



Using Anthropometric Indices to Assess Change in the Nutritional Status of A Population: A Case Study from Samosir District, Indonesia

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Abstract: Monitoring the growth of children under two years old needs to be carried out regularly to determine trends in nutritional status. Nutritional anthropometric data such as weight/age, height/age, and weight/height are important indicators in assessing nutritional status. The aim of this study was to analyze nutritional status based on the z-score of three anthropometric indices. This is a cross-sectional using secondary data taken web E-PPGBM from the year 2019-2022 in Samosir district. Around 17,349 data were taken from the web. The type of data collected was sex, age, birth weight and length, weight, and height of children aged 0-24 months. The z-score of weight/age, height/age, and weight/height was then analyzed by presenting the trend of each indicator. On average, there was an increase in z-score of weight/age and height/age in children aged 0-5 months and 6-11 months for girls and boys but not for weight/height. When entering aged 12-23 months z-score, girls z-score tend to decrease and boys ten to increase. However the range of z-score from -1.0 to 0.5. This study found that z-score of girls is higher than boys when they on ranged of age 0-12 months but when entering aged 13 months and upper, boys are more likely to have better nutrition than girls. Z-scores of three anthropometric indices in web E-PPGBM is powerful for analyzing nutrition trend.

Keywords: Anthropometric; Children; Nutritional status; Trend; Z-Score

Introduction

United Nations Children's Emergency Fund's (UNICEF) latest report on the State of the World's Children. It is estimated that almost half of all deaths in children under five are attributable to under-nutrition or about three million young lives a year (<http://www.unicef.org/>). Children under five years are more vulnerable to outside disruption. It is therefore a usual approach to use for monitoring the nutritional status of the under-5-years population and to draw conclusions of the whole population (Webb & Bhatia, 2005).

Anthropometric indices such as weight, weight-for-height/length, triceps skinfold and middle-upper

arm circumference performed well to detect of short term changes in the nutritional situation of a population. Height/Length-for-age has high correspond to long term change (Frison, 2016). Z-score is calculated for weight-for-height, weight-for-age, height-for-age, and BMI-for-age. Z score system expresses the anthropometric value as a number of standard deviations. Z-scores below or above the reference mean or median value (Mishra, 2020). Currently, Z-scores are routinely used in clinical practice to assess and monitor children's growth and nutritional status and in the analysis of data from child nutrition surveys (Mishra, 2020; Mutunga, 2021; Dah, 2022). Furthermore, the composite anthropometry analyses could explain how nutrition status of under five children (Widodo &

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Mulyati, 2010) and have good accuracy in determining nutrition status (Purwati & Amik, 2016). The first 1,000 days of life, age 0-2 years is known as the "golden period", it represents a critical and rapid phase of development that does not occur in any other age group (Simanjuntak & Wahyudi, 2021).

In contrast, the age range of 2-5 years is marked by various milestones developmental, encompassing language acquisition, creativity, social awareness, emotional development, and intelligence. Research findings indicate that to reach normal growth during golden period, there are several factors that influenced the child development and nutritional status, including family socio-economic status, exclusive breastfeeding and complementary feeding practices and nutritional intake. Routine growth monitoring during early childhood is essential to track nutritional status trends. Monitoring the trend of nutritional status using z-scores of anthropometric indices is a vital component of public health and nutrition programs because it can provide a quantitative and standardized means of assessing the well-being of children and populations (Frison, 2016) and WHO have been suggested to use the Z-score for child growth standards (Jones & Boag, 2007).

Weight-for-age (WAZ) and height-for-age z-scores are essential for monitoring weight and length gain in children (Razmpoosh et al., 2018; Yeasmin & Yeasmin, 2018; Ferreira, 2020). These indices can identify conditions of underweight, wasting and stunting. By tracking WAZ and HAZ over time, the healthcare professionals can assess the effectiveness of nutritional interventions and treatments (Frison, 2016; Gunawan & Ash shofar, 2018). Short term changes in the nutritional status of a population can be detected using weight, WFH/L, MUAC while H/LFA is a good measure of long term change (Ferreira, 2020).

The Indonesian Nutritional Status Study (SSGI) reported that wasting rates decreased from 7.4% in 2018 to 7.1% in 2021, prevalence of stunting decreased from 27.6 % (Kemenkes RI, 2018) to 24.6% (Kemenkes RI, 2021) and 21.4% (Kemenkes RI, 2023). While the prevalence of stunting in Samosir Regency decreased from 28.4% in 2021 to 26.3% (Kemenkes RI, 2023). However, the decreasing of stunting prevalence cannot be used to explain the condition of anthropometric status of children growth.

Currently Indonesia has launched a nutritional application and web called "Community-Based Nutrition Recording and Reporting System (E-PPGBM). This application can be used to monitor the implementation and achievement of community nutritional programs. In this application can be found various nutrition program such as breastfeeding coverage, supplementary feeding programs, and the z-scores of three indices of anthropometric; weight/age,

height/age and weight/height. Interpretation of these three anthropometric indices can be used for assessing nutritional status. Policymakers can use this data for planning and policy evaluation (Kemenkes RI, 2018).

Several studies found E-PPGBM information system can accelerate processes, streamline work, and enhance employee performance. It can be applied to determine food insecurity levels, assess the implementation of nutrition programs, and serve as a bridge between cross-sectoral stakeholders. However, the utilization of E-PPGBM data for these purposes has not been fully realized, while there are hundreds and thousands of data stored without further analysis.

The logical reason to raise z-score of three anthropometric indices because it can be a reliable way to do nutritional surveillance. It reminds district health office the importance of using e-PPGBM in expanding nutrition program and for legislators and medical professionals to be more closely monitor a population's nutritional state. In places where rates of malnutrition are on the rise, this data can be used to identify trends and patterns that will allow for focused interventions. The reason to study this topic because until now it is still very limited study using data from E-PPGBM to confirm the type of nutrition status of children and to motivate other health professional and researchers to run further analysis of E-PPGBM data.

The study aims to assess the trend in nutritional status changes by presenting z-score of three anthropometric indices: Weight-for-Age (WAZ), Height-for-Age (HAZ), and Weight-for-Height (WHZ) from the year 2019 until 2022 in Samosir district. While sex-specific data are routinely analyzed and reported in nutrition surveys, therefore in this study identify and understand sex differences.

Method

This study is a cross-sectional study using secondary data taken from nutrition data base in the web called "Aplikasi pencatatan dan pelaporan gizi berbasis masyarakat" (e-PPGBM) of Samosir Health Office. Here is representing the steps of the research. The first step involves accessing the e-PPGBM web platform. Afetraccessing, nagigating to the reporting features specifically children report and list nutrition status. Choose parameters such as age group, sex and year, then export the selected data into excel, including z-scores and indices of weight/age, height/age, weight/height. Finally, proceed with descriptive data processing as per research requirements.

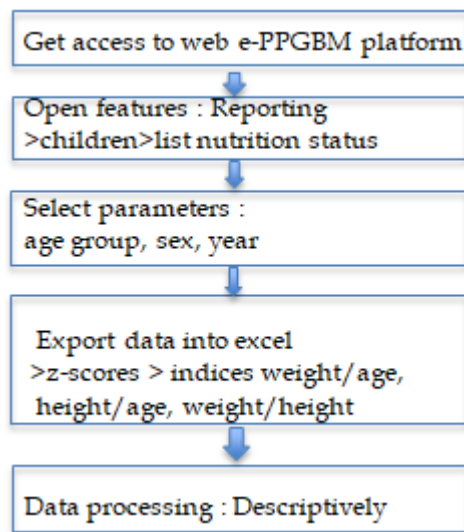


Figure 1. Steps of the research

Description of study location

Samosir Regency is an island surrounded by a lake called Toba Lake. It is a volcanic island located in the middle of Lake Toba in North Sumatra Province, the position is an altitude of 1,000 meters above sea level. The number of populations is only around 130,000 people, 18,000 of them are children under five years, consisting of 9 sub-districts, 6 sub-districts and 128 villages. The population density is 70 people/km². The majority of the population is Bataknese and earn money by farmers and fishing. Samosir district is a rice and corn producing center in North Sumatera (Badan Pusat Statistik Kabupaten Samosir, 2019). Samosir Health district office has been using E-PPGBM since year 2018. Data entry is mostly done by community midwife and staff of public health center called nutritional workers. Coverage of data entry was started by 20%, increase to 50 % and at year 2022 nearly 80%. Since year 2019, the training on E-PPGBM for health staff is once, therefore most data need to be validated.

Population and sample

The research population was all toddlers aged 0-5 years in Samosir Regency, while the sample size was 16,501 data on children aged 0-24 months from 2019-2022. Data on children exceeds the number of toddlers because the data source is the result of children's visits to growth monitoring post and entered into the E-PPGBM application.

Data collection

After obtaining password permission from the nutrition section of the Samosir District Health Service, then enter the E-PPGBM username and password. After the E-PPGBM application is open, then open the features: *report > children > nutritional status list*, then select location, age, time such as Province, Regency, Age.

Data sources taken were February and August 2019-2022. After the data has been successfully exported into the excel table, the next stage is data selection, removing incorrect data and averaging the z-score values for each weight/age, height/age and weight/height. The research targets were children aged 0-24 months, then grouped the target into gender and age; women and men, three age groups namely; 0-5 months old, 6-11 months old and 12-23 months old.

Data analysis

Data was analyzed using descriptive statistics. Data on the average z-score of three anthropometric indices presented in line graphic and making the trend graphs of each index such as weight/age, height/age, weight/height by sex and year. Steps to do data analysis; First, collect secondary data from e-PPGBM for 2019-2022. Data collected includes gender, age, birth weight and birth weight, current weight and birth weight. Secondly, calculate the z-score value of weight/age, height/age and weight/height. Then, presents the z-score value in a trend graph. The trend graph can be used to see the trend in the z-score value of each indicator. Finally, analyze the trends of each indicator based on the results of the analysis, it can be concluded that in general there was an increase in the z-score values of weight/age and height/age of 0-5 month, 6-11 month and 12-23 month age groups.

Result and Discussion

Number of samples

Total sample used in this study was 17,349 data, in detail numbers as presented in Table 1.

Table 1. Number of samples according to age group from 2019-2022

Periode (Year)	0-5 months	6-11 months	12-23 months	Total
2019	956	1130	1345	1131
2020	1200	1430	2176	4806
2021	1225	1587	2173	4985
2022	650	897	1490	3037
Total	3031	5034	9284	17.349

Table 1 shows that in the year 2019 number of samples less than year 2020, 2021 and 2022. Of the total 17.349 data, around 83.0% was data from children age 6-23 months and only 17% data from children aged 0-5 months. Figure 2 shows that for children aged 0-5 months, there was an increase of two indices; weight/age and height/age from 2019 to 2021 then in 2022 the z-score of those two indices increase sharply, while weight/height index decreased sharply from 0.73 to 0.27 SD.

Figure 3 shows that children aged 6-11 months, the z-score of three indices was stagnant in year 2019-2020, then in 2020-2022 there was a sharp increase of weight/age and height/age, while z-score of weight/height index decreased sharply from 0.01 to -0.24. Figure 4 shows that children in group age 12-23 months, the z-score of height-for-age increase sharply from -1.52 in 2019 to be -0.03 in 2022, while weight-for-height decreased slightly from 0.02SD to -0.33. They were presented in Figure 2, 3, 4.

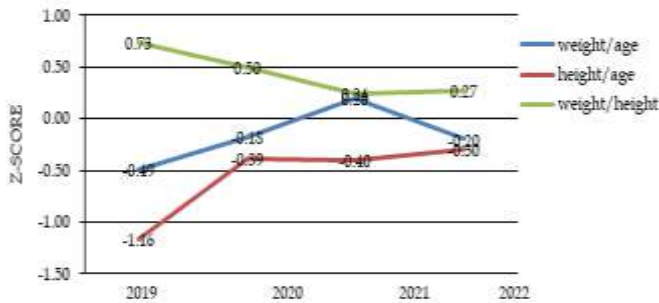


Figure 2. Z-score weight/age, height/age and weight/height of boy 0-5 month

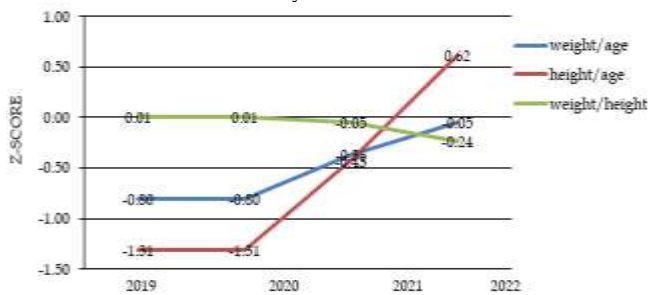


Figure 3. Z-score weight/age, height/age and weight/height of boy 6-11 month



Figure 4. Z-score weight/age, height/age and weight/height of boy 12-23 month

Figure 4 shows that for girl children aged 0-5 month there was a slight decreasing of two indices; weight/age and weight height from 2019 to 2022. While for height/age the decrease is sharply from 0.84 to 0.54. Figure 5 shows that the three indices are down and up for girl aged 6-11 months. There was a sharply increasing and decreasing of height for age z-scores

during observation years. In year 2021 to 2022 the z-score of weight/age and height for age are increasing sharply from -0.5 to 0.26 while weight for height index is almost stagnant at 0.01.

Figure 6 shows that the two indices (weight/age and weight/height for girl aged 12-23 months tend to increase during observation years. There was a sharply increasing of height for age z-scores from -1.55 to -0.14 during observation years. While weight/height index is slightly decrease from 0.13 to -0.16.

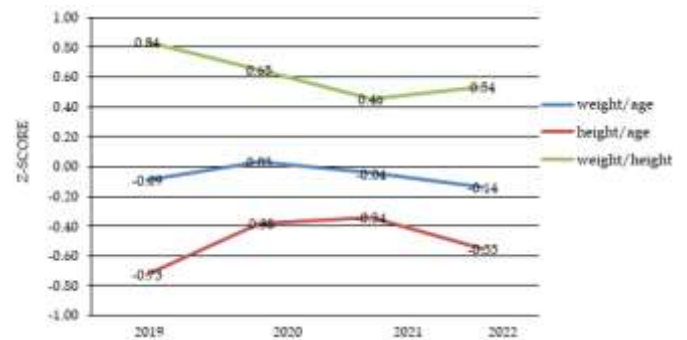


Figure 5. Z-score weight/age, height/age and weight/height of girl 0-5 month

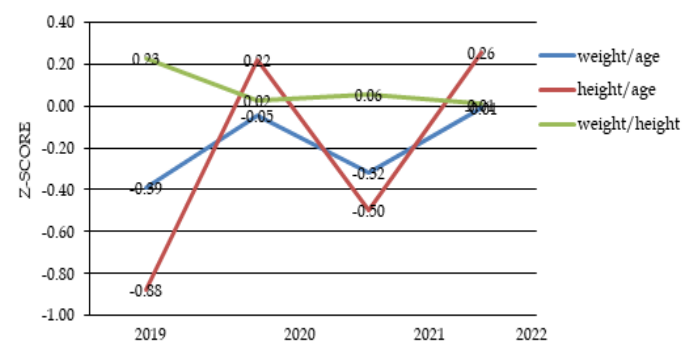


Figure 6. Z-score weight/age, height/age and weight/height of girl 6-11 month

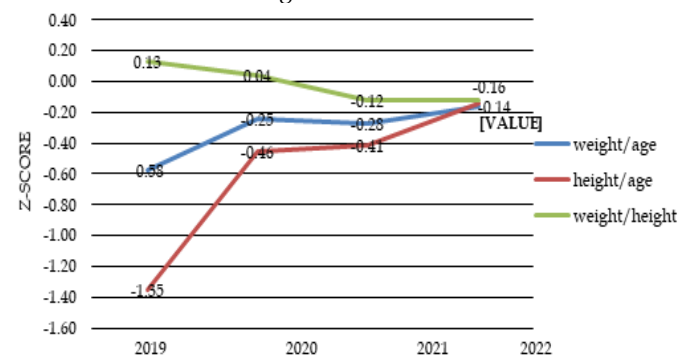


Figure 7. Z-score weight/age, height/age and weight/height of girl 12-23 month

Discussion

The aim of this research is to analyze the trends of three anthropometric indices of under two years children during year 2019 until 2022. This study found that the z-score of weight-for-age and height-for-age

tend to increase while weight-for-height decrease. In term of sex, nutrition status of girl is better when aged 0-6 months but boys status are better in aged 12-23 months. This shows that in general nutritional status of children aged 0-23 months however z-score still in the lower of normal standard as can be seen from the graphical processing of the data showed that the Z-scores for the three anthropometric indices generally ranged from -1.0 to 0.5 SD

Trend of anthropometric indices

Z-scores of anthropometric indices are powerful tools to identify malnutrition at an early stage. This study tracked the z-scores of three anthropometric indices over time. In average, z-score of weight-for-age and height-for-age tend to increase but weight for height tend to decrease. This findings have similar to several survey conducted in Indonesia (Kemenkes RI, 2018; Kemenkes RI, 2021; Kemenkes RI, 2023) and Yogyakarta (Siswati, 2022). In these survey the prevalence of stunting tend to decrease and height-for-age Z-score tend to increase.

Z-Score trends of weight/age and height/age

This study found that there was an increase in the average Z-score weight/age and height/age in children aged 0-5 months and 6-11 months for both for girls and boys. This indicates that children in this age group tend to increase in weight and height consistent with healthy growth. This increase is a positive indication of effective nutrition efforts and good child care. Similar findings in Yogyakarta, the average body length or height of male and female children from 2018- 2021 increased (Siswati, 2022). However, it is contrary with a study in sub-district in Samosir, children who have normal birth weight tended to be stunted or height/age lower than -2SD (Damanik, 2023). Low indices of weight/age and height/age and sickness had been found since previous years in several sub-districts in Samosir (Yesica, 2013; Situmorang & Saragih, 2021).

Z-Score trend of weight/height

This study proved that Z-score weight/height of children with age group 0-5 months did not increase significantly. This could indicate that there are other factors that influence body weight relative to height in this age group. Findings of this study explained that even though nutrition status of children is normal but there is a sign that children tend to have a risk to be wasted. As it is explained by Ermatita & Destriatania (2022), if Z-score of weight/age and height/age increase but weight/height is lower, the child's condition tend to be malnourished. Recent studies have similar findings to this study (Handayani et al., 2012; Perdani et al., 2017).

Greater attention of actual sex differences is needed within the field of nutrition. This finding does not match with a systematic reviews study in which more literatures explain that boys under five years have more higher risk to have undernutrition malnutrition and stunted (Thurstans, 2020; Wamani, 2007). Z-score monitoring is a reliable way to do nutritional surveillance (Dah, 2022). It makes it possible for legislators and medical professionals to closely monitor a population's nutritional state. This study found the z-score range in a normal range, -1.0 to 0.5, means that children include into categorize normal and healthy (Kemenkes RI, 2020; de Onis, 2006).

However, Samosir government should be aware of the condition of children nutrition status because Samosir have more low income families (Badan Pusat Statistik Kabupaten Samosir, 2019; Nadeak et al., 2022), hence the trend weight/height signs that children tend to be malnutrition. This indicator found in an anthropometric study in preschool children from fourteen daycare centers linked to the Department of Health and the Federation of charities (FEAS) in Santo Andre, Brazil (Shoeps, 2011). Actually Samosir should maximize the effectiveness e-PPGBM platform as nutrition information management strategy to improve the achievement of nutrition program as it has been practiced by UNICEF with its Community Level Nutrition Information System for Action in Africa (Sabitu, 2004).

The weaknesses of this study are the source of data, anthropometric tools to get weight and height. Source of data is from the lowest level of data management that is from growth monitoring post (posyandu). In this level the recording and reporting system is weak. Various measurements tools used over time during three years of data collection possibly affected the accuracy of data collection and recording that collected by used measurement over three period years. Therefore, for future research needs to concern the internal validity and for further research is suggested to study the factors that might influence weight/height z-score particularly for girls and compare z-score to percentile as it can present difference results (Sudiman, 1982).

Conclusions

Z-scores for the three anthropometric indices generally ranged from -1.0 to 0.5 SD. there was an increase in the average Z-score weight/age and height/age in children aged 0-5 months and 6-11 months for both for girls and boys Nutrition status of girl is better when aged 0-6 months but boys status are better

in aged 12-23 month. Z-scores analysis has a powerful for analyzing nutrition trends.

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Author Contributions

The first author, Haripin Togap Sinaga contributed to research design, instrument preparation, data collection and analysis, and article writing. The second author, Ignasius Simbolon, was also instrument preparation data processing and analysis and writing article.

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Conflicts of Interest

The authors declared no conflict of interest.

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