# Physical Growth of Primary School Children in Cambodia

**Chansean Mam[1]\*, PhD candidate;** ⓘ **Ryota Nawata[2], PhD; Kohei Yamada[3], PhD; Kazuko Maruoka[4], MA; Kenji Takita[5], BA; Keisuke Teramoto[2], PhD**

[1]Graduate School of Education, Aichi University of Education, Japan
[2]Department of Health and Physical Education, Aichi University of Education, Japan
[3]Department of School Health Sciences, Aichi University of Education, Japan
[4]Department of School Health Education, Senior High School Affiliated to Aichi University of Education, Japan
[5]Principal of Nagoya Primary School, Aichi University of Education, Japan

*\*Corresponding author:* Chansean Mam, PhD candidate; Graduate School of Education, Aichi University of Education, Japan;
**Email:** mamchansean@gmail.com

## Abstract

**Background:** Following up children's health at schools is crucial to ensuring their health and nutrition supply. Cambodia does not have a system for assessing the children's growth. In this regard, WHO child growth reference might be used to assess child growth in this country. The present study aimed to compare Cambodian primary schoolchildren's growth in three categories and assess their growth status by reference to the South-East Asian Nutrition Survey (SEANUTS) and WHO references.
**Methods:** This is a case study of primary school children's growth in Cambodia. Aichi University of Education in Japan conducted physical measurement in some primary schools in Cambodia in three categories: an urban school, a rural school with "school meals", and a rural school without "school meals". A total sample size of 9 487 primary schoolchildren was measured from 2015 to 2020. The data were analyzed by a computed formulation of LMS and SPSS statistics version 20.
**Results:** Cambodian primary schoolchildren in the urban school were taller and heavier than those in the rural school with "school meals" and the rural school without "school meals". The children in the rural school without "school meals" were the shortest and the lightest. The physical growth of the "schoolchildren" in Cambodia was similar to those of the pooled SEANUTS, but far below the WHO references.
**Conclusion:** School meals have a positive influence on children's growth. SEANUTS growth reference might be fitted to assess child growth in Cambodia, but the WHO reference is not fitted. National child growth curve and reference should be devised to accurately assess children's growth in Cambodia.

*Keywords:* Cambodia, Schools, Child, Growth, Height-for-age, Weight-for-age, Child growth reference, LMS

**How to Cite:** Mam C, Nawata R, Yamada K, Maruoka K, Takita K, Teramoto K. Physical Growth of Primary School Children in Cambodia. Int. J. School. Health. 2021;8(1):31-40.

## 1. Introduction

Student health is a main factor that influences their study achievements and participation at school. The Ministry of Education, Youth and Sport (MoEYS) has set a national policy on school health to enhance educational quality to support Cambodia in achieving its educational goals (1). This policy aims to contribute to improving the quality of education and giving learners and educational personnel access to good health and welfare services to become human resources of high potential. The MoEYS has also set a goal to improve participation until the last grade of primary education and the completion of primary education for all children (2). For this purpose, MoEYS has devised three priority strategies, one of which is to enhance children's health in primary schools. However, Cambodia does not have a system to assess primary schoolchildren's growth, and there are no standards in this country to assess their growth status. Child growth references produced by the World Health Organization (WHO) (3-14) are used as

references in many countries, including Cambodia. The samples collected by WHO to create the child growth reference might not represent all countries because the parents' genes and the environment in which they grow up determine their growth status. South-East Asian Nutrition Survey (SEANUTS) examined infants and children's growth in Indonesia, Malaysia, Thailand, and Vietnam, and the results showed that the height and weight percentile values in the pooled SEANUTS differed from those provided by WHO (15, 16). The anthropometric indices of schoolchildren from a municipality in Southern Brazil were also different from the WHO references (17).

Aichi University of Education (AUE) in Japan collaborated with the National Institute of Education (NIE) in Cambodia to conduct a study on the physical child growth of some primary schools in Cambodia from 2015 to 2020. The present study aimed (1) to compare primary schoolchildren's growth in three different contexts: an urban school, a rural school with

"school meals", and a rural school without "school meal", and (2) to assess the primary schoolchildren's growth status by referring to pooled SEANUTS and WHO references.

## 2. Methods

*Sampling*

This is a case study of primary school children's growth in Cambodia. Our study was designed to investigate the physical growth of schoolchildren over different geographical and socioeconomic areas in Cambodia. Phnom Penh is the capital of Cambodia and considered as a high socioeconomic area of the country. Siem Reap is a tourist province where the income of the people living in the tourist site is much higher than those living in rural areas. Prey Veng is a plain wet area in which most people do agricultural activities. The primary schools located in the capital or the provincial cities are mainly classified as urban schools, and those located in the rural areas are called rural schools. The World Food Program (WFP) has been providing nutritious school meals for certain primary schools located in rural areas. The WFP's School Meals Program provides nutritious breakfast to all students in the school prior class. The present research is a case study of eight primary schools among more than 7 000 public primary schools in the country. Two primary schools in Phnom Penh, one primary school in Prey Veng province, and one primary school in Siem Reap province were selected as the urban school samples. Another primary school in Prey Veng province and two primary schools in Siem Reap province were selected as the rural schools without "school meals". One primary school in Siem Reap province was selected as the rural school with "school meals". The school with "school meals" in this study is referred to the school that serves a nutritious breakfast (funded by the WFP) to all the schoolchildren.

*Data Collection*

The anthropometric measurements were conducted by AUE research team, including professors and students who collaborated with their NIE counterparts, and the Provincial Teacher Training College trainers and students in Siem Reap province. The measurement tools used in this study were daily life equipment that can be purchased from the markets in Cambodia, such as a daily life device used scale for weight measurement and a measuring tape for height measurement. The specific measurement methods were specially designed

by the AUE research team and applicable to primary schools in Cambodia. The research team, including the students, were trained by professional anthropometric professors in order to ensure accurate measurement. The AUE research team, comprised of around 25 members, conducted anthropometric measurements in the same primary schools in January annually from 2015 to 2020. Therefore, some schoolchildren were measured 6 times from the beginning to the end of primary education.

*Measurement Explanation*

Schoolchildren in each class were asked to exit the classroom in order to listen to an explanation about their attention and cooperation during the measurement. Following the explanation, they were divided into two groups based on their sex and body measurement. Each schoolchild received his/her information sheet to be used in the body measurement station.

*Weight Measurement Method*

*Step 1*, a schoolchild was asked to remove his/her shoes, socks, and any relevant items on his/her body except for light clothes; *step 2*, the schoolchild was asked to stand still with both feet on the footprint; *step 3*, the research team read the display on the scale screen and recorded the measurement to the nearest 100 g (0.1kg) in his/her information sheet.

*Height Measurement Method*

*Step 1,* the schoolchild was asked to remove his/her shoes, socks, and any relevant items worn on the head; *step 2,* they were asked to stand still with their both feet on the footprint ; *step 3*, they were asked to stand tall with their back against the wall and feet together, and we ensured that the head, buttocks, and heels were touching the wall as much as possible; *step 4*, the subject was asked to look straight ahead; *step 5*, the research team placed the right triangle gently and firmly on the subject's head, and pressed it against the wall; *step 6*, the research team read the measurement paralleled with the right triangle and recorded the measurement to the nearest 1 mm (0.1 cm) into the information sheet.

*Data Entry*

The data entry was performed by the AUE students using a specialized developed program in Microsoft Excel Spreadsheet with a fixed format. The data was fed into the fixed format every evening after the

measurement. The students were divided into groups of three or four, in which one student read the data from the information sheet, one student put the data in the format while the others confirmed the data entry. Finally, the obviously misaligned numbers or typing errors were corrected by the AUE research team prior to analysis.

*Statistical Analysis*

Cole's LMS method for constructing normalized growth standards (18), which refers to the Box–Cox transformation power (L), the median (M), and the coefficient of variation (S), was computed to calculate the LMS values of height-for-age and weight-for-age. IBM SPSS Statistics Version 20 was used to calculate the percentile values at 3rd, 15th, 50th, 85th, and 97th percentile values.

## 3. Results

The total sample size was 9 487 (4 685 girls, 4 802 boys). The sample size in each category was 6 422 (3 141 girls, 3 281 boys) for the urban schools, 1 060 (518 girls, 542 boys) in the rural school with "school meals", and 2 005 (1 026 girls, 979 boys) for the rural schools without "school meals" (Table 1).

*Height-for-Age*

The LMS values of the height distribution in this study were set at the arithmetic type (*i.e.* L=1) according to the WHO growth reference data. The medians (Ms) related to the height-for-ages of the schoolchildren in Cambodia and the children of the pooled SEANUTS were always lower than those of WHO. The Ms of the schoolchildren in Cambodia were generally taller than those of the pooled SEANUTS (from ages 6 to 8), but they were shorter than the pooled SEANUTS (ages 9

to 12). The coefficient of variations (S) of Cambodian schoolchildren aged 6 to 12 years were all higher than those of WHO (Tables 2 and 3). This indicated that the height-for-age of the schoolchildren in Cambodia had a greater level of dispersion around the mean compared with WHO. The SDs associated with the height-for-age of schoolchildren in Cambodia were all greater than the SDs of WHO and the pooled SEANUTS at certain age ranges.

In Cambodia, the S of children of all ages, except 8-year-old girls, in the rural school with "school meals" was between those in the urban schools and the rural schools without "school meals". This indicated that the height-for-age of the schoolchildren receiving school breakfast had a lower level of dispersion around the mean in comparison to those of the rural schools without serving the school breakfast. This was further confirmed by the lower SD of the height-for-age pertaining to both schoolboys and schoolgirls in the rural school with "school meals" compared to the rural school without "school meals" (Tables 2 and 3).

The height-for-ages of the schoolchildren in Cambodia and the children in the pooled SEANUTS were always lower than those of WHO at the 3rd, 50th, and 97th percentile values. The percentile values related to the height-for-ages of schoolchildren in Cambodia and the pooled SEANUTS were not different. The Cambodian schoolchildren were generally taller than the pooled SEANUTS at ages of 6, 7, 8, and 9 years old, but shorter than them at ages of 10, 11, and 12 years old (Tables 2 and 3).

Based on our results, the Cambodian schoolchildren in urban schools were always taller than those in the rural school with "school meals" and the rural school without "school meals" at all percentile values. The Ms of schoolchildren in the rural school with "school meals"

**Table 1:** Schoolchildren samples by sex and classification

| Characteristic | Number of schoolchildren (n) | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | 6 years | 7 years | 8 years | 9 years | 10 years | 11 years | 12 years | |
| Schoolgirls | | | | | | | | |
| Urban school | 425 | 467 | 534 | 461 | 460 | 505 | 289 | 3141 |
| Rural school with " school meals" | 67 | 92 | 93 | 75 | 82 | 82 | 27 | 518 |
| Rural school without "school meals" | 132 | 129 | 149 | 164 | 165 | 182 | 105 | 1026 |
| Schoolboys | | | | | | | | |
| Urban school | 429 | 520 | 463 | 457 | 558 | 555 | 299 | 3281 |
| Rural school with " school meals" | 77 | 80 | 85 | 89 | 98 | 58 | 55 | 542 |
| Rural school without "school meals" | 118 | 149 | 147 | 129 | 151 | 160 | 125 | 979 |
| Total | 1248 | 1437 | 1471 | 1375 | 1514 | 1542 | 900 | 9487 |

The data was collected from 2015 to 2020. The rural school with "school meals" is the school that provides breakfast to all the children in the school supported by World Food Program.

**Table 2:** Differences in height-for-age percentile values in girls among WHO, pooled SEANUTS, and Cambodia

| | L | S | SD | Percentiles (height in cm) | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | | | | 3rd | 15th | 50th (M) | 85th | 97th |
| **6 years** | | | | | | | | |
| WHO standard[1] | 1 | 0.0445 | 5.1196 | 105.5 | 109.8 | 115.1 | 120.4 | 124.8 |
| | | 0.0452 | 5.4393 | 110.1 | 114.7 | 120.3 | 126.0 | 130.6 |
| Pooled SEANUTS[2] | | | 5.8345 | 100.7 | | 111.4 | | 122.7 |
| Cambodia | 1 | 0.0513 | 5.7589 | 101.5 | 106.9 | 112.2 | 117.9 | 124.0 |
| Urban school | 1 | 0.0470 | 5.3353 | 103.1 | 108.8 | 113.5 | 119.3 | 124.4 |
| Rural school with "school meals" | 1 | 0.0392 | 4.3109 | 102.0 | 105.6 | 110.0 | 114.1 | 120.1 |
| Rural school without "school meals" | 1 | 0.0577 | 6.3135 | 99.4 | 104.0 | 109.4 | 115.0 | 120.8 |
| **7 years** | | | | | | | | |
| WHO standard | 1 | 0.0453 | 5.4954 | 110.9 | 115.6 | 121.3 | 127.0 | 131.6 |
| | | 0.0458 | 5.7703 | 115.2 | 120.1 | 126.1 | 132.1 | 136.9 |
| Pooled SEANUTS | | | 6.2080 | 105.8 | | 117.1 | | 129.1 |
| Cambodia | 1 | 0.0491 | 5.7746 | 107.5 | 112.0 | 117.8 | 123.5 | 129.1 |
| Urban school | 1 | 0.0482 | 5.7290 | 108.5 | 113.8 | 119.0 | 125.0 | 131.0 |
| Rural school with "school meals" | 1 | 0.0387 | 4.4572 | 105.3 | 110.5 | 115.7 | 119.3 | 124.5 |
| Rural school without "school meals" | 1 | 0.0458 | 5.2701 | 106.5 | 110.0 | 114.5 | 121.0 | 125.9 |
| **8 years** | | | | | | | | |
| WHO standard | 1 | 0.0458 | 5.7975 | 115.7 | 120.5 | 126.6 | 132.6 | 137.5 |
| | | 0.0461 | 6.0848 | 120.5 | 125.7 | 132.0 | 138.3 | 143.4 |
| Pooled SEANUTS | | | 6.5860 | 110.8 | | 122.9 | | 135.5 |
| Cambodia | 1 | 0.0514 | 6.3193 | 111.5 | 116.7 | 123.0 | 129.5 | 134.4 |
| Urban school | 1 | 0.0489 | 6.0782 | 114.0 | 118.6 | 124.3 | 130.6 | 136.5 |
| Rural school with "school meals" | 1 | 0.0437 | 5.2748 | 107.9 | 116.0 | 121.0 | 126.1 | 131.3 |
| Rural school without "school meals" | 1 | 0.0472 | 5.6093 | 109.1 | 112.8 | 119.0 | 124.8 | 128.9 |
| **9 years** | | | | | | | | |
| WHO standard | 1 | 0.0461 | 6.1106 | 121.0 | 126.2 | 132.5 | 138.8 | 144.0 |
| | | 0.0462 | 6.3741 | 126.1 | 131.5 | 138.1 | 144.7 | 150.1 |
| Pooled SEANUTS | | | 6.9638 | 115.8 | | 128.7 | | 142.0 |
| Cambodia | 1 | 0.0548 | 7.0243 | 115.8 | 121.0 | 128.0 | 135.7 | 142.3 |
| Urban school | 1 | 0.0516 | 6.7213 | 118.4 | 124.0 | 130.0 | 137.5 | 143.8 |
| Rural school with "school meals" | 1 | 0.0457 | 5.7712 | 114.7 | 120.0 | 126.8 | 132.0 | 138.1 |
| Rural school without "school meals" | 1 | 0.0480 | 5.9417 | 112.3 | 117.7 | 123.9 | 129.9 | 136.4 |
| **10 years** | | | | | | | | |
| WHO standard | 1 | 0.0461 | 6.3967 | 126.6 | 132.0 | 138.6 | 145.3 | 150.7 |
| | | 0.0459 | 6.6277 | 132.0 | 137.6 | 144.5 | 151.3 | 156.9 |
| Pooled SEANUTS | | | 7.3279 | 121.0 | | 134.7 | | 148.6 |
| Cambodia | 1 | 0.0570 | 7.6297 | 120.5 | 126.1 | 134.0 | 142.0 | 149.1 |
| Urban school | 1 | 0.0531 | 7.2181 | 123.3 | 128.5 | 135.8 | 143.0 | 151.5 |
| Rural school with "school meals" | 1 | 0.0475 | 6.2666 | 120.0 | 125.3 | 132.3 | 137.1 | 145.7 |
| Rural school without "school meals" | 1 | 0.0542 | 7.0031 | 117.0 | 122.1 | 128.5 | 137.1 | 142.8 |
| **11 years** | | | | | | | | |
| WHO standard | 1 | 0.0458 | 6.6465 | 132.5 | 138.1 | 145.0 | 151.9 | 157.5 |
| | | 0.0453 | 6.8270 | 137.9 | 143.7 | 150.7 | 157.8 | 163.6 |
| Pooled SEANUTS | | | 7.6996 | 126.1 | | 140.8 | | 155.1 |
| Cambodia | 1 | 0.0617 | 8.5941 | 123.0 | 130.5 | 139.8 | 148.8 | 155.0 |
| Urban school | 1 | 0.0539 | 7.6398 | 127.0 | 134.0 | 142.2 | 150.0 | 156.1 |
| Rural school with "school meals" | 1 | 0.0564 | 7.7083 | 119.5 | 129.8 | 136.1 | 144.6 | 152.3 |
| Rural school without "school meals" | 1 | 0.0646 | 8.6548 | 117.8 | 125.5 | 132.8 | 144.4 | 152.2 |
| **12 years** | | | | | | | | |
| WHO standard | 1 | 0.0452 | 6.8403 | 138.4 | 144.1 | 151.2 | 158.3 | 164.1 |
| | | 0.0445 | 6.9362 | 143.0 | 148.8 | 156.0 | 163.2 | 169.1 |
| Pooled SEANUTS | | | 8.0429 | 131.3 | | 146.8 | | 161.6 |
| Cambodia | 1 | 0.0590 | 8.4788 | 126.5 | 135.3 | 144.3 | 152.7 | 157.7 |
| Urban school | 1 | 0.0519 | 7.5794 | 129.4 | 139.0 | 146.5 | 154.4 | 159.7 |
| Rural school with "school meals" | 1 | 0.0556 | 7.7547 | 120.0 | 128.9 | 141.5 | 146.5 | |
| Rural school without "school meals" | 1 | 0.0576 | 7.9513 | 122.6 | 130.0 | 138.5 | 146.5 | 150.9 |

[1]The data source was extracted from 2007 WHO Reference Height-for-age girls 5-19 years (percentiles). The data at the specific age is at the specific age and 0 month (e.g 6 years and 0 month) and at the specific age and 11 months (e.g 6 years and 11 months). [2]The data source was extracted from Rojroongwasinkul et al. 2015, SEANUTS: South-East Asian Nutrition Surveys, supplemental Table 5. [3]The LMS data at arithmetic type (power:1) formulated by Cole T. J., 1989 was used.

**Table 3:** Differences in height-for-age percentile values in boys among WHO, pooled SEANUTS, and Cambodia

| | L | S | SD | Percentiles (height in cm) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 3rd | 15th | 50th (M) | 85th | 97th |
| **6 years** | | | | | | | | |
| WHO standard[1] | 1 | 0.0425 | 4.9268 | 106.7 | 110.8 | 116.0 | 121.1 | 125.2 |
| | | 0.0433 | 5.2554 | 111.4 | 115.8 | 121.3 | 126.7 | 131.1 |
| Pooled SEANUTS[2] | | | 5.7964 | 101.1 | | 112.6 | | 123.0 |
| Cambodia | 1 | 0.0514 | 5.8442 | 103.0 | 108.0 | 113.6 | 119.9 | 125.6 |
| Urban school | 1 | 0.0466 | 5.3550 | 105.8 | 109.9 | 114.7 | 120.5 | 125.9 |
| Rural school with "school meals" | 1 | 0.0441 | 4.8732 | 102.1 | 106.4 | 110.2 | 115.2 | 121.2 |
| Rural school without "school meals" | 1 | 0.0581 | 6.4483 | 99.4 | 105.2 | 110.9 | 117.8 | 124.3 |
| **7 years** | | | | | | | | |
| WHO standard | 1 | 0.0434 | 5.2857 | 111.8 | 116.3 | 121.7 | 127.2 | 131.7 |
| | | 0.0443 | 5.6179 | 116.2 | 121.0 | 126.8 | 132.6 | 137.4 |
| Pooled SEANUTS | | | 6.1102 | 106.3 | | 118.2 | | 129.3 |
| Cambodia | 1 | 0.0508 | 6.0061 | 107.5 | 112.4 | 118.0 | 124.8 | 130.7 |
| Urban school | 1 | 0.0477 | 5.7082 | 110.0 | 114.0 | 119.6 | 125.7 | 131.1 |
| Rural school with "school meals" | 1 | 0.0443 | 5.0654 | 102.5 | 108.9 | 115.0 | 119.0 | 124.4 |
| Rural school without "school meals" | 1 | 0.0454 | 5.2220 | 104.7 | 110.3 | 115.3 | 120.3 | 125.0 |
| **8 years** | | | | | | | | |
| WHO standard | 1 | 0.0444 | 5.6480 | 116.6 | 121.4 | 127.3 | 133.1 | 137.9 |
| | | 0.0453 | 5.9814 | 120.9 | 125.9 | 132.1 | 138.3 | 143.4 |
| Pooled SEANUTS | | | 6.4440 | 111.2 | | 123.6 | | 135.5 |
| Cambodia | 1 | 0.0517 | 6.4015 | 112.6 | 117.5 | 123.9 | 130.5 | 136.4 |
| Urban school | 1 | 0.0455 | 5.7422 | 115.5 | 120.6 | 126.0 | 132.0 | 138.2 |
| Rural school with "school meals" | 1 | 0.0458 | 5.5105 | 108.1 | 114.6 | 120.6 | 126.0 | 132.1 |
| Rural school without "school meals" | 1 | 0.0434 | 5.1640 | 108.2 | 114.0 | 118.8 | 124.4 | 127.6 |
| **9 years** | | | | | | | | |
| WHO standard | 1 | 0.0454 | 6.0118 | 121.3 | 126.3 | 132.6 | 138.8 | 143.9 |
| | | 0.0462 | 6.3441 | 125.4 | 130.8 | 137.3 | 143.9 | 149.3 |
| Pooled SEANUTS | | | 6.8036 | 115.9 | | 128.7 | | 141.5 |
| Cambodia | 1 | 0.0548 | 7.0268 | 116.3 | 120.7 | 128.1 | 135.8 | 142.8 |
| Urban school | 1 | 0.0508 | 6.6114 | 118.1 | 123.8 | 130.4 | 137.0 | 143.9 |
| Rural school with "school meals" | 1 | 0.0457 | 5.7249 | 115.7 | 119.3 | 125.5 | 131.2 | 138.7 |
| Rural school without "school meals" | 1 | 0.0474 | 5.8349 | 112.7 | 118.4 | 123.0 | 129.6 | 133.7 |
| **10 years** | | | | | | | | |
| WHO standard | 1 | 0.0463 | 6.3737 | 125.8 | 131.2 | 137.8 | 144.4 | 149.8 |
| | | 0.0470 | 6.7017 | 130.0 | 135.7 | 142.7 | 149.6 | 155.3 |
| Pooled SEANUTS | | | 7.1887 | 120.5 | | 133.8 | | 147.5 |
| Cambodia | 1 | 0.0574 | 7.6004 | 118.7 | 124.7 | 132.5 | 140.1 | 147.5 |
| Urban school | 1 | 0.0523 | 7.0426 | 122.5 | 127.3 | 134.7 | 142.2 | 149.3 |
| Rural school with "school meals" | 1 | 0.0473 | 6.1227 | 118.7 | 123.0 | 129.8 | 136.0 | 144.0 |
| Rural school without "school meals" | 1 | 0.0513 | 6.4921 | 114.1 | 119.9 | 126.5 | 133.7 | 139.1 |
| **11 years** | | | | | | | | |
| WHO standard | 1 | 0.0470 | 6.7306 | 130.5 | 136.1 | 143.1 | 150.1 | 155.8 |
| | | 0.0475 | 7.0560 | 135.3 | 141.2 | 148.5 | 155.9 | 161.8 |
| Pooled SEANUTS | | | 7.6001 | 125.1 | | 138.9 | | 153.7 |
| Cambodia | 1 | 0.0589 | 8.0962 | 123.3 | 129.2 | 137.5 | 146.2 | 154.2 |
| Urban school | 1 | 0.0543 | 7.5790 | 126.1 | 132.1 | 139.6 | 147.7 | 154.7 |
| Rural school with "school meals" | 1 | 0.0492 | 6.5203 | 122.9 | 126.4 | 131.5 | 139.2 | 149.9 |
| Rural school without "school meals" | 1 | 0.0519 | 6.8510 | 118.6 | 126.0 | 132.0 | 138.8 | 146.3 |
| **12 years** | | | | | | | | |
| WHO standard | 1 | 0.0475 | 7.0858 | 135.8 | 141.7 | 149.1 | 156.4 | 162.4 |
| | | 0.0476 | 7.4017 | 141.5 | 147.8 | 155.4 | 163.1 | 169.4 |
| Pooled SEANUTS | | | 8.0287 | 129.7 | | 144.0 | | 160.0 |
| Cambodia | 1 | 0.0640 | 9.0176 | 125.8 | 132.4 | 140.1 | 150.9 | 159.4 |
| Urban school | 1 | 0.0606 | 8.7194 | 129.7 | 135.3 | 144.0 | 153.7 | 161.0 |
| Rural school with "school meals" | 1 | 0.0508 | 6.9337 | 122.8 | 129.6 | 136.3 | 142.5 | 154.0 |
| Rural school without "school meals" | 1 | 0.0518 | 7.0335 | 122.2 | 129.0 | 135.3 | 143.0 | 151.9 |

[1]The data source was extracted from 2007 WHO Reference Height-for-age boys 5-19 years (percentiles). The data at specific age is a specific age and 0 month (e.g 6 years and 0 month) and a specific age and 11 months (e.g 6 years and 11 months). [2]The data source was extracted from Rojroongwasinkul et al. 2015, SEANUTS: South-East Asian Nutrition Surveys, supplemental Table 4.

**Table 4:** Differences in weight-for-age percentile values in girls among WHO, pooled SEANUTS, and Cambodia

| | L | S | Percentiles (weight in kg) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 3rd | 15th | 50th (M) | 85th | 97th |
| **6 years** | | | | | | | |
| WHO standard[1] | -0.5013 | 0.1490 | 15.5 | 17.4 | 20.2 | 23.7 | 27.3 |
| | -0.5321 | 0.1550 | 16.9 | 19.0 | 22.2 | 26.2 | 30.4 |
| Pooled SEANUTS[2] | -1.3316 | 0.1836 | 13.4 | | 17.9 | | 28.4 |
| Cambodia | -1.1468 | 0.1528 | 14.0 | 15.9 | 18.1 | 21.4 | 25.9 |
| Urban school | -1.2353 | 0.1538 | 14.8 | 16.3 | 18.6 | 22.2 | 27.6 |
| Rural school with "school meals" | -0.9765 | 0.1050 | 14.4 | 16.0 | 17.8 | 20.0 | 22.0 |
| Rural school without "school meals" | -0.9938 | 0.1346 | 13.4 | 14.8 | 16.9 | 19.4 | 21.8 |
| **7 years** | | | | | | | |
| WHO standard | -0.5347 | 0.1556 | 17.0 | 19.2 | 22.4 | 26.5 | 30.8 |
| | -0.5606 | 0.1614 | 18.7 | 21.1 | 24.8 | 29.5 | 34.6 |
| Pooled SEANUTS | -1.3891 | 0.1951 | 14.8 | | 19.9 | | 33.2 |
| Cambodia | -1.3912 | 0.1662 | 15.4 | 17.3 | 20.1 | 24.0 | 31.5 |
| Urban school | -1.3785 | 0.1748 | 15.9 | 18.2 | 20.7 | 25.6 | 33.1 |
| Rural school with "school meals" | -1.4435 | 0.1137 | 15.7 | 17.4 | 19.2 | 22.0 | 25.0 |
| Rural school without "school meals" | -1.2139 | 0.1330 | 15.0 | 16.4 | 18.6 | 21.5 | 25.3 |
| **8 years** | | | | | | | |
| WHO standard | -0.5627 | 0.1619 | 18.9 | 21.3 | 25.0 | 29.8 | 34.9 |
| | -0.5819 | 0.1672 | 20.9 | 23.7 | 27.9 | 33.5 | 39.5 |
| Pooled SEANUTS | -1.3835 | 0.2084 | 16.2 | | 22.2 | | 39.0 |
| Cambodia | -1.2476 | 0.1828 | 16.8 | 19.0 | 22.2 | 27.8 | 36.1 |
| Urban school | -1.2295 | 0.1894 | 17.3 | 20.0 | 23.0 | 29.4 | 38.2 |
| Rural school with "school meals" | -1.3345 | 0.1295 | 17.5 | 19.0 | 21.6 | 25.4 | 29.5 |
| Rural school without "school meals" | 0.0115 | 0.1293 | 15.6 | 18.0 | 20.3 | 22.9 | 26.0 |
| **9 years** | | | | | | | |
| WHO standard | -0.5833 | 0.1676 | 21.1 | 23.9 | 28.2 | 33.9 | 40.0 |
| | -0.5950 | 0.1722 | 23.4 | 26.6 | 31.5 | 38.1 | 45.2 |
| Pooled SEANUTS | -1.2953 | 0.2234 | 17.9 | | 25.0 | | 45.8 |
| Cambodia | -1.3394 | 0.1982 | 18.6 | 21.0 | 24.8 | 32.2 | 42.0 |
| Urban school | -1.2646 | 0.2092 | 19.8 | 22.0 | 25.8 | 35.0 | 43.0 |
| Rural school with "school meals" | -1.4732 | 0.1397 | 18.9 | 21.2 | 24.0 | 28.2 | 35.9 |
| Rural school without "school meals" | -0.4134 | 0.1354 | 17.2 | 19.5 | 22.5 | 26.0 | 29.5 |
| **10 years** | | | | | | | |
| WHO standard | -0.5958 | 0.1726 | 23.7 | 26.9 | 31.9 | 38.5 | 45.7 |
| | | | | | | | |
| Pooled SEANUTS | -1.1190 | 0.2393 | 19.7 | | 28.4 | | 53.2 |
| Cambodia | -1.1348 | 0.2238 | 20.4 | 23.1 | 28.0 | 36.6 | 50.5 |
| Urban school | -1.1661 | 0.2287 | 21.8 | 24.2 | 29.9 | 40.0 | 52.6 |
| Rural school with "school meals" | -1.0162 | 0.1601 | 20.1 | 23.4 | 26.9 | 32.6 | 39.9 |
| Rural school without "school meals" | -0.9008 | 0.1666 | 18.5 | 21.0 | 24.6 | 29.1 | 34.0 |
| **11 years** | | | | | | | |
| Pooled SEANUTS | -0.8714 | 0.2549 | 21.8 | | 32.6 | | 60.7 |
| Cambodia | -0.5710 | 0.2444 | 21.7 | 25.4 | 32.4 | 42.3 | 55.8 |
| Urban school | -0.5713 | 0.2381 | 23.0 | 27.2 | 34.4 | 45.5 | 57.7 |
| Rural school with "school meals" | -0.5019 | 0.1782 | 21.7 | 24.7 | 30.2 | 36.7 | 44.8 |
| Rural school without "school meals" | -0.6447 | 0.2027 | 19.6 | 22.6 | 27.8 | 34.2 | 40.6 |
| **12 years** | | | | | | | |
| Pooled SEANUTS | -0.5857 | 0.2698 | 23.9 | | 37.2 | | 68.0 |
| Cambodia | -0.5530 | 0.2488 | 23.4 | 27.3 | 34.6 | 45.5 | 59.2 |
| Urban school | -0.5624 | 0.2469 | 24.1 | 29.3 | 37.2 | 48.1 | 62.5 |
| Rural school with "school meals" | 1.1113 | 0.1751 | 20.9 | 25.6 | 32.0 | 37.0 | . |
| Rural school without "school meals" | -0.4821 | 0.2126 | 22.8 | 24.8 | 31.0 | 38.4 | 47.2 |

[1]The data source was extracted from 2007 WHO Reference Weight-for-age girls 5-10 years (percentiles). The data at specific age is a specific age and 0 month (e.g 6 years and 0 month) and a specific age and 11 months (e.g 6 years and 11 months). [2]The data source was extracted from Sandjaja et al. 2018, SEANUTS: South-East Asian Nutrition Surveys, supplemental Table 1 and Table 8.

**Table 5:** Differences in weight-for-age percentile values in boys among WHO, pooled SEANUTS, and Cambodia

| | L | S | Percentiles (weight in kg) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 3rd | 15th | 50th (M) | 85th | 97th |
| **6 years** | | | | | | | |
| WHO standard[1] | -0.3180 | 0.1337 | 16.1 | 17.9 | 20.5 | 23.6 | 26.7 |
| | -0.4305 | 0.1372 | 17.8 | 19.8 | 22.7 | 26.3 | 29.8 |
| Pooled SEANUTS[2] | -1.3975 | 0.1905 | 14.0 | | 18.7 | | 30.7 |
| Cambodia | -1.2922 | 0.1230 | 15.0 | 16.6 | 19.0 | 22.8 | 29.4 |
| Urban school | -1.2873 | 0.1673 | 15.6 | 17.2 | 19.8 | 24.2 | 30.0 |
| Rural school with "school meals" | -0.3204 | 0.1206 | 13.6 | 15.7 | 17.6 | 20.0 | 23.5 |
| Rural school without "school meals" | -1.2922 | 0.1230 | 14.3 | 16.0 | 17.7 | 20.4 | 25.0 |
| **7 years** | | | | | | | |
| WHO standard | -0.4402 | 0.1376 | 17.9 | 19.9 | 22.9 | 26.5 | 30.1 |
| | -0.5399 | 0.1428 | 19.6 | 21.9 | 25.2 | 29.4 | 33.7 |
| Pooled SEANUTS | -1.4016 | 0.2035 | 15.3 | | 20.8 | | 36.0 |
| Cambodia | -1.3890 | 0.1743 | 16.0 | 18.0 | 20.8 | 25.2 | 34.4 |
| Urban school | -1.5547 | 0.1776 | 16.8 | 18.6 | 21.5 | 26.6 | 36.1 |
| Rural school with "school meals" | -0.2223 | 0.1308 | 14.5 | 16.8 | 19.0 | 21.3 | 24.4 |
| Rural school without "school meals" | 0.0958 | 0.1232 | 15.2 | 17.1 | 19.4 | 22.0 | 24.9 |
| **8 years** | | | | | | | |
| WHO standard | -0.5482 | 0.1434 | 19.8 | 22.0 | 25.4 | 29.7 | 34.0 |
| | -0.6278 | 0.1515 | 21.4 | 24.0 | 27.9 | 32.9 | 38.2 |
| Pooled SEANUTS | -1.3826 | 0.2166 | 16.8 | | 23.1 | | 42.1 |
| Cambodia | -1.3327 | 0.1903 | 17.7 | 19.8 | 23.1 | 29.0 | 39.4 |
| Urban school | -1.4626 | 0.1884 | 19.0 | 21.0 | 24.8 | 31.0 | 41.2 |
| Rural school with "school meals" | -0.5399 | 0.1290 | 16.6 | 19.0 | 21.2 | 25.2 | 28.2 |
| Rural school without "school meals" | 0.5914 | 0.1155 | 16.5 | 18.1 | 20.6 | 23.1 | 25.3 |
| **9 years** | | | | | | | |
| WHO standard | -0.6337 | 0.1523 | 21.6 | 24.2 | 28.1 | 33.2 | 38.6 |
| | -0.6752 | 0.1621 | 23.4 | 26.3 | 30.9 | 36.9 | 43.5 |
| Pooled SEANUTS | -1.3439 | 0.2295 | 18.3 | | 25.7 | | 49.1 |
| Cambodia | -1.3645 | 0.2118 | 18.8 | 21.2 | 25.2 | 32.4 | 46.0 |
| Urban school | -1.2030 | 0.2239 | 19.7 | 22.3 | 26.8 | 35.6 | 49.4 |
| Rural school with "school meals" | -1.4959 | 0.1375 | 19.1 | 21.2 | 24.0 | 28.2 | 35.3 |
| Rural school without "school meals" | -0.2290 | 0.1256 | 17.8 | 19.8 | 22.0 | 25.6 | 28.3 |
| **10 years** | | | | | | | |
| WHO standard | -0.6764 | 0.1631 | 23.6 | 26.6 | 31.2 | 37.3 | 43.9 |
| | | | | | | | |
| Pooled SEANUTS | -1.2912 | 0.2423 | 20.0 | | 28.6 | | 56.8 |
| Cambodia | -1.1604 | 0.2301 | 20.1 | 22.6 | 27.4 | 37.6 | 48.9 |
| Urban school | -1.0030 | 0.2367 | 21.6 | 23.9 | 29.4 | 40.4 | 51.1 |
| Rural school with "school meals" | -1.3607 | 0.1544 | 20.6 | 21.9 | 26.0 | 31.2 | 36.1 |
| Rural school without "school meals" | -0.5735 | 0.1428 | 18.5 | 20.7 | 23.6 | 27.4 | 32.0 |
| **11 years** | | | | | | | |
| Pooled SEANUTS | -1.2306 | 0.2550 | 21.7 | | 31.6 | | 65.2 |
| Cambodia | -0.9361 | 0.2493 | 21.5 | 24.8 | 30.6 | 42.2 | 55.9 |
| Urban school | -0.7908 | 0.2516 | 22.9 | 26.1 | 32.8 | 46.7 | 57.4 |
| Rural school with "school meals" | -2.0339 | 0.1560 | 21.8 | 24.0 | 27.2 | 33.8 | 45.8 |
| Rural school without "school meals" | -0.5321 | 0.1699 | 19.1 | 22.8 | 26.3 | 31.6 | 40.3 |
| **12 years** | | | | | | | |
| Pooled SEANUTS | -1.1660 | 0.2667 | 23.3 | | 34.7 | | 74.0 |
| Cambodia | -0.9499 | 0.2506 | 23.2 | 26.8 | 32.2 | 45.0 | 62.1 |
| Urban school | -0.6008 | 0.2695 | 24.2 | 28.3 | 35.8 | 51.0 | 64.6 |
| Rural school with "school meals" | -1.1897 | 0.1615 | 23.3 | 26.0 | 30.0 | 37.3 | 43.8 |
| Rural school without "school meals" | -0.2489 | 0.1573 | 21.2 | 24.6 | 28.7 | 34.6 | 39.4 |

[1]The data source was extracted from 2007 WHO Reference Weight-for-age boys 5-10 years (percentiles). The data at specific age is a specific age and 0 month (e.g 6 years and 0 month) and a specific age and 11 months (e.g 6 years and 11 months). [2]The data source was extracted from Sandjaja et al. 2018, SEANUTS: South-East Asian Nutrition Surveys, supplemental Table 1 and Table 6.

were generally higher than those in the rural schools without "school meals", except the boys aged 6, 7, and 11 years old. The height-for-ages of the schoolchildren in the rural school with "school meals" were also generally more than those in the rural schools without "school meals" at the 3rd and 97th percentile values (Tables 2 and3).

*Weight-for-Age*

Tables 4 and 5 showed that the L values of the schoolchildren in Cambodia, the children in the pooled SEANUTS, and WHO were all lower than 1, meaning that the skewness of the body weight associated with those children had distributions to the right. Between the ages of 6 and 10, the medians (Ms) of the schoolchildren in Cambodia were much lower than those of WHO. However, the Ms of the schoolchildren in Cambodia and those of the pooled SEANUTS were not significantly different. The Cambodian schoolchildren aged 6 to 8 were heavier than the pooled SEANUTS, but lighter than them from the ages of 9 to 12. The Ss of Cambodia children were all higher than those of WHO but lower than those of the pooled SEANUTS. This indicates that the weight-for-age of Cambodian schoolchildren had a greater level of dispersion around the mean body weight compared with WHO but smaller than the pooled SEANUTS.

The Ms of the schoolchildren in the urban schools were all higher than those in the rural schools with and without "school meals". The Ms of the weight-for-ages of the schoolchildren in urban schools were all greater than the rural schools with and without "school meals"; furthermore, the Ms of the schoolchildren with "school meals" were generally higher than those in the rural schools without "school meals", except the boys aged 6 and 7 years. The Ss of the schoolchildren in the urban schools were all higher than those in the rural schools with and without "school meals". The Ss of the schoolchildren in the rural school with "school meals" were higher or lower than those in the rural school with "school meals" at a specific age (Tables 4 and 5).

From 6 to 10 years of age, the WHO children were much heavier than the schoolchildren in Cambodia and the children of the pooled SEANUTS at all percentile values. Cambodian schoolchildren aged 6-10 were heavier than those in pooled SEANUTS at the 3rd percentile value with the exception of girls aged 8 years who were lighter than them at ages 11 and 12 years. Cambodian schoolchildren were all lighter than the pooled SEANUTS' children at the 97th

percentile value at all ages. The weight-for-ages of the schoolchildren in the urban schools were the highest in the rural school with "school meals", followed by the rural school without "school meals" at the 3rd, 15th, 85th, and 97th percentile values. Except for some cases where the schoolgirls in the rural school without "school meals" were heavier than the schoolgirls in the rural school with "school meals" at 12 years of age at the 3rd and 85th percentile values, the schoolboys in the rural school without "school meals" were heavier than the schoolboys in the rural school with "school meals" at the age of 6 for all percentile values (Tables 4 and 5).

## 4. Discussion

One of the objectives of this study was to compare the child growth status between Cambodian cases and the pooled SEANUTS as well as the WHO growth reference; however, the sample size in Cambodia does not represent the whole country because they were selected from only two provinces and the capital city. 9 487 schoolchildren aged 6 to12 participated in this study, and the samples were measured annually for 5 years at the same schools. The pooled SEANUTS samples were 14 202 children aged 0.5 to12, the samples of two countries were population-based while the other two countries were school-based (16). The sample size used for the reconstruction of the WHO reference for school-aged children and adolescents aged 5 to 19 years were 22 917 (11 410 boys, 11 507 girls) (19). Although the sample size of Cambodia's cases was smaller than those of SEANUTS and WHO, it was sufficient for a case study; on the other hand, the samples of Cambodian schoolchildren were aged 6-12 while the samples of the pooled SEANUTS were 0.5 to 12 years of age and those of WHO were aged 5 to 19.

The comparison study of child growth among Cambodia, pooled SEANUTS, and WHO revealed that the child growth statuses in Cambodia and the pooled SEANUTS were different from that of WHO. According to the WHO reference, children aged 6 years should be from around 110 to 125 cm tall while below 110 cm is considered as stunted and over 126 cm is very tall (5, 7, 19). Theses standard assessment figures were the same as those in the height-for-age percentile values girls (6) and boys (8) aged 5 to 19 years in 2007 WHO reference and WHO height-for-age 6 girls (Table 2) and boys (Table 3) at the 3rd and 85th percentiles. The Ms of height-for-ages of the schoolchildren in Cambodia and the pooled SEANUTS were all always lower than WHO at the 15th percentile, and they were close to the 3rd percentile of WHO from in the age range of 6 to 12 for both girls

and boys. If the WHO height-for-ages reference is used to assess the children's growth status in Cambodia as well as the pooled SEANUTS, very high percentages of the children in these regions are considered as stunted due to the lack of nutritious food or diseases. These assessments might not reflect the real status of children's growth in these South-East Asian countries. Weight-for-age is also used to indicate a growth problem; a child with a weight plotted between the z-score 1 and -2, *i.e.* above 1, has a growth problem and below -2 is considered as underweight (20). According to the WHO reference, girls aged 6 years should be weighted from about 15 to 26 kg (13, 14). This range was between the 3rd and 85th percentiles in the present study (Tables 4 and 5). The weight-for-age of the schoolchildren aged 6 to 10 in Cambodia and those in the pooled SEANUTS at the 15th percentile were always between each specific age-0 month and specific age-11 months of WHO at the 3rd percentile of the same age (ages 6 to10) (Tables 4 and 5). This also indicates that children in Cambodia and SEANUTS are evaluated as underweight if the WHO references are employed as the reference to assess the weight status. The present case study and the reports of the pooled SEANUTS (15, 16) showed that WHO references are not suitable for assessing children's growth in these South-East Asian countries. Even though the children's growth in pooled SEANUTS seemed to fit Cambodian children's growth, national Cambodian children growth curves and references are crucial to accurately assessing their growth.

In Cambodia, the schoolchildren in the urban schools were generally taller and heavier than those in the rural schools with and without "school meals". This indicates that the children in the urban area had more nutritious food than other areas because their family had enough budget to spend on various kinds of food for their children. The malnutrition of schoolchildren in rural primary schools was caused by their poor family who did not have enough budget to spend on nutritious food. Physical accessibility of the children might be another reason why the schoolchildren in rural schools did not grow well because Cambodia is a developing country where health services are not enough for all people living in rural areas, and the families do not have enough money to pay for their children's treatment in a private clinic. On the other hand, the primary schools in Cambodia do not have any programs for investigating the schoolchildren's growth. The schoolchildren in the rural school with "school meals" were taller and heavier than those in the rural schools without "school meals", indicating that the school meal program has a positive effect on

providing nutritious food for children. In rural areas, there is no difference in the socioeconomic status of the schoolchildren's families; therefore, the schoolchildren in rural school with "school meals" grew better than those in the rural schools without "school meals" because the school breakfast was served in the school funded by the WFP. However, the conclusion in this research was made in accordance with the findings of one school with "school meals" selected for the study.

## 5. Conclusion

The schoolchildren in the rural schools without "school meals" lacks nutrient foods. Therefore school meal programs should be extended to primary schools in rural areas in order to promote those children's growth and health problems as well as to encourage them to participate in schools. The child growth status in the pooled SEANUTS might be able to be used temporarily as a reference to assess children's growth in Cambodia, but the WHO reference might not be accurate for assessing the Cambodian growth. Therefore, it might not be good if school personnel use WHO references to evaluate schoolchildren's growth in Cambodia. Since the samples in this study cannot represent the whole country, Cambodia should conduct more research by expanding the sample size with more diverse areas to make its own child growth standards and growth curve at each age.

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