skills are [OR (95%CI)= 3.33 (0.83–13.3)]. A stunted child had delayed hearing and language skills [OR (95%)= 2.36 (0.95–5.91)].	Nigerian
Boo, *et al.*[43]	2018	Cross-Sectional	0-3 years	6,737	Denver-II	Determine socioeconomic gradients in the measures of development and well-being of children <3 years old in Fortaleza.	Low weight had a negative significant association with language (r = -0.05; p< 0.01).	Brazil
Ho, *et al.*[52]	2018	Cross-Sectional	3-5 years old	7,108	East Asia - Pacific Early Child Development Scales (EAP-ECDS)	Estimate the association between malnutrition and early child development (ECD) at an individual level.	Height-for-age z score and BMI-for-age z score had positively correlation significant to language development with (β = 1.35, p < .001) and (β = 0.46, p < .001).	Asia Pacific Region (Cambodia, China, Mongolia, Papua New Guinea, Vanuatu)

Note: SAM: severe acute malnourished; MDAT: Malawi development assessment tool; HAZ: height-for-age z score; WHZ: weight-for-age z-score; HCZ: head circumference-for-age z-score; LAZ: length-for-age z-score; WLZ: weight-for-length z-score; ASQ: ages & stages questionnaire; BSID: Bayley scales of infant development; SGS: schedule of growing skills; ECD: early childhood development; SD: standard deviation; BMI: body mass index; EAP-ECDS: East Asia Pacific Early child development scales; MAM: moderate acute malnutrition; LC-PUFA: long chain-polyunsaturated fatty acids; DMC: development milestones checklist; HOME: home observation of the environment; p: statistical significance; r: correlation coefficient; β: beta coefficient; OR: odd ration; CI: confidence interval.

DISCUSSION

This study excluded the following conditions such as congenital diseases, neurological disorders, chromosomal abnormalities, and physical disabilities (e.g., deafness, anatomical abnormalities) because these conditions cause language delay directly without necessarily being caused by undernutrition.

In the study of Saleem, *et al.*[12] SAM had 5 times the risk of delayed language development [OR (95%CI) =5.41 (2.35 - 12.48); p < 0.001]. Wasted was defined as WHZ or WLZ < -2 SD some studies have correlated the WHZ score to language score. Mbabazi *et al.*,[13] and Muhoozi *et al.*,[14] found that increasing 1 unit of WHZ score can increase the language score. In the research of Ribe, *et al.*[15] Hossain *et al.*,[16] and Olsen *et al.*,[17] there was a positive but insignificant relationship between WHZ and language development. These findings align with the studies by Chertoff *et al.*[18] which indicate that severe malnutrition in children is a primary factor affecting brain development. This leads to decreased brain size, impaired dendritic growth, and hindered cell maturation, resulting in behavioral issues that can affect a child's adulthood, manifesting as social and behavioral disabilities.[18]

The odds from the study by Jimoh *et al.*,[29] indicate that the delay in speech and language skills for a stunted child is 1.32 (95%CI: 0.31–5.57; p=0.703). In study of Worku *et al.*,[19] Nguyen *et al.*,[20] and Nahar *et al.*,[21] found that the more stunted a child is, the lower their language score. On the other hand, the Koshy *et al.*,[22] study discovered a correlation between higher language scores and more stunting. According to Koshy's study, the majority of people in Vellore, South India, live in low-income urban slums and deal with additional environmental and nutritional issues.[22] This condition was related to the limitations of the study by Koshy *et al.*,[22] that the population in Vellore, South India had a condition of high iron deficiency in early childhood but body iron status was not significant. There have been no specific studies that discuss the biological and environmental mechanisms related to low-income urban slum conditions that can inhibit higher language scores, but low-income urban slums have the potential to get inadequate food due to economic conditions and unhealthy environmental conditions due to densely populated conditions due to the lack of spaces of Indian towns and cities due to rapid urbanization so that children will be susceptible to infections that will inhibit food absorption and can slow growth.[23,24]

Stunting was defined as having an HAZ or LAZ < -2 SD. Studies by Mbabazi *et al.*,[25] Muhoozi *et al.*,[14] Blakstad *et al.*,[26] Ahun *et al.*,[27] Larson *et al.*,[28] Hossain *et al.*,[16] and Olsen *et al.*,[17] found that HAZ or LAZ have positive and significant correlation with language development. In studies of Hossain *et al.*,[16] LAZ has first ranking as a dominant factor for language development.

In the study by Jimoh *et al.*,[29] the odds of delay in speech and language skills for underweight children are 3.33 (95% CI: 0.83–13.3; p=0.08416). In the studies by Worku *et al.*,[19] Nguyen *et al.*,[20] and Koshy *et al.*,[22] it was found that the more underweight a child is, the lower their language score. These findings align with the studies by Shrestha *et al.*,[30] which found that underweight was linked to a higher likelihood of being developmentally behind in ECD domains.

Undernutrition can result from inadequate food intake, particularly poor-quality protein, which is linked to stunting. This leads to lower levels of essential amino acids. When amino acids are deficient, mTORC1 suppresses protein and lipid synthesis, hindering growth. Inactivation of mTORC1 disrupts lipid synthesis and myelination in the nervous system, leading to

cognitive impairments and other brain impairments such as language delay.[6]

In this study, there are several countries from 3 continents, namely Asia, Africa, and the Americas. The Asian continent is in Pakistan, India, Vietnam, Bangladesh, India, Asia Pacific (Cambodia, China, Mongolia, Papua New Guinea, and Vanuatu). The African continent includes Uganda, Nigeria, Ethiopia, Tanzania, Ghana, and Burkina Faso. The American continent is in Brazil. All countries included in the study are developing countries, so this study has the disadvantage of not being able to generalize to all countries in the world. In addition, there are no European and Australian continents so it cannot generalize all countries in the world. All countries included in this study have problems related to nutritional status in children.[31-41] Several conditions in each country that can affect the results of the study. In Bangladesh, there are inadequate educational facilities that can affect language development because knowledge related to stimulation and child development is obtained through education.[42] In Tanzania, Limited access or the existence of open spaces for recreation and children's playgrounds even though they are very important for stimulation.[42] In India, having cities with rapid urbanization can create conditions that are susceptible to infection in children, thus affecting child development.[23,24]

However, there are several countries that have succeeded in reducing undernutrition rates such as Bangladesh, Burkina Faso, and Brazil. Bangladesh has a national stunting rate decline from 60% in 1997 to 28% in 2019 and is a developing country experiencing rapid economic growth.[37] Burkina Faso has a decline in stunting rates under the age of 5 from a peak at 45% in 1998/99 to 25% in 2018,[40] and in Brazil, the prevalence of stunting and undernutrition in children decreased significantly between 1974–1975 and 2008–2009. Brazil is a developing country that is developing.[39] If undernutrition can be handled quickly and rightly, it is hoped that the incidence of language delay will decrease.

Other factors that influence language delays are not just undernutrition. There are several factors that influence language development but not all are significant. Several factors as socioeconomic status (paternal education, maternal education, small age gestational, poverty), environment (sanitation and emotional & verbal responsivity), stimulation, and dietary diversity. In a study of Hossain *et al.*,[16] there are the rank of dominant factors for language development. Maternal education, paternal education, and wealth index got 6, 7, and 8 for rank with dominance statistics 0.0095, 0.0029, and 0.0028, respectively.[16] The first rank was LAZ.[16] Father's education with 5-9 years and > 10 years has a positive significant correlation to language development.[16] In a study of Nahar *et al.*,[21] mothers' education i.e, primary complete & higher secondary (11th to 12th grade) and above (graduation and masters) have significant correlation to language development. In study of Boo *et al.*,[43] mother's education have a positive significant correlation to language development ($r = 0.08$, $p < 0.01$). However in studies of Olsen *et al.*,[17] and Saleem *et al.*,[44] maternal education and language development did not significantly correlate.

According to existing literature, factors like low stimulation are linked to language delays. In 2019, a study by Sunderajan *et al.*,[45] found that insufficient stimulation has a statistically significant impact. In the study of Ahun *et al.*,[27] stimulation have positive correlation and significant to receptive and expressive language ($\beta = 0.16$; $p = 0.003$) and ($\beta = 0.27$; $p = 0.0001$). Language abilities are among the most immediate and long-lasting outcomes affected by the level

of learning stimulation at home and positive interactions between adults and children. Research indicates that being in language-rich environments promotes better language development.[46]

In the study of Nguyen *et al.*,[20] reported that early gestational age was not significant to language development.[20] For poverty, in the study of Ribe *et al.*,[15] monthly incomes have no significant correlation to language delay.[15] For environment, in the study of Ribe *et al.*,[15] sanitation and emotion & verbal response have no significant correlation to language delay. Therefore, in this study, other factors that significantly influence language delay are only paternal education, maternal education, and stimulation.

Inadequate food intake affects the equilibrium of gut microbiota, which is impacted by a child's diet via the gut-brain axis.[47] These pathways together help regulate neurogenic circuits.[48] Dysbiosis in the gut microbiota can contribute to neurological disorders like Alzheimer's, multiple sclerosis, and autism spectrum disorder. In the study of Liu *et al.*,[49] showed that children with autism have lower levels of butyrate-producing bacteria, such as *Ruminococcaceae* and *Eubacterium*, as well as reduced short-chain fatty acids (SCFAs).[49,50] However, the study of Ahun *et al.*,[27] found that diet diversity have no significant correlation to language delay. A study of Mbabazi *et al.*,[25] found that food insecurity has no significant correlation to language delay.

Based on our findings, undernutrition has a significant correlation with language delay. The government has a big role in improving nutrition through policies. Food policy strategies that can be implemented to overcome undernutrition include providing education to pregnant women and mothers with toddlers in fulfilling toddler nutrition and monitoring growth and development at integrated health posts; fiscal incentives and disincentives such as providing subsidies for nutritious staples, such as rice, eggs, fruits and vegetables; and regular health check-up programs for infants and toddlers. In addition, training programs for early detection of undernutrition and language delay need to be expanded so that children can be given the right intervention immediately.[51]

The limitations of this study include most of them are cross-sectional studies because there are still few cohort studies, thus limiting the ability to establish causal relationships; the tools used to measure language delay are not the same and are not the gold standard, and in several studies the language measurement tools were modified and revalidated so that they were less standardized; the research only took place in developing countries, so it cannot be generalized to all countries in the world; the factors that cause language delay are not only undernutrition, so it is necessary to control confounding factors properly so that the results obtained can be maximized. So it is hoped that in the future there will be more studies related to the topic of undernutrition and language delay with a cohort design, the measuring instruments used are the gold standard and have been validated, studies in developed countries even though there are few cases so that they can be used as learning and comparison with developing countries, there is control for confounding factors.

CONCLUSION

Undernutrition is associated with language delay. Most studies report that the more severe the conditions of wasting, stunting and underweight will cause more severe conditions of language delay. However, other factors that significantly affect language delay such as paternal education, maternal education, and stimulation. It is hoped

that in the future, more studies related to the topic of undernutrition and language delay with a cohort design, the measuring instruments used are the gold standard and have been validated, studies in developed countries even though there are few cases so that they can be used as learning and comparison with developing countries, there is control for confounding factors.

ACKNOWLEDGEMENTS

We are grateful to the Department of Physiatry Dr. Sardjito General Hospital, Yogyakarta, Special Region of Yogyakarta for the valuable contribution to this systematic review.

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