

Subnational Hunger Index (GHI-SN), Validity and Reliability to Assessing Health Inequality In Children Under Five in Indonesia

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ABSTRACT

Global hunger index (GHI) is a global measurement to assess the level of hunger and undernutrition in children under five at the global, regional and national levels. Using a subnational global hunger index (GHI-SN) with a simple indicator can be used to compare health status in each level and monitoring of health program achievement considering the global target. However, the validity and reliability of the subnational hunger index need to be adjusted. This objective study to ensure validity and reliability subnational global hunger index to assessing health inequality in children under five in Indonesia. Method. This is secondary data analysis using aggregate data prevalence of malnutrition and child mortality based on national basic health research survey report (2007, 2010, 2013,2018) and demographic survey report in 2002, 2012, 2017. Subnational hunger index was calculated in four domain (prevalence undernutrition, stunting, wasting and child mortality) that has been standardized previously. The validity and reliability of each domain and GHI-SN score were calculated to asses construct validity and reliability within indicator by period. Bivariate analysis using Pearson was used to asses correlation and similarity with another index, therefore can be considered to be an alternative and comparable index. Results. The subnational Global hunger index score was a descendant of GHI that it is performed by four domains. Validity construct using factor analysis shows the total percentage of variance was 56.32%, and each domain was reliable between period. Reliability analysis shows Cronbach Alpha Coefisien > 0.90. Pearson correlation between GHI-SN and Health Index status of children under five (IPKM) 2013 and 2018 and IKPS index shows a strong correlation with r : -0.8: -0.67, respectively. Conclusion. Subnational Global Hunger Index (GHI-SN) was valid and reliable and can be used to be an alternative measurement tool to asses health inequality and hunger in children under five in Indonesia.

Keyword: *GHI, Subnational hunger index , Children under five*

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1. INTRODUCTION

The double burden of malnutrition in children under five is the most public health problem worldwide. The recent national survey in most countries shows the high prevalence of undernutrition, whereas it only slightly decreases in the last decade. Otherwise, there is an increasing rate of obesity and related disease (Akombi, Chitekwe, & Sahle, 2019). In developing countries, 88% (124 countries from 141 countries) have malnourished children under five, and 29% (41 countries) have high levels of malnutrition. The prevalence of malnutrition in the world in children under five is 3.62% or 15.95 million children are stunted and wasted, while 1.87% under five or 8.23 million increase in stunting and overweight (Development initiatives, 2018).

World Health Organization (WHO) reports that hunger and malnutrition are threats to major health problems in the world. Hunger is a condition inability to acquire adequate intake to the daily minimum dietary energy requirement (Webb, 2018). The level of hunger reflects a relationship with poverty and an unhealthy environment. According to concepts of hunger Wiesmann et al, whereas it described in four indicators: prevalence of stunting that reflects chronic undernutrition, the prevalence of wasting to reflect acute undernutrition. children undernourishment that related to calory intake insufficient and

child mortality reflect a fatal mix of inadequate nutrition and unhealthy environment, GHI Scores was calculated (Welthungerhilfe, 2018).

GHI score is one of the comprehensive measurement tools that was designed to represent the level of hunger and undernutrition in the global, regional and national levels. The last GHI score showed a level of hunger at a global level declined from 29.2 to 20.9 in 2017 but it still was categorized at a serious level. The scores vary in each region. The most country in Asia shows GHI core in moderate and severe levels of hunger. It means children undernutrition still be a public health problem with high prevalence in some developing country (Welthungerhilfe, 2018).

Indonesia was classified at a serious level of hunger based on the National GHI score 2017 but it only represents a problem of hunger at the national level. National basic health research survey (Riskesdas) 2018 showed the proportion of malnutrition and underweight status in children under five was 17.7%, while the proportion of stunting 30.8%, and the proportion of wasting was 10.2% (National Institute Health Research And Development, 2019). Whilst, nutrition status has disparity due to varies characteristically of the environment.

Moreover, monitoring and controlling the health program was done by the decentralization approach. Therefore, it requires tools to measure health program achievement output in sub-national and district level (Hosseinpour et al., 2016). This objective of this study is to assess validity and reliability global hunger index in sub-national level to describe health inequality status in children under five in Indonesia

2. MATERIALS AND RESEARCH METHODS

2.1. Research design

This is secondary data analysis using aggregate data from two cross-sectional surveys; national basic health research survey report (Riskesdas) in 2007, 2010, 2013, 2018 and Indonesia demographic health survey in 2002, 2012, 2013 (SDKI). This survey was conducted in 541 districts and 34 provinces of Indonesia to represent national and regional health status in population with a multistage cluster sampling method.

2.2. Population and sample research

The population of this study was all data of the household that was reported in Riskesdas or SDKI surveys. The sample was a household that has children under five, measure high and weight and was calculated of nutrition status prevalence in each province as a sub-national level.

2.3. Collection / research stages

We get aggregate data of prevalence of nutrition status in series time from Riskesdas report in 2007, 2010, 2013 and 2018 (National Institute Health Research And Development, 2008, 2013, 2019). The child mortality rate was obtained from the DHS survey report in 2002, 2012 and 2017 (Planning, Agency, Ministry Of Health, & USAID, 2018). Entry and cleaning data was done before analysis. Compute index composite using the GHI calculation index. Then, we measure the validity and reliability of the index. Estimate the relationship with another index. Further analysis to assess the determinant factors that related to the index.

2.4. Data analysis

Data management and statistical analyses were performed using IBM SPSS 21 (IBM Corp., Armonk, NY, USA) and STATA. The GHI-SN score was calculated and adapted from the Global Hunger index calculation method that was performed in 3 dimensions and 4 indicators, whereas using three steps process. The first, we draw from available data to capture the multidimensional nature of hunger. They are the prevalence of

stunting, wasting, undernourishment and child mortality at each sub-national level. Second, all prevalence was standardized with denominators that were used in a global standard. Based on the highest observed level for the indicator on global scales in recent decades (Welthungerhilfe, 2018). Third standardized scores are aggregate to be GHI –SN score.

Each dimension of the GHI component contributes to equal 1/3 of the score. The inadequate food supply that was represented by children undernourishment (PUN), child undernutrition that was performed by stunting and wasting, child mortality that was performed by children under-five mortality (CMR). Stunting (CST) and wasting (CWA) contribute equally to weight 1/6 of the score. This three-step process results in GHI Score sub-national ranging 0-100, 100 reflect zero hunger and show the severity of hunger in line with decrease score of GHI –SN (Welthungerhilfe, 2018).

The denominator that was used to standardized score in each indicator based on a threshold set slightly above the highest prevalence of each indicator observed in worldwide 1998-2013. The highest prevalence of undernourishment (PUN) worldwide is 76.5. So the denominator is 80, the denominator for stunting based on highest prevalence is 70, the denominator of wasting based on highest prevalence is 30, the denominator of child mortality is 35. The aggregate score is the prevalence of each indicator divide into a standardized denominator and multiplication with weight. The summarize of GHI score method shown in the equation below (Welthungerhilfe, 2018)

$$\text{GHI score} : (1/3 \times \text{PUN}/80 \times 100 + 1/6 \times \text{CWA}/30 \times 100 + 1/6 \times \text{CST}/70 \times 100 + 1/3 \times \text{CMR}/35 \times 100)$$

GHI SN scores describe the level of hunger in each province in Indonesia. Validity construct by factor analysis was calculated to shows the percentage of variants contribute in a composite index (Larsson, Tegern, Monnier, & Skoglund, 2015; Strauss & Smith, 2009; Yahgmale, 2003). Reliability analysis by time using Cronbach Alpha Koefisien, whereas > 0,6 shows that this instrument reliable. GHI-SN score was analyzed by a parametric Pearson correlation to a similar index that was used previously and has a complicated variable.

IPKM (Public Health Development Index) is an index to describe health status in Indonesia that was performed in 30 indicator and divide into 7 sub index : (1) Health status in children under five sub index that was performed by 6 indicator (Proportion of stunting, proportion of wasting, , proportion of overweight, frequency of measurement of weight during last 12 month until survey was conducted, neonatal visited program, complete of immunization); (2) Reproduction health sub index that was performed by 3 indicator (using contraceptive method, pregnancy antenatal care, proportion of chronic energy malnutrition in women of childbearing) ; (3) Health service sub index that was performed by 5 indicator (delivery birth in health center with medical staff, ratio of doctor in sub district level, ratio of integrated service center (posyandu) in village level, ration midwife in village level, health assurance proportion in village level); (4) Health behavior sub index that was performed by 5 indicator (smoking behavior, hand washing behavior, open defecation free, physical activity, teeth brush activity) ; (5) Non communicable disease sub index that was performed by 6 indicator (hipertention, injury, diabetes mellitus, Mental emotional disorder, central obesity, dental and mouth health); (6) Infectious disease sub index that was performed by 3 indicator (pneumonia, children under five diarrhea, acute Respiratory Infectious disease); (7) Health Enviromental that was performed by 2 indicator (sanitation, clean water access). All indicator has different

weight considering a wide of exposure, outcome, urgent, visibility to reduce it (Badan Litbang Kesehatan, 2018).

IKPS (Performance of Reducing Stunting Index) is an index to describe five domains that represent the main indicator to combat stunting based on the INEY framework (Investing Nutrition in Early Years 2018) of the world bank. (1) Health domain that was performed by 1 indicator (complete immunization); (2) Nutrition domain that was performed by 3 indicator (exclusive breastfeeding, dietary diversity, inadequate intake) ;(3) Food access domain that was performed by 1 indicator (food insecurity experience scale) ; (4) House living that was performed in 2 indicator (safe drinking water, improved sanitation) ; (5) social protection that was performed by 1 indicator (birth certificate)(Statistik, 2017).

Validity test using factor analysis to assess construct validity. The reliability analysis using coefficient Cronbach alpha was done to measure the reliability of indicator and index over time. Further analysis carried out by STATA using longitudinal panel data analysis with random effect models. These to assess determinant factors related to the index and to describe inequality of outcome that was observed.

3. RESULTS AND DISCUSSION

The index is a statistical aggregate that was performed by some of the indicators into one value, to measure a relative change of variable in a wide variety of areas and overtime. Change of value of index estimating a trend of indicators performance so can be used to monitoring and evaluation (Chakrabarty & Campus, 2018). However, index score value can not directly measure in individual assessment because it was performed more than one variable and must considering a weight. Therefore, the index score has a cutoff point of score to classify of diagnosis that was obtained from a previous study or adjustment expert. In population, using index can represent of disparity status of indicator variety within in area borders. The index also was known as the composite score to standardized value to be more comparable and measurable.

Table 1. Validity and Realibility Indicator GHI-SN score

	Mean	SD	Realibility Test Cronbach Alfa	Validity Test Construct Validity
Prevalence of Undernourishment			0.96	
2007	20.41	5.30		
2010	19.84	5.98		
2013	21.67	5.62		
2018	19.28	4.58		
Prevalence of Wasting			0.63	
2007	15.78	5.77		56.31%
2010	13.54	2.98		
2013	12.57	2.32		
2018	11.06	2.06		
Prevalence of Stunting			0.87	
2007	36.88	6.57		
2010	35.55	7.37		
2013	38.22	6.09		
2018	30.36	5.35		

Children Mortality Rate (percentage)

0.91

2007	5.72	1.78
2012	5.07	2.28
2017	6.27	1.87

Global Hunger Index is one of an international index that reflects the level of hunger worldwide. Based on the global concept of hunger, GHI was performed by three dimensions and four categories. The first dimension shows inadequate food supply that was performed by children's prevalence of undernourishment. This indicator is the lead of international hunger targets including the SDGs. Inadequate food supply is an important indicator of hunger that refers to both adults and children. The second dimension is child undernutrition that represents inadequate intake of food either quantity, quality, poor utilization due to infections or other illness or a combination of them. These caused by household food insecurity, inadequate maternal health or childcare practice or inadequate access to health services, safe water, and sanitation. The third dimension is child mortality that represents a serious consequence of hunger (Welthungerhilfe, 2018).

Based on the original global hunger index score calculation method that was adopted in the global hunger index in 34 sub-national levels (GHI-SN) shows a mean of indicator in table 1, with reliability and validity test. The reliability test was calculated within indicators over time. Otherwise, construct validity was used to the total variance of each indicator contribute to the score (Larsson et al., 2015). Table 1 shows slightly decrease of prevalence of nutrition status in children during last decade. Proportion of undernourishment, wasting, stunting tends to decline. Stunting is a major nutrition problem in children under five with high prevalence more than 30%. However there is progress achievement to reduce stunting in 2018. Reliability test between time showed that all indicator are reliable to be indicator of measurement with Cronbach Alpha Coefficient >0.96. And for indicator has total of variance 56,31%. In means more than a half of hunger can be explained with the indicator.

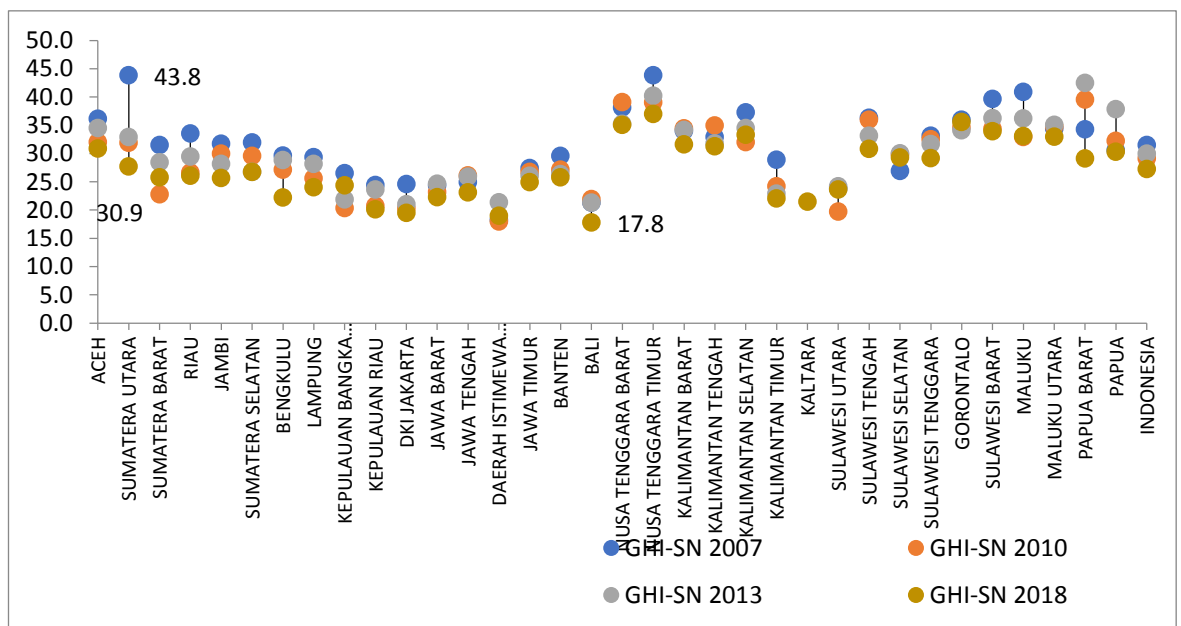


Figure 1. Global Hunger Index-Subnational (GHI-SN) in 2018 Indonesia

GHI score was classified following criteria: score ≥ 50.0 defined extremely alarming, 35.0-49.9 defined alarming, 20.00-34.9 defined serious level, 10.0-19.9 defined moderate and ≤ 9.9 defined low (Welthungerhilfe, 2018). Figure 1 shows the GHI score was calculated and classify at the subnational level. Based on figure 1, most of the province has the GHI score higher than GHI score in national levels. Nusa Tenggara Timur has the highest score in GHI-SN. It means NTT has the level of hunger in severe condition (alarming) more than another province. DIY has the lowest score of $< 20\%$ in GHI-SN since 2007. Sumatra Utara was shown has a significant toward progress combating hunger from 43.8 in 2007 to 30.9 in 2018.

Table 3. Validity, Realibility GHI-SN score and relationship with IPKM and IKPS index

	Mean	SD	Realibility Test Cronbach Alfa	Koefisien Korelasi	R Square
Global Hunger Index Sub National (GHI-SN) within year					
- 2007	31.50	6.3	0.96		
- 2010	29.08	6.1			
- 2013	29.95	5.7			
- 2018	27.38	5.2			
Global Hunger Index Sub National (GHI – SN) Correlate (between)					
GHI 2013					
- IPKM 2013	0.53	0.04		-0.83	0.69
- Health Indeks for Children Under Five 2013	0.60	0.04		-0.81	0.65
GHI 2018					
- IPKM 2018	0.63	0.04		-0.86	0.762
- Health Indeks for Children Under Five 2018	0.66	0.06		-0.81	0.657
- IKPS	72.95	8.06		-0.67	0.440

The reliability test shows the Cronbach alpha coefficient of more than 0,9. It means the prevalence of child nutrition status and child mortality was stable and can involve to index. Table 3 shows that the level of hunger shows tend to decline during the last decade despite still at a serious level. GHI- SN shows a strong correlation with another index either IPKM and IKPS that has a more complex variable with correlation coefficient > -0.8 and -0.6 respectively. It means the highest score of hunger has a strong relationship with the lowest score in IPKM and IKPS. GHI 2018 can represent the public health development index in 60-75% and represent the program to reduce stunting in IKPS 44%.

Constructing of GHI index at a sub-national level can classify the level of hunger in subnational. The results of this study that GHI-SN was valid and reliable. The previous study that conducted in Ethiopia shows the subnational global hunger index to assessing progress in region level outcome (Schmidt & Dorosh, 2015). However, the calculation of this index could be overestimated. It is influenced by the potential miss value that we used to calculate it. Therefore to get valid measurement, a variable that was involved has to derive from the right sample method survey or complete data routine. That can represent a generalization of a population that was observed. Children's mortality rate value has been transformed in 1000 life birth to adjusted. A previous study that was conducted shows that death that is not caused by a common form of illness related to nutrition is not suitable to measure the extent of hunger. Children mortality due to specific condition Natural disaster, earthquake, and war have to consider to exclude from the involving variable(Biesalski, 2015).

Multivariate analysis was used to assess the determinant factors that related to the GHI-SN index and indicator that was involved (table 3).

Table 3. Determinant of GHI-SN and each indicator that was involved

Variable	ρ^*	R Squared (overall)	Errors (overall)	Koefisien
GHI-SN		12.54%	4.91	
Capita Expenditure	0.00			-4.05
Prevalence of undernourishment	of	11%	4.34	
Capita expenditure	0.06			-3.59
Protein	0.00			-0.13
Prevalence of Stunting		31.90%	3.73	
Capita expenditure	0.00			-6.02
Protein	0.00			-0.37
Prevalence of Wasting				
Capita expenditure	0.00	17.89%	1.95	-4.89
Prevalence of Child Mortality				
Capita Expenditure	0.00	25.33%	1.36	1.36
Calorie	0.00			0.01
Protein	0.00			-0.25

*) Analysis was carried out using linear regression to longitudinal panel data, random effect models . Panel : Subnational (province) , Time : Year)

GHI-SN represents hunger and undernutrition and also the inequality of health. The results show that the level of hunger was influenced by the socioeconomic status that was predicted by capita expenditure. These approximately 12.54% can be explained. Capita expenditure also related to the prevalence of wasting, approximately 17.89%. The prevalence of stunting was determined by socioeconomic and protein consumption approximately 31.9%. Otherwise, the prevalence of child mortality was predicted by 25% by socioeconomic status, calorie consumption, and protein.

According to the conceptual framework from Unicef, shows that growth and development status in children was influenced by the quality of the home environment (Engle, 1999). A previous study that was conducted in American, African and Caucasian

shows quality of home environment related to children achievement (Baharudin & Luster, 1998). Quality of the home environment plays an important role in the link between family socioeconomic and child development (De Oliveira, Barros, Da Silva Anselmi, & Piccinini, 2006).

4. CONCLUSION

Subnational hunger index can be used to subnational level as a valid and reliable index to assessing hunger and undernutrition in children under five, whereas this is the outcome of inequalities of health.

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