

research

## Indonesian National Growth Reference Charts better reflect height and weight of Children in West Java Indonesia than WHO Growth Charts Standards

### Novina N et al. Growth Charts of Children in Bandung District

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#### What is already known on this topic?

WHO Growth Charts Standards (WHOGCS) are used worldwide to interpret anthropometric measurement in children, except for those countries who have their own growth charts. In 2019, Indonesian National Growth Reference Charts (INGRC) were made based on data from the Indonesia Basic Health Research 2013.

#### What this study adds?

Growth of Indonesian children is not well represented by WHOGCS as these standards overestimate the true prevalence of undernutrition. Indonesian National Growth Reference Charts (INGRC) should be used for practical and clinical purposes.

#### Abstract

**Objective:** The Indonesia Basic Health Research 2018 indicates that Indonesian children are still among the shortest in the world. When referred to WHOGCS, the prevalence of stunting reaches up to 43% in several Indonesian districts. INGRC were established in order to better distinguish between healthy short children and children with growth disorders. We analyzed height and weight measurements of healthy Indonesian children using INGRC and WHOGCS.

**Materials and Methods:** 6972 boys and 5800 girls (N=12,772) aged 0-59 months old in Bandung district were measured. Z-scores of length/height and body mass index (BMI) were calculated based on INGRC and WHOGCS.

**Results:** Under 5-year-old Indonesian children raised in Bandung are short and slim. Mean height z-scores of boys is -2.03 (SD1.31), mean height z-scores of girls is -2.03 (SD1.31) when referred to WHOGCS indicating that over 50% of these children are stunted. Bandung children are heterogeneous, with substantial subpopulations of tall children. Depending on the growth reference used, between 9 and 15% of them are wasted. Wasted children are on average half a SD taller than their peers.

**Conclusion:** WHOGCS seriously overestimates the true prevalence of undernutrition in Indonesian children. The present investigation fails to support evidence of undernutrition at a prevalence similar to the over 50% prevalence of stunting (WHOGCS) versus 13.3% (INGRC). We suggest refraining from using WHOGCS, and instead applying INGRC that closely mirror height and weight increments in Bandung children. They appear superior for practical and clinical purposes such as detecting growth and developmental disorders.

**Keywords:** Anthropometric Measurement, Indonesian National Growth Reference Charts, WHO Growth Charts Standard, Bandung District Children, undernutrition

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#### Introduction

Stunting is considered one of the most prevalent health problems in Indonesia. Stunting is defined as the percentage of children whose height-for-age is below minus two standard deviations (moderate stunting) respectively minus three standard deviations (severe stunting) from the median of the WHO Child Growth Standards. Stunting is the impaired growth and

development that children experience from poor nutrition, repeated infection, and inadequate psychosocial stimulation. The term “stunting” is commonly used to indicate chronic mal- or undernutrition during critical periods of growth and development, especially during the first 1000 days of life.<sup>1</sup>

The Indonesia Basic Health Research 2018 indicates that Indonesian children are still among the shortest in the world. When referred to WHO Growth Charts Standards (WHOGCS), the prevalence of stunting reaches up to 43% in several Indonesian districts.<sup>2</sup>

In 2015, Indonesia, along with other countries under United Nations, agreed on Sustainable Development Goals (SDGs) to be achieved by 2030 in order to reduce poverty, lessen the wealth gap, and protect the environment. SDGs consist of 17 core goals and 169 targets. The second goal is “to end hunger, achieve food security and improved nutrition and promote sustainable agriculture” (SDGs 2015). Stunting, since it is said to be related with nutritional status, was put on the SDGs second goal’s indicator framework: to eradicate all forms of malnutrition including achieving the 2025 target on stunting and wasting, and improve the nutritional needs.<sup>3,4</sup> The WHO’s Nutrition Landscape Information System (NLIS) defines stunting as length for age (LAZ) or height for age (HAZ) < -2 SD, and wasting as BMI for age (BAZ) < -2 SD from the median of the WHO Child Growth Standard.<sup>5</sup> The Indonesia Basic Health Research 2018 showed that the number of stunted children is still high. **While stunting is related to many factors such as infections or psychosocial neglect**, it is still believed to be related with nutritional intake. The Indonesian government has made plans to improve the nutritional intake of Indonesian children **by issuing Presidential Decree No. 42 of 2016 about the national movement for the Acceleration of Nutrition Improvement with a focus on the first 1000 days of life which prioritizes joint efforts between government and the community through coordinating stakeholder’s participation and awareness towards accelerate community nutrition improvement.**<sup>6</sup>

This concept has been questioned. Stunting *per se* is not a synonym of malnutrition.<sup>7</sup> A recent study performed in elementary school children from 3 Indonesian provinces, focused on the relationship between nutritional status and height and was unable to present evidence that stunting resulted from undernutrition in these children.<sup>7</sup> This view is supported by data obtained in the Indonesia Basic Health Research 2018 (table 1). The data illustrate the discrepancy between the large number of stunted and the comparably low number of wasted children, and question that stunting reflects undernutrition.<sup>2</sup>

**Table 1. Percentage of Indonesian Children Under Five Years Old below standard cut-offs for length and weight-for-height.**

Z-scores		2007	2013	2018
LAZ/HAZ	<-2SD ≥-3SD	18.0	19.2	19.3
	<-3SD	18.8	18.0	11.5
WHZ	<-2SD ≥-3SD	7.4	6.8	6.7
	<-3SD	6.2	5.3	3.5

(Adapted from Indonesia Basic Health Research, 2018).<sup>2</sup>

LAZ= length-for-age z-scores for children ≤ 2 years old, HAZ= height-for-age z-scores for children >2 years old and WHZ= weight-for-length/height z-scores in percentage based on Indonesia Basic Health Research in 2007, 2013 and 2018.

(Adapted from Indonesia Basic Health Research, 2018).<sup>2</sup>

Biological and socio-economic factors are known to influence child growth. The great variety of clinical conditions associated with short stature further complicates identifying reasons for poor growth. Accurate and regular anthropometric measurements are essential, easy and inexpensive tools to help disentangling the complicated regulation of growth and to detect relevant growth and development disorders.<sup>8</sup> As clinical practice has shown that WHOGCS seem to provide little help in this intricate matter, many countries have meanwhile constructed national growth reference charts.<sup>9-12</sup>

Indonesia is an archipelago country formed by 17,508 islands. Its population ranks at number four in the world. There are 5 main islands in Indonesia: Sumatra, Java, Kalimantan, Sulawesi, and Papua<sup>13</sup> housing an extremely heterogeneous composition of ethnically, culturally and economically very different population. In 2019, National Growth Reference Charts for Indonesian children (INGRC) were established based on the Indonesia Basic Health Research 2013. The samples were taken from all Indonesian provinces, and considered representative for the Indonesian child population.<sup>9</sup> The present study was undertaken to test the reliability of the new Indonesian National Growth Reference Charts. The aim of this study was to compare WHOGCS with the new INGRC in under 5-year-old Indonesian children raised in the Bandung District area. As Indonesian national references are based on healthy Indonesian children, we expected INGRC to better fit the Indonesian growth patterns than WHOGCS. Yet, as short stature is commonly associated with chronic undernutrition, we focused on body mass index as a rough indicator of the nutritional status, its association with height, and particularly, on the shape of the height and the body mass index distributions. Starving and malnourished populations are on average short, but a population is never equally affected by starvation or malnutrition. Some people may receive enough food, their children grow well or almost well, others may receive too little and their children stop growing and become stunted. Children may also differ in sensitivity to food deprivation: some may stop growing early, others may grow even when food ratios are very poor. Unequal food distribution and unequal biological responses do not only affect mean values of height and BMI, they will affect height and BMI variation. Unequal living conditions will raise height and BMI variance.

Indonesia’s Global Hunger Index (GHI) is 20.1, which indicates that Indonesian children are considered “seriously” affected by starvation. GHI values are determined for four indicators: undernourishment (insufficient caloric intake), wasting among children under 5 years of age/low WHZ (acute undernutrition), stunting among children under 5 years of age/low HAZ (chronic undernutrition) and mortality rate of children under 5 years of age (results from undernutrition and unhealthy environment).<sup>14</sup> As Indonesian children regardless of their nutritional state, are generally shorter and lighter than prescribed by WHOGCS, they will always be categorized as chronically undernourished as long as these growth charts are used.

We hypothesized that:

(1) height and body mass index of under 5-year-old Indonesian children raised in the Bandung District area are smaller than suggested by WHO growth standard.

(2) the variance of height and body mass index is broader than suggested by WHO growth standards.

In addition, we hypothesized:

(3) that wasted children ( $BMI < -2$  SD, using WHOGCS) are shortest.

### Sample and Methods

Length/height and weight of 12,772 healthy children, 6972 boys and 5800 girls aged 0-59 months, from Bandung District area, were measured. The sample was taken from 31 sub-districts and included both urban and rural children from the whole spectrum of economic provenance including children both from impoverished and affluent background. Length/height and weight measurements were performed according to standard procedure.<sup>15</sup> The weight was measured to the nearest 100 gram using Indonesian Dacin scale, which is the most commonly used scale for children in Indonesia Primary Maternal and Child Health Care. The length of children  $\leq 2$  years old was measured using infantometer in supine position. In children  $>2$  years old, height was measured using microtoise stadiometer to the nearest millimeter.

The data were obtained from the Health Office of Bandung District's Nutritional Status Monitoring for Children Under 5 Years Old. Measurements were done in March 2019 by healthcare providers using standardized tools. Weight, height and body mass index (BMI) were referred to WHO growth charts and Indonesian National Growth Reference Charts.<sup>9,16</sup>

Statistical analyses were performed by SPSS ver. 24.0.

All data were plotted on charts using The R project for statistical computing version 3.5.0.<sup>17</sup>

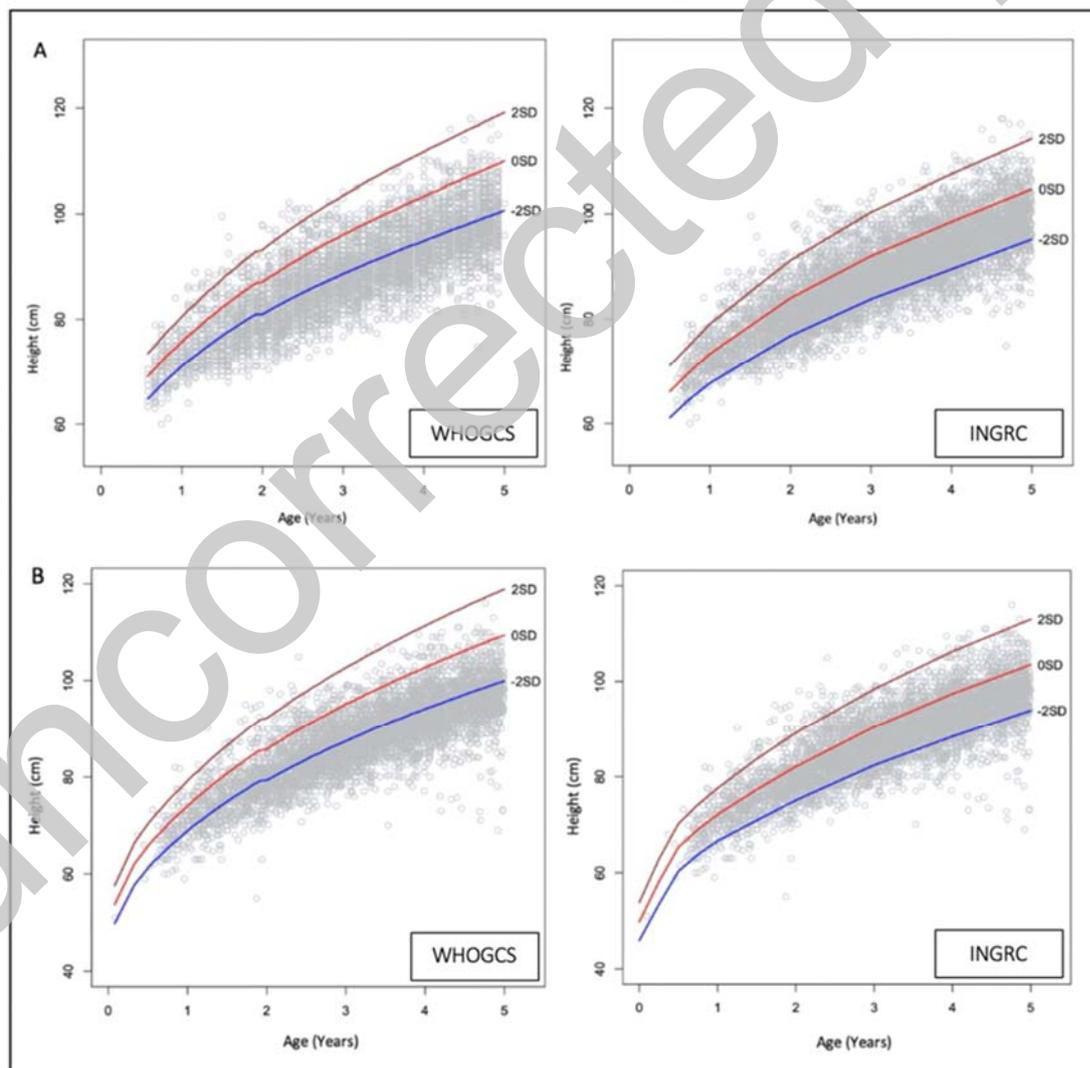
F-test was used to compare variances.

This study was approved by the Ethics Committee of Faculty of Medicine, Universitas Padjadjaran, Ethical Approval no 1170/UN6.KEP/EC/2019, and had been conformed to the ethical guidelines of the Declaration of Helsinki.

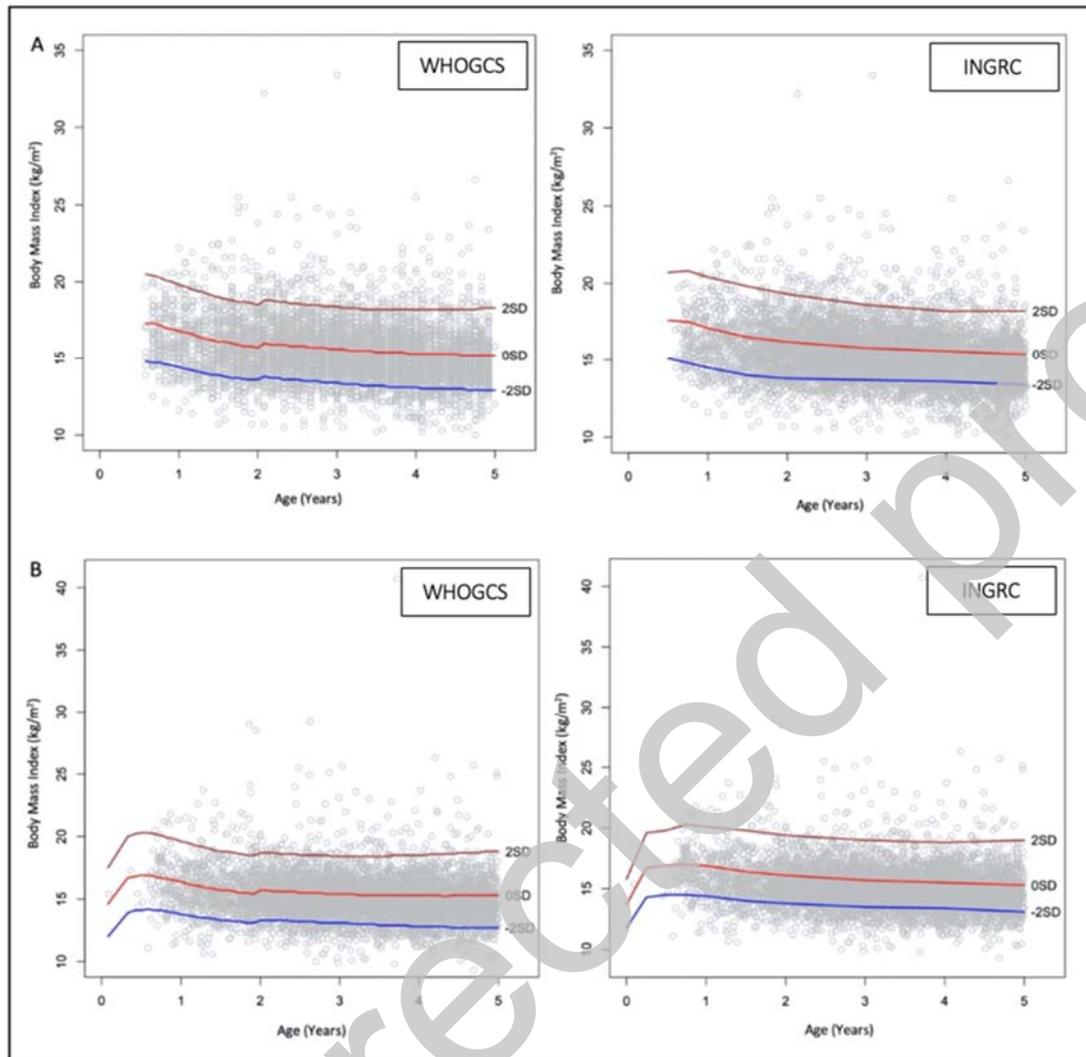
Children were anonymized and de-identified before analysis.

### Results

**Figure 1.** Height of Bandung District Boys (A) and Girls (B) plotted on WHOGCS and INGR. The children from Bandung District are short. More than 50% must be considered stunted according to WHO standard.



**Figure 2.** BMI of Bandung District Boys (A) and Girls (B) plotted on WHOGCS and INGRC. The number of obese children is very small.



Under 5-year-old Indonesian children raised in the Bandung District area are short (figure 1) and slim (figure 2). Mean height z-scores of boys is  $-2.03$  (SD 1.31), mean height z-scores of girls is  $-2.03$  (SD 1.31) when referred to WHO growth standards indicating that more than 50% of these children are stunted. When referred to Indonesian National Growth Reference Charts, the percentage of stunted children declines to 13.3%. Depending on the growth reference used, between 9% (WHOGCS) and 15% (INGRC) of the Bandung District area children are wasted (table 2).

**Table 2.** Number and percentage of severely stunted (length/height-for-age z-scores (LAZ/HAZ)  $< -3$  SD), moderately stunted (length/height-for-age z-scores (LAZ/HAZ)  $< -2$  SD), normal, and tall (length/height-for-age z-scores (LAZ/HAZ)  $> 3$ SD) children; and severely wasted (BMI-for-age z-scores (BAZ)  $< -3$  SD), moderately wasted (BMI-for-age z-scores (BAZ)  $< -2$  SD), normal, overweight (BMI-for-age z-scores (BAZ)  $> 2$  SD), and obese children (BMI-for-age z-scores (BAZ)  $> 3$  SD). P-values (Mann-Whitney Test) refer to the difference between WHO Growth Charts Standards (WHOGCS) and Indonesian National Growth Reference Charts (INGRC).

Table 2 illustrates to what extent the choice of the growth reference chart influences the apparent percentage of stunted and wasted children. Whereas INGRC identifies 10.8% moderately, and 2.5% severely stunted children, WHOGCS comes up with 34.72% moderately, and 21.59% severely stunted children in Bandung District.

	Z-scores	WHOGCS N (%)	INGRC N (%)	P Value
LAZ/HAZ	$> 3$ SD	75 (0.59)	246 (1.93)	$< 0.001$
	$\leq 3$ SD $\geq -2$ SD	5504 (43.09)	10828 (84.78)	
	$< -2$ SD $\geq -3$ SD	4435 (34.72)	1379 (10.80)	
BAZ	$< -3$ SD	2758 (21.59)	319 (2.50)	$< 0.001$
	$> 3$ SD	147 (1.15)	99 (0.78)	
	$\leq 3$ SD $> 2$ SD	320 (2.51)	266 (2.08)	

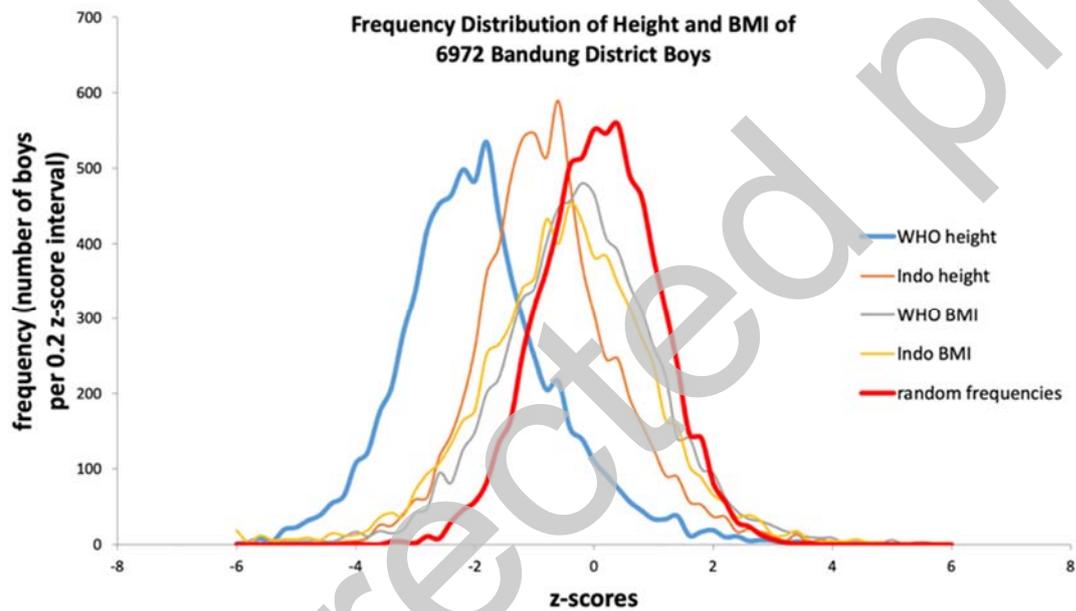
$\leq 2 \text{ SD} \geq -2 \text{ SD}$	11164 (87.41)	10505 (82.25)
$< -2 \text{ SD} \geq -3 \text{ SD}$	873 (6.48)	1227 (9.61)
$< -3 \text{ SD}$	268 (2.10)	675 (5.28)

**Table 3. Mean z-scores for length/height-for-age (LAZ/HAZ) and BMI-for-age (BAZ).**

	WHOGCS		INGRC	
	LAZ/HAZ (SD)	BAZ (SD)	LAZ/HAZ (SD)	BAZ (SD)
Boys	-2.03 (1.31*)	-0.33 (1.36*)	-0.84 (1.17*)	-0.57 (1.46*)
Girls	-2.05 (1.25*)	-0.36 (1.27*)	-0.83 (1.17*)	-0.70 (1.44*)

Z-scores for LAZ/HAZ and BAZ of 6972 boys and 5800 girls, aged 0-59 months, from Bandung District area, referred to WHO Growth Charts (WHOGCS) and to Indonesian National Growth Reference Charts (INGRC). Asterisks indicate that SD are greater than 1.0 ( $p < 0.001$ ).

**Figure 3. Frequency Distribution of Height and BMI of 6972 Bandung District Boys**



**Figure 4. Frequency Distribution of Height and BMI of 5800 Bandung District Girls**

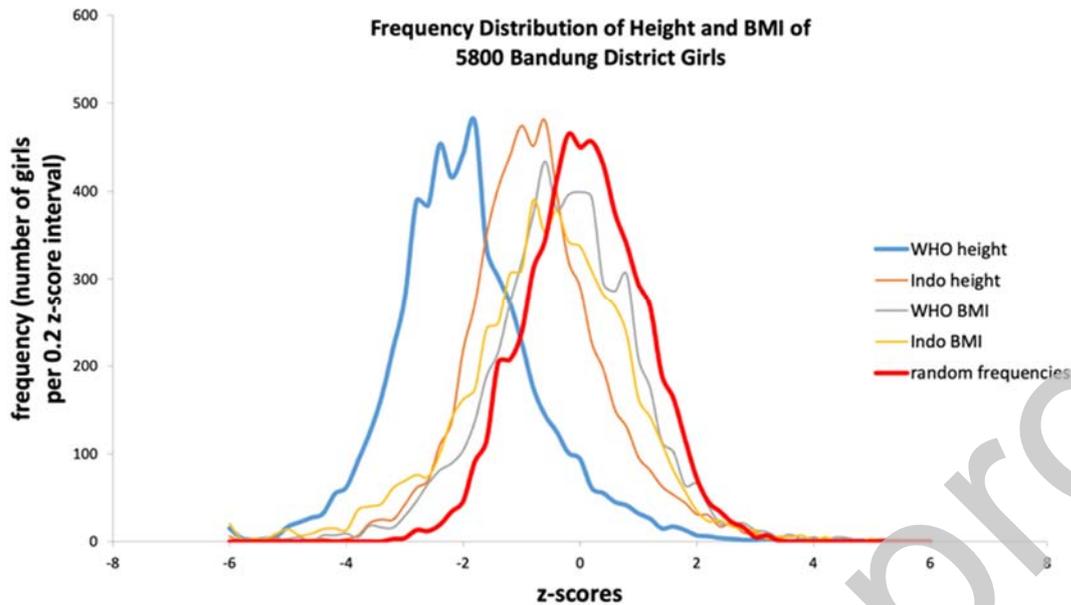


Figure 3 and 4 illustrate the frequency distributions of LAZ/HAZ and BAZ based on WHOGCS and on INGRIC, and a virtual cohort with random z-scores defined by mean values of zero, and standard deviations of one. Neither LAZ/HAZ nor BAZ are normally distributed. Bandung children are shorter and slimmer than suggested by WHOGCS and by INGRIC. LAZ/HAZ and BAZ distributions are broader than the random distributions, and the LAZ/HAZ distributions are significantly skewed ( $p < 0.001$ ). Table 3 and figures 3 and 4 indicate that Bandung District children are heterogeneous, with substantial subpopulations of tall children as indicated by the elongated right leg of the height z-score curves.

Figure 5. Association of Height and BMI Z-scores in 6972 Bandung District Boys

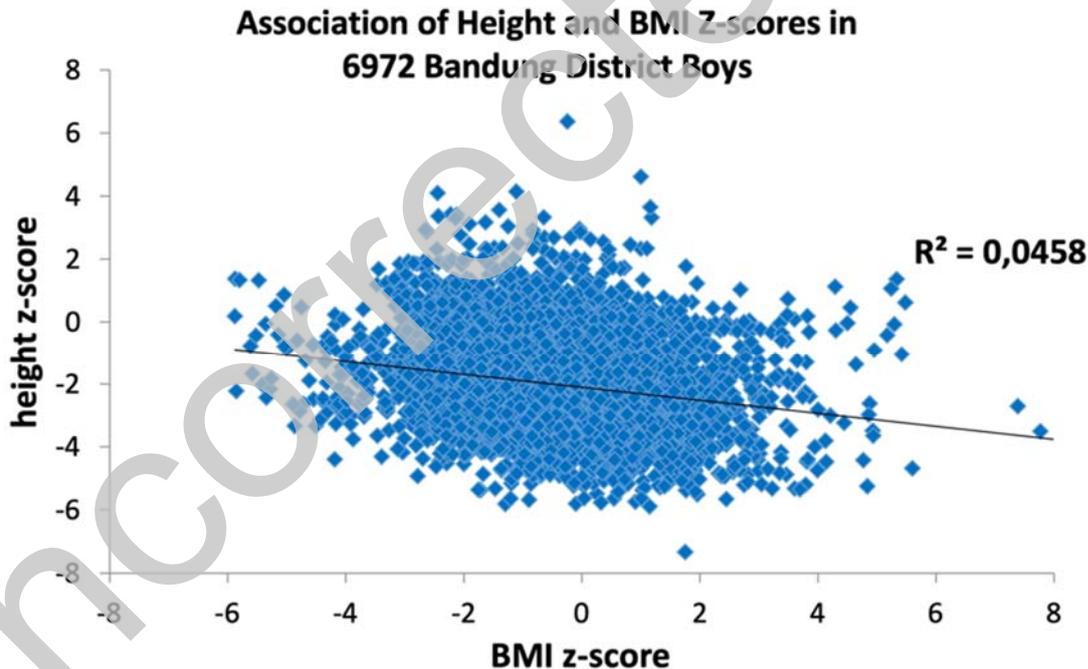
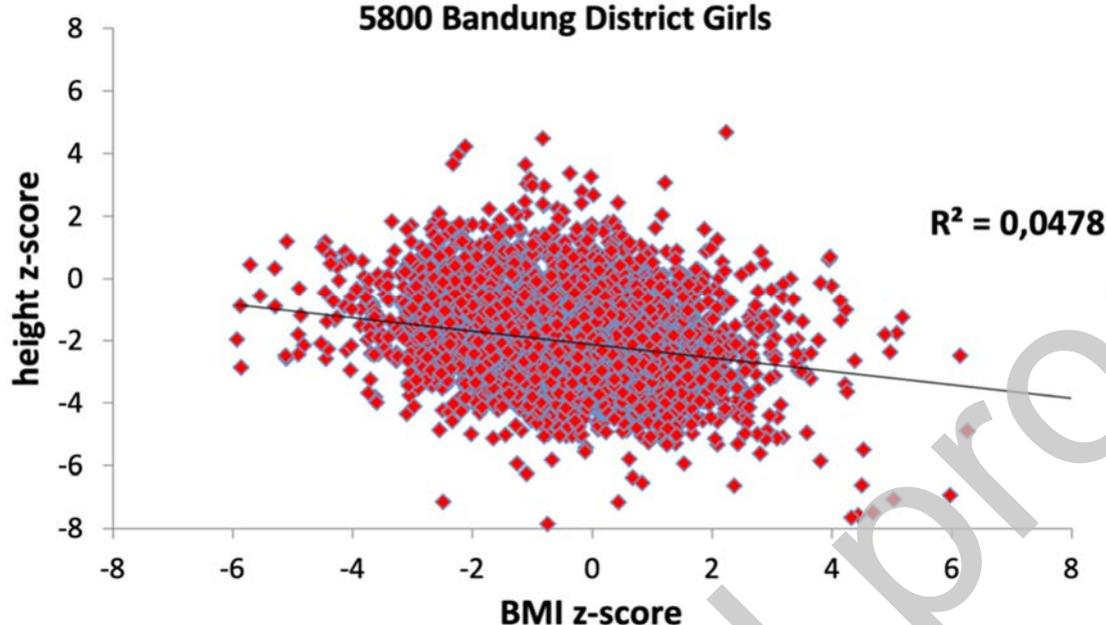


Figure 6. Association of Height and BMI Z-scores in 5800 Bandung District Girls

### Association of Height and BMI Z-scores in 5800 Bandung District Girls



The broadened and skewed distributions of height and weight z-scores suggest inequality among the Bandung District children. In view of the common perception that short stature is considered an indicator of chronic undernutrition, and BMI an indicator of the nutritional status, we also studied the association between height and body mass index (Figure 5 and 6). We found the opposite of what is expected: being thin is not associated with being short. The association between LAZ/HAZ and BAZ is negative. Slim children are taller. In order to further scrutinize this association, we investigated LAZ/HAZ of those children who are by definition considered wasted (BAZ < -2 SD, WHOGCS). LAZ/HAZ of wasted boys is -1.3 (SD 1.48), LAZ/HAZ of wasted girls is -1.34 (SD 1.44). Wasted Bandung District children are on average 0.7 SD taller than their peers (Table 3: all boys: -2.03 SD, all girls -2.05 SD;  $p < 0.001$  for both sexes).

#### Discussion

The Indonesia Basic Health Research 2018 indicated that Indonesian children are short. This also applies for children raised in the Bandung District area. When referred to WHO Growth Charts Standards (WHOGCS), more than 50% of these children are stunted. Under 5-year-old Bandung District children are also slim. This confirms our first hypothesis. Bandung District children are heterogeneous. The variance of height and body mass index is broader than suggested by WHOGCS confirming our second hypothesis. The combination of being on average short and slim and the heterogeneity of the population of Bandung children might at first view support the general perception that these children suffer from malnutrition, and that length-for-age may indeed serve as an appropriate indicator for chronic nutritional deficiency.<sup>18</sup> But this impression is deceptive. The present study illustrates that being slim is not associated with being short. The present analysis clearly rejects the third hypothesis. The very slim (**wasted**) children with BMI < -2 SD (WHOGCS) are not the shortest. On the contrary, children who are by definition "wasted" are on average 0.7 standard deviations taller than their peers.

Stunting is not a synonym of malnutrition.<sup>7</sup>

The observation that the thinnest children are tallest questions the current concept of nutrition-dependent growth regulation. An estimated 50 percent prevalence of stunting when using WHOGCS can by no means, plausibly suggest that half of the Bandung District children suffer from chronic undernutrition, repeated infections or child neglect and lack of psychosocial stimulation.

Indonesia produces a wide range of foods, rice as the main staple food across Indonesia and other regional staple foods which include maize, sweet potatoes, cassava, taro and sago. Indonesia produces 400 fruit species, 370 vegetable species, 70 tuber species and 55 spice species. Livestock and fish are an important source of protein and other nutrients. Indonesia has one of the largest fisheries industries in the world, estimated at more than 8 million mt of fish caught in 2013.<sup>19</sup> From the 2019 Global Food Security Index (GFSI), Indonesia ranked 62 out of 113, improved from 74 in 2015. The 2019 Food Security and Vulnerability Atlas (FSVA) classified districts in Indonesia into one to six priority groups, from the most food-insecure to the most food-secure. FSVA exhibits Districts in West Java as priority 5 (22%) and 6 (78%) which indicating appropriate food-security.<sup>20</sup> Studies in respect of availability of major food products, including fruits, vegetables, livestock and fisheries in West Java, especially Bandung District revealed steady and secured food diversification policies, which is able to cover production, distribution, access and consumption level among the community.<sup>21,22</sup> Bandung is the capital of West Java province in Indonesia. It has cooler temperatures than most other Indonesian cities. The city lies on a river basin surrounded by volcanic mountains. The Dutch during their colonialism move the capital from Batavia (now is Jakarta) to Bandung due to its development into a resort city. Luxurious hotels, restaurants, cafés, and European boutiques were opened and Bandung was nicknamed as Parijs van Java (Dutch: "The Paris of Java"). Nowadays, the economy is mainly built upon tourism, business, creative industry, high-tech and manufacturing industries, educational institutions, technology, retail services, financial services, pharmaceutical companies, and food production and the city is part of UNESCO Creative Cities Network in 2015.<sup>23</sup> Based on Central Bureau of Statistics Republic of Indonesia, the Gross Regional Product Nominal (GRP

Nominal) per capita of West Java Province on 2019 ranked the third highest of 34 provinces and the Gross Regional Domestic Revenue of Bandung District on 2016 ranked 27 out of 514 districts and cities in Indonesia. Bandung also ranked 114 of 120 in Global City Competitiveness Index in 2012.<sup>24-26</sup> Children in Bandung grew in supportive atmosphere. The Bandung city government built child friendly health centers, made local regulation on non-smoking areas, supported complete immunization and encouraged newborn babies to get exclusive breastfeeding by providing lactation room in every public service building. Following world information and supporting the educational process, the government provided reading park and free Wi-Fi area from the village to the city. Training of convention on the rights of a child is applied in all elementary schools, junior high schools, teachers and supervisors. Comprehensive attention on children's health and psychosocial needs leads Bandung won the Child-Friendly City award from the Ministry of Women's Empowerment and Child Protection for the third time in a row on 2019.<sup>27</sup>

Bandung District is wealthy, with no evidence of food shortage or clinical signs of malnutrition in the children raised in this area. The claim that 50% of the healthy Bandung District children as mal- or undernourished, is unsubstantiated. The observation that the slimmest children of Bandung District grew best, further challenges the prevalent concept of length-for-age being the indicator of choice in monitoring chronic nutritional deficiency.

Yet, the question remains: why are these children short, and why do the slimmest children grow best? Modern nutrition studies do not throw light into this matter, but numerous historic observations match our findings.

Most Europeans of the 19<sup>th</sup> century was shorter than modern Indonesians. In spite of the tremendous wealth of the European nations at that time, European children grew poorly. Even upper-class urban adolescents grew less than modern Indonesians.<sup>28</sup> This almost ubiquitous pattern of historic European growth changed after World War I. In 1919, the German pediatrician Schlesinger wrote: "In the second year of the war (World War I), there were more than a few groups of boys from the public citizens' and advanced educational schools who were 1–2 cm taller than in the year 1913 (before the war). This difference in the second year of the war was even more conspicuous, as at the same time there was a very clear and . . . not very small weight loss". And based on measurements of the loss in body fat, both in absolute terms and related to body height, Schlesinger wrote in 1924 that: "even more regular is the deficit in weight in 1916 versus 1913, when taking into account the length of the body, which in this period has partly shifted in the opposite direction" (Hermanussen et al. 2018).<sup>29</sup> Even though the children became slimmer, they nevertheless grew taller. The rapid secular height trends after World War I coincided with the political transition from feudalism (e.g. the German, the Austrian, and the Empire) to socialistic or democratic structures. The adolescents raised at that time, anticipated rapid political changes, liberation and equal opportunities, and closely coinciding with the political changes, increased in height by one to two millimeters per annual cohort.<sup>30</sup>

Human growth is regulated by biological factors such as nutrition, genetics, and general health<sup>28</sup>, but recent evidence also suggests social, economic, political and emotional (SEPE) factors.<sup>31</sup> Political transition appears to be one of the most distinguished promoters of human growth factors. Absence of political oppression is a growth stimulus. Hermanussen and Scheffler (2016) discussed community effects on body height, and considered stature as a social signal.<sup>30</sup> The data of the present investigation indirectly support this vision. Indonesia had experienced major changes during leadership transformation. From Independence Day on 1945 led by our first president, the leader of Indonesia's nationalist movement. This presidency ended by an attempted coup on 1965.<sup>32</sup> New order development policy on the second president main economic strategy were based on the World Bank and (International Monetary Fund) IMF development ideals of industrialization and liberalization and the accomplishment of high economic growth financed by external debt. For three decades from 1965, the new order created factitious suitability and maintained political stability by depressing opposition through lessen the number of political parties, depoliticizing disciples, peasantry and municipal workforce organizations and centralizing local government.<sup>33,34</sup>

Indonesia still is a developing country but it shows advancements in democratisation, personal freedom and equal opportunities. The recent political achievements provide suggestive explanations for the negative association between height and BMI. The Bandung children are slim, but not because of nutrition deficits. The subpopulation of the very slim and taller than average children of Bandung, mirrors the social/economic/political/emotional (SEPE) situation that was prevalent in central Europe after World War I, at the dawn of political modernization.<sup>31</sup>

The WHOGCS disqualifies more than 50% of the healthy Bandung District children as "stunted", thereby alleging chronic mal- and undernutrition<sup>1</sup> of these children. The present investigation fails to support evidence for this concept. We suggest refraining from using global growth charts, and instead strongly support applying the new Indonesian National Growth Reference Charts (INGRC). These charts are based on the data from Indonesia Basic Health Research 2013. They closely mirror height and weight increments also of the Bandung children, and appear superior for practical and clinical purposes such as detecting growth and developmental disorders.

In view of body height as a mirror of the social, economic, political and emotional situation of a country<sup>31</sup>, we consider frequent updating the Indonesian National Growth Reference Charts essential. We are convinced that coinciding with the political modernization, Indonesian children will in the near future follow the same global growth standards for height and weight as suggested by the WHO. Child health care and prevention require relevant national references for height, weight and body mass index.

#### **Study Limitations**

The study was performed in a cross-sectional sample of infants and children, with no detailed information on individual nutrition, individual health, individual repeated infection and the individual socio-economic background. Thus, the data do not allow direct inferences between growth, nutritional situation, morbidities, psychosocial status, and socio-economic circumstances. Instead we used data of the Indonesia Food Security and Vulnerability Atlas with verified local information. Considering the Gross Regional Product Nominal (GRP Nominal) per capita of West Java Province, the Gross Regional Domestic Revenue of Bandung District and Bandung children's health, education and social services, it seems that Bandung District is in good economy condition, adequate psychosocial stimulation status, with good food security and absence of child poverty.

## Conclusion

The WHOGCS seriously overestimates the true prevalence of undernutrition in Indonesian children. The present investigation fails to support evidence of undernutrition. We suggest refraining from using WHOGCS, and instead applying Indonesian National Growth Reference Charts (INGRC). These charts are based on the data from Indonesia Basic Health Research 2013, and closely mirror height and weight increments in Bandung children. They appear superior to currently used WHO Growth Charts Standards for practical and clinical purposes such as detecting growth and developmental disorders.

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## Conflict of Interest

There was no conflict of interest.

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## References

1. WHO. Nutrition. Stunting in a nutshell. Available from: [https://www.who.int/nutrition/healthygrowthproj\\_stunted\\_videos/en/](https://www.who.int/nutrition/healthygrowthproj_stunted_videos/en/). [ accessed 21<sup>st</sup> July 2020]
2. Kementerian Kesehatan Badan Penelitian dan Pengembangan Kesehatan. Hasil utama Riskesdas 2018. In: Kementerian Kesehatan Badan Penelitian dan Pengembangan Kesehatan, ed. 2018. Available from: [http://kesmas.kemkes.go.id/assets/upload/dir\\_519d41d8cd98f00/files/Hasil-riskesdas-2018\\_1274.pdf](http://kesmas.kemkes.go.id/assets/upload/dir_519d41d8cd98f00/files/Hasil-riskesdas-2018_1274.pdf). [ accessed 2<sup>nd</sup> November 2019 ]
3. WHO. Reducing stunting in children: equity considerations for achieving the Global Nutrition Targets 2025. Geneva: World Health Organization; 2018. Licence: CC BY-NC-SA 3.0 IGO.
4. Sustainable development goal 2. End hunger, achieve food security and improved nutrition and promote: United Nations; 2019. Available from: <https://sustainabledevelopment.un.org/sdg2>. [ accessed 2<sup>nd</sup> November 2019 ]
5. WHO. Nutrition Landscape Information System (NLIS). Available from: <https://apps.who.int/nutrition/landscape/help.aspx?menu=0&helpid=391&lang=EN>. [ accessed 12<sup>th</sup> July 2020]
6. Kementerian Kesehatan Republik Indonesia. Situasi balita pendek (Stunting) di Indonesia. Buletin Jendela Data dan Informasi. Semester. I, 2018. Available from: <https://www.kemkes.go.id> [ accessed 12<sup>th</sup> July 2020]
7. Scheffler C, Hermanussen M, Bogin B, Liana DS, Taolin F, Cempaka PMVP, et al. Stunting is not a synonym of malnutrition. *Eur J Clin Nutr*. 2019 May 29. doi: 10.1038/s41430-019-0439-4.
8. Novina N, Walenkamp M. Management of children with short stature. *Pediatr Oncall J*. 2019;16: 35-42. doi: 10.7199/ped.oncall.2019.19
9. Pulungan A, Julia M, Batubara JRL, Hermanussen M. Indonesian national synthetic growth charts. *Acta Sci Paediatr*. 2018;1:20–34.
10. Zong X-N, Li H. Construction of a new growth references for China based on urban Chinese children: comparison with the WHO growth standards. *PLoS one*. 2013;8(3):e59569.
11. Schaffrath Rosario A, Schienkiewitz A, Neuhauser H. German height references for children aged 0 to under 18 years compared to WHO and CDC growth charts. *Ann Hum Biol*. 2011;38(2):121–30.
12. Isojima T, Kato N, Ito Y, Kanzaki S, Murata M. Growth standard charts for Japanese children with mean and standard deviation (SD) values based on the year 2000 national survey. *Clin Pediatr Endocrinol*. 2016;25(2):71–6.
13. The Archipelago. The Embassy of Indonesia Prague. 2019. Available from: <http://www.indonesia.cz/the-archipelago/>. [ accessed 23<sup>th</sup> December 2019 ]
14. 2019 Global Hunger Index by Severity. Available from: <https://www.globalhungerindex.org/results.html>. [ accessed 12<sup>th</sup> July 2020]
15. Menteri Kesehatan Republik Indonesia Nomor 2 Tahun 2020 tentang Standar Antropometri Anak. 2020. Available from: [http://hukor.kemkes.go.id/uploads/produk\\_hukum/PMK\\_No\\_2\\_Th\\_2020\\_ttg\\_Standar\\_Antropometri\\_Anak.pdf](http://hukor.kemkes.go.id/uploads/produk_hukum/PMK_No_2_Th_2020_ttg_Standar_Antropometri_Anak.pdf). [ accessed 8<sup>th</sup> September 2019]
16. WHO Child Growth Standards. France: World Health Organization; 2006. Available from: <https://www.who.int/childgrowth/standards/en/>. [ accessed 2<sup>nd</sup> November 2019]
17. R Core Team (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL Available from: <http://www.R-project.org/>.
18. Lartey A. What would it take to prevent stunted growth in children in sub - Saharan Africa? *Proc Nutr Soc*. 2015;74:449–53.
19. Food Security Council, Ministry of Agriculture, World Food Programme. Food Security and Vulnerability Atlas of Indonesia 2015. Available from: [http://bkp.pertanian.go.id/storage/app/media/Bahan\\_2020/FSVA\\_2019\\_FINAL.pdf](http://bkp.pertanian.go.id/storage/app/media/Bahan_2020/FSVA_2019_FINAL.pdf). [ accessed 15<sup>th</sup> June 2020]
20. Food security and vulnerability atlas 2019. Available from: [http://bkp.pertanian.go.id/storage/app/media/Bahan\\_2020/FSVA\\_2019\\_FINAL.pdf](http://bkp.pertanian.go.id/storage/app/media/Bahan_2020/FSVA_2019_FINAL.pdf). [ accessed 15<sup>th</sup> June 2020]
21. Khaeron EH. Assessment of sustainable food diversification development model in West Java , Indonesia. *Int J Humanit Soc Sci*. 2016;6(11):175–81.
22. Raihan RZ, Kastaman R, Tensiska. Menentukan kondisi ketahanan pangan jawa barat wilayah IV menggunakan food security quotient (fsq). *J Ekon Pertan dan Agribisnis*. 2020;4:68–76.
23. Bandung. Available from: <https://en.wikipedia.org/wiki/Bandung>. [ accessed 15<sup>th</sup> June 2020]

24. List of Indonesian provinces by GRP per capita. Available from: [https://en.wikipedia.org/wiki/List\\_of\\_Indonesian\\_provinces\\_by\\_GRP\\_per\\_capita](https://en.wikipedia.org/wiki/List_of_Indonesian_provinces_by_GRP_per_capita). [ accessed 15<sup>th</sup> June 2020]
25. Daftar kabupaten dan kota di Indonesia menurut PDRB. Available from: [https://id.wikipedia.org/wiki/Daftar\\_kabupaten\\_dan\\_kota\\_di\\_Indonesia\\_menurut\\_PDRB](https://id.wikipedia.org/wiki/Daftar_kabupaten_dan_kota_di_Indonesia_menurut_PDRB)[ accessed 15<sup>th</sup> June 2020]
26. International rankings of Indonesia. Available from: [https://en.wikipedia.org/wiki/International\\_rankings\\_of\\_Indonesia](https://en.wikipedia.org/wiki/International_rankings_of_Indonesia). [ accessed 15<sup>th</sup> June 2020]
27. Solehudin M. Kota Bandung pertahankan penghargaan kota layak anak Nindya. Available from: <https://news.detik.com/berita-jawa-barat/d-4637299/kota-bandung-pertahankan-penghargaan-kota-layak-anak-nindya>, [ accessed 21<sup>th</sup> July 2020]
28. Hermanussen M (ed). Auxology - Studying Human Growth and Development. Stuttgart, Germany: Schweizerbart Science Publishers 2013. ISBN 978-3-510-65278-5.
29. Hermanussen M, Bogin B, Scheffler C. Stunting, starvation and refeeding: a review of forgotten 19th and early 20th century literature. *Acta Paediatr.* 2018 Jul;107(7):1166-1176.
30. Hermanussen M, Scheffler C. Stature signals status: The association of stature, status and perceived dominance—a thought experiment. *Anthropol Anz.* 2016;73(4):265–74.
31. Bogin B. Patterns of human growth. 3<sup>rd</sup> edition. Cambridge, in press; 2020.
32. Sukarno. Available from: <https://en.wikipedia.org/wiki/Sukarno>. [ accessed 15<sup>th</sup> June 2020]
33. Collins EC. Indonesia betrayed: How development fails. Honolulu: University of Hawaii Press, 2007.
34. Suharto. Available from: <https://en.wikipedia.org/wiki/Suharto>. [ accessed 15<sup>th</sup> June 2020]

Uncorrected proof