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Original Article

Comparison of *Growth Diagrams Of Indonesian Children* to *2006 World Health Organization Growth Standards* in diagnosing stunting

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Abstract

Background Stunting represents a linear growth disturbance due to chronic malnutrition, recurrent infection, and inadequate psychosocial stimulation. The *2006 World Health Organization (WHO) Growth Standards* are utilized as a modality in monitoring children's growth, but to date, there has been no recommendation on use of the *Growth Diagrams of Indonesian Children* to monitor the growth of Indonesian children.

Objective To determine the proportion of stunting, the sensitivity and specificity of *Growth Diagrams of Indonesian Children* for diagnosing stunting. In addition, we aimed to compare proportions of stunting using the *2006 WHO Growth Standards* and *Growth Diagrams of Indonesian Children*.

Method A cross-sectional study was conducted in Lawe Alas District, Southeast Aceh, Indonesia. Subjects were children aged 1-59 months who fulfilled the inclusion criteria. Weight and height measurements were plotted on the *Growth Diagrams of Indonesian Children* and on the *2006 WHO Growth Standards to determine* the stature of subjects. Stunting was defined as the index Z-score for HAZ of less than -2 SD for the *2006 WHO Growth Standards*, and an HAZ index of below the 10th percentile (p10th) for the *Growth Diagrams of Indonesian Children*.

Results Of 141 subjects, 66 (46.8%) had stunting based on the *2006 WHO Growth Standards* and 51 (34.8%) had stunting based on *Growth Diagrams of Indonesian Children*. The sensitivity and specificity of the *Growth Diagrams of Indonesian Children* were 75.5% and 98.66%, respectively. Significantly more children were considered to be stunted using the *2006 WHO Growth Standards* than using the *Growth Diagrams of Indonesian Children*.

Conclusion Stunting prevalence is high in Southeast Aceh. The *Growth Diagrams of Indonesian Children* is a spesific and sensitive tool to diagnosed stunting in accordance with Indonesian children's growth patterns. **[Paediatr Indones. 2020;60:95-100; doi: http://dx.doi.org/10.14238/pi60.2.2020.95-100].**

Keywords: : *WHO Growth Standards 2006; Growth Diagrams of Indonesian Children; stunting*

Stunting is characterized by short stature, but not every child with short stature is stunted.[1] Stunting reflects a disruption of linear growth due to chronic malnutrition, recurrent infections, and inadequate psychosocial stimulation due to environmental conditions and socioeconomic status.[2,3] By definition, stunting is the index of body length by age (BAZ) or height by age (HAZ), with Z-score less than -2 standard deviations (SD).[3] Stunting that occurs before the age of 2 years is predicted to lead to adverse cognitive functions.[4] In addition to the decline of cognitive abilities,[4]

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patients with long term stunting have poor immunity, so they easily get sick, increasing their morbidity and mortality.[5]

According to the *National Basic Health Research Report (Riskesdas)*, the prevalence of stunting in Indonesian children was above 30% in four separate years (2007, 2010, 2013 and 2018). Indonesia's prevalence of stunting was 36.8% in 2007, 35.6% in 2010, 37.2% in 2013, and 30.8% in 2018.[6-9] According to the *2018 National Basic Health Research Report*, Aceh was in the top three regions with the highest stunting prevalence in Indonesia.[9]

A diagnosis of stunting can be made by several standards, including the *National Center for Health Statistics/Centers for Disease Control* (NCHS/CDC) or the *2006 World Health Organization Child Growth Standards*. The most commonly used chart in Indonesia is the *2006 WHO Growth Standards* for children under 5 years.[2] Many countries have used the *2006 WHO Growth Standards* as a modality for monitoring children's growth. However, the *2006 WHO Growth Standards* are not always appropriate for assessing child growth due to differing racial, demographic, and growth patterns among the world's nations.[10]

To date, no recommendations have been made regarding child growth curves that best represent Indonesian child growth. So, in 2006 Batubara *et al.*[11] conducted a study to create a standard growth curve for Indonesian children. However, to our knowledge, no study has compared the *Growth Diagrams of Indonesian Children* to the *2006 WHO Growth Standard Curve*, with regards to the most appropriate chart for Indonesia's health workers in daily health practices. Therefore, we aimed to assess the sensitivity and specificity of the *Growth Diagrams of Indonesian Children* in diagnosing stunting in children in the Southeast Aceh District.

Methods

This cross-sectional study was done to assess the sensitivity and specificity of the *Growth Diagrams of Indonesian Children* compared to the *2006 WHO Growth Standard*. The subject population in this study were children aged 1 to 59 months and 30 days who lived in the Village Ngkeran and Lawe Konker, Lawe Alas District, Southeast Aceh District from December 2017 to May 2018. Subjects' parents provided written informed consent. Children with malignant or autoimmune diseases, bone abnormalities, or who received long-term steroid therapy which affects linear growth were excluded. This study was approved by the Research Ethics Committee of the Universitas Sumatera Utara Medical School.

Subjects' demographic data were collected consisting of gender, age, gestational age, birth weight, and birth length. Weight measurement for young children not yet able to stand was done using a *Seca 725* baby scale, while weight measurement for children able to stand was done using a *Seca 803* footprint scale. The infants wore only underwear during the weight measurement. The scale needle was read when the child was calm and the needle stayed constant. Subjects' body lengths were measured by a *Seca 334* infant scale for those under 2 years or a *Seca 206* microtoise for children above 2 years. Subjects wore no footwear while body length/height was measured.

Anthropometric data were plotted on the *Growth Diagrams of Indonesian Children* and the *2006 WHO Growth Standards* to determine the stature of subjects. Stunting was defined as the index Z-score for HAZ of less than -2 SD for the *2006 WHO Growth Standards*,[3] and an HAZ index of below the 10th percentile ($p10^{th}$) for the *Growth Diagrams of Indonesian Children*.[11]

Univariate analysis was performed on the data to determine the distribution of subjects' characteristics. Sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, and negative likelihood ratio were analyzed in a 2x2 table. McNemar test was used to compare the prevalence of stunting between the two growth charts. Results with P values <0.05 were considered to be significant, with 95% confidence intervals.

Results

The characteristics of 141 study subjects are shown in **Table 1**. The stunting prevalence was 36.2% by the *Growth Diagrams of Indonesian Children* and 46.8% by the *2006 WHO Growth Standards*.

The diagnostic analysis results of the *2006 WHO Growth Standards* as the gold standard compared to the *Growth Diagrams of Indonesian Children* are

shown in **Table 2**. The *Growth Diagrams of Indonesian Children* had 75.75% sensitivity, 98.66% specificity, 98.03% positive predictive value, 82.22% negative predictive value, as well as positive likelihood ratio of 75 and negative likelihood ratio of 0.24. There was a statistically significant difference in the diagnosis of stunting using *Growth Diagrams of Indonesian Children* compared to the *2006 WHO Growth Standards* (P <0.001).

Discussion

The *2006 WHO Growth Standards* is the current growth chart used in Indonesia for children under 5 years of age. This chart was made based on data from 8,500 children from several health centers throughout the world. The study was conducted on children from various ethnic backgrounds who received exclusive breastfeeding,[3] but there were no representatives from Southeast Asian countries in the sampling of the study.[2]

The population of Indonesian children has a lower mean height than the average population of children in Europe. A previous study conducted a meta-analysis of anthropometric data in 55 countries compared to the *2006 WHO Growth Standards*. The study found that European populations had a +0.5 SD higher mean height compared to the height of the *2006 WHO Growth Standards*. Asian populations such as Saudi Arabia and India had a -0.5 SD lower mean height compared to the *2006 WHO Growth Standards*.[12] Another study stated that the German population of children less than 5 years of age had mean height at the 60th percentile in males and 62nd percentile in females.[13] Although the WHO recommends using only one type of growth chart standard, a previous study recommended that national growth chart standards be the guide for each country.[13] Consistent with this recommendation, another previuous study showed that the use of the *2006 WHO Growth Standards* led to underdiagnosed stunting in children in Australia.[14]

Table 1. Characteristics of study subjects

Characteristics	(N = 141)
Sex, n (%)	
Male	73 (51.8)
Female	68 (48.2)
Median age (range), months	17.0 (1.0-60.0)
Median weight (range), kg	9.2 (3.0-21.0)
Mean height (SD), cm	77.8 (13.68)
Median gestational age (range), weeks	39.0 (35.0-40.0)
Median birth weight (range), grams	2750.0 (2100.0-3150.0)
Median birth height (range), cm	48.0 (44.0-51.0)
Height/age by *2006 WHO Growth Standards*, n (%)	
Stunted	66 (46.8)
Not stunted	75 (53.2)
Height/age by *Growth Diagrams of Indonesian Children*, n (%)	
Stunted	51 (36.2)
Not stunted	90 (63.8)

Table 2. Analysis of the *2006 WHO Growth Standards* compared to the *Growth Diagrams of Indonesian Children*

Height/age based on *Growth Diagrams of Indonesian Children*	Height/age based on *2006 WHO Growth Standards*		Total	P value*
	Stunted (%)	Not stunted (%)		
Stunted	50 (98.1)	1 (1.9)	51 (36.2)	< 0.001
Not stunted	16 (17.8)	74 (82.2)	90 (63.8)	
Total	66 (46.8)	75 (53.2)	141 (100)	

* McNemar test

Children should be screened for stunting in order to make an early diagnosis to correct the problem. Hence, a high sensitivity diagnostic examination is needed. Moreover, positive predictive value and negative predictive value are more important than sensitivity and specificity. These values can predict the likelihood of someone suffering from a disease if the results are positive, and the likelihood of someone to be healthy if the results of the examination are negative.[15] In the comparison to the *2006 WHO Growth Standards*, the *Growth Diagrams of Indonesian Children* had sensitivity of 75.75%, specificity of 98.66%, positive predictive value of 98.03%, negative predictive value of 82.22%, positive likelihood ratio of 75, and negative likelihood ratio of 0.24. Previous study comparing the proportions of stunting based on the two growth charts, showed that stunting is often overdiagnosed with the *WHO Growth Standards* assessment.[12] To our knowledge, this is the first study to compare the accuracy of the *Growth Diagrams of Indonesian Children* as a national growth chart to the *2006 WHO Growth Standards*.

The Basic Health Research Report recorded the prevalence of national stunting in 2018 to be 30.8%.[9] Several national surveys in other countries such as Nigeria in 2018,[16] India in 2017,[17] Ethiopia in 2018,[18] Guatemala in 2019,[19] and Gabon in 2008,[20] showed that successive stunting prevalences were 30.2%, 38.4%, 41.8%, 46.5% and 30.5%, respectively. The *2006 WHO Growth Standards* were used in those studies as a reference for the classification of stunting.

A study in Argentina compared the *2006 WHO Growth Standards* to the *Argentina Pediatric Society* (APS) *Committee of Growth and Development Chart* found prevalences of stunting to be 7.9% and 5.3%, respectively.[21] The authors noted that the difference in proportion may have been due to differences in age group and cut-offs between the APS and WHO criteria. Moreover, the WHO sample was standardized to be children who were healthy, well fed according to the WHO nutrition recommendation, and growing in good socioeconomic environments which supported good growth and development. Complex statistical analysis was done to normalize the asymmetrical distribution by removing extreme values.[21] The *2006 WHO Growth Standards* also has selective drop out criteria, which means that the chart is based on ideal child growth projection, and not based on real growth data.[3]

A study reported that Indonesian boys and girls were significantly shorter than the *2006 WHO Growth Standards*.[22] In our study, there was a significant difference in the proportion of stunting based on *2006 WHO Growth Standards* (46.8%) compared to the *Growth Diagrams of Indonesian Children* (36.2%). Our results were similar to several studies in other developing countries. Another study stated that the average height population of Indonesia's children was 1.47 SD lower in males and 1.43 SD lower in females, compared to the population of children in America. The WHO has 0.5 SD as the standard for significant difference. This greatest difference is at four years of age in boys and twelve years in girls.[11] This situation may lead to lower proportions of stunting using the *Growth Diagrams of Indonesian Children* compared to the *2006 WHO Growth Standards*.

Internal and external factors play important roles in the cause of stunting. Pre-natal and post-natal factors are included in the internal risk factors that cause stunting. In addition, chronic infections in infants and children also greatly affect the occurrence of stunting.[23] Other post-natal factors that can cause stunting are chronic recurrent infections, such as chronic diarrhea and acute respiratory infection.[24] External factors including sanitation and hygiene, play an important role in preventing stunting, since poor sanitation and hygiene increase the risk of chronic infection.[25]

The limitations of this study were the small sample size, no risk factor analysis, and the population was comprised from only one region. This study also had potential risks of bias because workups on other causes of short stature, such as Patau syndrome or growth hormone deficiency, were not conducted. For such reasons, further multicenter study needs to be done with a larger number of study subjects and with a risk factor analysis for causes of stunting.

In conclusion, the prevalence of stunting in this study is high by using both of the *Growth Diagrams of Indonesian Children* and the *2006 WHO Growth Standards*. Therefore, prevalence is higher when the *2006 WHO Growth Standards* is used. The *Growth Diagrams of Indonesian Children* appear to be a solid and reliable tool to diagnose stunting in Indonesian children. Shifting to the *Growth Diagrams of Indonesian*

Children may have considerable implications for child health programmes.

Conflict of Interest

None declared.

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