

# Adoption of the WHO Child Growth Standards to classify Indonesian children under 2 years of age according to nutrition status: Stronger indication for nutritional intervention

Madarina Julia

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## Abstract

**Background.** The National Center for Health Statistics/World Health Organization (NCHS/WHO) reference is considered unsuitable for assessing the nutritional status of breastfed children. It is gradually being replaced by the WHO Child Growth Standards in many countries.

**Objective.** To assess the implications of adopting the WHO Child Growth Standards to classify Indonesian children according to nutrition status.

**Methods.** Data were obtained from two cross-sectional surveys in two districts in Indonesia in 1998. Children under 2 years of age were randomly selected using a two-stage cluster sampling. Z-scores of weight-for-length (WLZ), length-for-age (LAZ), and weight-for-age (WAZ) were calculated based on both the NCHS/WHO reference and the WHO Child Growth Standards. Wasting, stunting, and underweight were defined as z-scores less than  $-2.0$ .

**Results.** We included 1,374 children, of whom 693 (50.4%) were male and 681 (49.6%) were female. Almost all of the children had initiated breastfeeding and were still being breastfed when the data were collected. According to the WHO Child Growth Standards, the prevalence of wasting did not change with age, but the prevalence rates of stunting and underweight rose steadily with age. Although the contribution of wasting to the classification of underweight was relatively constant, the contribution of stunting increased as the children grew.

**Conclusions.** The WHO Child Growth Standards are a better tool for assessing the nutritional status of Indonesian children than the NCHS/WHO reference. However, low WAZ is not a suitable indicator for commencing an extra feeding program, because it reflects stunting instead of wasting. The high prevalence of stunting indicates

*the need to perform preventive nutritional intervention beginning earlier in life, i.e., in utero.*

**Key words:** Children, Indonesia, malnutrition, nutritional program, WHO Child Growth Standards

## Introduction

Growth is one of the most commonly used and most valuable tools for assessing the general well-being of infants and children. However, the interpretation of a child growth trajectory is highly dependent on the growth chart used. The growth reference recommended for international use since the late 1970s, the National Center for Health Statistics/World Health Organization (NCHS/WHO) reference, is regarded as inappropriate for assessing children's growth. This is mostly because the reference is based on a sample of predominantly formula-fed children whose growth patterns substantially deviate from the patterns of healthy breastfed children [1–3].

Consequently, in April 2006, WHO released a new growth chart. The WHO Child Growth Standards are based on an international sample of breastfed children selected to represent optimum growth. They are designed to be used as a standard for how children should grow rather than just a reference. They are meant to be used for both individual diagnoses and international comparisons [4, 5].

The WHO Child Growth Standards are based on data from a multicenter study of six countries from different regions of the world: the United States (North America), Brazil (South America), Norway (Europe), Ghana (sub-Saharan Africa), Oman (Western Asia), and India (Southern Asia) [4]. Eastern Asia was not represented, as was originally planned [2, 3]. Representation of this region could be important, because the median height-for-age of children in the growth reference for Singapore, one of the most prosperous Asian countries, was lower than the NCHS/WHO reference

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The author is affiliated with the Department of Child Health, Gadjah Mada University, Yogyakarta, Indonesia.

Address queries to the author: Madarina Julia, Department of Child Health, Gadjah Mada University/Dr. Sardjito Hospital, Jl. Kesehatan, Sekip, Yogyakarta 55281, Indonesia; e-mail: [madarina@pediatric-gmu.org](mailto:madarina@pediatric-gmu.org), [madarinajulia@yahoo.com](mailto:madarinajulia@yahoo.com).

[6]. A similar finding was observed when the Indonesian growth reference was constructed [7].

There is enthusiasm for adopting the WHO Child Growth Standards in Indonesia. However, before doing so, it is important to assess how well Indonesian children match to, or diverge from, these standards. This is because the conclusions derived from adopting the standards will have implications for planning nutritional programs in the country. We explore these concerns using data from two samples of rural Indonesian children acquired in 1998.

## Methods

### Study design and sampling strategy

The data used in this paper were obtained from a multicenter study on complementary feeding performed from September 1997 to February 1998 in two districts in Indonesia, Belu and Purworejo. The results of the study have been reported elsewhere [8, 9]. Belu is located in Timor Island in East Nusa Tenggara, and Purworejo is located in Central Java, one of the provinces of Java Island.

To obtain a representative sample from both districts, the study took advantage of a large surveillance program performed by the Community Health and Nutrition Research Laboratory (CHN-RL). This study used a two-stage cluster sampling method to select a sample of households representative of each district. In the first stage, 20% of the clusters, which were the standard statistical enumeration areas developed by the Central Bureau of Statistics for the population census in 1990, were selected with the use of probability proportionate to estimated size (PPES) sampling methods. In the second stage, approximately 138 households from every cluster were selected.

Children under 2 years of age listed in the CHN-RL households sample were divided into seven age groups: 0 to 1, 2 to 3, 4 to 5, 6 to 8, 9 to 11, 12 to 17, and 18 to 23 months. These divisions were taken from the protocol for the complementary feeding study and were based on the type, composition, and consistency of foods usually consumed by each age group. About 100 children from each group were included. An equal number of children for every age group was randomly selected from each cluster.

### Data collection

Training for standardization of anthropometric measurements, followed by field practice and testing, was performed prior to data collection. The children were weighed naked to the nearest 0.1 kg twice, once with a standard hanging Salter scale and once with a SECA

digital scale, following the protocol of the complementary feeding study, and the average of the two measurements was then used. The correlation between the two weight measurements was very high (Pearson's correlation [ $\rho$ ] = 0.998,  $p < .001$ ). The mean difference between the two measurements was 0.003 kg (95% CI, -0.005 to 0.01;  $p < .001$ , paired samples  $t$ -test) [8].

Crown-heel length was measured on the recumbent child three times to the nearest 0.1 cm with the use of a locally constructed wood length-board with a rigid headboard and a sliding footpiece. All equipment was standardized to WHO recommendations [10].

Information on birth date was obtained from the child's caregiver, preferably the mother, and was then confirmed from the child's birth certificate or the child's growth chart at the local village health post. Other information, such as data on breastfeeding status, was collected by interviewers using a pre-coded questionnaire form.

Before data collection, informed consent was obtained from the child's mother or caregiver. The protocol of the study was approved by the ethical committee of Gadjah Mada University, Yogyakarta.

### Data entry and analysis

Field supervisors monitored the quality and completeness of the data collection. Ten percent of the households were randomly selected for spot-checking and rechecking of data contents. Field supervisors also edited and cross-edited the questionnaire forms, and in case of incomplete data, further visits to the household were conducted. Data were entered using dSurvey (dSurvey, a survey research system, 1989). Double data entry was performed on a randomly selected 10% sample of the data.

Anthropometric data on length-for-age, weight-for-length, and weight-for-age were converted to  $z$ -scores of the NCHS/WHO growth reference and the WHO Child Growth Standards using WHO-Anthro 2005. Flagged (extreme or potentially incorrect or out-of-range) values of either conversion were excluded. Since the minimum length for calculating weight-for-length  $z$ -scores based on the NCHS/WHO growth reference was 49 cm, infants with a body length less than 49 cm were also excluded.\* Scatter plots were constructed and linear regression analyses were performed with the use of SPSS for Mac, version 16; bar graphs were constructed with the use of Microsoft Excel 2004 for Mac, version 11. On-line statistical software Vassar-Stat was used to test for the statistical significance of

\*WHO Anthro 2005, Beta version Feb 17, 2006: Software for assessing growth and development of the world's children. Geneva: World Health Organization, 2006. Available at: <http://www.who.int/childgrowth/software/en/>. Accessed 9 June 2009.

TABLE 1. General characteristics of the study sample stratified according to age<sup>a</sup>

Characteristic	Age group (mo)						
	0–1 (n = 171)	2–3 (n = 201)	4–5 (n = 202)	6–8 (n = 206)	9–11 (n = 196)	12–17 (n = 209)	18–23 (n = 189)
Female sex—no. (%)	94 (55.0)	98 (48.8)	100 (49.5)	94 (45.6)	100 (51.0)	105 (50.2)	90 (47.6)
Ever breastfed—no. (%)	170 (99.4)	201 (100.0)	201 (99.5)	205 (99.5)	194 (99.0)	204 (97.6)	187 (98.9)
Still breastfed—no. (%)	168 (98.2)	201 (100.0)	199 (98.5)	199 (96.6)	186 (94.9)	171 (81.8)	114 (60.3)
Age (mo)	0.9 ± 0.5	2.6 ± 0.5	4.7 ± 0.5	7.2 ± 0.8	10.1 ± 0.8	14.2 ± 1.7	20.5 ± 1.6
Weight (kg)	4.1 ± 0.7	5.4 ± 0.8	6.5 ± 1.0	7.4 ± 1.0	7.9 ± 1.1	8.3 ± 1.1	9.3 ± 1.1
Length (cm)	53.6 ± 3.0	58.7 ± 3.3	63.1 ± 3.0	66.9 ± 3.4	69.9 ± 3.7	73.1 ± 3.6	77.9 ± 4.0

a. Plus-minus values are means ± SD.

TABLE 2. Linear regression equations of age (months) as the independent variable (x-axis) and z-scores based either on the NCHS/WHO reference or the WHO child growth standard as the dependent variable (y-axis):  $y = bx + a$ 

y-axis	b (95% CI)	a (constant)	Adjusted R <sup>2</sup>	p
WLZ based on NCHS/WHO	-0.079 (-0.087 to -0.070)	0.251	0.198	< .001
WLZ based on WHO	-0.032 (-0.042 to -0.022)	-0.265	0.027	< .001
LAZ based on NCHS/WHO	-0.103 (-0.113 to -0.094)	0.043	0.240	< .001
LAZ based on WHO	-0.104 (-0.115 to -0.093)	-0.027	0.188	< .001
WAZ based on NCHS/WHO	-0.121 (-0.129 to -0.112)	0.175	0.365	< .001
WAZ based on WHO	-0.070 (-0.079 to -0.061)	-0.324	0.138	< .001

NCHS, National Center for Health Statistics; LAZ, length-for-age z-score; WAZ, weight-for-age z-score; WHO, World Health Organization; WLZ, weight-for-length z-score

differences between two independent proportions; all tests were two-tailed.\*

## Results

Of the 1,434 eligible children (717 from each district), 1,417 (711 from Belu and 716 from Purworejo) underwent anthropometric measurement. After conversion to z-scores, the data on a further 43 children were flagged on the basis of the NCHS/WHO reference and/or the WHO Child Growth Standards. This paper is based on data from the remaining 1,374 children (95.8%), of whom 693 (50.4%) were male and 681 (49.6%) were female.

Conversion based on the NCHS/WHO reference flagged 39 cases, and conversion based on the WHO Child Growth Standards flagged 21 cases. Seventeen cases were flagged by both references. Almost 80% of cases (31 of 39) were flagged by the NCHS/WHO reference because of a body length less than 49 cm, the minimum body length for conversion to weight-for-length z-scores.

Virtually all children (99.1%) initiated breastfeeding, and 99.0% of those aged 0 to 5 months were still being breastfed at the time of the study. The corresponding

prevalence rates of breastfeeding at the age of 6 to 11, 12 to 17, and 18 to 23 months were 95.8%, 81.8%, and 60.3%, respectively. The general characteristics of the study sample are presented in **table 1**.

The fitted line for the scatter plot of age in months on the x-axis versus weight-for-length z-score (WLZ) on the y-axis showed a steeper decline when the NCHS/WHO reference was used. With the WHO Child Growth Standards, the line was relatively more parallel to the horizontal line. However, for length-for-age z-scores (LAZ), the decline was similar with the use of both references. The negative deviations of LAZ increased as the children grew (**fig. 1**). Linear regression equations supported these visual interpretations (**table 2**).

With the NCHS/WHO reference, the mean WLZ of the study sample originated above the median line and only crossed the line at the age of around 3 to 4 months. On the other hand, with the WHO Child Growth Standards, the mean WLZ of the study sample started below the median line from birth (**fig. 1**). That was why, compared with the NCHS/WHO reference, the WHO Child Growth Standards detected a higher prevalence of wasting in the first 6 months of life (**fig. 2**).

Thereafter, the prevalence of wasting was kept within a relatively narrow range, i.e., between 9.9% and 15.3%, whereas those of the NCHS/WHO reference rose steadily with age. The prevalence of stunting, on the other hand, behaved similarly with the use of either reference, increasing with increasing age. The WHO Child Growth Standards detected a slightly higher prevalence

\*VassarStats: Website for statistical computation. Available at: <http://faculty.vassar.edu/lowry/VassarStats.html>. Accessed 9 June 2009.

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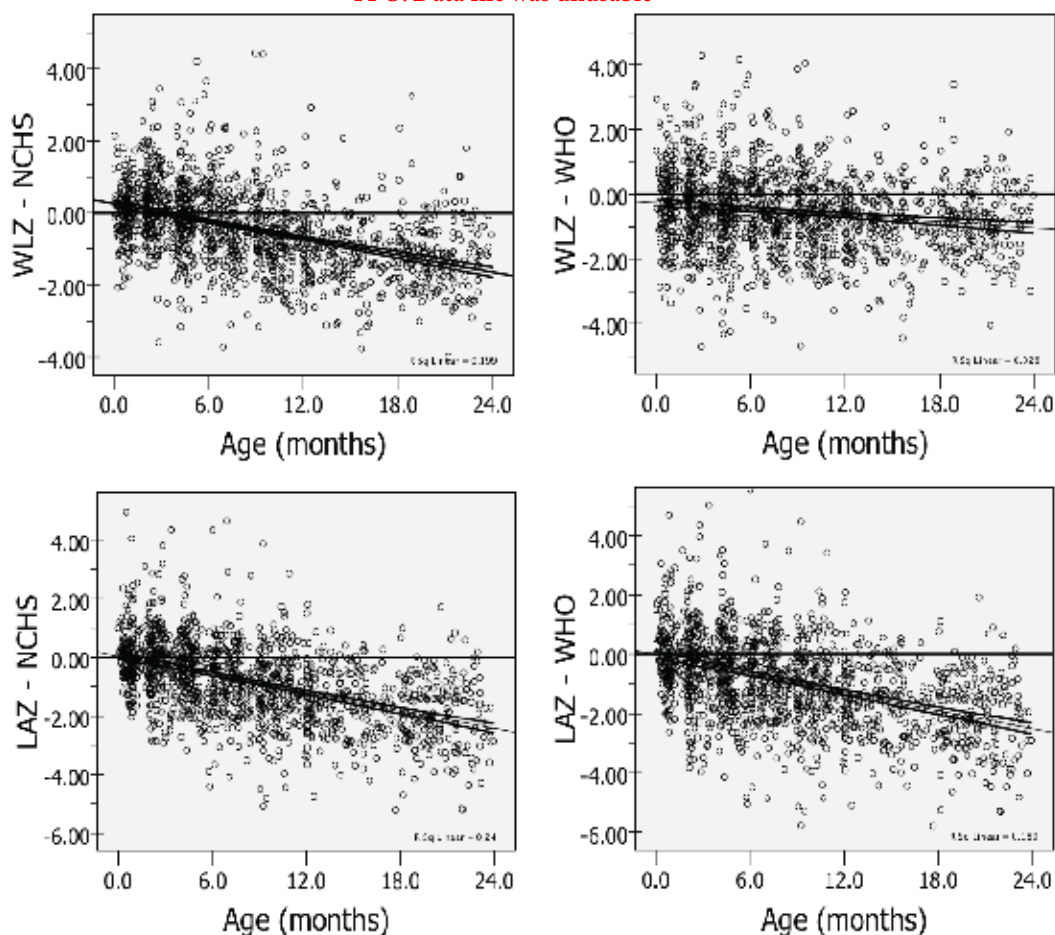


FIG. 1. Scatter plots with fitted regression lines (95% CI) of weight-for-length z-scores (WLZ) and length-for-age z-scores (LAZ) based on the National Center for Health Statistics/World Health Organization (NCHS/WHO) reference and the WHO Child Growth Standards

of stunting in all age groups (fig. 2).

The rise in the prevalence of stunting had a significant effect on the risk of being classified as underweight. With the use of either reference, the prevalence of underweight also rose steadily with increasing age (fig. 2). With the use of the WHO Child Growth Standards, the overall prevalence of underweight was 18.7% (257/1,374). Among those classified as underweight, 172 of 257 children (66.9%) were stunting; only 102 (39.7%) were wasting. The contribution of stunting and wasting to the classification of underweight was not consistent across age. The contribution of stunting increased as the children grew, whereas that of wasting was relatively constant, or even diminished (table 3).

## Discussion

One of the reasons for the construction of the WHO Child Growth Standards was that the NCHS/WHO

reference was regarded as unsuitable for assessing the nutritional status of predominantly breastfed children. The growth of breastfed children has been shown to deviate from the NCHS/WHO reference [2, 3].

The mean z-scores for weight-for-length (WLZ) of our subjects, who were predominantly breastfed children, tracked relatively more parallel with the x-axis when the WHO Child Growth Standards was used. However, for length-for-age z-scores (LAZ), a similar decline occurred with the use of either reference, with the negative deviation of LAZ increasing as the children grew. For all age groups, the prevalence of stunting was slightly higher with the WHO Child Growth Standards than with the NCHS/WHO reference. A similar finding was also observed when a dataset from Bangladeshi children was tested against the WHO Child Growth Standards. The prevalence of stunting in that dataset also increased sharply in the first 2 years of life [11].

The reason for this decline in LAZ is not easy to explain. The subjects in our study, although they

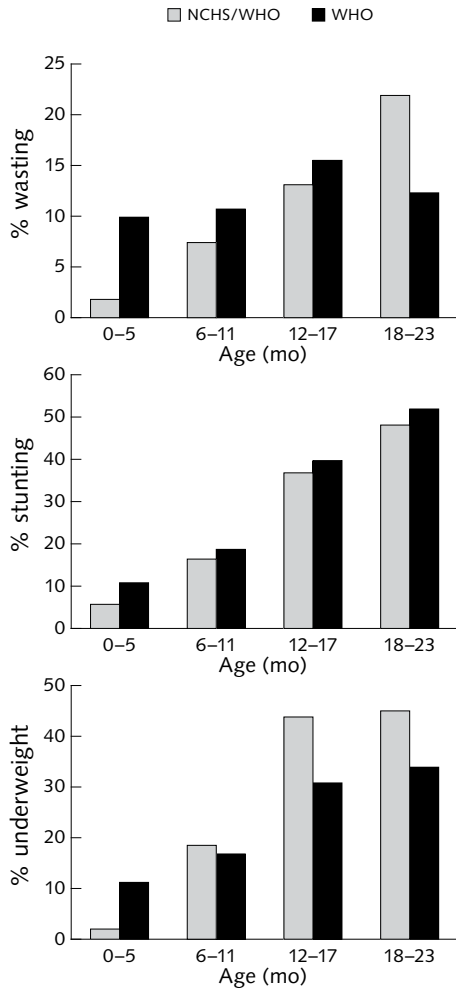


FIG. 2. Prevalence of wasting (length-for-age z-score < -2.00), stunting (weight-for-length z-score < -2.00), and underweight (weight-for-age z-score < -2.00) according to age group based on the National Center for Health Statistics/World Health Organization (NCHS/WHO) reference and the WHO Child Growth Standards

were predominantly breastfed, were not screened for conditions that might impair growth. Probably most of the children lived under socioeconomic conditions unfavorable for optimal growth [8, 9]. Inadequate diet and recurrent illnesses resulted in more and more children becoming stunted. These adverse conditions might even have been present *in utero*. A previous study in Indonesia observed that maternal height and weight were important predictors of increase in the infant's length in the first year of life and hence were significantly associated with length at 12 months of age [12]. Another study observed that prenatal intervention affected postnatal growth [13]. A previous report based on this dataset showed that LAZ was significantly and independently associated with maternal height [8].

The possibility that genetic background may play a role in this phenomenon is intriguing. However, it is not possible to answer this question unless the selection of subjects for comparison follows the strict requirements used for constructing the WHO Child Growth Standards.

The combination of WLZ and LAZ affects the interpretation of WAZ (weight-for-age z-scores), the most commonly used indicator in the field, because accurate measurement of length is not easy [14, 15]. In this dataset, we observed that most of the underweight children, especially the older ones, were underweight because they were stunted, not because they were wasted. This observation has important consequences for nutritional programs, because stunting cannot be reversed and the children will be most unlikely to benefit from extra feeding programs [15]. Recent studies have even shown that these children are at higher risk for obesity [16, 17].

We conclude that, compared with the NCHS/WHO reference, the WHO Child Growth Standards are a better tool for assessing the nutritional status of Indonesian children. However, indicators of malnutrition for planning nutritional interventions should be chosen wisely. Underweight (low WAZ) is not a suitable indicator for commencing extra feeding programs, because

TABLE 3. Contribution of stunting (weight-for-length z-score < -2.00) and/or wasting (length-for-age z-score < -2.00) to the prevalence of underweight (weight-for-age z-score < -2.00) based on the WHO child growth standard

Age group (mo)	Prevalence of underweight—no. (%)	Prevalence of stunting and/or wasting in those underweight—no. (%)			
		Stunting only	Wasting only	Stunting and wasting	Neither stunting nor wasting
0-5 (n = 554)	62 (11.2)	28 (45.2)	20 (32.3)	2 (3.2)	12 (19.4)
6-11 (n = 400)	67 (16.8)*	26 (38.8)	19 (28.4)	11 (16.4)	11 (16.4)
12-17 (n = 208)	64 (30.8)***	33 (51.6)	12 (18.8)	18 (28.1)	1 (1.6)
18-23 (n = 189)	64 (33.9)***	41 (64.1)*	7 (10.9)**	13 (20.3)	3 (4.7)
Total (n = 1,374)	257 (18.7)	128 (49.8)	58 (22.6)	44 (17.1)	27 (10.5)

\*p < .05, \*\*p < .01, \*\*\*p < .001 compared with the prevalence at the age of 0 to 5 months; all tests were two-tailed.

it reflects stunting as well as wasting. The increasing prevalence of stunting as the children grow indicates the need to perform preventive nutritional intervention beginning earlier in life, i.e., *in utero*.

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