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Puskesmas Accreditation Status And Asset Ownership Potentially Lowering Stunting : Multilevel Analysis In Jeneponto and Barru Districts, South Sulawesi

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ABSTRACT

The Puskesmas accreditation enhances public health service quality, but its role in stunting prevention is underexplored. Stunting, a critical public health issue, is influenced by healthcare services and socioeconomic factors, including family economic conditions. This study examines the impact of Puskesmas accreditation on stunting prevention in Jeneponto (highest stunting rate) and Barru (lowest stunting rate) in South Sulawesi. Using cross-sectional data from the 2022 Indonesian Nutritional Status Study, analyzed hierarchical data (individual, family, and district levels) comprising 192 mothers, (89 mothers in Jeneponto and 103 in Barru) with infants aged 0–23 months. Descriptive and multilevel binary logistic regression analyses were conducted. At the individual level, stunting was linked to basic education (aOR 3.26; 95% CI: 1.38–7.70) and non-exclusive breastfeeding (aOR 3.64; 95% CI: 1.25–10.6). At the family level, inadequate sanitation (aOR 0.16; 95% CI: 0.03–0.84), higher asset ownership (aOR 0.13; 95% CI: 0.03–0.54). At the district level, Puskesmas accreditation was associated with lower odds of stunting (aOR 0.32; 95% CI: 0.11–0.93). The findings highlight the importance of maintaining Puskesmas accreditation and addressing socioeconomic disparities, such as family economic conditions, to ensure sustainable stunting prevention.

Key Messages:

- Higher Puskesmas accreditation status has protecting children aged 0-23 of months from stunting
- Stunting is shaped by individual, household, and districts level factors including asset ownership as a proxy for family economic status and the quality of health services

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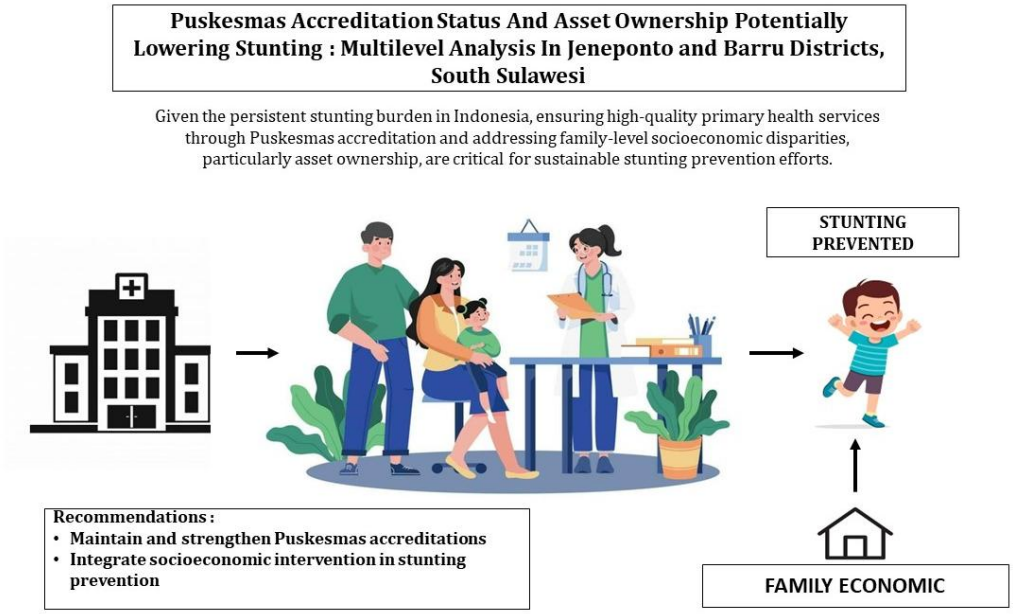
GRAPHICAL ABSTRACT



INTRODUCTION

Stunting remains a serious public health nutrition issue not only globally but also in several Asian countries, including Indonesia. Indonesia has drawn attention due to its potential for food surplus (1), as well as its social and economic conditions (2), which should ideally correlate with a reduction in stunting prevalence, even though this is not the case. Given its natural resources, social, and economic potential, Indonesia should be free from stunting, as per the WHO threshold of <20%. However, Indonesia's stunting rate remains above 20% as of 2023 (3). The Indonesian government has implemented a national action plan to accelerate stunting reduction since 2022, but the outcomes vary significantly across provinces and even among districts within provinces (4).

A review of stunting determinants in Indonesia has identified three key findings. First, most stunting determinants are at the individual and family levels, including factors such as gender, prematurity, short birth length, breastfeeding practices, healthcare services, socioeconomic status, inadequate sanitation, and untreated drinking water (5–7). Second, cultural factors, food systems, education, and water and environmental sanitation lack sufficient evidence as stunting determinants. Third, the WHO conceptual framework on stunting determinants cannot be fully applied to understand the roadmap for stunting prevention in real-world contexts due to limited empirical evidence (8,9).

This study highlights two novel variables focusing on the family and community levels in developing countries like Indonesia, given the limited empirical evidence at the district level within provinces, particularly in Barru and Jeneponto districts in South Sulawesi Province, which have the highest and lowest stunting prevalence, respectively (10). The two key variables are asset ownership and Puskesmas (Community Health Center) accreditation. Puskesmas accreditation is directly related to individuals' access to basic healthcare services. Previous reviews have shown disparities in healthcare quality between developing and developed countries, particularly in the effectiveness of intervention implementation (11). Another review highlights that differences in community health center services significantly impact individual and community health outcomes (12).

Meanwhile, asset ownership is a measure that reflects a family's socioeconomic status. A previous study found that high stunting rates are closely linked to a family's economic status (13). One commonly used indicator to measure a family's economic status is asset ownership. The relationship between asset value and stunting is inversely correlated, meaning that an increase in asset value contributes to a reduction in stunting (14). The objective of this study is to investigate the relationship between Puskesmas accreditation status and family asset ownership in relation to stunting in Jeneponto and Barru districts,

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South Sulawesi, Indonesia. This analysis responds to the limited empirical attention given to districts-levels drivers of stunting, particularly within decentralized health systems. By examining the roles of Puskesmas accreditation and socioeconomic disparities, this study contributes to a more context-sensitive understanding of stunting determinants in Indonesia and offers insight.

METHODS

This study is a quantitative study employing a cross-sectional approach, utilizing data from the 2022 Indonesian Nutritional Status Survey to examine the influence of Puskesmas (Community Health Center) accreditation and asset ownership as risk factors for stunting among children aged 0–23 months, specifically in Jeneponto and Barru districts, South Sulawesi Province These two districts represent areas with the highest (Jeneponto) and lowest (Barru) stunting prevalence based on the latest report from the survey (10).

The data utilized come from the 2022 Indonesian Nutritional Status Survey (SSGI), conducted by the Ministry of Health of the Republic of Indonesia. SSGI employed a two-stage stratified sampling method within a cross-sectional design, with a total sample of 334,848 infants and young children across 486 districts/cities and 33 selected provinces. The detailed methodology of the survey has been explained elsewhere (10). The study subjects are children aged 0–23 months. The total number of subjects is 192, obtained after data cleaning and initial processing from an original sample of 436 children.

The data were collected through requests submitted in May 2024 from the official website of Pusat Data dan Teknologi Informasi, an Indonesian government agency. Upon approval, the dataset was made available to the researchers through Pusat Data dan Teknologi Informasi's online platform. This study received ethical approval from the Health Research Ethics Committee of Dr. Moewardi Hospital, dated April 4, 2024 (number 909/IV/HREC/2024).

The height measurement of children in this research was used to determine stunting, which is the primary outcome variable. A child is considered stunted when their nutritional status does not meet the established criteria for height-for-age and has a z-score of <-2 SD to ≥-3 SD. The z-score value is reported as a standard deviation (SD) (15). For other predictors, variables were stratified into three levels: individual, household, and district. Each variable was divided into two categories.

At the individual level, variables included maternal height, categorized as short stature (<150 cm) or normal stature (≥150 cm) based on study (16). Age at first pregnancy, categorized as at risk (<18 and >35 years) or normal (≥18–35 years), in line with the classification adopted by the Indonesian Ministry of Health (17). Maternal education, categorized as basic education (high school or lower) or higher education (university/college). Birth weight, categorized as low birth weight (<2500 grams) or normal birth weight (≥2500 grams). Dietary diversity, categorized as low (consumed <4 food categories) or diverse (consumed ≥4 food categories) following the guidelines from the study (18). History of diarrhea and ARI, categorized as yes (ever diagnosed) or no (never diagnosed). History of breastfeeding, categorized as exclusive (breastfed exclusively up to 6 months) or non-exclusive (breastfeeding duration <6 months). Early initiation of breastfeeding, categorized as yes (if the baby was placed at the mother's breast within the first hour after birth) or no (if not placed immediately after birth). Duration of breastfeeding, categorized as suboptimal (<24 months) or optimal (≥24 months), in line with the updated recommendations for breastfeeding, which suggest that the need for continue breastfeeding for at least 2 years (19). Health-seeking behavior during illness, categorized as yes (if the baby received a health check-up when sick), no (if no check-up was received), or never sick in the last 12 months. Complete basic immunization, categorized as complete (all 11 basic immunizations received) or incomplete (<11 immunizations received). Growth monitoring, categorized as regular (≥8 times per year) or irregular (<8 times per year). Antenatal care service visits, categorized as insufficient (<6 visits) or sufficient (≥6 visits), in line with the Indonesian Ministry of Health's guidelines (20). Maternal iron-folic acid intake during pregnancy, categorized as inadequate (<90 tablets) or adequate (≥90 tablets).

At the household level, variables included: Household food security, categorized as secure (≥35 points) or insecure (<35 points). Household drinking water facilities are categorized as unimproved (using water terminals, unprotected springs, unprotected wells, or surface water) or improved (using metered

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water, retail water, public taps, public hydrants, PAH, drilled wells/pumps, protected wells/springs, bottled water, or refilled water). Household sanitation, categorized as unimproved (using open dug wells or shallow wells with/without covers) or improved (using a gooseneck toilet, septic tank, or direct sewage discharge). Household environment, categorized as unhealthy (ventilation area <10% of floor area, windows absent or rarely opened, insufficient lighting) or healthy (ventilation area ≥10% of floor area, windows present and opened daily, adequate lighting). Asset ownership, categorized as Q1 (poorest), Q2 (poor), Q3 (lower-middle), Q4 (upper-middle), or Q5 (richest). Social protection, categorized as no (if the household did not receive any social protection) or yes (if they received any type of social protection).

At the district level, variables included: Accreditation of Puskesmas, categorized as unaccredited, basic, intermediate, advanced, or highest level. Nutritionist ratio per population, categorized as insufficient (<1 per 1,000 population) or sufficient (≥1 per 1,000 population).

The first step in the data analysis was a descriptive analysis to obtain an overview and the percentage distribution of stunting cases and other predictor variables. The second step involved bivariate analysis using simple logistic regression to examine the influence of predictor variables on the occurrence of stunting. This second step was conducted in two stages: the first stage involved separating the data by district, while the second stage analyzed the data by combining the two districts into a single analytical group. This two-stage approach was necessary due to the small number of research subjects, which made multivariate analysis unfeasible if the data were separated by district. The third step was multivariate analysis using multilevel binary logistic regression to assess the contextual influence of district-level characteristics on the occurrence of stunting. The relationship or association between predictor variables and stunting was represented by the p-value. If the p-value of a variable was $p < 0.05$, the variable was considered statistically significant. The magnitude of the variable's effect was indicated by the Odds Ratio (OR) value, which quantified the strength and direction of the association. All data were analyzed using Stata v15.1 (StataCorp, http://www.stata.com).

RESULTS

There were 15 individual-level stunting predictor variables prominently described at the individual level. The predictor variables that stood out in the Jeneponto district included six factors: age at first pregnancy, basic education, lack of food diversity, non-exclusive breastfeeding, incomplete basic immunization, and irregular growth monitoring. In the Barru district, the dominant predictor variables included six factors: short maternal height, low birth weight, history of respiratory infections, duration of breastfeeding, lack of ANC visits, and lack of iron supplement intake. Three variables had similar positions in both districts: male gender, history of diarrhea, non-exclusive breastfeeding, and health-seeking behavior during illness.

Table 1. The frequency distribution of children aged 0-23 months based on individual, household, and district-level characteristics between the districts of Jeneponto and Barru

Variable	Jeneponto n = 89 (%)		Barru n = 103 (%)	
Nutritional status				
Stunting	23	25,8	49	47,6
Normal	66	74,2	54	52,4
Individual level predictors				
Maternal characteristics				
Maternal stature				
Short	23	25,8	31	30,1
Normal	66	74,2	72	69,9
Age at first pregnancy				
Risk	14	15,7	13	12,6
Normal	75	84,3	90	87,4
Maternal education				
Basic education	48	53,9	49	47,6

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Variable	Jeneponto n = 89 (%)		Barru n = 103 (%)	
High education	41	46	54	52,4
Child characteristics				
Birth weight				
Low	3	3,4	11	10,7
Normal	86	96,6	92	89,32
Gender				
Male	44	49,4	52	50,5
Female	45	50,6	51	49,5
Dietary intake				
Dietary diversity				
Low	43	48,3	43	41,8
Diverse	46	51,7	60	58,2
Infectious disease				
History of diarrhea				
Yes	13	14,6	15	14,6
No	76	85,4	88	85,4
History of ARI				
Yes	6	6,7	22	21,4
No	83	93,3	81	78,6
Infant and young child feeding practices				
History of breastfeeding				
Non exclusive	19	21,3	21	20,4
Exclusive	70	78,7	82	79,6
Early initiation breastfeeding				
No	86	96,6	86	83,5
Yes	3	3,4	17	16,5
Duration of breastfeeding				
Subpotimal	19	21,3	34	33
Optimal	70	78,7	69	77
Health and health care services				
Health seeking behaviour during illness				
Never sick	15	16,8	17	16,5
No	3	3,4	11	10,7
Yes	71	79,8	75	72,8
Basic immunization				
Incomplete	64	71,9	47	45,6
Complete	25	28,1	56	54,4
Growth monitoring				
Irregular	51	57,3	44	42,7
Regular	38	42,7	59	57,3
ANC visits				
Lack	14	15,7	31	30,1
Enough	75	84,3	72	69,9
Maternal IFA during pregnancy				
Inadequate	73	82	95	92,2
Adequate	16	18	8	7,8
Household level predictors				
Household Food Security				
Insecure	0	0	1	1
Secure	89	100	102	99

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Variable	Jeneponto n = 89 (%)		Barru n = 103 (%)	
Environmental health				
Source of drinking water				
Unimproved	6	6,7	8	7,78
Improved	83	93,3	95	92,2
Sanitation				
Unimproved	3	3,4	17	16,5
Improved	86	96,6	86	83,5
Household				
Unhealthy	72	80,9	64	62,1
Healthy	17	19,1	39	37,9
Socio economy				
Asset ownership				
Q1 (poorest)	13	14,6	27	26,2
Q2 (poor)	17	19,1	20	19,4
Q3 (lower-middle)	18	20,2	21	20,4
Q4 (upper-middle)	22	24,7	22	21,4
Q5 (richest)	19	21,3	13	12,6
Social protection				
No	51	57,3	53	51,5
Yes	38	42,7	50	48,5
District level predictors				
Accreditation of Puskesmas				
Advanced	15	16,9	28	27,2
High levels	74	83,1	75	72,8
Ratio of nutritionist				
Insufficient	81	91	77	74,8
Sufficient	8	9	26	25,2

The results on household-level predictors showed that the dominant factors in the Jeneponto district were unhealthy housing and lack of social protection, while in the Barru district, the dominant factors were unfeasible sanitation and asset ownership in the lowest quintile (poor). Specifically, the status of drinking water facilities and food security was similar in both districts. The results of this study indicate that, at the district level, Puskesmas accreditation in Jeneponto is higher than in Barru, while the ratio of nutritionists to the population is slightly better in Barru.

Table 2. Bivariat analysis of individual and household level stunting predictors on children aged 0-23 months between and combined Jeneponto and Barru Districts with simple logistic regression

Variable	Jeneponto OR (95% CI)	Barru OR (95% CI)	Combined OR (95% CI)
Maternal characteristics			
Maternal stature			
Normal	Normal (ref)	Normal (ref)	Normal (ref)
Short	1,01 (0,34-3)	0,59 (0,25-1,14)	0,77 (0,40-1,50)
Age at first pregnancy			
Normal	Normal (ref)	Normal (ref)	Normal (ref)
Risk	1,75 (0,52-5,92)	1,91 (0,58-6,29)	1,66 (0,73-3,78)
Maternal education			
High education	High education (ref)	High education (ref)	High education (ref)
Basic education	1,46 (0,55-3,84)	3,44 (1,53-7,74)*	2,17 (1,19-3,96)*
ANC visits			

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Variable	Jeneponto OR (95% CI)	Barru OR (95% CI)	Combined OR (95% CI)
Sufficient	Sufficient (ref)	Sufficient (ref)	Sufficient (ref)
Insufficient	1,75 (0,52-5,92)	1,04 (0,45-2,43)	1,46 (0,74-2,87)
Maternal IFA during pregnancy			
Adequate	Adequate (ref)	Adequate (ref)	Adequate (ref)
Inadequate	1,05 (0,30-3,67)	1,56 (0,35-6,92)	1,53 (0,60-3,89)
Child characteristics			
Birth weight			
Normal	Normal (ref)	Normal (ref)	Normal (ref)
Low	1,45 (0,12-16,8)	1,36 (0,38-4,79)	1,73 (0,58-5,17)
Gender			
Female	Female (ref)	Female (ref)	Female (ref)
Male	0,44 (0,16-1,19)	1,42 (0,65-3,09)	0,91 (0,50-1,64)
Dietary diversity			
Diverse	Diverse (ref)	Diverse (ref)	Diverse (ref)
Low	1,59 (0,53-4,71)	1,68 (0,55-5,11)	1,37 (0,65-2,89)
History of diarrhea			
No	No (ref)	No (ref)	No (ref)
Yes	0,47 (0,09-2,33)	0,5 (0,55-5,11)	0,50 (0,20-1,26)
History of ARI			
No	No (ref)	No (ref)	No (ref)
Yes	0,55 (0,06-5,01)	0,89 (0,34-2,31)	1,09 (0,48-2,48)
History of breastfeeding			
Exclusive	Exclusive (ref)	Exclusive (ref)	Exclusive (ref)
Non-exclusive	1,43 (0,47-4,37)	2,68 (0,98-7,35)	1,92 (0,95-3,89)
Early initiation breastfeeding			
Yes	Yes (ref)	Yes (ref)	Yes (ref)
No	0,16 (0,01-1,87)	1,83 (0,62-5,4)	0,88 (0,34-2,29)
Duration of breastfeeding			
Optimal	Optimal (ref)	Optimal (ref)	Optimal (ref)
Subpotimal	1,03 (0,32-3,26)	1,37 (0,60-3,14)	1,40 (0,73-2,68)
Health seeking behaviour during illness			
Yes	Yes (ref)	Yes (ref)	Yes (ref)
Never sick	1,07 (0,30-3,78)	2,46 (0,82-7,36)	1,69 (0,78-3,67)
No	1,47 (0,12-17,2)	1,61 (0,45-5,75)	1,92 (0,63-5,77)
Basic immunization			
Complete	Complete (ref)	Complete (ref)	Complete (ref)
Incomplete	1,56 (0,51-4,80)	1,51 (0,69-3,3)	1,13 (0,62-2,05)
Growth monitoring			
Regular	Regular (ref)	Regular (ref)	Regular (ref)
Irregular	0,59 (0,22-1,54)	1,39 (0,63-3,04)	0,86 (0,48-1,55)
Household characteristics			
Household Food Security			
Secure	Secure (ref)	Secure (ref)	Secure (ref)
Insecure	-	-	-
Source of drinking water			
Improved	Improved (ref)	Improved (ref)	Improved (ref)
Unimproved	0,55 (0,06-5,01)	1,11(0,26-4,7)	0,92 (0,29-2,86)
Sanitation			
Improved	Improved (ref)	Improved (ref)	Improved (ref)

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Variable	Jeneponto OR (95% CI)	Barru OR (95% CI)	Combined OR (95% CI)
Unimproved	-	0,39 (0,12-1,22)	0,52 (0,18-1,50)
Household			
Healthy	Healthy (ref)	Healthy (ref)	Healthy (ref)
Unhealthy	0,56 (0,18-1,76)	0,66 (0,12-1,22)	0,53 (0,28-1)
Asset ownership			
Q5 (richest)	Q5 (ref)	Q5 (ref)	Q5 (ref)
Q1 (poorest)	1,23 (0,25-5,97)	0,69 (0,17-2,66)	0,66 (0,26-1,70)
Q2 (poor)	1,61 (0,32-7,89)	0,16 (0,03-0,70)*	0,42 (0,15-1,13)
Q3 (lower-middle)	1,25 (0,23-6,65)	0,94 (0,26-3,33)	0,95 (0,37-2,42)
Q4 (upper-middle)	0,2 (0,01-2,22)	0,25 (0,07-0,85)*	0,29 (0,10-0,79)*
Social protection			
Yes	Yes (ref)	Yes (ref)	Yes (ref)
No	1,21 (0,46-3,21)	0,82 (0,38-1,79)	0,91 (0,50-1,64)

*Significant at p-value <0,05; -No statistic result

Based on the bivariate analysis conducted for each district, as presented in Table 2, the findings reveal that, at the individual level, only one variable was significantly associated with the occurrence of stunting. Mothers with only a basic education background had a 3.44 times higher risk of stunting (95% CI: 1.53–7.74). Meanwhile, at the household level, only asset ownership showed a significant association with stunting incidence. Households in the upper-middle asset category (Q4) were associated with a 0.25 times lower risk of stunting (95% CI: 0.07–0.85). This pattern was observed exclusively in Barru District.

Based on the combined bivariate analysis of the districts, as presented in Table 3, the results consistently indicate that the significant predictor variables associated with stunting are maternal education and household asset ownership. Mothers with only a basic education background had a 2.17 times higher risk of stunting (95% CI: 1.19–3.96). At the household level, asset ownership in the upper-middle category (Q4) was associated with a 0.29 times lower risk of stunting (95% CI: 0.10–0.79).

The multilevel analysis of stunting predictors in this study is presented in Table 3. Based on the results of the null model analysis, which examined the random effects at all levels (individual, family, and district), the Likelihood Ratio Test value was found to be not significant (p = 0.169). However, another model analysis that included stunting predictors showed that Model 4, which incorporated random effects at the district, sub-district, and household levels, was the best-fitting model (p = 0.002).

Table 3 also presents the Intraclass Correlation Coefficient (ICC) values. In Model 4, the ICC value for the district level was 22.2, while the sub-district and household levels had proportional values of 24.5. This indicates that variations in stunting risk factors should account for differences at the sub-district level within the district (sub-district and household) and at the household level within the sub-district (household and child), as approximately 22.2% of the total variation in stunting is attributable to differences between districts, and 24.5% to differences between sub-districts and households. In other words, contextual factors at the community and household levels contribute significantly to the overall risk of stunting.

In the comprehensive estimation results, predictor variables were included at the individual, family, and district levels. Several variables at these levels were found to be significantly associated with stunting. At the individual level, mothers with only a basic education were 3.26 times more likely to have stunted children (95% CI: 1.38–7.70), and non-exclusive breastfeeding increased the risk of stunting by 3.64 times (95% CI: 1.25–10.6). At the family level, inadequate sanitation was associated with a 0.16 times lower risk of stunting (95% CI: 0.03–0.84), while asset ownership in the Q4 quintile reduced the stunting risk by 0.13 times (95% CI: 0.03–0.54). At the district level, community health center accreditation at the primary level was associated with a 0.32 times lower risk of stunting (95% CI: 0.11–0.93).

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Table 3. Multilevel binary logistic regression assessing the contextual influence of district-level characteristics on the occurrence of stunting on children aged 0-23 months

Variable	Model 1 (Null) n = 192	Model 2 (Individual) n = 192	Model 3 (Individual & Household) n = 192	Model 4 (Individual, Household, and District) n = 192
		aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Fixed Effect				
Individual Level				
Maternal height short	-	0,59 (0,26 – 1,30)	0,74 (0,31 – 1,78)	0,74 (0,31 – 1,79)
Pregnancy at risk age	-	1,44 (0,54 – 3,82)	2,38(0,79 – 7,20)	2,08 (0,68 – 6,37)
Maternal education at basic level	-	2,91* (1,37 – 6,19)	2,66* (1,15 – 6,12)	3,26* (1,38 – 7,70)
Low birth weight	-	2,17 (0,59 – 7,98)	1,77 (0,43 – 7,19)	1,96 (0,47 – 8,10)
Gender of children male	-	1,01 (0,50 – 2,03)	1,04 (0,48 – 2,27)	1,08 (0,49 – 2,36)
Low dietary diversity	-	1,29 (0,51 – 3,28)	1,13 (0,40 – 3,18)	1,25 (0,43 – 3,60)
Having diarrhea	-	0,37 (0,12 – 1,13)	0,29 (0,08 – 1,04)	0,31 (0,08 – 1,14)
Having ARI	-	1,56 (0,55 – 4,42)	1,27 (0,36 – 4,39)	1,03 (0,29 – 3,66)
Breastfeeding not exclusive	-	3,45* (1,34 – 8,89)	3,97* (1,37 – 11,5)	3,64* (1,25 – 10,6)
No early initiation breastfeeding	-	1,53 (0,49 – 4,76)	1,26 (0,35 – 4,51)	1,52 (0,42 – 5,50)
Suboptimal duration of breastfeeding	-	1,08 (0,47 – 2,48)	1,11 (0,43 – 2,81)	1,56 (0,59 – 4,13)
No health seeking behaviour during illness	-	1,60 (0,40 – 6,44)	2,46 (0,47 – 12,8)	3,32 (0,64 – 17,1)
Basic immunization incomplete	-	2,21 (0,88 – 5,51)	2,60 (0,94 – 7,18)	2,89 (1,02 – 8,17)
Irregular growth monitoring	-	0,68 (0,26 – 1,77)	0,72 (0,25 – 2,08)	0,71 (0,24 – 2,12)
Insufficient ANC services	-	1,26 (0,55 – 2,90)	1,33 (0,52 – 3,37)	1,21 (0,46 – 3,19)
Inadequate IFA during pregnancy	-	0,64 (0,20 – 1,97)	0,64 (0,19 – 2,15)	0,59 (0,17 – 2,02)
Household Level				
Household food insecure	-	-	ommited	omitted
Source of drinking water unimproved	-	-	1,73 (0,41 – 7,31)	2,10 (0,48 – 9,04)
Sanitation unimproved	-	-	0,13* (0,02 – 0,68)	0,16* (0,03 – 0,84)
Household unhealthy	-	-	0,67 (0,29 – 1,57)	0,63 (0,27 – 1,49)
Asset ownership Q1 (poorest)	-	-	0,52 (0,15 – 1,79)	0,55 (0,16 – 1,91)
Asset ownership Q2 (poor)	-	-	0,38 (0,10 – 1,38)	0,33 (0,09 – 1,25)
Asset ownership Q3 (lower-middle)	-	-	0,57 (0,16 – 2)	0,49 (0,13 – 1,78)
Asset ownership Q4 (upper-middle)	-	-	0,15* (0,03 – 0,60)	0,13* (0,03 – 0,54)
No social protection	-	-	1,30 (0,61 – 2,79)	1,45 (0,66 – 3,15)
District Level				

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Variable	Model 1 (Null) n = 192	Model 2 (Individual) n = 192	Model 3 (Individual & Household) n = 192	Model 4 (Individual, Household, and District) n = 192
		aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Advanced accreditation of Puskesmas	-	-	-	0,32* (0,11 – 0,93)
Insufficient Nutritionist ratio among population <1000	-	-	-	2,54 (0,75 – 8,57)
Random Effect				
Constant	-0,90 (0,809)	0,16 (0,148)	0,07 (0,097)	0,02 (0,043)
Variance (SE) between District/City	0,42 (0,774)	0,39 (0,494)	0,62 (0,766)	0,96 (1,120)
Variance (SE) between Sub-district	0,17 (0,521)	0,11 (0,224)	0,24 (0,377)	0,17 (0,277)
Variance (SE) between Household	3,63 (7,579)	1,19e-32 (1,40e-16)	3,73e-37 (1,36e-19)	4,29e-37 (1,66e-19)
ICC District/City (%)	5,6	10,2	15	22,2
ICC District/City and Sub-district (%)	7,9	13,2	20,8	24,5
ICC District/City, Sub-district, and Household (%)	56	13,2	20,8	24,5
Fit Model				
Likelihood Ratio (LR) (*p-value*)	5,04 (0,169)	6,62 (0,036)	9,49 (0,008)	11,89 (0,002)
AIC	257	263,9	261,5	259,6

aOR: Adjusted Odds Ratio, AIC: Akaike's information criterion, ICC: intraclass correlation coefficient, LR: Likelihood ratio, SE: Standard error, ARI: Acute Respiratory Infection, ANC: Antenatal care, IFA: Iron Folic Acid. *Significant at p<0,05

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DISCUSSION

In this study, the discussion focuses exclusively on variables for which information remains limited. These include asset ownership and the accreditation status of community health centers (Puskesmas), which serve as contextual factors at the family and district levels with potential implications for stunting prevention, particularly in Barru and Jeneponto districts.

The findings indicate that families with an upper-middle economic status (Q4) have a reduced risk of stunting. This is consistent with previous research showing that families with higher economic status tend to have lower stunting prevalence (21). The determinants of stunting may vary based on a family's socioeconomic status, as suggested on this study (22). Conceptually, economic factors are fundamental causes of stunting, and improvements in socioeconomic conditions can lead to reductions in its prevalence. Additionally, ongoing enhancements within and beyond the health sector, alongside targeted health interventions, play a crucial role in addressing stunting (23). However, as highlighted in a previous study economic growth alone does not guarantee a reduction in stunting unless underlying causes, such as dietary patterns, inequality, the economic conditions of poor families, sanitation, and environmental factors are effectively addressed (24).

Given these complexities, stunting prevention requires a multisectoral approach. A previous study highlighted that a decline in stunting prevalence among low-income families occurs when stunting determinants are mitigated through specific and broad-based intervention programs. One of the key institution in this effort is the community health center. Puskesmas, as primary healthcare providers, play a strategic role in stunting prevention, enabling healthcare professionals to collaborate across sectors due to their access to early nutritional status data and associated determinants at the community level (25).

These findings suggest that both asset ownership at the household level and the Puskesmas accreditation status play instrumental roles in shaping child health outcomes. Greater asset ownership may enable families to afford diverse and nutrient-rich diets, improve living conditions, and seek timely healthcare services factors that are directly and indirectly linked to reduced stunting risk (26). Meanwhile, higher levels of Puskesmas accreditation are associated with improved service delivery, including better adherence to national standards, enhanced availability of trained personnel, and essential equipment (27,28) . Puskesmas are responsible for delivering basic health services while maintaining standardized service quality (29). In Indonesia, accreditation is conducted to ensure that Puskesmas operate optimally by improving both quality and performance (27). However, in practice, many Puskesmas face challenges in providing health services, including stunting prevention. Studies indicate that common issues include a shortage of professional healthcare workers, weak coordination between program planners and implementers, and limited availability of anthropometric tools. These challenges contribute to persistently high stunting prevalence (30,31). Ensuring that Puskesmas maintain quality health services, an adequate workforce, and proper infrastructure is therefore essential (32).

In this study, Puskesmas with advanced and highest accreditation levels were found to be associated with a reduced risk of stunting, with an adjusted odds ratio (aOR) of 0.32. As no Puskesmas with lower accreditation levels were included in the sample, the analysis only captures the effect of higher accreditation levels, suggesting that these Puskesmas provide better quality services, which may contribute to a lower risk of stunting. However, the impact of lower or unaccredited Puskesmas could not be assessed, and further research is needed to explore this relationship.

While the focus of this study is on contextual factors, individual-level determinants, such as maternal education and exclusive breastfeeding also play a significant role in stunting risk. A more detailed analysis of these individual-level factors is available in a separate manuscript currently under preparation. However, it is important to note that maternal education and exclusive breastfeeding have been consistently found to influence stunting risk in previous studies, which also suggest a strong interaction between these individual factors and broader contextual factors (8,33). Nonetheless, their inclusion here highlights the complex interaction between individual and contextual factors in shaping stunting outcomes. Enhanced service standards at the Puskesmas, along with informed maternal behavior and improved child feeding practices, create a more comprehensive approach to stunting prevention.

Enhanced service standards can lead to increased community satisfaction (34). Although statistical

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evidence is limited, antenatal and delivery services tend to be better in Puskesmas with higher accreditation levels than those with lower accreditation (35). Additionally, the availability of health facilities in a community is associated with greater utilization of preventive services, fostering higher trust in the healthcare system (36). This is particularly relevant in Indonesia, where healthcare facility usage is influenced by both internal and external factors, including individual perceptions of service quality (37).

As the primary provider of basic health services with a strong focus on preventive and promotive approaches, Puskesmas are expected to play a crucial role in disease prevention efforts, including improving community nutritional status and reducing stunting prevalence. Their widespread presence across sub-districts, extensive coverage, and deployment of health workers focused on prevention and promotion represent significant potential in tackling malnutrition and stunting (38).

However, the finding related to sanitation in the final model presents an unexpected result, where unimproved sanitation is associated with a reduced risk of stunting (39). While this contrasts with common findings that poor sanitation typically increases the risk of stunting, this result may be influenced by unmeasured factors or specific model specifications. Other external factors, such as the cleanliness of household environments, community involvement in health behaviors, or access to additional healthcare services, may play a more significant role in the relationship between sanitation and stunting, which were not captured in this analysis (40,41). Therefore, this finding suggests that more complex, unmeasured factors must be considered in the effective prevention of stunting.

This study contributes to public health policy, particularly in Jeneponto and Barru districts, by emphasizing the need for targeted improvements in maternal and child health services. These efforts should be implemented in an accountable and context-specific manner, taking socioeconomic factors into consideration. Regular audits and quality control measures, as outlined in Puskesmas accreditation guidelines, are essential to maintaining high service standards and ensuring effective stunting prevention efforts (42). A limitation of this study is the small sample size, which may affect the generalizability of the findings to a broader population.

CONCLUSION

Households with high asset ownership and high community health centers (Puskesmas) play a crucial role in stunting prevention. The findings highlight the importance of maintaining Puskesmas accreditation and addressing socioeconomic disparities, such as family economic conditions, to ensure sustainable stunting prevention. Effective stunting prevention and management efforts should align standardized healthcare quality with targeted interventions that address both household-level asset ownership and broader socioeconomic factors, thus contributing to a comprehensive approach to reducing stunting prevalence.Effective stunting prevention and management efforts should be aligned with standardized healthcare

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CONFLICTS OF INTEREST

The authors declare no conflict of interest

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