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Has COVID-19 influenced household food security in the Timorese population?

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Abstract

Food scarcity as an effect of the COVID-19 pandemic has caused famine around the world. The solution of the COVID-19 problem, will involve the minor elements of the community, such as overcoming household food security. This cross-sectional study was carried out to assess whether composite index of household food security, nutrient intake, nutritional status, individual and household dietary diversity score with food and agricultural organization measuring household and individual dietary diversity score among the Timorese family with toddlers' population during pandemic period, using interviews and direct measurements of respondents, involving 1444 participants. Areas prone to food insecurity had a lower average index score than food-insecure areas. There was a strong correlation between the index score and the level of nutritional adequacy of children under five in: energy, protein, fat, calcium, iron, zinc, and vitamin B12. In addition, the index scores also had a strong positive correlation with the dietary diversity of children under five years old, as seen from the individual dietary diversity score (IDDS) score with r value 0.231 (p value 0.000). There was a strong positive correlation between the index score and the nutritional status of children under five according to body weight for age (BW/A), height for age (H/A), and body weight for height (BW/H). In general, the index developed from this study described the status of household food security. In addition, the total index score could be a fairly strong predictor of nutrient intake and nutritional status in children under five years old.

1. Introduction

As of March 12, 2020, the Coronavirus Disease 2019 (COVID-19) had been confirmed in 125,.048 people all over the world, with high mortality rate of around 3-7%, compared to a mortality rate of influenza which was less than 1%. Pandemic also affects the social and food security sectors, both in individuals and community levels. The resolution of the COVID-19 problem, especially on social impacts, involve the minor elements of the community, such as overcoming household food security. Therefore, issues related to food security challenges all countries because food availability have a relation to the economy and be the main factor in achieving the quality of human life (Gibson, 2012; Derek *et al*., 2020).

According to FAO (2009a), food security is the condition of food availability for everyone, both in quantity and quality (Pourreza *et al*., 2018). The availability of the right to food is the key to overcome hunger (Pérez-Escamilla, 2017). World data from study reports from Rosen *et al*. (2015) stated that the number of people who consumed calories below the recommended in 2015 reached 13.4%. This data generally occurs in developing countries and is projected to increase to 15.1% in 2025. Food insecurity indirectly causes the problem of malnutrition (Gödecke *et al.,* 2018). The need for food, along with the world population, which is estimated to increase from 7.3 billion to 9 billion in 2050, requires regular production systems and consumption patterns that are adjusted to take policy action (FAO, 2018) and increase agricultural

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productivity by 30-40% (Mango *et al*., 2014) so that the need for food can be fulfilled.

Achieving food and nutrition security, especially with various resources alone, is not easy due to its complexity. Barret (2010) and Cafiero *et al.* (2014) reported that the various metrics and indicators proposed are unequal and convey different information for food security and the indicators are difficult to apply, which would affect validity and reliability, thus limiting their potential empirical relevance (FAO 2012; 2017).

These three pillars are fundamental determinants of food security and are hierarchically related. Food availability is a mandatory, but it can't guarantee that every people have adequate access to it. Food availability refers to the physical availability of food in the neighborhood in sufficient quantities and every individual has access to it. Food access refers to the ability to access food that is already available either through the medium of exchange (market) or through transfer (institutional). Food utilization refers to the allocation and processing of food obtained (accessed) so that each individual gets adequate food intake (FAO, 2018) as a component to be included and analyzed in the food security index. This will be a better guidance for policy maker to address the issues regarding food security in one area. The complexity that arises from describing food security is the difficulty to measure the food security, a central role is needed in discussing the benefits of various indicators, and there is no single indicator that can be used to capture all the dimensions identified from the problem of food and nutrition security (Godfrey *et al.,* 2010).

Methods of measuring food security and nutrition at the global level include the GFSI (Global Food Security Index) and HANCI (Hunger and Undernutrition Index). Meanwhile, the Ministry of Agriculture and World Food issued at the national level, such as the FSVA (Food Security and Vulnerability Atlas of Indonesia). The indicators still get fragmented by sub system and not all indicators can be applied in different regions, it depends on the characteristic of the area. Several single indicators are strong predictors of food security at the household level, such as the proportion of food expenditure and the diversity of household dietary. The two indicators can be used as a standard reference in developing a new instrument such as a composite index. One of the age groups at the most significant risk of undernutrition due to household food insecurity is children under five years old or toddlers (Augustin *et al*., 2016). Referring to the UNICEF framework, food security at the household level is one of the indirect factors causing nutritional status through the intake of food nutrients.

Therefore, the programs that concern about food security should be integrated into joint efforts of politic, economic, and social aspect to mobilize the awareness of how important of the accurate information systems in providing fast and timely information. Of course, this will help overcome the problem of changing food consumption patterns during the COVID-19 pandemic. The assessment of the composite index of household food security during the COVID-19 pandemic needs to develop and to be linked to nutrient intake and nutritional status of children under five years old. This can be achieved through an overall food and nutrition security evaluation method by utilizing indicators available in Kupang, East Nusa Tenggara, which are valid for measuring regional food security during the covid 19 pandemic.

This study aimed to assess the household and individual food security, nutritional adequacy, nutritional status among family with children under five years old during the COVID-19 in Kupang, East Nusa Tenggara, Indonesia.

2. Materials and methods

This research design was a cross-sectional and data collection was conducted in Timorese in Kupang district, East Nusa Tenggara, Indonesia. Sample was taken from Timorese family children under five years old and 1444 families participated in this study. The data collection was taken place from 15 March 2021 to 21 June 2021. The questionnaire was piloted on a sample of 30 to test its validity and reliability, and all of the data obtained from the pilot study were not included in the final analysis. A total 1444/1600 (90.25%) participants had completed the survey.

The research data were carried out by food availability, access to markets. The economic access variable consisted of two types of data, food prices and household income. Data on household dietary diversity was collected through the 24 hours food recall method, earlier, using the Household Dietary Diversity Score (HDDs) indicator. Food consumption level in children included the level of nutritional adequacy (energy, carbohydrates, protein, fat, calcium, iron, zinc, vitamin B12) that will be categorized (Excess, normal, mild deficit, medium deficit, heavy deficit, low, adequate), and the diversity of diets/IDDS scores (Individual Dietary Diversity Score). Nutritional status included body weight for age (BW/A) will be categorized as (Severely underweight, underweight, normal, overweight) height for age (H/A) will be categorized (severely stunted, stunted, normal), and body weight for height (BW/H) will be categorized (severely wasting,

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wasting, normal, overweight) and anthropometric measurements using standard weight and stature meters.

Based on the researcher's definitions, the proportions of the three aspects were divided into the following details: 40% physical aspects, 35% social aspects and 25% economic aspects. After the transformation and weighting process was executed, a mathematical equation of the index was formed through the merging or aggregation method. The composite index equation formed from this study was Total Score of the Household Food Security Index (TSHFSI) = $0.24X_{11}$ + $0.16X_{12}$ + $0.21X_{21}$ + $0.14X_{22}$ + $0.15X_{31}$ + $0.10X_{32}$). The index preparation involved six types of indicators, including mother's education (X_{31}), father's education (X_{32}), income per capita (X_{21}), food prices (X_{22}), food availability (X_{12}), travel time to the market (X_{12}). The index scores were grouped into four categories based on the researcher's justification, namely Very Food Security (VFS) if households scored 75-100; food security (FS) with a score of 60-75, moderate food insecurity (MFI) with a score of 50-60, and severe food insecurity (SFI) with a score of 0-50.

This study also applied bivariate analysis by conducting a composite index score validation test through the Spearman's rank correlation test against the two standard benchmark indicators, the HDDs and the proportion of food expenditure. Another correlation was to examine index scores on nutritional status, nutritional adequacy level, dietary diversity (IDDS) in children. The type of correlation test applied was Pearson Product Moment, depending on the normality of the data. Another bivariate analysis in this study used the One-Way Anova difference test followed by the tukey test. The different test is used to see the difference in index scores based on the region's vulnerability to food insecurity.

3. Results and discussion

3.1 Socio-demographic registry

This study has 1444 total of respondents. During the COVID-19 lockdown, the sense of hunger and satiety changed for more than half of the population. During the quarantine there would have been a reduction of the consumption of fresh food, followed by vitamins and minerals deficiency, including vitamin C and vitamin E and beta-carotene with antioxidants and anti-inflammatory properties. The deficiency of these micronutrients is associated with both undernutrition and impaired immune responses, thus making more susceptible to viral infections. Table 1 shows all the respondents' characteristics. Based on gender of respondents, female/girl respondents (57.1%) are dominating compare to male/boy respondents (42.9%). Children who participate in this study were 1-3 years old (58.2%), and the remaining 41.8% were 3-5 years old. Civil servant, military and police was the most dominant type of the father's occupation (33.7%). The proportion of father's occupation as a farmer was 25.4%. Meanwhile, almost half of the children's mothers (35.4%) are housewives or did not work permanently. Some mothers work as private sector employee (5.7%).

Table 1. Socio-demographic parameters.

Characteristic variable	Total	
	N	%
Age		
12 - 36 month	841	58.2
37 - 60 month	603	41.8
Gender		
Boys	619	42.9
Girls	825	57.1
Father's occupation		
Farmer	367	25.4
Fisherman	135	9.4
Trader	261	18.1
Private sector employee	194	13.4
Civil servant/Military/Police officer	487	33.7
Mother's occupation		
Housewife	511	35.4
Trader	273	18.9
Farmer	258	17.9
Private sector employee	82	5.7
Civil servant/Military/Police officer	320	22.1
Household size		
Small ≤ 4 persons	461	31.9
Medium 5-6 persons	603	41.8
Big ≥ 7 persons	380	26.3

The grouping process of children's age was determined based on the division of the age range in the Table of Indonesian Recommended Dietary Allowances (RDA). Children from early life to 3 years old need nutrients to support brain development which has long-term consequences (Keating *et al*., 2014). Table 1 shows the proportion of child subjects by gender. Children under five years old who lack nutrient intake can cause nutritional problems/malnutrition. According to WHO (2018), malnutrition can lead to death and reduces the health status of children under five (Barret, 2010).

According to Ochieng *et al*. (2017), children and women in households with a father as head of household have significantly more diverse diets than households with woman as a head of household. Meanwhile, mothers' work as housewives is strongly correlated with good food security conditions in the family (Suryana, 2014). This is related to the frequency of mothers are at home to be involved in the food making process started from buying the ingredients to provide food for

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household members (Santeramo, 2015). The proportion of small-sized households was 31.9%, and 26.3% were included in large-sized households. According to Mango *et al*. (2014), a small household size can guarantee better food security. The smaller the family size, the more food opportunities for everyone in the household to eat. This becomes important thing in improving the optimal nutritional status of each individual in the household (Cusick *et al*., 2016). The presence of many children in the family usually causes limited resources to meet household needs. In addition, limited access to households in providing nutritional quality food can have implications for suboptimal nutritional conditions in children (Yeganeh *et al*., 2018).

3.2 Household food access indicators

Table 2 summarizes how the respondents access the food. The highest average food availabilities in households after rice were oil (248.7), sugar (151.8) and fresh fish (159). Overall, the average energy provided by all types of food is 1740 kcal/cap/day. This study also wants to know the distance between the households to the nearest market by asking how much time the respondents need to reach the traditional market. The result discovered that most household in Timorese (47.9%) need five to ten mins to reach the traditional market. The range time indicates that most households located close to the market and the households and have easy access to food sources. This study also examined the relation between household income and food purchases. The result indicates that most households (65.3%) had incomes below the regional minimum wage while the remaining household 36.7% had income above the regional minimum wage. Regarding food price, animal-based foods for protein (chicken, beef and eggs) appeared to be relatively expensive compared to the price for staple foods (rice, cooking oil and sugar). Overall food prices were above the maximum and minimum price range at the National Strategic Food Price Information Center (PIHPS) within one month of data collection. Table 2 also shows the distribution of education level of parents. Most of the fathers (39.0%) and mothers (30.4%) had a history of education, most of the parents were graduated from secondary education. The study results explained that the proportion of lower expenditures (more than 50% of households) still dominated most households by 59.1%.

Food availability is the main element in food security, especially the physical presence of food sourced from own production, purchases in the market and gifts/ transfers. Measuring food security at the household level generally uses indicators of food availability expressed in the energy content of food. Food availability expressed in calories/cap/day has been widely used in survey activities because it is closely related to household income and expenditure (Mango *et al*., 2014; Adepoju *et al*., 2015). Staple foods are the primary energy source, especially in the developing countries (Petralias *et al*., 2016). The highest average food availabilities in households after rice were cooking oil (248.7), sugar (151.8) and fresh fish (159). Cooking oil is an important staple food because every household consumes cooking oil for cooking needs. Based on the food outlook analysis report, there has been an increase in cooking oil consumption per capita in Indonesia. It started in 2014 with an average consumption of 9.10 kg/ capita/year and in 2013 continued to show an increase to 23.30 kg/capita/year. This is projected to continue to increase until 2019.

The study results showed that most 47.9% households reach to the traditional market in 5 to 10 mins. The travel time range indicates that most households have access to the closest market from their house and get an easy access to food sources. According to Joshi and Joshi (2017), household food security is significantly negatively related to access or distance to reach the nearest traditional market. The closer the market, the more secure the food in a household is. The house's location close to traditional markets can facilitate household food access at any time and can reduce transportation costs and allocate income for food purchasing (Gurmu and Etana, 2013).

Economic access as an element of food access can be reflected in the total income of each household member (Parvathama 2015; Ahmed *et al*., 2017). The income from all households originates from the main job, financial assistance, and side work. Income data is calculated using the unit of time of the month, which is commonly used in many studies. Households with incomes below the regional minimum wage are vulnerable to food insecurity (Hamad and Khasroum, 2016). According to Ilhab *et al*. (2015), low income impacts the decreasing of household food purchasing. The food purchased for low-income household is generally less healthy and less varied compared to families with high incomes (French *et al*., 2019). Limited access to household food can impact the quality of food consumption and individual diets, especially in children and ultimately affect children's nutritional status (Dave and Cullen, 2012). The increase in food prices impacts households being forced to access cheaper or less nutritious food (Mkhawani *et al*., 2016). When food prices rise, households will replace foods high in protein, vitamins, and minerals with foods high in carbohydrates. This is because the prices of staple foods (rice, corn, cassava) and foods which is low in complex nutrients are generally lower than fruits, vegetables and animal

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Table 2. Household food access indicators.

Food group (kcal)	Rice	Corn	Chicken	Egg	Cooking Oil	Sugar	Instant noodles	Fish	Total
	939±382	74±31.6	20±21.9	29±32.5	248.7±237.3	151.8±92.8	19.3±26.9	59.0±110.3	1540.2±935.8
Time needed to reach the market	< 5 mins	5-10 mins	10-15 mins	15-20 mins	> 20 mins				
(%)	19.2	12.9	13.4	6.4	49.1				
Total Income (%)	< minimum wage	minimum wage							
	36.7	65.3							
Education level	None	Elementary	Junior School	High School	University				
Father (%)	3.3	21.3	39	19.5	16.9				
Mother (%)	1.6	20.1	30.4	28.9	19				
Food Expenditure (%)	Low	Adequate							
	59.1	40.9							

Table 3. Distribution on diversity of food consumption and food type groups consume.

Categories	Nutrients															
	Energy		Protein		Fat		Carbohydrate		Calcium		Iron		Zinc		Vitamin B12	
	n	%	n	%	n	%	N	%	n	%	n	%	n	%	n	%
Excess	95	6.6	188	13	248	17.2	507	35.1	N.A		N.A		N.A		N.A	
Normal	604	41.8	371	25.7	634	43.9	616	42.7	N.A		N.A		N.A		N.A	
Mild deficit	359	24.9	208	14.4	166	11.5	137	9.5	N.A		N.A		N.A		N.A	
Medium deficit	240	16,6	297	20.6	266	18.4	113	7.8	N.A		N.A		N.A		N.A	
Heavy deficit	146	10.1	380	26.3	130	9	71	4.9	N.A		N.A		N.A		N.A	
Low	N.A		N.A		N.A		N.A		943	65.3	1037	71.8	674	46.7	1135	78.6
Adequate	N.A		N.A		N.A		N.A		501	34.7	407	28.2	770	53.3	309	21.4
Average±SD	94±21.6		76.2±18.2		83.1±25.7		91±28.4		69±43.2		63.6±32.9		84.6±54.1		61.3±39.5	

N.A: Not applicable

protein sources. If household members are accustomed to only consuming staple foods and few other foods, it will make the needs for protein, fat, and micronutrients are not fulfilled (Green *et al*., 2013; Darmon and Drewnowski, 2015). However, an imbalance between intake of macro and micronutrients will increase the risk of stunting and poor health (Vellakal *et al*., 2015). High food prices will reduce individual food consumption and ultimately risk malnutrition, especially in children (Melani, 2014; Russel *et al*., 2018).

3.3 Dietary diversity

Table 3 shows 86.6% of households had a fairly high HDD score. The average score of HDDs as a whole was 6.3. Food's group with quite high level of consumption by most households in Timorese are cereals (100%), sugar and sweeteners (90.2%), oils and fats (93.7%), seasonings and spices (89.4%) (Figure 1). Table 3 shows that the subjects under five years old had consumed grains, nuts, fruits and other vegetables with the respective proportions of 99.8%, 78.4% and 68.1%. However, subjects' consumption proportion are quite low in the meat and egg food category, with the proportions of 42.5% and 49.4%, respectively.

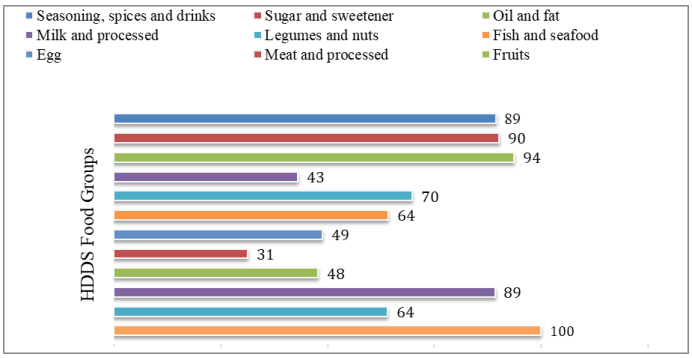

Figure 1. Distribution of households by food group consumed.

Dietary diversity illustrates household consumption over a certain period and is an important indicator of food security. According to Russel *et al*. (2018), the diversity of food consumption is an indicator of food insecurity in households. The results obtained as presented the Table 3 showed that 86.6% of households had a fairly high HDD score.

The average score of HDDs as a whole was 6.3. Melani (2014) supports the results of this study, where most households in agricultural agro ecology areas (72.7%) have high HDD scores. The food consumed by each individual in determining the HDDs can be obtained through several ways such as self-cooking, buying, and through assistance or giving. Households in this study generally provide the food by cooking the food and buying the food. The main menu for the family, such as rice and side dishes, generally are home cooked meal. Meanwhile, processed food menus, including snacks, are mostly consumed by children in the household from the nearest food stalls. Several factors that contribute to the low consumption of this food group are income level, type of work, gender, household size, and community knowledge of food and nutrition (Powell *et al*., 2017; Mukherjee *et al*., 2018).

A qualitative assessment of food consumption for toddlers can be viewed from the diversity of food consumption (Humphries *et al*., 2015). According to Cardona Cano *et al.* (2015), most preschool children aged 3 years old are able to choose their food. Picky eating is a temporary behavior and part of normal development in preschool children. Picky eating behavior (pocky eating) in preschool children harms the growth process, nutritional status, development, physical activity, and health status of children (Chao, 2018).

According to Santiago-Torre *et al*. (2014), the type of food consumed by children is influenced by the availability of family food. According to Scaglioni *et al*. (2018), parents' eating habits and eating strategies are the most dominant determinants of children's eating behavior, especially dietary diversity. Parents should teach their children various excellent food choices because it becomes a good role model for children. According to Temesgen *et al*. (2018), main meal frequency is positively related to dietary diversity. The IDDS score used to assess dietary diversity is strongly related to the adequacy of macro and micro nutrients for toddlers (Habte and Krawinkel, 2016). This indicates that poor dietary diversity in children under five can impact the fulfillment of nutritional needs in the short term and nutritional status in the long term (Viloria and Barrion, 2018).

3.4 Nutrient adequacy level

Table 4 shows that most children under five years old experienced a severe deficit for the level of protein adequacy (26.3%). Meanwhile, fat (43.9%) and carbohydrate (42.7%) nutrients in children under five years old were normal. The average value reinforced this data in all subjects for the adequacy of energy (94%), fat (83.1%), carbohydrates (91%) and protein (76.2%). Most children under five years old were in deficient levels of calcium (65.3%), iron (71.8%) and vitamin B12 (78.6%). The rest, there were still children under five years old with adequate calcium, iron and vitamin B12 with a proportion of 34.7%, 28.2% and 21.4%, respectively. Meanwhile, at the zinc adequacy level, most children under five years old were in the sufficient category, with a proportion of 53.3%. The rest were of the children under five years old with a low zinc adequacy level (46.7%). Overall, the level of adequacy of iron, calcium

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and vitamin B12 in children had an average of 69%, 63.6% and 61.3%.

Table 4. Distribution of children under five of age based on the level of adequacy of nutrients.

Categories	n	%
Household Dietary Diversity Score (HDDS)		
Low (≤ 3 food types)	52	3.6
Moderate (4-5 food types)	141	9.7
High (≥ 6 food types)	1251	86.6
Average±SD (Proportion)	6.3±1.8	
Individual Dietary Diversity Score (IDDS)		
12 - 36 Months		
≥ 4 food types (good)	529	62.9
< 4 food types (low)	312	37.1
37 - 60 Months		
≥ 4 food types (good)	356	59.0
< 4 food types (low)	247	41.0
Boys		
≥ 4 food types (good)	384	62.0
< 4 food types (low)	235	38.0
Girls		
≥ 4 food types (good)	501	60.7
< 4 food types (low)	324	39.3
Grains/grains, roots and tubers	1441	99.8
Vitamin A rich fruits and vegetables	457	31.6
Egg	713	49.4
Group of beans and legumes	1132	78.4
Dairy Products (breast milk, milk, yoghurt, cheese)	853	59.1
Meat Products (meat, fish, poultry, or other organs)	614	42.5
Other fruits and vegetables	983	68.1

Lack of nutrient intake in children under five can cause malnutrition problems such as stunting, being underweight, and wasting (Branca *et al*., 2015). Lee (2014) states that there is no shortage of aggregated protein intake in children under five in Southeast Asian countries. However, protein food sources need to be considered because most of the protein intake in toddlers comes from rice and other cereals that contain lower protein or lack of essential amino acids. Overall, the average value of fat and carbohydrates adequacy level was 83.1% and 91%, respectively. According to Baek *et al*. (2018), most of the calories (23%) of children aged 1-5 years old, come from fat. The main food sources of carbohydrates come from vegetables, grains, dairy products, fruits and milk. Certain grains and vegetables, including corn and potatoes, are high in starch, while sweet potatoes are high in sucrose (Slavin and Carlson, 2014).

3.5 Nutritional status

Anthropometric measurements using weight scale and stature meter for height. Three anthropometric indices are often applied in determining the nutritional status of children under five years old, weight/for height Z-score (WHZ), weight for age Z-score (WAZ), and height for age (HAZ). Based on the height for age (HAZ) indicator, it can be seen that the majority of the nutritional status of the subjects were in the normal category with a proportion of 70.2%. From gender's perspective, girls generally had a better mean z-score (-1.1) than boys (-1.8%). This is supported by the prevalence of stunting in boys (42.5%) and girls (20.2%). The results also show that the overall number of stunt toddlers and severely stunted toddlers was still quite high, with proportions of 7.4% and 22.4%, respectively.

The results obtained in this study related to the distribution of children based on the classification of nutritional status were described in Table 5. Based on the indicators of weight for height z-score (WHZ) in Table 5, most toddlers' nutritional status was in the normal category with a proportion of 81.8%. In addition, in the WHZ indicator, there were severely wasted and wasted subjects with a proportion of 3.0% and 10.0%, respectively.

Based on the indicators of weight for age Z-score (WAZ) in Table 5, most toddlers' nutritional status was in the normal category with a proportion of 72.3%.

In addition, the underweight indicator has been universally used as an indicator of the MDGs (Millennium Development Goals) related to poverty and hunger (Beal *et al*., 2018). Handling underweight toddlers must be done as early as possible because it is related to the child's current condition. Malnutrition/ being underweight can impact the physiological processes of the child's body and increase the risk of death. Types of physiological disorders can occur: increased fat accumulation in the central region of the body, high blood pressure, inhibited fat oxidation, and dyslipidemia (Black *et al*., 2013). According to Beal *et al*. (2018), the determinants of the incidence of stunting in Indonesia include maternal failure in exclusive breastfeeding for the first 6 months, low household socioeconomic status, premature birth, short birth length, and low maternal height and education level of parents. Taking control of these factors is important because chronic malnutrition/stunting has several adverse effects such as the increased risk of child mortality, decreased cognitive and motoric development, increased risk of malnutrition and non-communicable diseases, and reduced productivity in adulthood (Payab *et al*., 2014).

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Table 5. Distribution of toddlers based on the classification of nutritional status.

Anthropometric index	Boys		Girls		Total	
	n	%	n	%	n	%
Weight for age Z-Score (WAZ)						
Severely Underweight	32	5.2	40	4.9	72	5.0
Underweight	132	21.3	179	21.7	311	21.5
Normal	452	73.0	592	71.7	1044	72.3
Overweight	3	0.5	14	1.7	17	1.2
Total	619	100	825	100	1444	100
Average±SD (*z-score)*	-1.3±0.8		-1.5±1.2		-1.4±1.2	
Height/length for age Z-Score (HAZ)						
Severely stunted	72	11.6	35	4.2	107	7.4
Stunted	191	30.9	132	16.0	323	22.4
Normal	356	57.5	658	79.8	1014	70.2
Total	619	100	825	100	1444	100
Average±SD (*z-score)*	-1.8±0.9		-1.1±0.7		-1.5±0.8	
Weight for Height Z-score (WHZ)						
Severely wasted	18	2.9	25	3.0	43	3.0
Wasted	53	8.6	92	11.2	145	10.0
Normal	521	84.2	660	80.0	1181	81.8
Overweight	27	4.3	48	5.8	75	5.2
Total	619	100	825	100	1444	100
Average±SD (*z-score)*	-0.9±1.4		-1.3±1.6		-1.1±1.5	

3.6 Household food security index validation

After the transformation and weighting process was performed, a mathematical equation of the index was formed through the merging or aggregation method. The composite index equation formed from this study was Total Score of the Household Food Security Index (TSHFSI) = $0.24X_{11} + 0.16X_{12} + 0.21X_{21} + 0.14X_{22} + 0.15X_{31} + 0.10X_{32}$. The index preparation involved six types of indicators, including mother's education (X_{31}), father's education (X_{32}), income per capita (X_{21}), food prices (X_{22}), food availability (X_{12}), travel time to the market (X_{12}). Furthermore, the index scores were grouped into four categories based on the researcher's justification, namely food secure (FS) if the household scores 75-100; mildly food insecure (MFI) with a score of 60-75, moderately food insecurity (MoFI) with a score of 50-60, and severely food insecurity (SFI) with a score of 0-50. A total of two reference indicators were used for the index score validation process, the Dietary Diversity Score or HDDs (Household Dietary Diversity Score) and the proportion of food expenditure. The results obtained as shown in Table 6 show that most household with a good proportion value were food secure (63.2%) and food insecure (52.6%) households. On the other hand, most households with a low proportion value were categorized as moderate (88.2%) and severe food insecurity (88.7%). Severely food insecure households owned the average proportion of 34.3%, and 52.9% was food secure (FS). Meanwhile, the proportion value of 61.4% was experienced by households with moderate food insecurity conditions and 73.1% for households with severe food insecurity.

The statistical analysis results showed that the HDD score was significantly positive (p = 0.000) with the index score. These results concluded that households with food security conditions had better diversity to meet household nutrient intake. Table 6 show that almost all households (>50%) had an HDD score of more than or equal to 6 types of food for all index score categories. However, households that still consumed less than six types of food were in severe food insecurity at 32.8%. On average, households with the category of very food insecure had a fairly high HDD score of 7.9. Meanwhile, the average HDD score for households in the insecure food category was 7.3, while households with moderate food insecurity were 5.4. Households with food insecurity conditions had the lowest average HDD score of 4.1

Several studies have proven that each indicator is positively correlated with household food security conditions (Parvathamma, 2015). Multiply the data from the transformation by the weight value of each indicator added together produces a Total Score of the Household Food Security Index (TSHFSI)) with a minimum value of 0 and a maximum of 100. A total of two reference indicators were used for the index score validation process, the Dietary Diversity Score or HDDs (Household Dietary Diversity Score) and the proportion of food expenditure. Ogundari (2017) has used these two indicators to describe the condition of food security at

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Table 6. Households and the proportion of food expenditure and HDDS by category index score.

Index score category	Food expenditure proportion category		Proportion of food expenditure (mean±SD)	HDD Score categories		HDD Score (mean±SD)
	Adequate (≤ 50%) n (%)	Lack (>50%) n (%)		< 6 food types n (%)	≥ 6 food types n (%)	
Food secure (≥ 75)	337 (63.2)	196 (36.8)	34.3±19.7	21 (3.9)	512 (96.1)	7.9±2.7
Mildly food insecure (60-75)	191 (52.6)	172 (47.4)	52.9±21.2	37 (10.2)	326 (89.8)	7.3±3.2
Moderately food secure (50-60)	29 (11.8)	217 (88.2)	61.4±23.8	36 (14.6)	210 (85.4)	5.4±3.8
Severely food insecure (≤ 50)	34 (11.3)	268 (88.7)	73.1±25.3	99 (32.8)	203 (67.2)	4.1±1.3
p-value (r)		0.000 (0.233)			0.000 (0.255)	

Spearman correlation test, significant on p<0.01

the household level in Nigeria. An indicator of the proportion of expenditure positively related to energy consumption, dietary diversity, and household income.

3.7 Food secure index

Table 7 displays that most households categorized as severe food insecurity (65.6%) were in priority area 1. While priority areas 2 and 3 were inhabited mainly by households in moderate food insecurity with 48.9% and 31.3%. A total of 45.1% of households with food secure conditions (FS and MFI) lived in priority area 3. In general, most households (36.9%) fall into food secure with an overall index score of 68.7. Meanwhile, the proportion of moderately and severely food insecure categories also showed with the same score 37.9%. The remaining 25.1% of households can be said to have food insecure conditions. Overall, food secure or priority 3 areas have an average index score of 63.3. This score is higher than the average index score in priority area 1 (46.1) and priority area 2 (55.1). Priority area 6 has the highest number of food-insecure households (FS and MFI), namely 301 households or 97%. The bivariate analysis stated that the index score had a significant difference (p = 0.000) between regions as a whole. The data shows that the index score compiled can be used to see a picture of the region based on the level of vulnerability to food insecure.

3.8 Nutrient intake and index score

The statistical analysis results in the Table 7 could not prove a relationship (p>0.05) between the level of carbohydrate adequacy and the index score. Table 8 describes the statistical analysis results with a strong correlation (p = 0.000) between IDDS scores and index scores. The results of the bivariate analysis showed a strong positive correlation (p<0.01) between the nutritional status of children and the index scores measured by all types of anthropometric indices (weight for height, height for age, and weight for age). Based on the results of the bivariate analysis in the Table 8, the index score had a strong positive relationship with children's level of nutritional adequacy, particularly fat, energy, protein, calcium, vitamin B12, iron, and zinc. Table 8 describes the statistical analysis results with a strong correlation (p = 0.000) between IDDS scores and index scores.

The results of the bivariate analysis in Table 8 show a strong positive correlation (p<0.01) between the nutritional status of children and the index scores

Table 7. Index scores of food vulnerability level.

Region category		Index score category				Index score (Mean±SD)
		FS[g]	MFI[h]	MoFI[i]	SFI[j]	
		n (%)	n (%)	n (%)	n (%)	
Priority 1[a]	n = 212	3 (1.4)	7 (3.3)	63 (29.7)	139 (65.6)	46.3±8.1[l]
Priority 2[b]	n = 188	5 (2.7)	14 (7.4)	92 (48.9)	77 (40.9)	55.1±7.9[m]
Priority 3[c]	n = 217	38 (17.5)	60 (27.6)	68 (31.3)	51 (23.5)	63.3±8.0[m]
Priority 4[d]	n = 219	119 (54.3)	75 (34.2)	11 (5.1)	14 (6.4)	69.8±7.5[n]
Priority 5[e]	n = 298	180 (60.4)	94 (31.5)	8 (2.7)	16 (5.4)	76.2±8.1[o]
Priority 6[f]	n = 310	188 (60.6)	113 (36.4)	4 (1.4)	5 (1.6)	83.4±6.9[o]
Total	n = 1444	533 (36.9)	363 (25.1)	246 (17.0)	302 (20.9)	68.7±9.8
P-value[k]				*0.000*		

[a]Regions with high food insecurity conditions, [b]Areas with moderately food insecurity conditions, [c]Regions with low food insecurity conditions, [d]Areas with low food security conditions, [e]Regions with moderate food security conditions, [f]Areas with high food security conditions, [g]Highly Food Resistant, hFood Security, [i]Moderate Food Insecurity, [j]Heavy Food insecurity, [k]Significant p-value<0.05 with One Way ANOVA difference test. Values under the index score column with different superscripts are statistically significantly different.

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measured by all types of anthropometric indices (WHZ, WAZ and HAZ).

The HDD score is highly recommended to assess household access to energy from food (Leroy *et al*., 2015). In addition, the HDDs score indicator has been validated in Indonesia to assess household dietary diversity based on food security status (Baliwati *et al*., 2015). The results of the study of McDonald *et al*. (2015) explained that diverse food intake was proportional to the condition of food-secure households. Under these conditions, households can obtain and provide better and more diverse food for family consumption. This can affect the convenience of individuals in the household to consume quality food in terms of nutrition (Grobler, 2016).

Tukey's further difference test results indicated that households living in food-insecure areas (priority 3) had a higher index score and were significantly different from households in areas with severe food insecurity (priority 1) and moderate (priority 2). This indicated that areas at risk for food insecurity had a higher number of households with food-insecure conditions. Most households with a low average income or poor generally live in areas that are at risk of being vulnerable to food insecurity (McDonal *et al*., 2015; Grobler, 2016). Yuniarti *et al*. (2017) reported that almost all households in the study area had low food security conditions due to poverty. In addition to socioeconomic factors, areas without food were also caused by food availability factors in the region (Hapsari and Rudianto, 2017). According to Widiyanto (2018), alternative programs in overcoming food insecurity at the regional level increase local food production and expand access to people's livelihoods.

Table 8. Correlation between index scores and nutrient adequacy levels.

Nutrient adequacy level	Index score	
	r	*p-value*
Energy	0.152	0.007[a]
Protein	0.249	0.000[a]
Fat	0.275	0.000[a]
Carbohydrate	0.072	0.238
Calcium	0.212	0.000[a]
Iron	0.29	0.000[a]
Zinc	0.238	0.000[a]
Vitamin B12	0.152	0.000[b]
Dietary diversity (IDDS score)	0.231	0.000
Weight for Height Z-Score (WHZ)	0.33	0.000[a]
Weight for Age Z-Score (WAZ)	0.251	0.000[b]
Height for Age Z-Score (HAZ)	0.211	0.000[a]

[a]Spearman correlation test is significant at $p<0.01$
[b]significant at $p<0.05$

4. Conclusion

A high index score indicated a low proportion of food expenditure. Index scores were positively correlated with household dietary diversity. Areas prone to food security had a lower average index score than food-insecure areas. There was a strong correlation between the index score and the level of nutritional adequacy of children under five years old in: energy, protein, fat, calcium, iron, zinc, and vitamin B12. In addition, the index score also had a strong positive correlation with the dietary diversity of children under five years old, as seen from the IDDS score. There was a strong positive correlation between the index score and the nutritional status of children under five years old according to body weight for age (BW/A), height for age (H/A), and body weight for height (BW/H). In general, the index developed from the research results described the status of household food security. In addition, the total index score could be a fairly strong predictor of nutrient intake and nutritional status in children under five years old.

Conflict of interest

The authors declare no conflict of interest.

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