

## Conference Paper

# Sensitivity (Se) and Specificity (Sp) Anthropometric Wall Chart (Awc) Tb/U for Detecting Stunting on Children Aged 6-12 Years

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## Abstract

Anthropometric Wall Chart (AWC) TB/U is a tool developed to screen nutritional status that is easy and fast to use for children aged 6-12 years in the population. The accuracy of the tool in measuring stunting can be seen from its validity. This study aims to get the validity of AWC in 3 (three) cities representing the West (Medan), Central (Bandung) and East (Kupang), Indonesia so that the results could be used for stunting screening of elementary school children wider coverage. The study was conducted in a cross-sectional manner with a sample of 270 elementary students from grade 1 to grade 6 in 3 cities (Medan, Kupang, and Bandung) whose nutritional status was measured by using AWC TB / U and TB / U index using microtoise. The results of the study of the use of AWC in Medan showed that there were 20 (22.2%) stunting children, with Se value of 68.8% and Sp value of 87.8%, PPV 55%, and NPV 92.9%. In Kupang, there were 21 (23.3%) children who were stunting with a value of Se 60.0% and Sp 98.2%, and in Bandung, there were 12 (13.3%) stunted children with Se value of 72.7% and Sp 94.9%. Combined in 3 (three) cities get Se value 66.0% and Sp 93.3%, PPV 73.6% and NPV 90.3%. AWC TB / U can be used as a stunting screening tool for diagnosis with the aim of a high Sp value. For students who are detected stunted, further treatment is needed to overcome their nutritional problems.

## ABSTRAK

*Anthropometric Wall Chart (AWC) TB/U* merupakan alat yang dikembangkan untuk tujuan skrining status gizi yang mudah dan cepat digunakan pada anak usia 6-12 tahun di populasi. Ketepatan alat dalam mengukur kejadian *stunting* dapat dilihat dari validitasnya. Tujuan penelitian ini adalah untuk mendapatkan validitas AWC di 3 (tiga) kota yang mewakili daerah Barat (Medan), daerah Tengah (Bandung) dan daerah Timur (Kupang), Indonesia sehingga hasilnya dapat digunakan untuk skrining *stunting* anak SD dalam cakupan yang lebih luas. Penelitian dilakukan secara cross-sectional dengan sampel 270 siswa SD kelas 1 sampai kelas 6 di 3 kota (Medan, Kupang dan Bandung) diukur status gizinya dengan menggunakan AWC TB/U dan indeks TB/U dengan menggunakan mikrotoise. Hasil penelitian penggunaan AWC di Medan menunjukkan anak yang mengalami *stunting* sebanyak 20 (22.2%) siswa, dengan nilai Se 68.8% dan Sp 87.8%, PPV 55% dan NPV 92.9%. Di Kupang terdapat sebanyak 21 (23.3 %) anak yang mengalami *stunting* dengan nilai Se 60.0% dan Sp 98.2% dan di Bandung

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terdapat sebanyak 12 (13.3%) anak *stunted* dengan nilai Se 72.7% dan Sp 94.9%. Gabungan di 3 (tiga) kota mendapatkan nilai Se 66.0% dan Sp 93.3%, PPV 73.6% dan NPV 90.3%. AWC TB/U dapat digunakan sebagai alat skrining *stunting* untuk kepentingan diagnosis dengan tujuan untuk nilai Sp yang tinggi. Untuk siswa yang terdeteksi *stunted* perlu penanganan lebih lanjut untuk mengatasi masalah gizinya.

**Keywords:** Anthropometric Wall Chart (AWC) TB/U, Sensitivity (Se), Specificity (Sp), Stunting, Aged 6-12 years

**Kata kunci:** Anthropometric Wall Chart (AWC) TB/U, Sensitifitas (Se), Spesifisitas (Sp), Stunting, Usia 6-12 tahun

## 1. Introduction

Stunting is one of the biggest health care priorities in the world which reaches 150.8 million children under 5 years of age in 2017 [1]. Stunting is a condition when the height according to the age below than -2 SD of WHO child growth standard [2]. Based on Basic Health Research 2013, the number of stunting (short and very short nutritional status) in children aged 5 - 12 years in Indonesia is high, amounting to 30.7% [3]. The number indicates that around one in three children in the school age group in Indonesia experience stunting. The impact of this condition is impaired children's cognitive function<sup>4–6</sup>, low motoric skill<sup>5</sup>, decreased physical capacity and neurodevelopmental<sup>7</sup>, delayed age of school-entry, and decreased productivity [4]. Therefore, nutritional screening in children is needed to make early detection of stunting conditions so that nutrition interventions can be done as early as possible. One of the most widely used nutrition screening methods to evaluate and monitor nutritional status and growth of children is anthropometry [8]. Anthropometry is the most appropriate method because it is harmless, easy to do, fast, and does not require high costs [9].

Anthropometry in children has evolved through the development of growth references, growth charts, until WHO made growth standards [10]. Some countries have developed and modified growth charts based on the WHO growth standard following the conditions of children in these countries [11–16]. Some developments of growth charts are also intended to facilitate understanding of data interpretation in the growth chart [17, 18], because there are still many who do not comprehend the data presented in growth charts to monitor children's growth [19]. One of the tools developed for screening

nutritional status in children aged 6-12 years and is a development of WHO (2005) standard growth chart so that it is easy to understand and fast to use is Height-for-age Anthropometric Wall Chart (AWC TB/U) [20]. This tool is practical because children can find out their nutritional status at any time and health workers or school health service's staff do not need a particular time for plotting until they can detect the meaning of the results of the measurements made.

Nutrition screening tools that can meet the objectives are valid, reliable, easy to use, fast, and harmless tools [21, 22]. Before a nutritional screening tool is used, the validity of the tool must be examined so that the device can accurately assess nutritional status [9, 21]. However, many nutritional screening tools have not been tested for validity and/or reliability, yet have been used in clinical practice, specifically related to nutritional screening tools for hospital patients and the elderly [23, 24]. For finding out the validity of a measuring instrument, the tool must be compared with other measuring instruments that are better (gold standard) which are usually invasive or expensive [25]. The validity of a device is related to its measurement of sensitivity and specificity [26]. Sensitivity is the ability of a tool to detect individuals who are sick (malnutrition), while specificity is the ability of a tool to detect healthy individuals [26].

The AWC TB/U nutritional screening tool has been tested for validity in Cimahi to 330 students in 4 elementary schools. The tool gets a value of Se 85.7%, and Sp 87.2% [20]. This study aims to examine the validity of AWC in the broader area, namely in 3 (three) cities representing the West (Medan), Central (Bandung) and East (Kupang), Indonesia so that the results can be used for broader stunting screening of elementary school children.

The long-term objectives of developing AWC TB/U are: 1) practical tools for nutritional status screening in the field, 2) socializing AWC TB / U in elementary school so students can measure their nutritional status on their own, 3) the stunting rate can be reduced gradually because stunted children are expected to try to catch up with the height, and 4) help school health service's staff become more sensitive to the nutritional status of students.

## 2. Method

## 2.1. Design, Location, and Time

The design of this study was cross-sectional. The research was conducted in 3 (three) primary schools: Sarijadi Selatan Elementary School in Bandung, West Java, MI Tembung Elementary School in Medan, North Sumatra and Lasiana Elementary Schools in Kupang City, East Nusa Tenggara in 2016.

## 2.2. Sampling Size and Method

The number of samples in this study was 270 children, where each school consisted of 90 children from grade 1 to class 6. The samples in each class were 15 students each. Determination of Elementary School based on the existence of school health service activities.

## 2.3. Data Collection Type and Method

The height was obtained by measuring height using microtoise with a capacity of 200 cm and an accuracy of 0.1 cm, while age data were obtained from student records in school. Measurement of actual height using microtoise is considered as the gold standard for AWC TB/U in detecting stunting in children aged 6-12 years. Then, each child is measured again by using AWC TB/U to see the color shown.

The AWC tool is placed on a flat wall and base [20]. Then, the child is asked to stand against the wall chart in the middle of the column according to age. Then, the staff or enumerator will see the top of the head shown in the graphics and record it. If the top of a child's head is in the red or yellow band at a certain age, the child has a short nutritional status (stunting). If the top of a child's head is in the green band, the child has a good nutritional status. AWC TB/U was developed based on WHO standards (2005). Yellow color for  $<-2$  SD and red color for  $<-3$  SD WHO growth standard. AWC is made with a range of 30 cm for each age group [20]. AWC is made from materials that are quite strong and durable (plastic material) and can be used for all students for a considerable period of time [20].

## 2.4. Data Processing and Analysis

Height-for-age (TB/U) data is calculated based on Z-score values using the WHO standard (2005). Sensitivity (Se) and specificity (Sp) values are calculated using the Se and



Figure 1: How to measure height with microtoise and AWC.

Sp calculation formula with the gold standard value which is the measurement result of the TB/U (HAZ) index (in years and months) based on WHO standards (2005).

### 3. Result

TABLE 1: Nutritional Status Assessment with AWC TB/U in 3 Cities of Medan, Kupang, dan Bandung.

AWC band color	City					
	Medan		Kupang		Bandung	
	N	%	n	%	n	%
Red	3	3,3	3	3,3	0	0,0
Yellow	17	18,9	18	20,0	12	13,3
Green	70	77,8	69	76,7	78	86,7
Total	90	100,0	90	100,0	90	100,0

The results of the assessment of nutritional status using AWC TB/U in 3 cities indicated that the distribution of children was very short (red) found in Medan and Kupang 3 people each, but not found in Bandung. Overall, the proportion of stunted children in Kupang (23.3%) is higher than in Medan (22.2%) and Bandung (13.3%).

The result of the nutritional status assessment of students using the height-for-age index in 3 cities showed that students with very short (<-3SD) and short stature nutritional status (-2SD) were found in all cities. The highest number of short stature nutritional status was 33 students (36.7%) out of 90 students in Kupang. Students with tall stature nutritional status were found in Medan and Kupang 1 student each and were not found in Bandung City.

The results of the nutritional status measurement in students in Medan indicated that as many as 20 students (22.2%) had short nutritional status shown in red and yellow color at AWC. The results of the measurement of nutritional status based on students'

TABLE 2: Nutritional Status Assessment Based on Height-for-age Index in 3 Cities of Medan, Kupang, and Bandung.

Height-for-age Index Nutritional Status	Kota					
	Medan		Kupang		Bandung	
	n	%	n	%	n	%
Very Short	2	2,2	7	7,8	2	2,2
Short	14	15,6	26	28,9	9	10,0
Normal	73	81,1	56	62,2	79	87,8
Tall	1	1,1	1	1,1	0	0,0
Total	90	100,0	90	100,0	90	100,0

TABLE 3: Sensitivity (Se) and Specificity (Sp) of AWC TB/U in Medan.

AWC Band Color	Height-for-age Nutritional Status		Total
	Stunting	Normal & Tall	
Yellow – Red	11	9	20
Green	5	65	70
Total	16	74	90

Se : 68,8%; Sp; 87,8%; PPV : 55,0; NPV : 92,9%; FP : 45,0%; FN : 31,3%

height compared to the Z-score showed that 16 students (17.8%) had short and very short nutritional status (<-2 SD). The results of the Se and Sp value of AWC assessment in school children in Medan get a Se value of 68.8% and Sp value of 87.8%.

TABLE 4: Sensitivity (Se) and Specificity (Sp) of AWC TB/U in Kupang.

AWC Band Color	Height-for-age Nutritional Status		Total
	Stunting	Normal & Tall	
Yellow- Red	20	1	21
Green	13	56	69
Total	33	57	90

Se : 60,6%; Sp; 98,2%; PPV : 95,2; NPV : 81,2%; FP : 4,8%; FN : 39,4%

The results of measurements of nutritional status in students in Kupang got as many as 21 students (23.3%) had a short nutritional status shown in red and yellow color at AWC. The results of the measurement of nutritional status based on students' height compared to the Z-score score found that 33 students (36.7%) had short and very short nutritional status (<- 2 SD). The results of the Se and Sp AWC assessment in school children in Kupang got a Se value of 60.6% and Sp 98.2%.

The results of measurements of nutritional status in students in Bandung got as many as 12 students (13.3%) had short nutritional status shown in the red and yellow band at

TABLE 5: Sensitivity (Se) and Specificity (Sp) of AWC TB/U in Bandung.

AWC Band Color	Height-for-age Nutritional Status		Total
	Stunting	Normal & Tall	
Yellow – red	8	4	12
Green	3	75	78
Total	11	79	90

Se : 72,7%; Sp; 94,9%; PPV : 66,7; NPV : 96,2%; FP : 33,3%; FN : 27,3%

AWC. The results of the measurement of nutritional status based on students' height compared to the Z-score score showed that 11 students (12.2%) had short and very short nutritional status. (< - 2SD). The results of the Se and Sp AWC assessment in school children in Bandung got a Se value of 72.2% and Sp 94.9%.

TABLE 6: Sensitivity (Se) and Specificity (Sp) of AWC TB/U in 3 Cities of Medan, Kupang, and Bandung.

AWC Band Color	Height-for-age Nutritional Status		Total
	Stunting	Normal & Tall	
Yellow – Red	39	14	53
Green	21	196	217
Total	60	210	270

Se : 66,0%; Sp; 93,3%; PPV : 73,6; NPV : 90,3%; FP : 26,4%; FN : 35,0%

The results of nutritional status measurement in students in 3 cities (Medan, Kupang, and Bandung) at 270 students, getting as many as 53 students (19.6%) had short nutritional status indicated by the red and yellow band at AWC. The results of the measurement of nutritional status based on students' height compared to the Z-score score showed that 60 students (22.2%) had short and very short nutritional status (<-2 SD). The results of Se and Sp AWC assessment in school children in 3 cities (Medan, Kupang, and Bandung) get a Se value of 66.0% and Sp 93.3%. If the number of children measured is greater, (combined with the measurement results in Cimahi in 2015) the number of students analyzed was 600 students, presented in table 7.

TABLE 7: Sensitivity (Se) and Specificity (Sp) of AWC TB/U in 4 Cities of Medan, Kupang, Bandung, and Cimahi.

AWC Band Color	Height-for-age Nutritional Status		Total
	Stunting	Normal & Tall	
Yellow – Red	75	51	126
Green	27	447	474
Total	102	498	600

Se : 73,5%; Sp; 89,8%; PPV : 59,5; NPV : 94,3%; FP : 40,5%; FN : 26,5%

The results of students nutritional status measurement in 4 cities (Medan, Kupang, Bandung, Cimahi) get as many as 126 students (21.0%) having short nutritional status

which are indicated by red and yellow AWC bands. The results of the measurement of nutritional status based on students' height compared to the Z-score score showed that 102 students (17.0%) had short and very short nutritional status. (<- 2SD). The results of the Se and Sp AWC assessments in 4 cities (Medan, Kupang, Bandung, and Cimahi) get Se values of 73.5% and Sp 89.8%.

TABLE 8: Sensitivity (Se) and Specificity (Sp) of AWC (using median age) in 3 Cities (Medan, Kupang, dan Bandung).

AWC Band Color	Height-for-age Nutritional Status		Total
	Stunting	Normal & Tall	
Yellow – red	4	0	4
Green	5	32	37
Total	9	32	41

Se: 44,4%; Sp:100,0%; PPV:100,0%; NPV:86,5%; FP:0,0%; FN:55,6%

Because AWC is made with the age-range of 1 year, to increase sensitivity (Se) and specificity (Sp), AWC was analyzed in students around the median with a range of 3 months. The results get a value of Se = 44.4% and Sp = 100%.

#### 4. Discussion

The method for detecting stunting that has been done using the height-for-age index, namely by measuring height using microtoise requires special skills and accuracy of the caregivers when taking measurements and when comparing with the standards used at the right age. The Anthropometric Wall Chart (AWC) TB/U was developed to answer the limitations of detection tools for stunting that are practical for use in the field. If the prevalence of students who have nutritional problems can be immediately known, prevention can be done immediately.

A measuring instrument is indicated to be valid if the tool has high Se and Sp value [26], which reflects the ability of the tool to detect truly sick people, in this case, stunted children, and people who are truly healthy (normal nutritional status). The results of the research in 3 (three) cities of Medan, Kupang and Bandung AWC TB / U can detect elementary school students who are stunting 22.2%; 23.3%; and 13.3% respectively. This is in line with the prevalence of stunting in school-age children (5-12 years) based on 2013 Basic Health Research, which is 39.9% in Medan (North Sumatra), 43.9% in Kupang (NTT), and 29.6% in Bandung (West Java) [3].

Se values of AWC TB/U in 3 cities (Medan, Kupang, and Bandung) varied from 60.6% - 72.7% and Sp values from 87.7% - 98.2%. The results of the combined analysis in

3 cities showed Se value 66.0% and Sp 93.3% with PPV 73.6% and NPV 90.3%. Se value increased to 73.5%, Sp value decreased to 89.8%, PPV 59.5%, and NPV 94.3% by increasing the number of children measured to 600 children. The Se value needs to be increased to be able to detect more stunting students or by increasing the Sp value to indicate that the measured students have normal nutritional status.

A low Se value leads to a negative error [26]. That happens because of the probability of children who have normal nutritional status according to the AWC TB/U tool, but actually, the child is stunted. Meanwhile, the low Sp value leads to a higher positive error [26], which means that there is a probability that the child is classified as stunting according to AWC TB/U, but actually, the child has a normal nutritional status. For early detection of stunting, a high negative error (FN) will lead to inaction for caregivers and have an adverse effect on nutrition intervention programs that are being carried out, while a high positive error (FP) can make alertness to health workers towards prevention programs especially for students in the borderline between yellow and green.

The value of Se and Sp can be increased by setting the cut-off point with the Receiver Operating Characteristic (ROC) curve [25]. The curve is made by calculating the true positive ratio (sensitivity) and the false positive ratio (specificity) at each intersection [25]. What needs to be considered if willing to set a cutoff point for diagnostic purposes is to choose the least minimal error for both positive errors and negative errors. According to Hass and Habicht, the purpose of determining the cutoff point of a test tool is based on the size of the scope, the importance of the intervention program, and the screening criteria. The best cut-off point will be discovered, as a common screening criterion without looking at program or coverage purposes, if it selects the cut points for the biggest Se and Sp summation [25].

In this study, the cut-off point of AWC TB/U could not be adjusted because the stunting standard was based on the reference of the Ministry of Health Republic of Indonesia on  $<-2SD$ . AWC was developed for stunting screening for children aged 6-12 years, then the cutoff remained at  $<-2SD$  for yellow band and  $<-3SD$  for red band [20].

Efforts can be made to increase Se and Sp by reducing the range at AWC TB/U. AWC TB/U is made with an age range of 1 year and a width of 30 cm for each age group. With an age range of 1 year, the number of FPs and FNs is likely to be large, especially children whose age at the beginning or end of the year is in their age group. The analysis was carried out with a range of ages around the median (3 months) to overcome that. The result shows Se value of 44.4% and Sp value of 100% with PPV value of 100% and NPV of 86.5%. If the range is narrowed, the width of the AWC will be more than 2.2 meters. This can be an obstacle in the field of equipment installation.

According to Ovid's strategy [27], the tool must have Se value of 98% and Sp value of 74% if it is intended to get a high Se diagnosis, but for high Sp diagnosis, the device must have Se 64% and Sp 98%. Whereas if it is intended for prognosis with a high Se, the tool must have Se 90% and Sp 80%, and vice versa, if what is intended is a high Sp value, the number to be achieved is Se 52% and Sp 94%. The results of the SE and Sp AWC TB/U assessment in 3 (three) cities of Medan, Kupang, and Bandung meet the importance of diagnosis with a high Sp. Diagnostic tests are used to determine the presence or absence of disease in the subject as measured by symptoms or signs of disease. Diagnostic tests are carried out after the positive screening results for diagnosis [28]. Whereas for the prognosis with a high Sp, the Sp value still needs to be increased from 93.3% to 98% [27]. For children who have stunting in the screening results, it is necessary to refer to the treatment of nutritional problems by improving diet and optimizing bone growth.

## 5. Conclusion

Anthropometric Wall Chart (AWC) TB/U can detect stunting in children aged 6-12 years as much as 19.6% with Se value of 66.0%, Sp value of 93.3%, PPV of 73.6, and NPV of 90.3%. AWC TB / U can be used as a stunting screening tool for diagnosis with the aim of a high Sp value. An increase in the number of samples can increase the Se value from 66.0% to 73.5%.

## Recommendation

The use of AWC TB / U needs to pay attention to stunting prevalence in urban and rural areas related to the diversity of factors causing stunting in children and the number of samples.

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