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Original Article

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Risk Factors and Nutritional Profiles Associated with Stunting in Children

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ABSTRACT

Purpose: To analyze risk factors and various nutrients associated with stunting among children aged 6–60 months.
Methods: This is a case-control and cross-sectional study between 40 stunting cases and 40 controls. Data on possible risk factors associated with stunting were obtained through direct interviews and using a questionnaire. Examination of vitamin D, zinc, albumin, and ferritin levels was performed on both groups. Data were analyzed using IBM SPSS Statistics for Windows, Version 23.0 (IBM Co., Armonk, NY, USA) to determine risk factors for stunting and to assess the relationship between nutritional levels and stunting.
Results: The incidence of stunting was highest in children aged 12–36 months. Children with low weight and very low weight for age comprised of 55% and 22.5%, respectively, of the study participants. The highest mother's educational level was junior high school (40%). History of low birth weight (LBW) was more commonly observed in the stunting group than that in the control group (25.0% and 7.5%, respectively; p=0.034, odds ratio, 0.310 [95% confidence interval, 0.122–0.789]). Approximately 7.5% of cases had premature birth. Exclusive breast feeding was found to be not correlated with stunting. The mean zinc level in the stunting group was 34.17 ng/mL, which was different from that in the control group (50.83 ng/mL) (p=0.023). Blood ferritin, vitamin D, albumin, and calcium levels were not strongly correlated with stunting.
Conclusion: LBW is the main risk factor contributing to stunting and is strongly associated with low zinc level.

Keywords: Growth disorders; Risk factors; Child

INTRODUCTION

Stunting is one of the world's major nutritional problems prominently in developing countries, characterized by chronic growth and development impairment of children. Globally, one in four children aged under 5 years had stunted growth [1].

In Indonesia, the World Health Organization (WHO) describes the stunting prevalence to be as high as 30.8% [2]: 19.2% are short and 18.0% are very short. Stunting with the prevalence

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Conflict of Interest
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of ≥20% is considered as a health problem and should be immediately treated; thus, it is included as one of the health development priorities [2,3].

Stunting may lower the immune system and increase the risk for developing infection. Stunted children have a higher risk of developing hypertension, diabetes, and obesity when they reach adulthood, with their average IQ 11 points lower than in children without stunting [4-6]. Therefore, this study aimed to identify the dangerous effects of stunting, which then can help establish the strategies for its treatment.

Previous studies reported multiple risk factors associated with the incidence of stunting in infancy, such as inadequate nutritional intake, low birth weight (LBW), parental height, familial economic status, poor educational status of parents, unemployed father, exclusive breast milk feeding, and weaning during the food initiation age [7,8]. The study in South Ethiopia proved that children aged <5 years without history of weaning food delivery for 6 months are highly at risk to develop stunting [6]. Several other previous studies showed micronutrient and vitamin deficiency such as iron, zinc, vitamin D, and calcium can cause stunting. A study in Nepal concluded that birth length was associated with stunting, and infants with LBW were more prone to develop stunting [9]. This study reports several factors associated with stunting and various nutritional profiles among children aged 6–60 months in Makassar, Indonesia, at the South Sulawesi province.

MATERIALS AND METHODS

This case-control and cross-sectional study has been approved by the ethics committee of the Faculty of Medicine of Hasanuddin University (approval number: UH19110992), aiming to analyze various factors associated with stunting incidence in children aged 6–60 months in Makassar, Indonesia, conducted from April to November 2019 in all 14 districts. Participants were recruited via cluster random sampling. Random sampling technique was used in every district to select Maternal and Health primary care (Posyandu) for data collection. Inclusion criteria are children aged 6–60 months with WHO Z-score of <−2 standard deviation based on weight and height for age for the stunting group, whereas children with WHO Z-score of −2 and +2 standard deviation was classified as the control group. For both groups, written informed consent were obtained from parents of all children (participants). Children with previous iron supplementation therapy, with vitamin D or zinc supplementation, with clinical hormonal impaired symptoms (obesity, short stature, and dysmorphic face), or with congenital disorder were excluded.

Questionnaire data include age, sex, birth weight, breastfeeding history, total income of parents, mother's educational background, father and mother's body height (to eliminate the possibility of familial short stature), participant's body height and body weight, and history of chronic disease(s). For children aged 6–12 months, body height was measured using the baby length board, whereas for children aged 12–60 months using the stature meter. Measurement data were analyzed using the WHO Anthro software 3.0.1 that finalized the Z-score height and weight for age. Blood examination was performed to evaluate calcium, zinc, vitamin D, ferritin, and albumin levels at Hasanuddin University Medical Research Center laboratory in Faculty of Medicine in Hasanuddin University. Blood calcium level was measured using the cresol phthalein complex method. Zinc was measured using the zinc assay kit with quantitative chelometric method. Vitamin D was measured using the

25(OH) vitamin D enzyme-linked immunosorbent assay (ELISA) kit, colorimetric method. Ferritin was measured using human ferritin ELISA kit, colorimetric method. Albumin level was measured with ELISA.

Data analysis

Data were analyzed using IBM SPSS Statistics for Windows, Version 23.0 (IBM Co., Armonk, NY, USA) Univariate analysis was used to analyze subject and parental characteristic distribution. Bivariate analysis was used to analyze the relationship between risk factors and stunting incidence using the Fisher's exact test. Odds ratio (OR) analysis with 95% confidence interval (CI) was used to determine risk factors of stunting. Chi-squared test, independent *t*-test, and Mann–Whitney test were used to determine the statistical significance. The $p<0.05$ indicates statistical significance.

RESULTS

Out of 129 children aged 6–60 months who visited the Mother and Children Primary Care center (Posyandu), 43 children suffered from stunting (33.3%).

A total of 80 children were recruited, consisting 40 children with stunting (stunting group) and 40 without stunting (control group). The mean height in the stunting group was 80.02 cm, whereas that in the control group was 92.98 cm.

Participant characteristics are shown in **Table 1**. Approximately 47.5% of the study participants were girls and 52.5% were boys in both groups. According to age, the most age group was 13–36 months, comprising 55% of participants, whereas in the control group, the most age group is >36 months, also 55%, with mean age of 31.9 and 38 months, respectively.

Table 1. Characteristics of the study participants

Sample characteristic	Stunting (n=40)	Control (n=40)	*p*-value
Sex			1.000
Male	21 (52.5)	21 (52.5)	
Female	19 (47.5)	19 (47.5)	
Age (mo)			0.388
6–12	2 (5.0)	2 (5.0)	
13–36	22 (55.0)	16 (40.0)	
37–60	16 (40.0)	22 (55.0)	
Age (mo)			0.050
Mean±SD	31.90±13.07	38.00±14.35	
Median	29.50	37.00	
Range	10–57	12–60	
Weight (kg)			0.000*
Mean±SD	9.80±1.87	13.03±2.74	
Median	9.55	12.25	
Range	6.60–13.00	8.00–19.50	
Height (cm)			0.000*
Mean±SD	80.02±8.26	92.98±9.75	
Median	80.25	95.00	
Range	65.20–98.00	72.50–110.00	

Values are presented as number (%).
SD: standard deviation.
*Statistically significant ($p<0.05$).

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Table 2. Independent variables chosen for possible association with stunting

Risk factor	Stunting (n=40)	Control (n=40)	*p*-value	OR (95% CI)
Birth weight			0.034*	0.310 (0.122–0.789)
≥2,500 g	30 (75.0)	37 (92.5)		
<2,500 g	10 (25.0)	3 (7.5)		
Birth weight			0.005*	-
Mean±SD	2,730±468.60	3,035±364.83		
Median	2,800	3,000		
Range	1,400–3,500	2,100–3,600		
Gestational age			0.241	0.481 (0.381–0.606)
Mature	37 (92.5)	40 (100.0)		
Premature	3 (7.5)	-		
Exclusive breastfeeding			0.363	0.571 (0.169–1.928)
Yes	32 (80.0)	35 (87.5)		
No	8 (20.0)	5 (12.5)		
Age			0.396	-
<6 mo	4 (10.0)	2 (5.0)		
≥6 mo	36 (90.0)	38 (95.0)		
Mother's education			0.087	-
Elementary	6 (15.0)	4 (10.0)		
Junior high	16 (40.0)	7 (17.5)		
Senior high	13 (32.5)	22 (55.0)		
College/university	5 (12.5)	7 (17.5)		

Values are presented as number (%).
OR: odds ratio, CI: confidence interval, SD: standard deviation.
*Statistically significant ($p<0.05$).

The height of the stunting group was 80.02±8.26 cm, which was significantly smaller than that of the control group with 92.98±9.75 cm ($p<0.05$).

Based on the analysis, the proportion of children with LBW in the stunting group was 25.0%, whereas that in the control group was 7.5%. The risk factor related to stunting is birth weight with *p*-value of 0.034 and OR of 0.310 (95% CI, 0.122–0.789), indicating that birth weight of ≥2,500 g is a protective factor for stunting (**Table 2**).

Based on data analysis in **Table 3**, the nutrient associated with stunting is zinc with *p*-value 0.023. The average zinc level in the stunting group is 34.17 ng, whereas that in the control group is 50.83.

DISCUSSION

This analytical study aims to identify factors associated with stunting in children aged 6–59 months. This study found that majority of children with stunting aged 13–36 months. In other studies, the risk of developing stunting is higher in children aged 24–59 months than that in those aged 0–23 months (50% and 24%, respectively) [10-12]. These data show that stunting is not reversible in children aged 24–59 months. A study performed by Ramli et al. [5] in Maluku emphasized previous studies that claimed stunting will last after aged 2 or 3 years. This also confirms that stunting is more commonly observed in children aged >12–36 months and >6 months with 55% and 40%, respectively, with 31.9 months as the mean age in the stunting group. Other risk factors that increase the stunting risk in this age group were affected by the lack of passive immunity, exposure on unhealthy condition, which could affect their appetite and directly affect nutritional metabolism and mother reversion to her workplace.

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Table 3. Blood putritional profile

Nutritional profile	Stunting (n=40)	Control (n=40)	*p*-value
Ferritin (ng/mL)			0.679
Mean±SD	45.73±80.29	40.41±82.22	
Median	14.70	8.70	
Range	0.18–366.11	0.16–460.42	
Vitamin D (nmoL/L)			0.166
Mean±SD	37.98±28.20	49.77±42.55	
Median	31.24	32.94	
Range	4.54–171.26	17.81–179.64	
Albumin (g/dL)			0.725
Mean±SD	4.41±3.17	4.19±2.26	
Median	4.01	4.31	
Range	0.57–16.52	0.25–10.80	
Calcium (mg/dL)			0.331
Mean±SD	1.71±1.15	1.49±1.11	
Median	1.43	1.27	
Range	0.31–4.30	0.26–4.44	
Zinc (ng)			0.023*
Mean±SD	34.17±29.62	50.83±40.88	
Median	23.05	31.62	
Range	3–119	6–159	

SD: standard deviation.
*Statistically significant (p<0.05).

A study by Ramli et al. [5] showed that sex is a factor significantly associated with stunting in children aged 0–23 and 0–59 months, in which boys are more at risk than girls. Our study also comprised of higher number of boys (52.5%) than girls (47.5%). Mean body weight in the stunting and control groups was 9.8 and 13.03 kg and the mean body height was 80.02 and 92.98 cm, respectively.

In contrast, a study by Hana Sofia Anugraheni et al. [4] in Semarang showed that birth weight is not a risk factor for stunting, which is inconsistent with our study demonstrating that the birth weight is a risk factor of stunting with *p*-value of 0.034 and OR of 0.310 (95% CI, 0.122–0.789). This is also in accordance with another study in Semarang and Libya that claim the relationship between stunting and LBW [13,14]. In this study, the stunting group predominantly comprised of children with LBW, although some of them were also found in the control group. Infants with LBW had growth retardation since the intrauterine period. Lack of nutrition for infants in early pregnancy could affect their birth weight and length, which made them short and thin. In this study, we also found 75% children with normal birth weight are stunting. This could be caused by inadequate food intake in toddlers that leads to growth faltering (failure to thrive). The insufficient nutritional intake along with exposure to infection could cause more severe growth faltering in normal toddlers [6].

Our study found that stunting was not associated with exclusive breastfeeding. In contrast, the study by Fikadu et al. [6] in Ethiopia that revealed higher risk of stunting in children exclusively breastfed for less than and over than 6 months compared to children exclusively breastfed for 6 months. This study is in accordance with some other studies in various fields. A study in Senegal showed that exclusive breastfeeding for >2 years was associated with low mean of L/A Z-score. In that study, the prevalence of stunting was found to be higher in toddlers exclusively breastfed for >2 years. However, we did not analyze the duration of breastfeeding and complementary food administration on stunted children that might be accountable for this condition in this study.

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We also found that nutrient levels of ferritin, vitamin D, calcium, and albumin were not associated with the incidence of stunting. This result is different from that of several studies [7,8,15]. We found that only low zinc level could affect the incidence of stunting in children. A study by Meilyasari and Isnawati [16], Gibson et al. [17], and Dewi et al. [18] also found that B2, B6, Fe, and zinc deficiencies could increase the incidence of stunting. Lack of zinc intake in children, as reported by Hidayati et al. [19] in Yogyakarta could elevate the risk of the stunting incidence by 2.67 times. We also found a remarkable difference of the serum zinc level between the stunting and control groups with p=0.023; however, multivariate analysis showed that the difference was no longer found remarkable. The interesting finding of this study is that both groups had calcium deficiency. This could provide a basis for further studies on calcium intake among children in Makassar. With regard to the ferritin result, its average level in the stunting and control groups was 45.73 and 40.41, respectively. This study was limited because the hemoglobin level was not measured, leading to an inability to differentiate children with iron deficiency anemia.

REFERENCES

1. United Nations Children's Fund (UNICEF), World Health Organization, International Bank for Reconstruction and Development/The World Bank. Levels and trends in child malnutrition: key findings of the 2019 Edition of the Joint Child Malnutrition Estimates. Geneva: World Health Organization, 2019.
2. Kesehatan K. Profil Kesehatan Indonesia Tahun 2015. Jakarta: Kementerian Kesehatan, 2016:169.
3. Scaling Up Nutrition. Scaling Up Nutrition (SUN) movement strategy [2012-2015]. SUN Movement, 2012:3.
4. Anugraheni HS, Kartasurya MI. [Faktor risiko kejadian stunting pada anak usia 12-36 bulan di kecamatan Pati, kabupaten Pati]. J Nutr Coll 2012;1:30-7. Indonesia.
   CROSSREF
5. Ramli , Agho KE, Inder KJ, Bowe SJ, Jacobs J, Dibley MJ. Prevalence and risk factors for stunting and severe stunting among under-fives in North Maluku province of Indonesia. BMC Pediatr 2009;9:64.
   PUBMED | CROSSREF
6. Fikadu T, Assegid S, Dube L. Factors associated with stunting among children of age 24 to 59 months in Meskan district, Gurage Zone, South Ethiopia: a case-control study. BMC Public Health 2014;14:1-7.
   PUBMED | CROSSREF
7. Sari EM, Juffrie M, Nurani N, Sitaresmi MN. [Protein, calcium and phosphorus intake of stunting and non stunting children aged 24-59 months]. J Gizi Klin Indones 2016;12:152-9. Indonesia.
   CROSSREF
8. van Stuijvenberg ME, Nel J, Schoeman SE, Lombard CJ, du Plessis LM, Dhansay MA. Low intake of calcium and vitamin D, but not zinc, iron or vitamin A, is associated with stunting in 2- to 5-year-old children. Nutrition 2015;31:841-6.
   PUBMED | CROSSREF
9. Paudel R, Pradhan B, Wagle RR, Pahari DP, Onta SR. Risk factors for stunting among children: a community based case control study in Nepal. Kathmandu Univ Med J (KUMJ) 2012;10:18-24.
   PUBMED | CROSSREF
10. Arif GM. Child health and poverty in Pakistan. Pak Dev Rev 2004;43:211-38.
    CROSSREF
11. National Institute of Population Research and Training (NIPORT), Mitra and Associates, ICF International. Bangladesh demographic and health survey 2014. Dhaka, Rockville: NIPORT, Mitra and Associates, ICF International, 2016.
12. International Institute for Population Sciences (IIPS). ICF. National family health survey (NFHS-4) [Internet]. Mumbai: IIPS; 2017 [cited 2019 Sep 7]. Available from: https://dhsprogram.com/pubs/pdf/FR339/FR339.pdf
13. Candra A, Puruhita N, Susanto JC. Risk factors of stunting among 1-2 years old children in Semarang city. Media Med Indones 2011;45:206-12.
14. El Taguri A, Betilmal I, Mahmud SM, Monem Ahmed A, Goulet O, Galan P, et al. Risk factors for stunting among under-fives in Libya. Public Health Nutr 2009;12:1141-9.
    PUBMED | CROSSREF

15. Peacock M. Calcium metabolism in health and disease. Clin J Am Soc Nephrol 2010;5 Suppl 1:S23-30.
PUBMED | CROSSREF

16. Meilyasari F, Isnawati M. [Faktor risiko kejadian stunting pada balita usia 12 bulan di Desa Purwokerto Kecamatan Patebon, Kabupaten Kendal]. J Nutr Coll 2014;3:303-9. Indonesia.
CROSSREF

17. Gibson RS, Manger MS, Krittaphol W, Pongcharoen T, Gowachirapant S, Bailey KB, et al. Does zinc deficiency play a role in stunting among primary school children in NE Thailand? Br J Nutr 2007;97:167-75.
PUBMED | CROSSREF

18. Dewi IAKC, Adhi KT. [Pengaruh konsumsi protein dan seng serta riwayat penyakit infeksi terhadap kejadian stunting pada anak balita umur 24-59 bulan di wilayah kerja Puskesmas Nusa Penida III]. Arc Com Health 2016;3:36-46. Indonesia.

19. Hidayati L, Hadi H, Kumara A. Kekurangan energi dan zat gizi merupakan faktor risiko kejadian stunted pada anak usia 1-3 tahun yang tinggal di wilayah kumuh perkotaan Surakarta. J Kesehat 2010;3:89-104.