RESEARCH ARTICLE

Comparison of WHO and Indonesian growth standards in determining prevalence and determinants of stunting and underweight in children under five: a cross-sectional study from Musi sub-district [version 1; peer review: awaiting peer review]

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Abstract

Background: Undernutrition among children under five continues to be a critical global public health challenge, especially in developing countries. However, it is believed that Indonesian children are “below” the global standard, thus the WHO standard is not reliable to present the actual prevalence. This study aims to compare the difference between WHO and Indonesian growth standards regarding prevalence of stunting and underweight and its determinants.

Methods: This is a cross-sectional study carried out in Musi sub-district, East Nusa Tenggara province in July 2019. East Nusa Tenggara province had the highest prevalence of stunting and underweight in Indonesia. The study population were children under five, and total sampling method was used for this study. Length/height-for-age and weight-for-age were plotted using WHO and national standards. Univariate and multivariate binomial logistic regression were used for statistical analysis.

Results: The prevalence of stunting and underweight were higher for the WHO than the national standard (53.9% vs 10.7% and 29.17% vs 17.7%; all $p < 0.001$). Determinants of stunting were maternal mid-upper arm circumference below 23.5cm and maternal height below 150cm when the WHO standard was used, and no determinant was found when the national standard was used. Determinants of underweight were intrauterine growth restriction, young maternal age during pregnancy, and multiple parities when the WHO standard was used. When the national standard was used, the determinants of underweight were intrauterine growth restriction and

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maternal education.
Conclusions: The WHO standard over-diagnosed stunting and underweight in Musi sub-district. Future studies should be done to re-evaluate the prevalence and determinants of stunting and underweight nationwide using the Indonesian standard.

Keywords
growth chart, Indonesia, risk factors, stunting, underweight

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Introduction

Undernutrition among children under five continues to be a critical global public health challenge, especially in developing countries[1]. Not only affecting the health of one individual, undernutrition also contributes to many aspects of sustainable development[2]. There are three indicators to measure nutritional imbalance that lead to undernutrition, which are: stunting (low height for age), underweight (low weight for age), and wasting (low weight for height). Stunting is the result of chronic nutritional deprivation, reflecting the cumulative effects of undernutrition and infection. Underweight is a composite indicator and it includes both acute and chronic undernutrition. Wasting is a symptom of acute undernutrition, usually caused by insufficient food intake or high incidence of infectious disease. High prevalence of those indicators reflects poor nutrition and health status among children under five in the population[3].

According to the data from 2011, the global incidence of stunting, underweight, and wasting were approximately 164.8 million (25.7%), 100.7 million (15.7%), and 51.5 million (8%) among children under five, respectively. Meanwhile, the global deaths attributed to stunting, underweight, and wasting were approximately 1.017 million (14.7%), 999,000 (14.4%), and 875,000 (12.6%)[4]. Until 2018, undernutrition rates remained alarming, although the prevalence was declining. Among continents, Asia has the highest prevalence of stunting (55%) and wasting (68%). Based on country income classification, 65% of all stunted and 73% of all wasted children live in lower- and middle-income countries[5]. However, in the 2018 report, there is no updated data regarding the prevalence of underweight.

The latest basic health survey in Indonesia in 2018 showed that the prevalence of stunting, underweight, and wasting was 30.8%, 17.7%, and 10.2%, respectively. Among other provinces in Indonesia, East Nusa Tenggara province has the highest prevalence of stunting and underweight, at 42.6% and 29.5%, respectively. Meanwhile, the prevalence of wasting was lower, ranked 8th out of 35 provinces[6]. According to undernutrition severity classification, the severity of stunting is high and underweight is medium in Indonesia. In East Nusa Tenggara province, the severity of stunting is very high, and the severity of underweight is high[7].

The determinants of child undernutrition are multifaceted and interconnected[8]. Understanding the determinants of childhood undernutrition is important to improve children's nutrition by developing the effective and sustained multi-sectorial nutrition programs and interventions over the long term[9]. Unfortunately, studies evaluating the risk factors of child malnutrition in Indonesia were scarce[10]. A recent review article showed that determinants of stunting in Indonesia were similar to other countries, including maternal height and education, premature birth and birth length, exclusive breastfeeding, and socioeconomic status[11].

However, determination of undernutrition always uses the WHO growth standard in Indonesia. It is believed that Indonesian children are "below" the global standard in general, thus the WHO standard is not reliable to present the actual prevalence. Therefore, the Indonesia national growth standard was made using data from National Basic Health Survey[12]. To this date, no study has been done to scrutinize the difference between these two standards. This study aims to compare the prevalence and determinants of stunting and underweight using WHO and national standards. We use the data from one of the sub-districts in East Nusa Tenggara province because this province had the highest prevalence of stunting and underweight among children under five in Indonesia.

Methods

Ethical statement

This study followed the principles of the Declaration of Helsinki and was approved by the Department of Health Timor Tengah Utara district (approval number: DINKES.440/995/XI/2019). This study also complies with STROBE guidelines[13,14]. All parents gave their written informed consent prior to their children's inclusion in the study. Information for informed consent was given before the informed consent form was signed. Details that might disclose the identity of the study subjects were omitted from the published data file.

Study design and population

This study was an observational cross-sectional study conducted in Musi sub-district, one of the sub-districts in East Nusa Tenggara province. Participant recruitment and data collection were conducted in July 2019. Data analysis was conducted in October – December 2019. There were six villages in Musi sub-district. The study population were children aged less than five years old. Total sampling was used for this study. The children and their parents were approached face-to-face by JF during the monthly growth monitoring program in Posyandu ("Pos Pelayanan Terpadu"), a healthcare program by the Indonesian government. Inclusion criteria were children under five who attended the growth monitoring program during the study period, who were born and live with their parents in Musi sub-district, and had both maternal and child health books (*Buku Kesehatan Ibu dan Anak* / KIA) and health record card (*Kartu Menuju Sehat* / KMS) published by the Ministry of Health Republic Indonesia. Children with incomplete KIA and KMS were excluded from the determinants analysis.

Data collection

Both primary and secondary data was used in this study. Primary data for this study consisted of data obtained through interviews with parents, child anthropometry measurements, and maternal height measurements. The interviews took place in the same location as the Posyandu and were conducted by JF using a predetermined questionnaire. The length of the interview was around five minutes. JF is a female general practitioner who worked in primary healthcare in the sub-district where the study took place. She had worked there for seven months when the study was conducted. Interviews with parents was carried out to obtain information regarding village of origin, parents' highest education, number of parities, delivery method, and gender and age of their children. Anthropometry measurements of maternal height and child length/height were done by healthcare workers from Oeolo Primary Healthcare. Secondary

data from KIA and KMS was used to obtain data regarding birthweight, gestational age, maternal mid-upper arm circumference, and maternal age during pregnancy.

Categorization of variables

Underweight and stunting were categorized using WHO child growth standards and Indonesian growth standards for the same sex[12,15]. Underweight is defined as weight for age below -2 standard deviations (SD), and severe underweight is defined as weight for age below -3 SD. Stunting is defined as length/height for age below -2 SD, and severe stunting is defined as length/height for age below -3 SD. The cut-off level for maternal mid-upper arm circumference was 23.5 cm, for maternal height was 150 cm, and for children's birthweight was 2500 g. The cut-off level for maternal mid-upper arm circumference was according to the Indonesian national cut-off[16], while for maternal height and children's birthweight, the cut-off was based on a previous study[17]. Maternal age during pregnancy was categorized to <20 years old, 20–35 years old, and >35 years old. Gestational age and intrauterine growth were categorized based on Lubchenco charts. It categorizes the gestational age to preterm (<37 weeks), term (37–42 weeks), or postterm (>42 weeks) and the intrauterine growth to small for gestational age (SGA) (<10th percentile), appropriate for gestational age (AGA) (10th – 90th percentile), or large for gestational age (LGA) (>90th percentile)[18].

Statistical analysis

Acquired data was analysed using SPSS Statistic for Windows, version 25.0 (IBM Corp., Armonk, N.Y., USA). Data analysis was conducted in two phases. In the first phase, univariate logistic regression was used to identify independent variables that were associated with stunting or underweight. Variables with $p < 0.1$ were included in the next phase. In second phase, multivariate logistic regression using backward selection was used. Variables with $p < 0.05$ from multivariate analysis were considered as the determinants.

Results

There was a total of 408 children under five in Musi sub-district. Based on WHO standard, the prevalence of stunting and underweight were 53.9% and 29.17%, respectively[19,20]. Using national standard, the prevalence of stunting and underweight were 10.7% and 17.7%, respectively. There was a significant difference of stunting and underweight between the prevalence from the WHO and national standard (both $p < 0.001$). However, there were only 218 children that fulfilled the criteria to be included for the determinants analysis (Table 1).

Sociodemographic characteristics

The prevalence of stunting and underweight among this study population were 51.4% and 31.7% according to WHO standard and 8.3% and 19.3% according to national standard (Table 1). The number of male and female children was almost equal. More than half of the children were aged between 24 and 59 months old. Majority of the children were born term with a birthweight of more than 2500 g. The education level of both parents was mainly elementary school graduates. Almost half of the mothers had a height of less than 150 cm and more than half of the mothers had a mid-arm circumference of ≤23.5 cm during pregnancy (Table 2).

Determinants of stunting according to WHO and national standards

Based on WHO standard, univariate logistic regression analysis indicated that children with maternal height below 150 cm (OR = 2.844; 95% CI = 1.632 – 4.956) were more likely to be stunted (Table 3). In the multivariate logistic regression analysis, other variables with p-value between 0.05 and 0.1 from the univariate analysis (child's birthweight, child's intrauterine growth status, maternal mid-upper arm circumference, and number of parities) were included. Multivariate analysis indicated that children with maternal height below 150 cm

Table 1. Prevalence of stunting and underweight of children aged 0 – 59 months in Musi sub-district.

Variable	Total prevalence (N = 408) n (%)		p-value	Study participants (N = 218) n (%)		p-value
	WHO	National		WHO	National	
Stunting (length/height for age index)			< 0.001*			< 0.001*
Normal (-2 SD and above)	188(46.1)	364(89.22)		106(48.6)	200(91.7)	
Stunted (<-2 SD to ≤-3 SD)	148(36.3)	41(10.05)		75(34.4)	17(7.8)	
Severely stunted (<-3 SD)	72(17.6)	3 (0.73)		37(17)	1(0.5)	
Underweight (weight for age index)			< 0.001#			< 0.001#
Normal (-2 SD and above)	289(70.83)	336(82.3)		149(68.3)	176(80.7)	
Underweight (<-2 SD to ≤-3 SD)	96(23.53)	57(14)		55(25.3)	33(15.2)	
Severely underweight (<-3SD)	23(5.64)	15 (3.7)		14(6.4)	9(4.1)	

Chi square test was used.

*p-value between stunted (and severely stunted) and normal.

#p-value between underweight (and severely underweight) and normal.

$p < 0.05$ was considered statistically significant.

Table 2. Sociodemographic characteristics among children aged 0–59 months in Musi Sub-district.

Characteristic	Total		WHO		National	
	(N = 218)		Stunted	Underweight	Stunted	Underweight
	n	%	%	%	%	%
Infant						
Child's gender						
Male	108	49.5	52.8	30.6	7.4	16.7
Female	110	50.5	50	32.7	9.1	21.8
Child's age group						
0–23 months	98	45	45.9	29.6	9.2	17.3
24–59 months	120	55	55.8	33.3	7.5	20.8
Child's birthweight						
<2500 g	35	16.1	65.7	54.3	17.1	40
≥2500 g	183	83.9	48.6	27.3	6.6	15.3
Intrauterine growth						
SGA	38	17.4	65.8	57.9	15.8	44.7
AGA	174	79.8	48.9	27	6.9	14.4
LGA	6	2.8	33.3	0	0	0
Gestational age						
Preterm	13	6	61.5	30.8	15.4	23.1
Term	204	93.6	51	31.9	7.8	19.1
Postterm	1	0.4	0	0	0	0
Parents						
Paternal education						
No formal education	6	2.8	83.3	50	33.3	50
Primary school graduates	126	57.8	54.8	31.7	9.5	22.2
Secondary school graduates	32	14.7	50	28.1	6.3	15.6
High secondary school graduates	42	19.3	45.2	38.1	4.8	14.3
University graduates	12	5.5	25	8.3	0	0
Maternal education						
No formal education	4	1.8	75	75	25	75
Primary school graduates	103	47.2	52.4	29.1	8.7	20.4
Secondary school graduates	35	16.1	65.7	40	8.6	22.9
High secondary school graduates	48	22	47.9	35.4	10.4	18.8
University graduates	28	12.8	32.1	17.9	0	3.6
Maternal MUAC						
≤23.5 cm	125	57.3	43.2	31.2	10.4	22.4
>23.5 cm	93	42.7	44.1	32.3	5.4	15.1
Maternal height						
<150 cm	96	44	65.6	40.6	12.5	26
≥150 cm	122	56	40.2	24.6	4.9	13.9
Maternal age during pregnancy						
<20 years old	20	9.2	70	65	15	40
20–35 years old	166	76.1	50.6	25.9	8.4	15.7
>35 years old	32	14.7	43.8	40.6	3.1	25
Number of parities						
1	51	23.4	56.9	35.3	9.8	19.6
2	65	29.8	43.1	24.6	7.7	18.5
3	51	23.4	60.8	37.3	9.8	27.5
4	30	13.8	36.7	16.7	0	3.3
>4	21	9.6	61.9	52.4	14.3	23.8

SGA, small for gestational age; AGA, appropriate for gestational age; LGA, large for gestational age; MUAC, mid-upper arm circumference.

(OR = 2.936; 95% CI = 1.672 – 5.154) or maternal mid-upper arm circumference below 23.5 cm (OR = 1.796; 95% CI = 1.008 – 3.105) were more likely to be stunted (Table 4).

Based on national standard, univariate logistic regression analysis indicated that children with birthweight below 2500 g (OR = 2.948; 95% CI = 1.025 – 8.476) or with a father without formal education (OR = 10; 95% CI = 1.094 – 91.441) were more

Table 3. Univariate analysis of determinants for stunting among children aged 0–59 months in Musi Sub-district.

Variables	WHO			National		
	OR	95% CI	*p* value	OR	95% CI	*p* value
Infant factors						
Child's gender						
Male	1.118	[0.657 – 1.902]	0.682	0.8	[0.303 – 2.111]	0.652
Female (ref)	-	-	-	-	-	-
Child's age group						
0–23 months	0.672	[0.393 – 1.148]	0.146	1.247	[0.475 – 3.274]	0.654
24–59 months (ref)	-	-	-	-	-	-
Child's birthweight						
<2500 g	**2.024**	**[0.951 – 4.310]**	**0.067**	**2.948**	**[1.025 – 8.476]**	**0.045**
≥2500 g (ref)	-	-	-	-	-	-
Intrauterine growth						
SGA	**2.014**	**[0.967 – 4.192]**	**0.061**	**2.531**	**[0.885 – 7.239]**	**0.083**
AGA (ref)	-	-	-	-	-	-
LGA	0.524	[0.093 – 2.933]	0.462	0.0	[0]	0.999
Gestational age						
Preterm	1.538	[0.487 – 4.862]	0.463	2.136	[0.435 – 10.484]	0.350
Term (ref)	-	-	-	-	-	-
Postterm	0.0	[0]	1.0	0.0	[0]	1.0
Parent factors						
Paternal education						
No formal education	6.053	[0.65 – 56.365]	0.114	**10**	**[1.094 – 91.441]**	**0.041**
Primary school graduates	1.465	[0.727 – 2.956]	0.286	2.105	[0.451 – 9.817]	0.343
Secondary school graduates	1.211	[0.482 – 3.042]	0.685	1.333	[0.178 – 10.014]	0.780
High secondary school graduates (ref)	-	-	-	-	-	-
University graduates	0.404	[0.096 – 1.705]	0.217	0.0	[0]	0.999
Maternal education						
No formal education	3.261	[0.316 – 33.614]	0.321	2.867	[0.249 – 33.065]	0.399
Primary school graduates	1.198	[0.603 – 2.378]	0.606	0.823	[0.260 – 2.604]	0.741
Secondary school graduates	2.083	[0.848 – 5.118]	0.109	0.806	[0.179 – 3.623]	0.779
High secondary school graduates (ref)	-	-	-	-	-	-
University graduates	0.515	[0.194 – 1.364]	0.182	0.0	[0]	0.998
Maternal MUAC						
≤23.5 cm	**1.668**	**[0.971 – 2.865]**	**0.064**	2.043	[0.702 – 5.947]	0.190
>23.5 cm (ref)	-	-	-	-	-	-
Maternal height						
<150 cm	**2.844**	**[1.632 – 4.956]**	**< 0.001**	**2.762**	**[0.997 – 7.655]**	**0.051**
≥150 cm (ref)	-	-	-	-	-	-
Maternal age during pregnancy						
<20 years old	2.278	[0.835 – 6.214]	0.108	1.916	[0.500 – 7.346]	0.343
20–35 years old (ref)	-	-	-	-	-	-
>35 years old	0.759	[0.354 – 1.626]	0.479	0.350	[0.044 – 2.762]	0.319
Number of parities						
1 (ref)	-	-	-	-	-	-
2	0.574	[0.274 – 1.204]	0.142	0.767	[0.209 – 2.807]	0.688
3	1.176	[0.534 – 2.589]	0.687	1.0	[0.271 – 3.689]	1.0
4	**0.439**	**[0.174 – 1.109]**	**0.082**	0.0	[0]	0.998
>4	1.233	[0.435 – 3.490]	0.693	1.533	[0.332 – 7.092]	0.584

SGA, small for gestational age; AGA, appropriate for gestational age; LGA, large for gestational age; MUAC, mid-upper arm circumference.

likely to be stunted (Table 3). In multivariate logistic regression analysis, other variables with p-value between 0.05 and 0.1 from the univariate analysis (child's intrauterine growth status and maternal height) were included. No determinant was found in the multivariate analysis (Table 4).

Determinants of underweight according to WHO and national standards

Based on WHO standard, univariate logistic regression analysis indicated that children with birthweight below 2500 g (OR = 3.159; 95% CI = 1.507 – 6.622) or intrauterine growth

Table 4. Multivariate analysis of determinants for stunting among children aged 0–59 months in Musi Sub-district.

Variables	WHO			National		
	OR	95% CI	*p* value	OR	95% CI	*p* value
Infant factors						
Child's gender Male Female (ref)						
Child's age group 0–23 months 24–59 months (ref)						
Child's birthweight <2500 g ≥2500 g (ref)						
Intrauterine growth SGA AGA (ref) LGA						
Gestational age Preterm Term (ref) Postterm						
Parent factors						
Paternal education No formal education Primary school graduates Secondary school graduates High secondary school graduates (ref) University graduates						
Maternal education No formal education Primary school graduates Secondary school graduates High secondary school graduates (ref) University graduates						
Maternal MUAC ≤23.5 cm >23.5 cm (ref)						
Maternal height <150 cm ≥150 cm (ref)	1.769 -	[1.008 – 3.105] -	0.047 -			
Maternal age during pregnancy <20 years old 20–35 years old (ref) >35 years old	2.936 -	[1.672 – 5.154] -	<0.001 -			
Number of parities 1 (ref) 2 3 4 >4						

SGA, small for gestational age; AGA, appropriate for gestational age; LGA, large for gestational age; MUAC, mid-upper arm circumference.

restriction (OR = 3.715; 95% CI = 1.798 – 7.677) were more likely to be underweight. Children with maternal height below 150 cm (OR = 2.098; 95% CI = 1.176 – 3.745) or maternal age under 20 years old during pregnancy (OR = 5.312; 95% CI = 1.989 – 14.186) were also more likely to be underweight (Table 5). In multivariate logistic regression analysis, other variables with p-value between 0.05 and 0.1 from the univariate analysis (paternal education and number of parities)

Table 5. Univariate analysis of determinants for underweight among children aged 0–59 months in Musi Sub-district.

Variables	WHO			National		
	OR	95% CI	*p* value	OR	95% CI	*p* value
Infant factors						
Child's gender						
Male	0.904	[0.511 – 1.601]	0.730	0.717	[0.363 – 1.413]	0.336
Female (ref)	-	-	-	-	-	-
Child's age group						
0–23 months	0.841	[0.472 – 1.496]	0.555	0.798	[0.403 – 1.580]	0.517
24–59 months (ref)	-	-	-	-	-	-
Child's birthweight						
<2500 g	**3.159**	**[1.507 – 6.622]**	**0.002**	**3.690**	**[1.680 – 8.107]**	**0.001**
≥2500 g (ref)	-	-	-	-	-	-
Intrauterine growth						
SGA	**3.715**	**[1.798 – 7.677]**	**< 0.001**	**4.825**	**[2.241 – 10.389]**	**< 0.001**
AGA (ref)	-	-	-	-	-	-
LGA	0.0	[0]	0.999	0.0	[0]	0.999
Gestational age						
Preterm	0.950	[0.282 – 3.200]	0.935	1.269	[0.333 – 4.831]	0.727
Term (ref)	-	-	-	-	-	-
Postterm	0.0	[0]	1.0	0.0	[0]	1.0
Parent factors						
Paternal education						
No formal education	1.625	[0.292 – 9.050]	0.579	**6.0**	**[0.973 – 36.986]**	**0.054**
Primary school graduates	0.756	[0.365 – 1.564]	0.450	1.714	[0.656 – 4.481]	0.272
Secondary school graduates	0.636	[0.236 – 1.713]	0.370	1.111	[0.307 – 4.026]	0.873
High secondary school graduates (ref)	-	-	-	-	-	-
University graduates	**0.148**	**[0.017 – 1.255]**	**0.080**	0	[0]	0.999
Maternal education						
No formal education	5.474	[0.527 – 56.714]	0.154	**13.0**	**[1.207 –139.959]**	**0.034**
Primary school graduates	0.749	[0.362 – 1.553]	0.438	1.110	[0.465 – 2.646]	0.814
Secondary school graduates	1.216	[0.495 – 2.985]	0.670	1.284	[0.440 – 3.748]	0.647
High secondary school graduates (ref)	-	-	-	-	-	-
University graduates	0.396	[0.128 – 1.232]	0.110	**0.160**	**[0.019 – 1.342]**	**0.091**
Maternal MUAC						
≤23.5 cm	0.952	[0.535 – 1.695]	0.868	1.629	[0.803 – 3.303]	0.176
>23.5 cm (ref)	-	-	-	-	-	-
Maternal height						
<150 cm	**2.098**	**[1.176 – 3.745]**	**0.012**	**2.175**	**[1.095 – 4.318]**	**0.026**
≥150 cm (ref)	-	-	-	-	-	-
Maternal age during pregnancy						
<20 years old	**5.312**	**[1.989 – 14.186]**	**0.001**	**3.590**	**[1.337 – 9.638]**	**0.011**
20–35 years old (ref)	-	-	-	-	-	-
>35 years old	**1.957**	**[0.892 – 4.296]**	**0.094**	1.795	[0.728 – 4.428]	0.204
Number of parities						
1 (ref)	-	-	-	-	-	-
2	0.599	[0.274 – 1.204]	0.212	0.928	[0.365 – 2.360]	0.876
3	1.089	[0.534 – 2.589]	0.837	0.1551	[0.615 – 3.913]	0.352
4	**0.367**	**[0.174 – 1.109]**	**0.079**	**0.141**	**[0.017 – 1.166]**	**0.069**
>4	2.017	[0.435 – 3.490]	0.182	1.281	[0.379 – 4.336]	0.690

SGA, small for gestational age; AGA, appropriate for gestational age; LGA, large for gestational age; MUAC, mid-upper arm circumference.

were included. Multivariate analysis indicated that children with intrauterine growth restriction (OR = 3.182; 95% CI = 1.450 – 6.980) were more likely to be underweight. Children with maternal age under 20 years old during pregnancy (OR = 6.252; 95% CI = 1.911 – 20.457) or with mother that had more than four parities (OR = 4.319; 95% CI = 1.189 – 15.689) were also more likely to be underweight (Table 6).

Based on national standard, univariate logistic regression analysis indicated that children with birthweight below 2500 g

Table 6. Multivariate analysis of determinants for underweight among children aged 0–59 months in Musi Sub-district.

Variables	WHO			National		
	OR	95% CI	*p* value	OR	95% CI	*p* value
Infant factors						
Child's gender						
Male						
Female (ref)						
Child's age group						
0–23 months						
24–59 months (ref)						
Child's birthweight						
<2500 g						
≥2500 g (ref)						
Intrauterine growth						
SGA	3.182	[1.450 – 6.980]	0.004	4.191	[1.820 – 9.649]	0.001
AGA (ref)	-	-		-	-	-
LGA	0.0	[0]	0.999	0.0	[0]	0.999
Gestational age						
Preterm						
Term (ref)						
Postterm						
Parent factors						
Paternal education						
No formal education						
Primary school graduates						
Secondary school graduates						
High secondary school graduates (ref)						
University graduates						
Maternal education						
No formal education				27.341	[1.281 - 583.318]	0.034
Primary school graduates				1.147	[0.412 – 3.188]	0.793
Secondary school graduates				1.409	[0.444 – 4.468]	0.561
High secondary school graduates (ref)				-	-	-
University graduates				0.193	[0.022 – 1.674]	0.136
Maternal MUAC						
≤23.5 cm						
>23.5 cm (ref)						
Maternal height						
<150 cm						
≥150 cm (ref)						
Maternal age during pregnancy						
<20 years old	6.252	[1.911 – 20.467]	0.002			
20–35 years old (ref)	-		-			
>35 years old	1.449	[0.565 – 3.718]	0.441			
Number of parities						
1 (ref)	-	-	-			
2	1.283	[0.480 – 3.430]	0.619			
3	2.601	[0.938 – 7.210]	0.066			
4	0.827	[0.220 – 3.101]	0.778			
>4	4.319	[1.189 – 15.689]	0.026			

SGA, small for gestational age; AGA, appropriate for gestational age; LGA, large for gestational age; MUAC, mid-upper arm circumference.

(OR = 3.690; 95% CI = 1.680 – 8.107) or intrauterine growth restriction (OR = 4.825; 95% CI = 2.241 – 10.389) were more likely to be underweight. Children with mother without formal education (OR = 13.95%; CI = 1.207 – 139,959), with height below 150 cm (OR = 2.175; 95% CI = 1.095 – 4.318), or aged under 20 years old during pregnancy (OR = 3.590; 95% CI = 0.011) were also more likely to be underweight (Table 5). In multivariate logistic regression analysis, other variables with

p-value between 0.05 and 0.1 from the univariate analysis (paternal education and number of parities) were included. Multivariate analysis indicated that children with intrauterine growth restriction (OR = 4.191; 95% CI = 1.820 – 9.649) were more likely to be underweight. Children with mother without formal education (OR = 27.341; 95% CI =1.281 – 583,318) were also more likely to be underweight (Table 6).

Discussion

In our study, the prevalence of both stunting and underweight were significantly lower when measured using Indonesian standard compared to when using WHO standard. It has been suggested that overdiagnoses of stunting or underweight are more likely to occur in developing countries[21]. There are many countries that already proposed their own national growth standard, which are: Korea[22], Thailand[23], Argentina[24], China[25], India[21], and 18 European countries[26]. It is argued that the national growth standard of each country is more suitable to reflect the condition in its own population[23]. However, there were only few published studies that compare the difference between national growth standards and WHO growth standard. A comparison study among Thai children in the first two years of life showed that the prevalence of stunting was higher when using WHO standard in both sexes, but at 24 months the only significant difference was in girls. The prevalence of underweight showed a monotonic increment when using WHO standard, but the Thailand national standard showed a fluctuation[23]. In Argentina, the prevalence of underweight using WHO standard was 2 times higher than when using their national standard. Meanwhile for stunting, the prevalence when using WHO standard was 1.5 times higher[24]. In contrary, a comparison study from China showed that the prevalence of stunting and underweight was significantly higher when measured using their national standard[25].

The marked difference in measurements using Indonesian standard and WHO standard probably stems from the difference in methodology during the development of both growth reference standards. The WHO standard was developed using data from five cities in five different countries: United States, Turkey, Norway, Brazil, and India. The children included in the study were healthy children with suitable sociodemographic conditions for growth. Moreover, all participants agreed to follow the feeding recommendation by WHO[27]. In contrary, the development of Indonesian standard did not have any inclusion and exclusion criteria for study participants. It also did not mention the sociodemographic background of the participants or their feeding habits. The study, however, collected data from all 33 provinces of Indonesia to better reflect the growth of Indonesian children[12].

Review article by Beal *et al.* concluded that the determinants of stunting in Indonesia are maternal height and education, child's gender, premature birth and birth length, exclusive breastfeeding for six months, living area, and household socio-economic status[11]. In our study, the determinants of stunting according to WHO standard were maternal height less than 150 cm and maternal upper mid-arm circumference <23.5 cm. In contrast, no determinant was found when Indonesian standard was used. It is because the prevalence of stunting according to Indonesian standard was low. The significant difference in stunting prevalence calculated using Indonesian and WHO standards might be because the WHO standard does not represent local growth appropriately due to population differences in height[26], and Indonesian people are generally shorter than the rest of the world.

Regarding underweight, the determinants were also different according to the two different standards. However, there was one common determinant: intrauterine growth restriction. The difference of underweight prevalence between the two standards was not as marked as the difference in stunting prevalence; this may explain that there was still one overlapping determinant. The increased odds of undernutrition in SGA infants are more relevant in low- and middle-income countries[28]. SGA children are born with lower intrinsic potential for growth due to the persistent effect of growth restriction in utero[29,30]. SGA is a result of poor maternal nutrition during pregnancy when the child is totally dependent on getting nutrition from the mother through the placenta, hence any nutrition deprivation from the mother will affect the proper growth and development of the fetus[31].

There were several limitations of this study. We did not discern the feeding habits of the participants of this study. Feeding habit could be an important determinant of malnutrition. For example, introduction of complimentary food earlier than four months increased the likelihood of being underweight and stunted[32]. Data on exclusive breastfeeding and history of immunization cannot be obtained because some of our samples have not yet completed the exclusive breastfeeding and basic immunization period. Data regarding socioeconomic status could not be obtained due to parents' unstable monthly income. Data regarding the frequency of diarrhea could not be obtained because this was not well documented in primary healthcare medical records. These factors should be accounted for in the ensuing studies. Nevertheless, despite all of the limitations, this is the first study that compare the prevalence and determinants of stunting and underweight among Indonesian children under five using Indonesian growth standard and WHO growth standard.

Conclusion

The WHO standard was not suitable to diagnose stunting and underweight in Musi sub-district, since the prevalence was significantly higher when using WHO standard compared to when using Indonesian standard. Future studies should be done to re-evaluate the prevalence and determinants of stunting and underweight nationwide using the Indonesian standard. An Indonesian standard for weight-for-height should also be made to re-evaluate the prevalence and determinants of wasting in Indonesia.

Data availability

Underlying data

Figshare: Growth standard comparison between WHO and Indonesian Growth Chart-Population Data. https://doi.org/10.6084/m9.figshare.12121938.v5[19]

Figshare: Growth standard comparison between WHO and Indonesian Growth Chart-Determinants Data. https://doi.org/10.6084/m9.figshare.12127425.v3[20]

Reporting guidelines

Figshare: STROBE Checklist-Indonesian and WHO Growth Standard Comparison. https://doi.org/10.6084/m9.figshare.12127689.v2[13]

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