

Original Article

Parental stature as a risk factor for stunting in Indonesia: A systematic review and metaanalysis

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Abstract

Stunting is defined by height of more than two standard deviations below the World Health Organization's (WHO) child growth standard median. It is a significant nutritional problem in developing countries, where in 2021, Indonesia recorded a stunting prevalence at 24.4%, slightly higher than the global prevalence (22%). Reducing the prevalence of stunting has been the focus of the current administration in the Indonesian government, as delineated in the 2020–2024 National Medium-Term Development Plan. Globally, many studies have addressed parental stature as a risk factor of stunting. However, systematic reviews that summarized and critically appraised the relationship between parental stature and the incidence of stunting in Indonesia was scarce. This systematic review aimed to assess parental stature as a risk factor for stunting among Indonesian toddlers. Studies were searched through PubMed (MEDLINE), Google Scholar and Mendeley. Studies on Indonesian toddlers under five years old living in Indonesia were included. The quality of the included studies was assessed using Joanna Briggs Institute (JBI) critical appraisal tool. Data were extracted using a standardized data extraction form and were analyzed using Cochrane's RevMan 5.3. Twenty-seven prospective and retrospective cohort, case-control and cross-sectional studies were included with a total 4041 children. Out of 27 included studies, eight were found to be of low, seven of moderate and twelve of high quality. The result showed that parental stature was associated with the incidence of stunting among toddlers in Indonesia, either the mother only (odds ratio (OR) 1.92; 95% confidence interval (95%CI: 1.71–2.15), the father only (OR 5.21; 95%CI: 1.71-15.86) or both parents (OR 3.01; 95%CI: 2.41-3.75). However, studies on father and both parental statures suffered from substantial heterogeneity, imprecision and mixed qualities, therefore, they should be cautiously interpreted.

Keywords: Stunting, Indonesia, parental stature, risk factor, systematic review

Introduction



Health is an investment for developing quality of human capital to be economically and socially productive and it has been an important measure of the human capital index [1]. The health development program of the Indonesian Ministry of Health aims to improve the standard of healthy living for every Indonesian to achieve the best possible health status. However, the high prevalence of stunting among Indonesian children under five years old has challenged the efforts to improve the life quality of human capital in the country [2]. Currently, stunting has been included in the list of strategic priority projects for the 2020-2024 National Medium-Term

Development Plan with an allocated funding of 87 trillion rupiah with a target achievement of reducing the prevalence of stunting to 14% by 2024 [3].

Stunting is a health condition of toddlers characterized by body height being shorter than children of the same age [4]. Children are defined as stunted if their height-for-age is less than two standard deviations (SD) below the World Health Organization's (WHO) child growth standard median [5]. Usually, stunting begins to appear when a child has just entered the age of two [6]. In Indonesia, according to the Anthropometric Standards for the Assessment of Child Nutritional Status, a toddler is considered stunted if the child *Z*-score falls between -3 SD and less than -2 SD, and is classified as severely stunted if the score is below -3 SD [7]. The *Z*-score is calculated based on the length or height index for age, and a score of less than -3 SD indicates a significant deviation from the normal [7].

Indonesia has a high prevalence of stunting, with an average incidence of 36.4% in children under five, based on the data between 2005–2017 [8]. However, according to the Nutritional Status of Indonesian Toddlers survey in 2021, the prevalence of stunting has decreased to 24.4%, affecting 5.33 million children [9]. The survey collected data from 34 provinces and 514 districts/cities with a total of 153,228 children under five. The survey revealed that only one province had a good category (stunted <20% and wasted <5%), five provinces showed nutritional problems in the acute category (stunted <20% and wasted \geq 5%), one was in the chronic category (stunted >20% and wasted \leq 5%) and 27 others were in the chronic-acute category. The data indeed showed that stunting is a nationwide problem affecting almost all provinces in Indonesia [9].

The chronic impact of stunting on children can lead to sub-optimal learning capacity, confer a higher risk of obesity, and reduce productivity levels [10]. Short-term impacts of stunting include decreased cognitive and motor and verbal abilities as well as an increased risk of perinatal and neonatal death [11].

Stunting is conferred by multifactorial risks, including environment, nutritional intake and parental stature [12,13]. Parental height is a form of genetic expression which cannot be changed or modified and therefore this factor is directly passed down from parents to the children [13]. A study on the relationship between parental stature and the incidence of stunting in toddlers aged 6–23 months found that maternal height influenced stunting, while paternal height did not significantly affect the incidence of stunting [12]. In contrast, another study found that the father's height is one of the risk factors for stunting [13]. Unfortunately, a systematic review that summarizes and critically appraises the relationship between parental stature and the incidence of stunting in Indonesia is not available. The aim of this systematic review was to assess whether parental stature is a risk factor for stunting among Indonesian toddlers.

Methods

Study setting and search strategy

A systematic review with meta-analysis for quantitative studies was conducted. The protocol was in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) and the Joanna Briggs Institute (JBI) Manual for systematic review of etiology and risk factors [14].

The following electronic databases were used for the searches: MEDLINE (PubMed), Google Scholar and Mendeley. The combination of keywords as follows: "stunting" AND "parental stature" OR "*tinggi orang tua*" OR "*tinggi badan orang tua*" AND "Indonesia". Keywords were searched in the title and abstract. The searches were limited to articles in English and Bahasa Indonesia.

Eligibility criteria

In this systematic review, studies were considered eligible if they reported the effect of parental stature on the incidence of stunting in Indonesia, including prospective and retrospective cohort, case-control and analytical cross-sectional studies. Only original articles were included. The target population was Indonesian toddlers under five years old living in Indonesia. Stunted

toddlers with congenital diseases, whose parents have achondroplasia, whose parents have mental disorders and those with evidence of an absent biological relationship were excluded.

Screening of studies

To conduct the screening process, the authors firstly removed all duplications. In the initial screening, the title and abstract of each remaining study were then checked individually. Finally, the full text of each study that passed the initial screening was read to determine its eligibility for inclusion in the systematic review.

Data extraction

After establishing the final set of included studies, an author (MPA) extracted the data independently according to the eligibility criteria using a standardized data extraction form. To ensure consistency and reliability, the data extraction form on the first ten included studies were pilot-tested. Another author (THS) checked the data extraction for clarity and completeness. Following independent data extraction, the authors (MPA and THS) met four times to resolve any discrepancies and reached a consensus.

Assessment of methodological quality

The quality of the included studies was assessed using JBI critical appraisal tool whereby a score was given for every one-star symbol, which indicate a "yes" response. If there were any discordant responses, two of the authors discussed to reach a consensus. Studies with scores above or equal to the median were considered high quality [15]. Based on this assessment, the studies were classified as either low, moderate (scored at median) or high quality.

Data synthesis

The meta-analysis method for quantitative studies was used to analyze the extracted data. Stunted toddlers were compared with non-stunted toddlers regarding the risk factors. The data was analyzed by combining similar data from all studies and the effect variable scale was in numerical data. The data was analyzed using Cochrane's RevMan 5.3.

Assessment of heterogeneity and identifying possible sources of heterogeneity

Variability among studies in a systematic review is referred to as heterogeneity. Clinical variation may cause heterogeneity if the exposure effect is influenced by factors that differ across studies, such as patient characteristics. In this systematic review, the heterogeneity analysis was conducted using the chi-squared statistics. Heterogeneity was considered substantial when the I² was 40% or above.

In cases where there was substantial heterogeneity between the studies, the maternal and paternal statures were examined separately as subgroups and sensitivity analysis was performed as attempts to identify possible sources of heterogeneity.

Results

Study selection

In total, 1,020 studies were identified, of which 137 were excluded due to duplication and 847 were excluded after screening the titles and abstracts. The full texts of the remaining 36 studies were assessed for eligibility, of which nine studies did not provide clear data and were subsequently excluded from the meta-analysis. The excluded nine studies could not provide the necessary data despite requests for clarification. A total of 27 studies [12,25-50] were included in the data extraction and analysis. Out of total, 14 case-control studies [12,27,28,38-48] and 13 cross-sectional studies [25,26,29-37,49,50]. The search and screening process followed the PRISMA, and the flowchart is presented in **Figure 1**. An overview of the characteristics of the included studies, including socioeconomic status, gender the parents' profession and education level are presented in **Table 1**.



Figure 1. PRISMA flow diagram of study selection.

Гable 1. Demographic data с	of the family of the	included 27 studies
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Variable	Category, n (%)						
	Stunting	Non-stunting	No information				
Socioeconomic status of the family			2,767 (36.7)				
High	755 (10.03)	1,277 (16.9)					
Low	1,257 (16.6)	1,466 (19.4)					
Gender of the toddler			4,905 (65.2)				
Male	723 (9.6)	602 (8.0)					
Female	609 (8.2)	683 (9.2)					
Mother's employment status			6,128 (81.4)				
Employed	319 (4.2)	372 (4.9)					
Unemployed	293 (3.9%)	410 (5.4)					
Mother's education level			6,060 (80.5)				
High	1,080 (14.3)	1,655 (22.0)					
Low	1,565 (20.8)	1,760 (23.3)					
Father's employment status			7,176 (95.4)				
Employed	173 (2.2)	173 (2.2)					
Unemployed	0 (0.0)	0 (0.0)					
Father's education level			5,421 (72.06)				
High	354 (4.7)	608 (8.0)					
Low	499 (6.6)	640 (8.5)					

Assessment of methodological quality

Among 14 case-control studies [12,27,28,38-48], three were assessed as having low [38,41,42], three as moderate [12,28,48] and eight as high quality [27,39,40,43-47]. Among the 13 cross-

sectional studies [25,26,29-37,49,50], five were assessed as having low quality [25,29,30,32,50], four had moderate quality [26,35-37] and four had high quality [31,33,34,49].

Association between parental stature and the incidence of stunting

The effects of maternal and paternal height on stunting among toddlers in Indonesia are presented in forest plots. The data analysis was conducted using two statistical models: the fixed-effect (**Figure 2**) and the random-effects model (**Figure 3**). The random-effect model was also utilized due to significant heterogeneity despite the significant results of data synthesis (p<0.05 and I² >50%).

There were significant effects of both mother's and father's heights on incidence of stunting (**Figure 2** and **Figure 3**). However, the studies included in the analysis had mixed levels of quality. Among the studies focused on maternal stature, eight [25,29,30,32,38,41,42,50], seven [12,25,28,30,32,48,50] and 12 studies [27,31,33,34,39,38,43-47,49] had low, moderate and high quality, respectively. For the studies on paternal stature, two were of moderate [12,26] and three were of high quality [39,47,40]. Moreover, all analyses showed substantial heterogeneity, with I² ranging from 69% to 81%. In addition, the random-effects approach for the effect of the father's stature showed imprecision, as evidenced by the wide 95% confidence interval (95%CI) (1.71 to 15.86). Therefore, caution is necessary when interpreting the results.

Study or Subgroup Events Total Events Total Weight M-H, Fixed, 95% Cl M-H, Fixed, 95% Cl 2.1.1 Mother Alim 2021 41 60 6 34 0.4% 10.07 [3.57, 28.38]	\rightarrow
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Alim 2021 41 60 6 34 0.4% 10.07 [3.57, 28.38] Amin 2014 49 79 77 173 3.3% 2.04 [1.18, 3.51]	→
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Arnisam 2020 28 47 11 34 0.9% 3.08 [1.22, 7.77] Dahliansyah 2021 6 14 26 86 0.7% 1.73 [0.55, 5.49]	→ →
Dahliansyah 2021 6 14 26 86 0.7% 1.73 [0.55, 5.49]	\rightarrow
	\rightarrow
Febrina 2017 31 42 52 124 1.2% 3.90 [1.80, 8.47]	\rightarrow
Ferani 2019 50 53 9 65 0.1% 103.70 [26.59, 404.52]	 →
Istiningsih 2022 13 33 29 103 1.5% 1.66 [0.73, 3.76]	
Izah 2019 8 8 35 78 0.1% 20.83 [1.16, 373.48]	
Khairani 2019 14 35 18 67 1.3% 1.81 [0.76, 4.31]	
Larasati 2018 14 16 62 136 0.3% 8.35 [1.83, 38.18]	
Lubis 2021 17 18 25 66 0.1% 27.88 [3.49, 222.54]	\longrightarrow
Masdahlianah 2021 12 23 20 41 1.2% 1.15 [0.41, 3.18]	
Mutiarasari 2021 111 207 159 353 9.7% 1.41 [1.00, 1.99]	
Nadiyah 2014 691 991 278 562 19.1% 2.35 [1.90, 2.91]	
Najahah 2013 37 55 39 103 1.6% 3.37 [1.69, 6.72]	
Nasikhah 2012 18 27 13 35 0.7% 3.38 [1.18, 9.71]	
Nasrul 2015 71 120 95 230 4.7% 2.06 [1.31, 3.23]	
Nurdin 2019 34 56 25 62 1.7% 2.29 [1.09, 4.79]	
Nurlaily 2021 14 16 62 136 0.3% 8.35 [1.83, 38, 18]	
Oktarina 2013 347 735 200 604 20.6% 1.81 [1.45, 2.26]	
Permadi 2021 15 24 18 76 0.6% 5.37 [2.01, 14.32]	
Putri 2018 9 9 69 147 0.1% 21.46 [1.23, 375.51]	→
Qurani 2022 13 39 20 112 1.2% 2.30 [1.01, 5.24]	
Sindhughosa 2020 22 43 18 80 1.1% 3.61 [1.63, 8.00]	
Wahdah 2015 47 78 9 42 0.8% 5.56 [2.34, 13.21]	
Wardani 2022 189 361 157 436 12.0% 1.95 [1.47, 2.60]	
Yuliani 2018 221 354 108 219 8.9% 1.71 [1.21, 2.40]	
Subtotal (95% Cl) 3543 4204 94.2% 2.29 [2.08, 2.52] ♦	
Total events 2122 1640	
Heterogeneity: Chi ² = 85.16, df = 26 (P < 0.00001); l ² = 69%	
Test for overall effect: Z = 16.59 (P < 0.00001)	
2.1.2 Father	
Amin 2014 46 84 80 168 4.3% 1.33 [0.79, 2.25]	
Izah 2019 9 9 34 77 0.1% 23.96 [1.35, 426.22]	\rightarrow
Nasikhah 2012 15 22 16 40 0.6% 3.21 [1.07, 9.63]	
Permadi 2021 11 15 12 75 0.2% 14.44 [3.93, 52.99]	_
Wahdah 2015 50 82 6 38 0.6% 8.33 [3.13, 22.17]	
Subtotal (95% Cl) 212 398 5.8% 2.94 [2.01, 4.29]	
Total events 131 148	
Heterogeneity: Chi ² = 20.90, df = 4 (P = 0.0003); l ² = 81%	
Test for overall effect: Z = 5.59 (P < 0.00001)	
Total (95% Cl) 3755 4602 100.0% 2.33 [2.12, 2.56] ♦	
Total events 2253 1788	
Heteropeneity: Chi ² = 107 10, df = 31 (P < 0.00001); l = 71%	<u> </u>
Det for overall effect Z = 17.49 (P < 0.00001) 0.01 0.1 1 10	100
Test for subgroup differences: Chi ² = 158, df = 1 (P = 0.21) l ² = 36.5% Favours [Normal Stature] Favours [Normal Stature]	

Figure 2. Association between mother and father height with stunting at toddler age (fixed effect).

Sensitivity analysis

Due to substantial heterogeneity in our analysis, we did the sensitivity analyses to identify possible sources of heterogeneity. The sensitivity analyses were conducted based on four factors of exclusion: (a) to exclude the studies that are not statistically significant; (b) to exclude the studies with totals in low- and normal-parental-stature groups of less or more than 100 each; (c) to exclude the studies conducted in Java or outside Java; and (d) to exclude the studies of low and moderate quality studies.

Exclusion of studies that are not statistically significant

Statistical significance was determined based on the *p*-value and the 95%CI and studies that had no statistically significant results were excluded. Among the studies four were excluded for maternal stature [27,31,36,42] and one was excluded on paternal stature [12] (**Figure 4**). Heterogeneity was not improved after the exclusion of studies with non-significant results. This sensitivity analysis showed that studies with non-significant results are not the source of heterogeneity.

	Low Mother S	Stature	Normal Mother	Stature		Odds Ratio	Odds	a Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% C	M-H, Rand	dom, 95% Cl
2.1.1 Mother								
Alim 2021	41	60	6	34	2.6%	10.07 [3.57, 28.38]		
Amin 2014	49	79	77	173	4.5%	2.04 [1.18, 3.51]		
Arnisam 2020	28	47	11	34	3.0%	3.08 [1.22, 7.77]		·
Dahliansyah 2021	6	14	26	86	2.3%	1.73 [0.55, 5.49]		
Febrina 2017	31	42	52	124	3.5%	3.90 [1.80, 8.47]		
Ferani 2019	50	53	9	65	1.9%	103.70 [26.59, 404.52]		→
Istiningsih 2022	13	33	29	103	3.3%	1.66 [0.73, 3.76]	-	├
Izah 2019	8	8	35	78	0.5%	20.83 [1.16, 373.48]		· · · · · ·
Khairani 2019	14	35	18	67	3.2%	1.81 [0.76, 4.31]	-	
Larasati 2018	14	16	62	136	1.6%	8.35 [1.83, 38.18]		· · · · · · · · · · · · · · · · · · ·
Lubis 2021	17	18	25	66	1.0%	27.88 [3.49, 222.54]		· · · · · · · · · · · · · · · · · · ·
Masdahlianah 2021	12	23	20	41	2.7%	1.15 [0.41, 3.18]		+
Mutiarasari 2021	111	207	159	353	5.3%	1.41 [1.00, 1.99]		
Nadiyah 2014	691	991	278	562	5.8%	2.35 [1.90, 2.91]		-
Najahah 2013	37	55	39	103	3.9%	3.37 [1.69, 6.72]		
Nasikhah 2012	18	27	13	35	2.6%	3.38 [1.18, 9.71]		
Nasrul 2015	71	120	95	230	4.9%	2.06 [1.31, 3.23]		
Nurdin 2019	34	56	25	62	3.7%	2.29 [1.09, 4.79]		
Nurlaily 2021	14	16	62	136	1.6%	8.35 [1.83, 38.18]		
Oktarina 2013	347	735	200	604	5.8%	1.81 [1.45, 2.26]		
Permadi 2021	15	24	18	76	2.8%	5.37 [2.01, 14.32]		
Putri 2018	9	9	69	147	0.5%	21.46 [1.23, 375.51]		
Qurani 2022	13	39	20	112	3.3%	2.30 [1.01, 5.24]		
Sindhughosa 2020	22	43	18	80	3.4%	3.61 [1.63, 8.00]		
Wahdah 2015	47	78	9	42	3.2%	5.56 [2.34, 13.21]		
Wardani 2022	189	361	157	436	5.6%	1.95 [1.47, 2.60]		
Yuliani 2018	221	354	108	219	5.4%	1.71 [1.21, 2.40]		 .
Subtotal (95% CI)		3543		4204	87.7%	2.83 [2.26, 3.54]		•
Total events	2122		1640					
Heterogeneity: Tau ² =	0.18; Chi ² = 85.	16, df = 2	6 (P < 0.00001); P	² = 69%				
Test for overall effect:	Z = 9.09 (P < 0.	00001)						
2.1.2 Father								
Amin 2014	46	84	80	168	4.6%	1.33 [0.79, 2.25]	-	+•
Izah 2019	9	9	34	77	0.5%	23.96 [1.35, 426.22]		$ \longrightarrow$
Nasikhah 2012	15	22	16	40	2.5%	3.21 [1.07, 9.63]		
Permadi 2021	11	15	12	75	2.0%	14.44 [3.93, 52.99]		
Wahdah 2015	50	82	6	38	2.8%	8.33 [3.13, 22.17]		
Subtotal (95% CI)		212		398	12.3%	5.21 [1.71, 15.86]		
Total events	131		148					
Heterogeneity: Tau ² =	1.17; Chi ² = 20.	90, df = 4	(P = 0.0003); I ² =	81%				
Test for overall effect:	Z = 2.91 (P = 0.	004)						
I otal (95% CI)	0055	3755	1700	4602	100.0%	3.01 [2.41, 3.75]		- ▼
Total events	2253		1788					
Heterogeneity: Tau ² =	0.21; Chi ² = 107	'.10, df =	31 (P < 0.00001);	I² = 71%			0.01 0.1	1 10 100
Test for overall effect:	Z = 9.71 (P < 0.	00001)					Favours [Normal Stature]	Favours [Low Stature]
Test for subgroup diffe	rences: Chi ² = 1	l.11, df =	1 (P = 0.29), I ² = 9	9.8%				

Figure 3. Association between mother and father height with stunting at toddler age (random effect).

Exclusion of studies with totals in low- and normal-parental-stature groups of less or more than 100 each

The total sample means the number of sample of parents with low stature on stunting and nonstunting and for mother with normal stature. Sensitivity analysis on this variable was performed in two ways: (a) by including only studies with totals low- and normal-parental-stature above 100 each (15 studies with <100 participants in each group were excluded [12,26,28,30,32,38-40,44-50]) and (2) by including only studies with totals low-and normal-parental-stature below 100 each (six studies with >100 participants were excluded [25,29,33,35,37,41]. All studies on the father's height showed less than 100 participants in each group.

When the studies with sample sizes of above 100 were separately analyzed, the heterogeneity (I²) was improved to 32%, which was non-substantial with OR 1.92 (95%CI: 1.71–2.15) (**Figure 5**). This demonstrated that studies with small sample sizes (<100 in each group) have become a source of heterogeneity. This result was applicable only to the effect of the mother's height because all studies on the father's height were excluded. When the studies with sample sizes below 100 were analyzed separately, the heterogeneity (I²) remained prominent. This demonstrated that studies with larger sample sizes (>100 in each group) were not the source of heterogeneity.

	Low Mother S	tature	Normal Mother	Stature		Odds Ratio	Odds Ratio			
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% C	M-H, Fixed, 95% Cl			
2.1.1 Mother										
Alim 2021	41	60	6	34	0.5%	10.07 [3.57, 28.38]				
Amin 2014	49	79	77	173	3.6%	2.04 [1.18, 3.51]				
Arnisam 2020	28	47	11	34	1.0%	3.08 [1.22, 7.77]				
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Febrina 2017	31	42	52	124	1.3%	3.90 [1.80, 8.47]				
Ferani 2019	50	53	9	65	0.1%	103.70 [26.59, 404.52]				
Istiningsih 2022	13	33	29	103	0.0%	1.66 [0.73, 3.76]				
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Wardani 2022	189	361	157	436	13.2%	1.95 [1.47, 2.60]				
Yuliani 2018	221	354	108	219	9.8%	1.71 [1.21, 2.40]				
Subtotal (95% CI)		3438		3907	98.4%	2.33 [2.11, 2.57]	•			
Total events	2077		1547							
Heterogeneity: Chi ² = 8	32.75, df = 22 (P	< 0.0000	01); I² = 73%							
Test for overall effect:	Z = 16.54 (P < 0	.00001)								
2.1.2 Father										
Amin 2014	46	84	80	168	0.0%	1.33 [0.79, 2.25]				
Izah 2019	9	9	34	77	0.1%	23.96 [1.35, 426.22]				
Nasikhah 2012	15	22	16	40	0.7%	3.21 [1.07, 9.63]				
Permadi 2021	11	15	12	75	0.2%	14.44 [3.93, 52.99]				
Wahdah 2015 Subtotal (95% CI)	50	82 128	6	38 230	0.6% 1.6%	8.33 [3.13, 22.17] 7.63 [4.13, 14.08]	•			
Total events	85		68				-			
Heterogeneity: Chi ² = :	3 94 df = 3 (P =	0 27) [.] l ² :	= 24%							
Test for overall effect:	Z = 6.49 (P < 0.0	00001)								
Total (95% CI)	0400	3566	4045	4137	100.0%	2.41 [2.19, 2.66]	•			
I otal events	2162		1615							
Heterogeneity: Chi ² =	100.58, df = 26 (P < 0.000	jui); l² = 74%				0.01 0.1 1 10 100			
l est for overall effect:	∠ = 17.53 (P < 0	.00001)					Favours [Normal Stature] Favours [Low Stature]			
Lest for subgroup diffe	Test for subgroup differences. Chi? = \4.00 df = \ (P = 0.0002) i? = 92.9%									

Figure 4. Sensitivity analysis by excluding studies with non-significant effects.

	Low Mother S	Stature	Normal Mothe	r Stature		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% C	I M-H, Fixed, 95% CI
2.1.1 Mother							
Alim 2021	41	60	6	34	0.0%	10.07 [3.57, 28.38]	
Amin 2014	49	79	77	173	0.0%	2.04 [1.18, 3.51]	
Arnisam 2020	28	47	11	34	0.0%	3.08 [1.22, 7.77]	
Dahliansyah 2021	6	14	26	86	0.0%	1.73 [0.55, 5.49]	
Febrina 2017	31	42	52	124	0.0%	3.90 [1.80, 8.47]	
Ferani 2019	50	53	9	65	0.0%	103.70 [26.59, 404.52]	
Istiningsih 2022	13	33	29	103	0.0%	1.66 [0.73, 3.76]	
Izah 2019	8	8	35	78	0.0%	20.83 [1.16, 373.48]	
Khairani 2019	14	35	18	67	0.0%	1.81 [0.76, 4.31]	
Larasati 2018	14	16	62	136	0.0%	8.35 [1.83, 38.18]	
Lubis 2021	17	18	25	66	0.0%	27.88 [3.49, 222.54]	
Masdahlianah 2021	12	23	20	41	0.0%	1.15 [0.41, 3.18]	
Mutiarasari 2021	111	207	159	353	12.9%	1.41 [1.00, 1.99]	
Nadiyah 2014	691	991	278	562	25.4%	2.35 [1.90, 2.91]	+
Najahah 2013	37	55	39	103	0.0%	3.37 [1.69, 6.72]	
Nasikhah 2012	18	27	13	35	0.0%	3.38 [1.18, 9.71]	
Nasrul 2015	71	120	95	230	6.3%	2.06 [1.31, 3.23]	
Nurdin 2019	34	56	25	62	0.0%	2.29 [1.09, 4.79]	
Nurlaily 2021	14	16	62	136	0.0%	8.35 [1.83, 38,18]	
Oktarina 2013	347	735	200	604	27.4%	1.81 [1.45, 2.26]	
Permadi 2021	15	24	18	76	0.0%	5.37 [2.01, 14.32]	
Putri 2018	9	9	69	147	0.0%	21.46 [1.23, 375.51]	
Qurani 2022	13	39	20	112	0.0%	2.30 [1.01, 5.24]	
Sindhughosa 2020	22	43	18	80	0.0%	3.61 [1.63, 8.00]	
Wahdah 2015	47	78	9	42	0.0%	5.56 [2.34, 13.21]	
Wardani 2022	189	361	157	436	16.0%	1.95 [1.47, 2.60]	
Yuliani 2018	221	354	108	219	11.9%	1.71 [1.21, 2.40]	
Subtotal (95% CI)		2768		2404	100.0%	1.92 [1.71, 2.15]	•
Total events	1630		997				
Heterogeneity: Chi2 =	7.40, df = 5 (P =	0.19); l ²	= 32%				
Test for overall effect:	Z = 11.20 (P < 0).00001)					
2.1.2 Father							
Amin 2014	46	84	80	168	0.0%	1.33 [0.79, 2.25]	
Izah 2019	9	9	34	77	0.0%	23.96 [1.35, 426.22]	
Nasikhah 2012	15	22	16	40	0.0%	3.21 [1.07, 9.63]	
Permadi 2021	11	15	12	75	0.0%	14.44 [3.93, 52.99]	
Wahdah 2015	50	82	6	38	0.0%	8.33 [3.13, 22,17]	
Subtotal (95% CI)		0	-	0		Not estimable	
Total events	0		0				
Heterogeneity: Not ap	plicable						
Test for overall effect:	Not applicable						
Total (95% CI)		2768		2404	100.0%	1.92 [1.71, 2.15]	•
Total events	1630		997				
Heterogeneity: Chi ² =	7 40 df = 5 (P =	0 19) 12	= 32%				· · · · · · · · · · · · · · · · · · ·
Test for overall effect:	7 = 11.20 (P < 0)	00001					0.01 0.1 1 10 100
Tast for submany diff.	oronooo: Not one	liooblo					Favours [Normal Stature] Favours [Low Stature]

Figure 5. Sensitivity analysis by excluding studies with totals in low- and normal-mother-stature groups of less than 100 each.

	Low Mother S	Stature	Normal Mother	Stature		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% C	M-H, Fixed, 95% CI
2.1.1 Mother							
Alim 2021	41	60	6	34	1.7%	10.07 [3.57, 28.38]	
Amin 2014	49	79	77	173	13.1%	2.04 [1.18, 3.51]	_ _ _
Arnisam 2020	28	47	11	34	3.7%	3.08 [1.22, 7.77]	
Dahliansvah 2021	6	14	26	86	3.0%	1.73 [0.55, 5,49]	
Febrina 2017	31	42	52	124	4.9%	3.90 [1.80, 8.47]	
Ferani 2019	50	53	9	65	0.3%	103.70 [26.59, 404.52]	\longrightarrow
Istiningsih 2022	13	33	29	103	6.1%	1.66 [0.73, 3.76]	
Izah 2019	8	8	35	78	0.3%	20.83 [1.16, 373.48]	
Khairani 2019	14	35	18	67	5.3%	1.81 [0.76, 4.31]	+
Larasati 2018	14	16	62	136	1.2%	8.35 [1.83, 38.18]	
Lubis 2021	17	18	25	66	0.4%	27.88 [3.49, 222.54]	
Masdahlianah 2021	12	23	20	41	4.9%	1.15 [0.41, 3.18]	
Mutiarasari 2021	111	207	159	353	0.0%	1.41 [1.00, 1.99]	
Nadiyah 2014	691	991	278	562	0.0%	2.35 [1.90, 2.91]	
Najahah 2013	37	55	39	103	6.3%	3.37 [1.69, 6.72]	——————————————————————————————————————
Nasikhah 2012	18	27	13	35	2.7%	3.38 [1.18, 9.71]	
Nasrul 2015	71	120	95	230	0.0%	2.06 [1.31, 3.23]	
Nurdin 2019	34	56	25	62	6.6%	2.29 [1.09, 4.79]	
Nurlaily 2021	14	16	62	136	1.2%	8.35 [1.83, 38.18]	
Oktarina 2013	347	735	200	604	0.0%	1.81 [1.45, 2.26]	
Permadi 2021	15	24	18	76	2.3%	5.37 [2.01, 14.32]	· · · · · · · · · · · · · · · · · · ·
Putri 2018	9	9	69	147	0.3%	21.46 [1.23, 375.51]	
Qurani 2022	13	39	20	112	4.9%	2.30 [1.01, 5.24]	
Sindhughosa 2020	22	43	18	80	4.4%	3.61 [1.63, 8.00]	
Wahdah 2015	47	78	9	42	3.3%	5.56 [2.34, 13.21]	
Wardani 2022	189	361	157	436	0.0%	1.95 [1.47, 2.60]	
Yuliani 2018	221	354	108	219	0.0%	1.71 [1.21, 2.40]	
Subtotal (95% CI)		775		1800	76.9%	3.72 [3.07, 4.52]	•
Total events	492		643				
Heterogeneity: Chi ² =	57.64, df = 20 (F	o < 0.0001); l² = 65%				
Test for overall effect:	Z = 13.31 (P < 0	0.00001)					
2.1.2 Father							
Amin 2014	46	84	80	168	17.2%	1.33 [0.79, 2.25]	
Izah 2019	9	9	34	(1	0.3%	23.96 [1.35, 426.22]	
Nasikhah 2012	15	22	16	40	2.6%	3.21 [1.07, 9.63]	
Permadi 2021	11	15	12	75	0.8%	14.44 [3.93, 52.99]	
Wahdah 2015	50	82	6	38	2.3%	8.33 [3.13, 22.17]	
Subtotal (95% CI)		212		290	23.1%	2.94 [2.01, 4.29]	\bullet
Total events	131		148				
Heterogeneity: Chi ² =	20.90, dt = 4 (P	= 0.0003)	; 1- = 81%				
Test for overall effect:	Z = 5.59 (P < 0.	00001)					
Total (95% CI)		987		2198	100.0%	3.54 [2.98, 4.21]	•
Total events	623		791				
Heterogeneity: Chi2 =	79.26, df = 25 (F	o < 0.0000	01); l² = 68%				
Test for overall effect:	Z = 14.39 (P < 0	0.00001)					Eavours [Normal Stature] Eavours [I ow Stature]
Test for subgroup diffe	rences: Chi ² = 1	20 df =	$1 (P = 0.27) I^2 = 1$	6.6%			

Figure 6. Sensitivity analysis by excluding studies with totals in low- and normal-mother-stature groups of more than 100 each.

Exclusion of studies in Java or non-Java region only

Because people on Java have better access to both education and health services compared to people outside Java, we also did the sensitivity analysis by excluding studies using non-Java [27,28,38,41-43,46] and Java setting [12,39,40,44,45,47,48] and the results are presented in **Figure 7**. Heterogeneities remained after the exclusion of studies, which indicated that geographic origins (Java vs. Non-Java) were not a source of heterogeneity.

Exclusion of studies with low and moderate quality

The next sensitivity analysis excluded studies with low and moderate qualities [12,25,26,28-30,32,35-37,38,41,42,48,50] (**Figure 8**). The sensitivity analysis showed that heterogeneity remained substantial after excluding low and moderate quality studies, which means that these studies seemed not the source of heterogeneity. Therefore, based on five variables studied in sensitivity analysis, the studies with smaller sample sizes were the source of heterogeneity.

Risk of publication bias

The sensitivity analyses revealed that small sample size contributed to heterogeneity, indicating a small-study effect. The most well-known explanation of the small-study effect is publication bias, where studies tend to include only positive findings. This possibility may influence the result or the combined effect size in data synthesis of the effect of parental stature on the incidence of stunting. A funnel plot was drawn to picture the risk of publication bias further (**Figure 9**). Our data indicated that 16 studies on the right side of the triangle and 11 on the left side. This asymmetrical scatter indicated a high risk of publication bias.

Δ		Low Mother St	tature	Normal Mother	Stature		Odds Ratio	Odds Ratio
Π_	Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% Cl	M-H, Fixed, 95% Cl
	2.1.1 Mother			_				
	Alim 2021	41	60	6	34	3.7%	10.07 [3.57, 28.38]	
	Amin 2014 Aminam 2020	49	/9	11	173	27.6%	2.04 [1.18, 3.51]	•
	Amisam 2020 Dabliansvab 2021	20	4/	26	34 86	0.0%	3.00 [1.22, 7.77]	
	Febrina 2017	31	42	52	124	10.4%	3 90 [1 80 8 47]	
	Ferani 2019	50	53	9	65	0.0%	103.70 [26.59, 404.52]	
	Istiningsih 2022	13	33	29	103	0.0%	1.66 [0.73, 3.76]	
	Izah 2019	8	8	35	78	0.6%	20.83 [1.16, 373.48]	
	Khairani 2019	14	35	18	67	0.0%	1.81 [0.76, 4.31]	
	Larasati 2018	14	16	62	136	2.5%	8.35 [1.83, 38.18]	
	Lubis 2021	17	18	25	66	0.0%	27.88 [3.49, 222.54]	
	Masdaniianan 2021	12	23	20	41	0.0%	1.15 [0.41, 3.18]	
	Nadivab 2014	691	207	278	562	0.0%	2 35 [1 90 2 91]	
	Naiahah 2013	37	55	39	103	0.0%	3 37 [1 69 6 72]	
	Nasikhah 2012	18	27	13	35	5.7%	3.38 [1.18, 9.71]	
	Nasrul 2015	71	120	95	230	0.0%	2.06 [1.31, 3.23]	
	Nurdin 2019	34	56	25	62	0.0%	2.29 [1.09, 4.79]	
	Nurlaily 2021	14	16	62	136	0.0%	8.35 [1.83, 38.18]	
	Oktarina 2013	347	735	200	604	0.0%	1.81 [1.45, 2.26]	
	Permadi 2021	15	24	18	/6	4.9%	5.37 [2.01, 14.32]	
	Ourani 2022	9	30	20	147	0.7%	21.40 [1.23, 375.51]	,
	Sindhughosa 2020	22	43	18	80	0.0%	3 61 [1 63, 8 00]	
	Wahdah 2015	47	78	9	42	0.0%	5.56 [2.34, 13.21]	
	Wardani 2022	189	361	157	436	0.0%	1.95 [1.47, 2.60]	
	Yuliani 2018	221	354	108	219	0.0%	1.71 [1.21, 2.40]	
	Subtotal (95% CI)		265		803	56.0%	4.05 [2.91, 5.64]	•
	Total events	185		332				
	Heterogeneity: Chi ² = 1	2.94, df = 7 (P =	: 0.07); l ²	= 46%				
	l est for overall effect: Z	. = 8.27 (P < 0.0	0001)					
	2.1.2 Father							
	Amin 2014	46	84	80	168	36.4%	1 33 [0 79 2 25]	
	Izah 2019	9	9	34	77	0.6%	23.96 [1.35, 426.22]	│ ———→
	Nasikhah 2012	15	22	16	40	5.4%	3.21 [1.07, 9.63]	
	Permadi 2021	11	15	12	75	1.6%	14.44 [3.93, 52.99]	
	Wahdah 2015	50	82	6	38	0.0%	8.33 [3.13, 22.17]	
	Subtotal (95% CI)		130		360	44.0%	2.35 [1.55, 3.56]	
	Total events	81		142				
	Test for overall effect: 7	4.78,01 = 3 (P = ' = 4.01 (P < 0.0	: 0.002); I 001)	* = 80%				
	Test for overall effect. Z	. – 4.01 (F < 0.0	001)					
	Total (95% CI)		395		1163	100.0%	3.30 [2.55, 4.27]	•
	Total events	266		474				
	Heterogeneity: Chi ² = 3	1.47 df = 11 (P)	- 0.0000) 12 - 65%				
	notorogeneity. On o	1.47, di 11 (i	- 0.0003), T = 0070				0.01 0.1 1 10 100
	Test for overall effect: Z	= 9.06 (P < 0.0	0001)), T = 00 %				0.01 0.1 1 10 100 Favours [Normal Stature] Favours [Low Stature]
	Test for subaroup differ	= 9.06 (P < 0.0) ences: Chi ² = 4.	0001) 02. df = 1), 1 = 0.05). l ² = 1	75.1%			0.01 0.1 1 10 100 Favours [Normal Stature] Favours [Low Stature]
P	Test for subaroup differ	Lev Mother St	= 0.0003 0001) 02. df = 1 tature	(P = 0.05), ² = 1	75.1% Stature		Odds Ratio	0.01 0.1 1 10 100 Favours [Normal Stature] Favours [Low Stature]
B	Test for overall effect: Z Test for subgroup differ	Low Mother St Events	0001) 02. df = 1 tature <u>Total</u>	(P = 0.05). ² = ⁻ Normal Mother Events	75.1% Stature Total	Weight	Odds Ratio M-H, Fixed, 95% Cl	0.01 0.1 1 1 10 100 Favours [Normal Stature] Favours [Low Stature] Odds Ratio
B	Test for subgroup differ Study or Subgroup 2.1.1 Mother	Low Mother St Events	0001) 02. df = 1 tature Total	(P = 0.05). ² = ' Normal Mother Events	75.1% Stature Total	Weight	Odds Ratio M-H, Fixed, 95% Cl	0.01 0.1 1 1 0 100 Favours [Normal Stature] Favours [Low Stature] Odds Ratio <u>M-H, Fixed, 95% CI</u>
B	Study or Subgroup 2.1.1 Mother Alim 2021	i = 9.06 (P < 0.0 ences: Chi ² = 4. Low Mother St Events 41	0001) 02. df = 1 tature Total	(P = 0.05), I ² = ' Normal Mother <u>Events</u>	75.1% Stature Total 34	Weight 0.0%	Odds Ratio M-H, Fixed, 95% Cl 10.07 [3.57, 28.38]	0.01 0.1 1 1 0 100 Favours [Normal Stature] Favours [Low Stature] Odds Ratio M-H, Fixed, 95% Cl
B	Study or Subgroup 2.1.1 Mother Alim 2021 Amin 2014	i = 9.06 (P < 0.0 ences: Chi² = 4. Low Mother St <u>Events</u> 41 49	0001) 02. df = 1 tature Total 60 79	Normal Mother Events 6 77	75.1% Stature Total 34 173	Weight 0.0% 0.0%	Odds Ratio M-H, Fixed, 95% Cl 10.07 [3.57, 28.38] 2.04 [1.18, 3.51]	0.01 0.1 1 1 0 100 Favours [Normal Stature] Favours [Low Stature] 100 0dds Ratio M-H, Fixed, 95% Cl
B	Study or Subgroup 2.1.1 Mother Alim 2021 Amin 2014 Amin 2014 Amin 2014	i = 9.06 (P < 0.0 ences: Chi² = 4. Low Mother St <u>Events</u> 41 49 28	0001) 02. df = 1 tature Total 60 79 47	Normal Mother Events 6 77 11 26	75.1% Stature Total 34 173 34	Weight 0.0% 0.0% 1.0%	Odds Ratio M-H, Fixed, 95% Cl 10.07 [3.57, 28.38] 2.04 [1.18, 3.51] 3.08 [1.22, 7.77]	0.01 0.1 1 1 0 100 Favours [Normal Stature] Favours [Low Stature] Odds Ratio M-H, Fixed, 95% Cl
B	Study or Subgroup 2.1.1 Mother Amin 2021 Amin 2021 Aminsa 2020 Dahliansyah 2021 Echoina 2017	= 9.06 (P < 0.0 ences: Chi ² = 4. Low Mother Si <u>Events</u> 41 49 28 6 31	0001) 02. df = 1 tature Total 60 79 47 14 42	1 (P = 0.05), I ² = 1 Normal Mother Events 6 77 11 26 52	75.1% Stature Total 34 173 34 86 124	Weight 0.0% 0.0% 1.0% 0.8% 0.0%	Odds Ratio M-H, Fixed, 95% Cl 10.07 [3.57, 28.38] 2.04 [1.18, 3.51] 3.08 [1.22, 7.77] 1.73 [0.55, 5.49] 3.90 [1.80, 847]	0.01 0.1 1 1 0 100 Favours [Normal Stature] Favours [Low Stature] Odds Ratio M-H, Fixed, 95% Cl
B	Study or Subgroup 2.1.1 Mother Aim 2021 Amin 2014 Amina 2020 Dahliansyah 2021 Febrina 2017 Ferani 2019	= 9,06 (P < 0.0 ences: Chi ² = 4. Low Mother Si <u>Events</u> 41 49 28 6 31 50	0001) 02. df = 1 tature Total 60 79 47 14 42 53	(P = 0.05). ² = ' Normal Mother <u>Events</u> 6 77 11 26 52 9	75.1% Stature Total 34 173 34 86 124 65	Weight 0.0% 0.0% 1.0% 0.8% 0.0% 0.1%	Odds Ratio M-H, Fixed, 95% Cl 10.07 [3.57, 28.38] 2.04 [1.18, 3.51] 3.08 [1.22, 7.77] 1.73 [0.55, 5.49] 3.90 [1.80, 8.47] 103 70 [26.59, 404 52]	0.01 0.1 1 1 0 100 Favours [Normal Stature] Favours [Low Stature] Odds Ratio M-H, Fixed, 95% Cl
B	Study or Subgroup Study or Subgroup 2.1.1 Mother Alim 2021 Amin 2014 Amisam 2020 Dahliansyah 2021 Febrina 2017 Ferani 2019 Istiningsih 2022	41 49 28 6 31 50 13	00000 0001) 02. df = 1 tature Total 60 79 47 14 42 53 33	(P = 0.05), I ² = - Normal Mother Events 6 77 11 26 52 9 29	75.1% Stature Total 34 173 34 86 124 6 125 103	Weight 0.0% 1.0% 0.8% 0.1% 0.1%	Odds Ratio M-H, Fixed, 95% Cl 10.07 [3.57, 28.38] 2.04 [1.18, 3.51] 3.08 [1.22, 7.77] 1.73 [0.55, 5.49] 3.90 [1.80, 8.47] 103.70 [26.59, 404.52] 1.66 [0.73, 3.76]	0.01 0.1 1 1 0 100 Favours [Normal Stature] Favours [Low Stature] 0dds Ratio M-H, Fixed, 95% CI
B	Study or Subgroup differ: 2 Test for overall effect: 2 Test for subaroup differ 2.1.1 Mother Alim 2021 Amin 2014 Arnisam 2020 Dahliansyah 2021 Febrina 2017 Ferani 2019 Istiningsih 2022 Izah 2019	41 49 6 31 50 13 8	0001) 02. df = 1 tature Total 60 79 47 14 42 53 33 8	(P = 0.05). I ² = ⁻¹ Normal Mother <u>Events</u> 6 77 11 26 52 9 29 35	75.1% Stature Total 34 173 34 86 124 65 103 78	Weight 0.0% 1.0% 0.8% 0.1% 1.7% 0.0%	Odds Ratio M-H, Fixed, 95% CI 10.07 [3.57, 28.38] 2.04 [1.18, 3.51] 3.08 [1.22, 7.77] 1.73 [0.55, 5.49] 3.90 [1.80, 8.47] 103.70 [26.59, 404.52] 1.66 [0.73, 3.76] 20.83 [1.16, 373.48]	0.01 0.1 1 1 0 100 Favours [Normal Stature] Favours [Low Stature] 100 0dds Ratio M-H, Fixed, 95% Cl
B	Study or Subgroup 2.1.1 Mother Alim 2021 Amin 2014 Amin 2014 Aminsam 2020 Dahliansyah 2021 Febrina 2017 Ferani 2019 Istiningsih 2022 Izah 2019 Khairani 2019	= 9.06 (P < 0.0 ences: Chi ² = 4. Low Mother SI <u>Events</u> 41 49 28 6 31 50 13 8 14	0001) 02. df = 1 tature Total 60 79 47 14 42 53 33 8 35	(P = 0.05), I ² = - Normal Mother <u>Events</u> 6 77 11 26 52 9 29 35 18	75.1% Stature Total 34 173 34 173 34 173 34 173 34 173 34 173 34 173 34 173 34 173 34 173 34 173 34 173 34 174 174 175 175 175 175 175 175 175 175	Weight 0.0% 1.0% 0.8% 0.1% 0.1% 0.1% 0.15%	Odds Ratio M-H, Fixed, 95% Cl 10.07 [3.57, 28.38] 2.04 [1.18, 3.51] 3.08 [1.22, 7.77] 1.73 [0.55, 5.49] 3.90 [1.80, 8.47] 103.70 [26.59, 404.52] 1.66 [0.73, 3.76] 20.83 [1.16, 373.48] 1.81 [0.76, 4.31]	0.01 0.1 1 1 0 100 Favours [Normal Stature] Favours [Low Stature] 100 0dds Ratio 1 M-H, Fixed, 95% Cl
B	Study or Subgroup Test for overall effect: 2 Test for subaroup differ 2.1.1 Mother Alim 2021 Amin 2014 Arnisam 2020 Dahliansyah 2021 Febrina 2017 Febrina 2017 Istiningsih 2022 Izah 2019 Istiningsih 2022 Izah 2019 Larasati 2018 Larasati 2018	= 9.06 (P < 0.0 ences: Chi ² = 4. Low Mother Si <u>Events</u> 41 49 28 6 31 50 13 8 14 14	0001) 02. df = 1 tature Total 60 79 47 14 42 53 333 8 35 16	(P = 0.05), I ² = - Normal Mother Events 6 77 11 26 52 9 29 35 18 62 07	75.1% Stature Total 34 173 34 86 124 65 103 78 67 136 67 136 67	Weight 0.0% 1.0% 0.0% 0.1% 0.1% 0.0% 1.7% 0.0%	Odds Ratio M-H, Fixed, 95% Cl 10.07 [3.57, 28.38] 2.04 [1.18, 3.51] 3.08 [1.22, 7.77] 1.73 [0.55, 5.49] 3.90 [1.80, 8.47] 103.70 [26.59, 404.52] 1.66 [0.73, 3.76] 20.83 [1.16, 373.48] 1.81 [0.76, 4.31] 8.35 [1.83, 38.18] 27 88 [4 0.005 ci	0.01 0.1 1 10 100 Favours [Normal Stature] Favours [Low Stature] Odds Ratio M-H, Fixed, 95% Cl
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B	Study or Subgroup Study or Subgroup 2.1.1 Mother Alim 2021 Amin 2014 Amin 2014 Amin 2014 Amin 2014 Amin 2014 Amin 2014 Febrina 2020 Dahliansyah 2021 Febrina 2017 Ferani 2019 Larasati 2018 Lubis 2021 Masdahlianah 2021 Mutiarasari 2021 Mutiarasari 2021 Mutiarasari 2021 Mutiarasari 2021 Nasikhah 2013 Nasikhah 2013 Nasikhah 2013 Nasikhah 2013 Nurdin 2019 Nurdin 2019 Nurdin 2019 Nurdin 2019 Nurdin 2019 Permadi 2021 Petri 2018 Qurani 2022 Sindhughosa 2020 Wahdah 2015 Wardani 2018 Vuliani 2018 Subtotal (95% CI) Total eyents	= 9.06 (P < 0.0 ences: Chi ² = 4. Low Mother Si <u>Events</u> 41 49 28 6 31 50 13 8 14 14 17 12 111 691 37 18 71 34 14 347 15 9 13 22 47 189 221 1937	0001) 02. df = 1 tature Total 60 79 47 44 42 53 33 8 8 35 5 5 7 7 4 4 42 5 33 33 33 33 33 33 33 33 5 5 5 7 7 991 5 5 7 7 991 5 5 7 7 991 5 27 7 993 9 39 39 39 39 39 39 39 30 30 5 24 5 4 5 30 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	(P = 0.05), P = - Normal Mother Events 6 77 11 26 52 9 29 35 18 62 25 20 159 278 39 13 95 25 62 200 18 69 20 18 95 25 62 200 18 13 95 25 62 200 18 13 95 25 13 13 157 108 1308	75.1% Stature Total 34 173 34 124 65 103 78 67 136 66 41 353 35 230 62 133 604 76 604 76 147 112 80 42 436 604 219 3401	Weight 0.0% 0.0% 0.0% 0.1% 0.0% 0.1% 0.1% 0.1%	Odds Ratio M-H, Fixed, 95% Cl 10.07 [3.57, 28.38] 2.04 [1.18, 3.51] 3.08 [1.22, 7.77] 1.73 [0.55, 5.49] 3.90 [1.80, 8.47] 103.70 [26.59, 404.52] 1.66 [0.73, 3.76] 20.83 [1.16, 373.48] 1.81 [0.76, 4.31] 8.35 [1.83, 38.18] 27.88 [3.49, 222.54] 1.15 [0.41, 3.18] 1.41 [1.00, 1.99] 2.35 [1.90, 2.91] 3.37 [1.69, 6.72] 3.38 [1.18, 9.71] 2.06 [1.31, 3.23] 2.29 [1.09, 4.79] 8.35 [1.83, 38.18] 1.81 [1.45, 2.26] 5.37 [2.01, 14.32] 21.46 [1.23, 375.51] 2.30 [1.01, 5.24] 3.61 [1.63, 8.00] 5.56 [2.34, 13.21] 1.95 [1.47, 2.60] 1.71 [1.21, 2.40] 1.71 [1.21, 2.40] 2.16 [1.95, 2.39]	0.01 0.1 1 10 100 Favours [Normal Stature] Favours [Low Stature] 00dds Ratio 1 00 0 dds Ratio 1 0 0 dds Ratio 1
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B	Test for overall effect: Z Test for overall effect: Z Test for subaroub differ Study or Subgroup 2.1.1 Mother Alim 2021 Amin 2014 Arnisam 2020 Dahliansyah 2021 Febrina 2017 Ferani 2019 Istiningsih 2022 Izah 2019 Khairani 2019 Larasati 2018 Lubis 2021 Masdahlianah 2021 Mutiarasari 2021 Nadiyah 2014 Najahah 2013 Nasikhah 2013 Nasikhah 2013 Oktarina 2019 Nurdini 2019 Nurdini 2021 Oktarina 2013 Permadi 2021 Sindhughosa 2020 Wahdah 2015 Wardani 2022 Sindhughosa 2020 Wahdah 2015 Otal events Heterogeneity: Chi ² = 6 Test for overall effect: Z 2.1.2 Father	= 9.06 (P < 0.0 ences: Chi ² = 4. Low Mother Si Events 41 49 28 6 31 50 13 8 14 14 17 12 111 691 37 18 71 34 14 14 37 15 9 13 22 47 189 221 1937 1.79, df = 18 (P < 0. 46 9 57 57 57 57 57 57 57 57 57 57	0001) 02. df = 1 tature Total 60 79 47 74 42 53 38 8 35 6 16 18 23 207 991 5 27 71 20 991 12. df = 1 33 8 35 5 5 27 7 120 16 16 16 16 16 16 16 16 16 16	(P = 0.05), P = - Normal Mother Events 6 77 11 26 52 9 29 35 18 62 25 20 159 278 39 13 95 25 62 200 18 69 20 18 69 20 159 133 85 25 62 200 18 69 20 159 278 39 13 15 25 62 278 39 13 15 25 62 278 39 13 15 25 6 278 39 13 15 25 278 278 39 13 15 25 278 278 278 278 278 278 278 278	75.1% Stature Total 34 173 34 86 61 103 78 67 136 66 41 1353 562 103 35 230 62 103 35 230 62 103 35 230 62 103 35 230 62 103 35 230 62 103 35 230 62 136 604 76 147 136 60 41 135 35 230 62 136 60 41 135 35 230 62 136 60 41 147 136 60 41 135 35 230 62 136 60 41 147 136 60 41 135 35 230 62 136 604 77 136 604 77 136 604 77 136 604 77 136 604 77 136 78 78 78 79 70 70 70 70 70 70 70 70 70 70	Weight 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.0	Odds Ratio M-H, Fixed, 95% Cl 10.07 [3.57, 28.38] 2.04 [1.18, 3.51] 3.08 [1.22, 7.77] 1.73 [0.55, 5.49] 3.90 [1.80, 8.47] 103.70 [26.59, 404.52] 1.66 [0.73, 3.76] 20.83 [1.16, 373.48] 1.81 [0.76, 4.31] 8.35 [1.83, 38.18] 1.41 [1.00, 1.99] 2.35 [1.90, 2.91] 3.37 [1.69, 6.72] 3.38 [1.18, 9.71] 2.06 [1.31, 3.23] 2.29 [1.09, 4.79] 8.35 [1.83, 38.18] 1.81 [1.45, 2.26] 5.37 [2.01, 14.32] 2.146 [1.23, 375.51] 2.30 [1.01, 5.24] 3.61 [1.63, 8.00] 5.56 [2.34, 13.21] 1.95 [1.47, 2.60] 1.71 [1.21, 2.40] 2.16 [1.95, 2.39] 1.33 [0.79, 2.25] 23.96 [1.35, 426.22] 23.96 [1.35, 426.22] 24.96 [1.95, 23.96 [1.35, 426.22] 25.96 [1.35, 426.2]	0.01 0.1 1 10 100 Favours [Normal Stature] Favours [Low Stature] 00dds Ratio 1 00 0
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B	Test for overall effect: Z Test for overall effect: Z Test for subaroub differ 2.1.1 Mother Alim 2021 Amin 2014 Arnisam 2020 Dahliansyah 2021 Febrina 2017 Ferani 2019 Istiningsih 2022 Izah 2019 Khairani 2019 Larasati 2018 Lubis 2021 Masdahlianah 2021 Mutiarasari 2021 Nadiyah 2014 Najahah 2013 Nasikhah 2012 Nasrul 2015 Nurdin 2019 Nurdini 2019 Nurdini 2019 Nurdini 2019 Putri 2018 Qurani 2022 Sindhughosa 2020 Wahdah 2015 Subtotal (95% Cl) Total events Heterogeneity: Chi ² = 6 Test for overall effect: Z 2.1.2 Father Amin 2014 Izah 2019 Nasikhah 2012 Permadi 2021 Yuliani 2018 Subtotal (95% Cl)	= 9.06 (P < 0.0 ences: Chi ² = 4. Low Mother Si Events 41 49 28 6 31 50 13 8 14 14 17 12 111 691 37 18 71 34 14 14 37 15 9 13 22 1937 1.79, df = 18 (P < 0. 46 9 15 11 50	0001) 02. df = 1 tature Total 600 79 47 42 53 33 8 35 56 16 18 23 207 991 52 27 71 200 56 16 16 735 277 1200 56 16 16 16 279 991 52 277 1200 56 16 16 16 16 16 16 16 16 16 1	(P = 0.05), P = -7 Normal Mother Events 6 77 11 26 52 9 29 35 18 62 25 20 159 278 39 13 95 25 62 200 18 69 20 159 278 39 13 5 25 62 200 159 278 39 13 5 25 62 200 159 278 39 13 5 25 62 200 159 278 39 13 5 25 62 200 159 278 39 13 5 25 62 200 18 69 200 18 108 1); P = 71% 80 34 16 12 6	75.1% Stature Total 34 173 34 86 124 65 103 34 103 87 78 67 136 66 41 1353 562 103 355 2300 2300 2300 2300 2300 2300 240 201 35 2300 240 201 202 136 66 201 203 203 203 203 203 204 203 204 204 205 205 205 205 205 205 205 205	Weight 0.0% 0.0% 0.1% 0.0% 0.1% 0.0% 0.1% 0.0% 0.1% 0.0% 0.0	Odds Ratio M-H, Fixed, 95% Cl 10.07 [3.57, 28.38] 2.04 [1.18, 3.51] 3.08 [1.22, 7.77] 1.73 [0.55, 5.49] 3.90 [1.80, 8.47] 103.70 [26.59, 404.52] 1.66 [0.73, 3.76] 20.83 [1.16, 373.48] 1.81 [0.76, 4.31] 8.35 [1.83, 38.18] 27.88 [3.49, 222.54] 1.15 [0.41, 3.18] 1.41 [1.00, 1.99] 2.35 [1.90, 2.91] 3.37 [1.69, 6.72] 3.38 [1.18, 9.71] 2.06 [1.31, 323] 2.29 [1.09, 4.73] 2.29 [1.09, 4.73] 2.35 [1.83, 38.18] 1.81 [1.45, 2.26] 5.37 [2.01, 14.32] 21.46 [1.23, 375.51] 2.30 [1.01, 5.24] 3.61 [1.63, 8.00] 5.56 [2.34, 13.21] 1.95 [1.47, 2.60] 1.71 [1.21, 2.40] 2.16 [1.95, 2.39] 1.33 [0.79, 2.25] 23.92 [1.07, 9.63] 14.44 [3.93, 52.99] 8.33 [3.13, 22.17] 8.33 [3.13, 22.17]	0.01 0.1 1 10 100 Favours [Normal Stature] Favours [Low Stature] 0 Odds Ratio 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
B	Test for overall effect: Z Test for overall effect: Z Test for subaroub differ 2.1.1 Mother Alim 2021 Amin 2014 Amisam 2020 Dahliansyah 2021 Febrina 2017 Ferani 2019 Istiningsih 2022 Izah 2019 Khairani 2019 Larasati 2018 Lubis 2021 Masdahlianah 2021 Mutiarasari 2021 Mutiarasari 2021 Mutiarasari 2021 Mutiarasari 2021 Nasikhah 2013 Nasikhah 2013 Oktarina 2013 Permadi 2021 Sindhughosa 2020 Wahdah 2015 Vardani 2022 Sindhughosa 2020 Wahdah 2015 Vardani 2022 Sindhughosa 2020 Wahdah 2015 Otal events Heterogeneity: Chi ² = 6 Test for overall effect: Z 2.1.2 Father Amin 2014 Izah 2019 Nasikhah 2012 Permadi 2021 Valiani 2014 Izah 2019 Nasikhah 2012 Permadi 2021 Vahdah 2015 Subtotal (95% CI) Total events	= 9.06 (P < 0.0 ences: Chi ² = 4. Low Mother Si Events 41 49 28 6 31 50 13 8 14 14 17 12 111 691 37 18 71 34 14 14 37 15 9 13 22 47 189 221 1937 1.79, df = 18 (P < 0. 46 9 15 11 50 50 50	0001) 02. df = 1 Total Total 60 79 47 74 42 53 33 8 35 35 35 35 33 8 35 527 727 120 55 57 727 120 991 135 24 99 43 36 16 16 16 16 16 16 16 16 16 1	(P = 0.05), P = - Normal Mother Events 6 77 11 26 52 9 29 35 18 62 25 20 159 278 39 13 95 25 62 200 18 69 20 18 69 20 159 278 39 13 95 25 62 200 18 66 77 11 18 62 25 20 159 278 39 13 95 25 62 200 18 66 69 20 159 278 39 13 95 25 62 200 18 66 25 200 159 278 39 13 95 25 62 200 18 66 20 159 278 39 13 95 25 62 200 18 69 200 18 69 200 18 69 20 18 108 1); P = 71% 80 34 12 6 6 6 6 6 6 6 6 157 108 125 6 6 6 6 6 157 108 125 6 6 6 6 6 157 108 126 6 6 6 6 6 6 157 108 127 6 6 6 6 6 6 6 6 6 6 6 6 6	75.1% Stature Total 34 173 34 86 61 124 65 103 78 67 136 66 41 353 562 103 35 230 62 103 35 230 64 41 353 35 230 64 41 353 35 230 64 41 353 35 230 64 41 353 35 230 64 41 75 36 80 42 43 66 60 41 41 353 35 230 62 136 60 41 47 136 60 41 136 60 41 135 35 230 62 136 60 41 147 75 200 62 136 60 41 147 75 200 62 136 60 41 147 75 200 62 136 60 42 103 35 230 62 136 60 42 136 60 42 136 60 42 136 60 42 136 60 42 136 60 42 136 60 42 136 60 42 136 80 42 136 80 42 136 80 42 33 33 80 219 3401 340 35 38 38 38 38 38 38 38 38 38 38	Weight 0.0% 0.0% 0.1% 0.0% 0.1% 0.0% 0.1% 0.0% 0.1% 0.0% 0.3% 0.0% 0.3% 0.0% 0.0% 0.0% 0.0	Odds Ratio M-H, Fixed, 95% Cl 10.07 [3.57, 28.38] 2.04 [1.18, 3.51] 3.08 [1.22, 7.77] 1.73 [0.55, 5.49] 3.90 [1.80, 8.47] 103.70 [26.59, 404.52] 1.66 [0.73, 3.76] 20.83 [1.16, 373.48] 1.81 [0.76, 4.31] 8.35 [1.83, 38.18] 1.41 [1.00, 1.99] 2.35 [1.90, 2.91] 3.37 [1.69, 6.72] 3.38 [1.18, 9.71] 2.06 [1.31, 3.23] 2.29 [1.09, 4.79] 8.35 [1.83, 38.18] 1.81 [1.45, 2.26] 5.37 [2.01, 14, 32] 2.146 [1.23, 375.51] 2.30 [1.01, 5.24] 3.61 [1.63, 8.00] 5.56 [2.34, 13.21] 1.95 [1.47, 2.60] 1.71 [1.21, 2.40] 2.16 [1.95, 2.39] 1.33 [0.79, 2.25] 23.96 [1.35, 426.22] 3.21 [1.07, 9.63] 1.444 [3.93, 52.99] 8.33 [3.13, 22.17] 8.33 [3.13, 22.17]	0.01 0.1 1 10 100 Favours [Normal Stature] Favours [Low Stature]

Test for overall effect: Z = 4.25 (P < 0.0001)

Total (95% CI)

 Total events
 1987
 1314

 Heterogeneity: Chi² = 69.49, df = 19 (P < 0.00001); P² = 73%</td>
 Test for overall effect: Z = 15.12 (P < 0.00001)</td>

 Test hor subgroup differences
 Chi² = 7 25 ch = 1 (P = 0.007); i² = 86 2%.

3360

Figure 7. Sensitivity analysis by excluding studies taking non-Java (A) and Java (B) regions as the setting.

2.20 [1.98, 2.43]

3439 100.0%

100

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0.01 0.1 1 10 Favours [Normal Stature] Favours [Low Stature]

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	Low Mother S	tature	Normal Mother	Stature		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% C	M-H, Fixed, 95% CI
2.1.1 Mother							
Alim 2021	41	60	6	34	2.5%	10.07 [3.57, 28.38]	
Amin 2014	49	79	77	173	0.0%	2.04 [1.18, 3.51]	
Arnisam 2020	28	47	11	34	0.0%	3.08 [1.22, 7.77]	
Dahliansvah 2021	6	14	26	86	4.2%	1.73 [0.55, 5,49]	
Febrina 2017	31	42	52	124	0.0%	3.90 [1.80, 8.47]	
Ferani 2019	50	53		65	0.5%	103.70 [26.59, 404.52]	
Istiningsih 2022	13	33	29	103	0.0%	1.66 [0.73, 3.76]	
Izah 2019	8	8	35	78	0.4%	20.83 [1.16, 373.48]	·
Khairani 2019	14	35	18	67	7.5%	1.81 [0.76, 4.31]	
Larasati 2018	14	16	62	136	1.6%	8.35 [1.83, 38, 18]	
Lubis 2021	17	18	25	66	0.0%	27 88 [3 49 222 54]	
Masdahlianah 2021	12	23	20	41	0.0%	1.15 [0.41, 3.18]	
Mutiarasari 2021	111	207	159	353	0.0%	1 41 [1 00 1 99]	
Nadivah 2014	691	991	278	562	0.0%	2 35 [1 90, 2 91]	
Najahah 2013	37	55	39	103	0.0%	3 37 [1 69 6 72]	
Nasikhah 2012	18	27	13	35	3.8%	3 38 [1 18 9 71]	
Nasrul 2015	71	120	95	230	0.0%	2.06 [1.31, 3.23]	
Nurdin 2019	34	56	25	62	9.4%	2 29 [1 09 4 79]	
Nurlaily 2021	14	16	62	136	0.4%	8 35 [1 83 38 18]	
Oktarina 2013	347	735	200	604	0.0%	1 81 [1 45 2 26]	
Permadi 2021	15	24	18	76	0.0%	5 37 [2 01 14 32]	
Putri 2018	9	24 Q	69	147	0.0%	21 46 [1 23 375 51]	│ →
Ourani 2022	13	39	20	112	7.0%	2 30 [1 01 5 24]	
Sindhughosa 2020	22	13	18	80	0.0%	3.61 [1.63, 8.00]	
Wahdah 2015	47	78	9	42	1 7%	5 56 [2 34 13 21]	
Wardani 2013	189	361	157	436	0.0%	1 95 [1 47 2 60]	
Vuliani 2018	221	354	108	210	50.7%	1 71 [1 21 2 40]	
Subtotal (95% CI)	221	749	100	1083	92.7%	3.11 [2.50, 3.87]	
Total events	475		400				•
Heterogeneity: Chi ² = 5	2 77 df = 11 (P		400 11): l ² = 79%				
Test for overall effect: 2	7 = 10 22 (P < 0	00001)	/1), 1 = / 5 / 6				
	- 10.22 (1 10						
2.1.2 Father							
Amin 2014	46	84	80	168	0.0%	1 33 [0 79 2 25]	
Izah 2019	9	9	34	77	0.4%	23 96 [1 35 426 22]	· · · · · · · · · · · · · · · · · · ·
Nasikhah 2012	15	22	16	40	3.7%	3.21 [1.07, 9.63]	
Permadi 2021	11	15	12	75	0.0%	14.44 [3.93, 52.99]	
Wahdah 2015	50	82	6	38	3.2%	8 33 [3 13 22 17]	
Subtotal (95% CI)		113	•	155	7.3%	6.62 [3.32, 13.18]	•
Total events	74		56				-
Heterogeneity: Chi ² = 2	P_{64} df = 2 (P =	0.27): l ² =	= 24%				
Test for overall effect: 2	Z = 5.37 (P < 0.0	00001)					
Total (95% CI)		862		1238	100.0%	3.37 [2.74, 4.14]	•
Total events	549		456			-	
Heterogeneity: Chi ² = 5	9.87. df = 14 (P	< 0.0000	(1): $ ^2 = 77\%$				
Test for overall effect: 2	Z = 11.51 (P < 0	.00001)	<i>y</i>				U.U1 U.1 1 10 100
Test for subgroup differ	rences: Chi ² = 4	.18, df =	1 (P = 0.04), I ² = 7	76.1%			ravours (Normai Stature) Favours (Low Stature)

Figure 8. Forest plot of sensitivity analysis by excluding low and moderate quality studies.



Figure 9. Funnel plot of data synthesis from the effect of parental stature on stunting among Indonesian toddlers.

Discussion

The findings of this present systematic review suggest that parental height is a risk factor for stunting in Indonesian population, with significant effects seen for maternal stature. These findings are consistent with previous studies showing parental height as a significant risk factor for stunting in young children [4,16]. However, caution should be exercised when interpreting the results of studies examining the effects of paternal stature and both parental stature on stunting, as these studies may suffer from imprecision, heterogeneity and low quality. There was also a high risk of publication bias among studies examining parental stature and stunting in Indonesia.

Our study highlights the need for a continuous monitoring of children's height and the implementation of interventions that address environmental factors contributing to stunting, such as access to adequate nutrition and healthcare [18,19] to reduce the prevalence of stunting in Indonesia which resonates with Indonesian Medium-Term Development Plan 2020–2024. Future studies may benefit from addressing the limitations identified in this review, such as the need for more extensive and higher-quality studies that account for potential confounding factors. Additionally, the use of standardized methods for measuring height and the inclusion of diverse populations may enhance the generalizability of findings.

Overall, this systematic review highlights the need for continuous efforts to address the complex and multifactorial nature of stunting in Indonesia. Furthermore, it also underscores the importance of conducting high-quality systematic reviews to accurately assess the evidence base for interventions aimed at reducing stunting in young children. By identifying parental stature as a potential risk factor for stunting, the findings of this study provide important insights for policymakers, healthcare providers, and researchers working towards the goal of reducing the burden of stunting in Indonesian population.

Conclusions

Our systematic review indicates that parental height may be associated with the incidence of stunting of toddlers in Indonesia. While the finding showed a significant effect of maternal stature (OR 1.92 with 95%CI: 1.71–2.15), paternal stature (OR 5.21; 95%CI: 1.71–15.86) and both parental stature (OR 3.01 with 95%CI: 2.41–3.75) on the incidence of stunting among toddlers in the country, it should be cautiously interpreted primarily because of imprecision, substantial heterogeneity with unidentified source and mixed qualities of studies. Our systematic review also reveals a high risk of publication bias among studies reporting the effect of parental stature on the incidence of stunting in Indonesia.

Ethics approval

Not required.

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Competing interest

All the authors declare that there are no conflicts of interest.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

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