Volume 16, Number Supplement 1, February 2021

ISSN 1978-1059
EISSN 2407-0920

# JURNAL GIZI DAN PANGAN
## JOURNAL OF NUTRITION AND FOOD

Vol. 16 No. Supp.1, February 2021

Supplementary Issue:

The 1st IPB International Conference on Nutrition and Food (ICNF) 2020

18–19 November 2020

1ST ICNF
IPB INTERNATIONAL CONFERENCE ON NUTRITION AND FOOD 2020

Published by:

Food and Nutrition Society of Indonesia

Department of Community Nutrition, Faculty of Human Ecology, IPB

Jurnal Gizi dan Pangan

Volume 16, Number Supplement 1, February 2021



9 771978 105189

**Jurnal Gizi dan Pangan**
**(Journal of Nutrition and Food)**

**ISSN : 1978-1059** **(printed)**
**EISSN : 2407-0920** **(electronic)**



Publication Frequency : Three times a year (March, July, and November)

Editorial Address : Secretariat of Jurnal Gizi dan Pangan (Journal of Nutrition and Food)
Department of Community Nutrition, Faculty of Human Ecology,
IPB University, Dramaga, Bogor 16680
Telephone : (0251)8621363
Email : jgp@apps.ipb.ac.id

**Jurnal Gizi dan Pangan (Journal of Nutrition and Food)** is routinely published three times per year since 2006 and received accreditation from Ministry of Research, Technology, and Higher Educational Decree Number 28/E/KPT/2019 in 26 September 2019. This journal focuses on research publications in the fields of nutrition and food encompasses topics related to biochemistry aspect, clinical nutrition, community nutrition, functional food, socio-economic, and regulation in nutrition and food information.

This supplement issue of the Indonesian Journal of Nutrition and Food features the presentations given at the "1st IPB International Conference on Nutrition and Food 2020 (ICNF 2020)" organized by the Department of Community Nutrition, IPB University in Bogor, Indonesia, which was held online on 18–19 November 2020.

These papers were reviewed by the Scientific Committee of ICNF 2020 before their presentation, but they did not undergo the conventional reviewing system of the Indonesian Journal of Nutrition and Food.

The Indonesian Journal of Nutrition and Food, Bogor, Indonesia

# EDITORIAL MESSAGE

The 1st IPB International Conference of Nutrition and Food 2020 (ICNF 2020) was the first international conference that is fully organized by the Department of Community Nutrition, IPB University. The event was aimed to be a platform where academia, researchers, private sectors and general public can get updates on nutrition and food, ranging from clinical nutrition, community nutrition, and food innovation topics.

The organizing committee of the ICNF 2020 had chosen to focus on Nutrition and Food Innovation for Better Life as the theme of the conference and there was a total of 97 oral and poster presentations delivered in the two-day online conference on 18–19 November 2020, coming from variety of countries.

The ICNF 2020 is supported by the Indonesian Journal of Nutrition and Food as one of the publishing partners to publish articles in original research paper format. In this supplement issue, there are articles that have been presented at the ICNF 2020 from the three main topics, with the authors varied from variety of academic and research institutions. We hope that this supplement issue can contribute as a source of scientific information in the field of nutrition and food for our readers.

Editor in Chief

Prof. Dr. Ir. Dodik Briawan, MCN

*ISSN 1978-1059*
*J. Gizi Pangan, Volume 16, Number Supp.1, February 2021*

# MANUSCRIPT REVIEWERS & EDITORS

Prof. Dr. Ir. Ali Khomsan, MS
(*Head of Scientific Committee ICNF 2020*)

Prof. Dr. Ir. Sri Anna Marliyati, M.Si

Prof. Dr. Ir. Dodik Briawan, MCN

Dr. Rimbawan Rimbawan

Dr. Ir. Budi Setiawan, MS

Dr. Ir. Cesilia Meti Dwiriani, M.Sc

Dr. dr. Mira Dewi, M.Si

Dr. Zuraidah Nasution, STP, M.Sc

Dr. agr Eny Palupi, STP, M.Sc

Anna Vipta Resti Mauludyani, SP, M.Gizi

dr. Karina Rahmadia Ekawidyani, M.Gizi

Muhammad Aries, SP., M.Si

Hana Fitria Navratilova, S.Gz., M.Sc

Purnawati Hustina Rachman, S.Gz., M.Gizi

*Available online: http://journal.ipb.ac.id/index.php/jgizipangan* ***J. Gizi Pangan, March 2021, 16(1):1-10***
*Accredited based on DGHE, Republic of Indonesia No. 28/E/KPT/2019* *DOI: 10.25182/jgp.2021.16.1.1-10*
*ISSN 1978-1059 EISSN 2407-0920*

# Evaluation of Food and Nutrition Security Level at Provincial Level Based on Outcome Indicators in Indonesia

**Andra Vidyarini[1*], Drajat Martianto[2], Hidayat Syarief[2]**
[1]Program Study of Nutrition Science, Faculty of Health Sciences, Prof. Dr. Hamka Muhammadiyah University, South Jakarta 12210, Indonesia
[2]Department of Community Nutrition, Faculty of Human Ecology, IPB University, Bogor 16680, Indonesia

## ABSTRACT

This study aims at evaluating the situation of Food and Nutrition Security (FNS) at provincial level using six outcome indicators. The cross-sectional study, utilized secondary data from 33 provinces published in 2013. It used a modification of the Global Hunger Index (GHI) method and changed the number of outcome indicators. In addition, an equalization was performed, so that the results obtained were positive. The results showed that all provinces in Indonesia have moderate or less secure food and nutrition level. Hence, the performance of the Indonesian government in food and nutrition security need to be improved. Bali Province had the highest rank in food and nutrition security, while East Nusa Tenggara and Papua Province had the lowest ranks of the 33 provinces during 2013. The low performance achievement of food and nutrition security based on the six outcome indicators signified by the high prevalence of the undernourished population and the high prevalence of stunting and wasting of children under five in all provinces in Indonesia.

**Keywords**: evaluation, food and nutrition security, outcome indicators

## INTRODUCTION

Efforts to achieve food security have become a global concern because of its implications for economic and national resilience (FAO 2005; Godfray & Garnett 2014; Maricic *et al.* 2016). In the last few decades, food security development has shown state of improvement in several countries in Asia and America, yet there are still gaps in several aspects, one of which is nutrition (FAO/IFAD/WFP 2014). Food insecurity and nutritional problems are interrelated in achieving food security; hence, it is necessary to integrate nutritional aspects in food security development (FAO 1996; Fanzo 2014; Keino *et al.* 2014; FAO 2012). The unachieved objective of food and nutrition security development in an area can be seen from the nutritional problems arising. For instance, the emergence of nutritional problems in vulnerable age groups such as stunting, underweight and micronutrient deficiency problems (Black *et al.* 2008; Ng *et al.* 2014; Bruce *et al.* 2004).

Currently, the efforts to address food and nutrition security in Indonesia have not been fully synergized with the efforts to improve nutrition status (BKP 2009). This can be seen from the persistent nutrition problems, such as stunting, wasting, low birthweight and others (MoH RI 2013a & 2013b), despite the increasing trend in food availability (BKP 2015). The prevalence of stunting problems increased from 35.6 percent in 2010 to 37.2 percent in 2013 (MoH RI 2013b). The prevalence of wasting and undernourished has decreased from the previous year, but it is still relatively high, which is above 10 percent (MoH RI 2013a). It shows that the food and nutrition security program planned has not been implemented thoroughly due to various factors (Suryana *et al*. 2016).

Various measurement methods have been developed to evaluate the achievements of food and nutrition security development at the global level. The indicators developed at the global level can be modified for various purposes according to the level of evaluation of the achievement of food security and nutrition development based on the regional level (Santeramo 2015; Pangaribowo *et al.* 2013). In measuring the evaluation of the food and nutrition security level, Indonesia

[*]**Corresponding Author:** tel: +6281369446388, email: andra.vidyarini@uhamka.ac.id

has developed one evaluation parameter and prioritization of programs in increasing food and nutrition security through the preparation of the Food Security and Vulnerability Atlas (FSVA) since 2005 (BKP 2009).

Evaluation of the food and nutrition security level based on outcome indicators can be used as a standard of development evaluation, and it is required in comparing assessments of food and nutrition security level. This evaluation can be carried out through inputs and through the results of programs or government policies (OECD 2008). This study aimed to evaluate the food and nutrition security level based on the achievement of outcome indicators at the provincial level in Indonesia. The results of this evaluation can be utilized to compare the rank of each province in their achievement on food and nutrition security development based on outcome indicators, as well as a refference for government evaluation in determining and implementing food and nutrition security development programs.

## METHODS

### Design, location, and time

The research was a descriptive, cross-sectional study, utilizing secondary data. Data collection and processing were carried out from March to September 2017. Data processing was carried out at the IPB Univetsity, Bogor, West Java.

### Sampling

The unit of analysis was 33 provinces. A province, North Kalimantan, was excluded in this study because it was not included in the Basic Health Research (RISKESDAS) 2013 since it was a newly formed province in 2012.

### Data collection

In this study, the data utilized were nutritional and health status data published in 2012 and 2013. The selection of data publication year is based on the availability of the most recent data of RISKESDAS in 2013 and the latest mortality rate of under-five-year-old children in 2012. Research data was obtained through electronic data access and published reports from related agencies (Food Security Agency, Ministry of Agriculture of the Republic of Indonesia, Statistics Indonesia and Ministry of Health the Republic of Indonesia).

### Data analysis

The preparation of the evaluation of food and nutrition security level was carried out in two stages, namely (1) identification and selection of indicators and (2) calculation of evaluation score and the evaluation of food and nutrition security levels. The initial stage in this study is the identification and selection of indicators. The identification and selection of prospective candidates for indicators are adjusted to the pillars of food and nutrition security, which are the pillars of availability, affordability and utilization. The identification of prospective outcome indicators used refers to the indicators used by FAO (2014), WHO (2015), RPJMN (BAPPENAS 2015) and KS-RANPG (DKP 2016) to produce 10 outcome indicators. Outcome indicators of food and nutrition security are indicators describing the long-term results of a program or activity related to food and nutrition security. Outcome indicators in food and nutrition security are indicated from nutrition status and public health problems in the community (FAO 2006).

The selection of indicators was carried out qualitatively based on several criteria; (1) according to the concept of food and nutrition security; (2) availability of data at the provincial level and not overlapping (redundant) between indicators. Qualitative selection of indicators resulted in six outcome indicators which are Percentage of undernourished population (PUN), Percentage of under-five-year-old children with stunting (CST), Percentage of under-five-year-old Children with wasting (CWA), Percentage of mortality rate on under-five-year-old children (CM), Percentage of infants with low birth weight (<2,500 g) (LBW), Percentage of pregnant women with Chronic Energy Deficiency (CED) (Upper Arm Circumference (UAC) is less than 23cm) (CED) (FAO (2014); WHO (2015); KSRANPG (DKP 2016))

The measurement of nutrition problems is carried out on under-five-year-old children because children in this age range are sensitive to changes in nutrition status. Hence, it can be utilized as an indicator in evaluating food and nutrition security. This led to the decision to utilize the prevalence rate of under-five-years-old children with stunting and wasting as indicators of food and nutrition programs achivement in the long run (DKP/Kementan/WFP 2015; Susanty & Margawati 2012; Suryana *et al*. 2016). Stunting

is a condition in which the child's height is too short for their age, measured for height for age with a value of below minus two standard deviations (<–2SD) based on the WHO definition (WHO 2010). Whereas, wasting is a condition where the child's weight based on their height is below minus two standard deviations (<–2SD) (WHO 2010). Apart from stunting and wasting in under-five-year-old children, the percentage of undernourished population also can be used to describe the nutrition status of the community at a broader age range. People experiencing undernourishement defined as citizens with a food consumption of less than 70% of the RDA (less than 1,470 kcal) per day.

In this study, the method utilized was modified from the Global Hunger Index (GHI) method. GHI arranged by the International Food Policy Research Institute (IFPRI) is a measurement tool for assessing food and nutrition security, especially hunger. The GHI method combines indicators of nutrition and health problems and describes the nutritional situation in the pupolation, especially children, as sensitive age group to changing nutrient intake such as energy, protein and other micronutrients (von Grebmer *et al.* 2017). The GHI employs four indicators and does not equalize the final value, while the method used in this study modified it by using six selected indicators, changing the calculation methods, and employing a value equalization (all indicators are positive for food and nutrition security).

The succeeding stage of this research is the calculation of the index value. The steps undertaken in calculating the index value are: (1) standardization of the indicator value; (2) calculation of the total provincial evaluation score; (3) equalization of the total score; (4) evaluation of the provincial food and nutrition security level based on the evaluation score: (1) Standardization of the indicator values. Standardization of the indicator value is performed by multiplying the actual value by the maximum value of each indicator in percentage units. The maximum value of the indicator is the rounding off of the highest value for each indicator. The examples of standardization of indicator values are as follows: The prevalence of actual value for stunting in under-five-year-old children is 32 percent, and the highest value for the prevalence of stunting for under-five-year-old children is 51.7 percent (rounded to 60 percent). Accordingly, the standardized indicator value for under-five-year-old children with stunting is 32/60x100=53; (2) Calculation of the total provincial evaluation score. The formulation used to calculate the total score in this study is a modification of the formula for calculating the index of GHI. The formulas used are:

$$[1/6((PUN/50)\,x\,100)] + [1/9((CWA/20)\,x\,100)] + [1/9((CST/60)\,x\,100)] + [1/9((LBW/20)\,x\,100)] + [1/3((CM/20)\,x\,100 + [1/6((CED/50)\,x\,100)]$$

Information:
- PUN : Proportion of undernourished population (%)
- CST : Proportion of stunting among under-five-year-old children (%)
- CWA : Proportion of wasting among under-five-year-old children (%)
- CM : Percentage of mortality of under-five-year-old children
- LBW : Percentage of babies with low birth weight (<2500 g)
- CED : Percentage of pregnant women with Chronic Energy Deficiency

Source: Global Hunger Index (GHI) (2017)

(3) Equalization of the total score. The value or evaluation score obtained is subjected to an equalization, so that it has a positive effect on food and nutrition security. The equalization is carried out using the formula 100–a, where a is the total evaluation score for each province (in stage 2); (4) Evaluation of food and nutrition security level at provincial level. The scale of evaluation score in this study ranged from 0 to 100, where the higher the score, the ideal conditions will be established. The value of 100 illustrates the food and nutrition security level at the provincial level are good where the province does not have an undernourished population; there are no under-five-year-old children who are stunted and wasted; there are no deaths among under-five-year-old children; and there are no pregnant women who suffered from chronic energy deficiencies, as well as there are no infants born with low weight (under 2,500 g). If a province has a value close to 0, it illustrates the opposite (IFPRI 2014). After the score is obtained, it is categorized based on the cut off point. Determination of the cut off value for the outcome indicator refers to the planning document or standard set by the The Ministry of Health (MoH RI 2002), and NLIS-WHO (2010) for indicators of nutrition status. The categorization of the food and nutrition security level were divided into four categories which are high (≥77.41), moderate (77.41–58.33), low (58.33–35.92) and very low (≤35.92). The total evaluation score shows that the higher the evaluation score, the better the food and nutrition security level of a province. The determination of the cut off point employed the same method as the calculation of the evaluation score, but it uses

the ideal number set by the Ministry of Health Republic of Indonesia (2002), and NLIS-WHO (2010). Processing and data analysis in this study were done using Microsoft Excel 2007.

## RESULTS AND DISCUSSION

### Situation of food and nutrition security based on outcome indicators

Nutrition problems, morbidity and mortality rates reflect problems that exist in a country ranging from the level of availability and access of food to environmental health and individual health status. In this study, the outcome indicators used indicators of nutrition problems, morbidity and mortality, namely the proportion of undernourished people, the percentage of under-five-year-old children with wasting, the percentage of under-five-year-old children with stunting, the percentage of mortality rates of under-five-year-old children, the percentage of infants with Low Birth Weight (LBW) and the percentage of pregnant women with Chronic Energy Deficiency (CED) (Table 1).

The percentage of under-five-year-old children experiencing stunting and wasting is one of the globally recognized indicators used to assess the food and nutrition security level in a region. It is because stunting and wasting are nutritional problems influenced by various factors related to food, sanitation, and infectious diseases or health. The low level of household socio economic status which hinder the family access in meeting the need for quality food is also one of the causes of the high rate of stunting in the community (Ulfani *et al.* 2011).

Based on the data (Table 1), Province of Riau Islands had the lowest stunting rate of under-five-year-old children (26.3%) when compared to other provinces. Whereas, NTT had the highest prevalence of under-five-year-old children (51.7%). Based on the category of under-five-year-old children with wasting, Province of Bali (8.8%) had the lowest percentage, while the Province of West Kalimantan (18.7%) had the highest percentage compared to other provinces.

Apart from stunting and wasting, the percentage of undernourished population is an outcome indicator that can be used in evaluating the food and nutrition security level. FAO (2015) states that the undernourished population is closely related to the existence of gaps in meeting their food needs in the long term, thus will affect their nutrition status. Based on the percentage of undernourished population indicators, DIY and Bali provinces had the lowest proportion of undernourished population, while Papua and West Papua had the highest proportion.

The provinces of Riau, North Sumatra and Bali had the lowest percentages based on indicators of mortality among under-five-year-old children, infants with low birth weight and pregnant women with CED, while Papua province had the highest percentages for indicators of mortality rates of under-five-year-old children and pregnant women with CED. In addition, Central Sulawesi had the highest percentage of infants with low birth weight.

Based on the outcome indicator data, the eastern part of Indonesia had the highest prevalence in almost all indicators. It shows the eastern part of Indonesia is lacking in quality of health compared to the other parts of Indonesia. The low quality of health in the eastern region this could be due to the lack of public awareness of the importance of maintaining environmental health and food quality (Tono *et al.* 2016).

### Evaluation of food and nutrition security level based on the outcome indicators

The food and nutrition security level based on the outcome indicators can be used as an evaluation tools to measure the success of government programs in developing food security and to improve nutrition status (Suryana *et al.* 2016). Outcome indicators, generally described as impaired physical growth and cognitive development of under-five-year-old children (under-five-year-old children with stunting and wasting), are indirect indicators of food security (UNICEF 1992).

Based on the results of the calculation of the evaluation score on the food security level based on the 2013 outcome indicators, all provinces (100%) in Indonesia fall into the medium and low categories. It shows that the food and nutrition security level based on outcomes indicators in Indonesia is still sub optimal, hence the local government efforts in developing food security and nutrition must be improved, especially in dealing with food and nutrition problems. Nationally, the low level of food and nutrition security can be seen from the fact that there are still nutrition problems in all provinces

Table 1. Outcome indicators by province in Indonesia 2013

| Province | PUN (%) | CWA (%) | CST (%) | CM (%) | LBW (%) | CED (%) |
|---|---|---|---|---|---|---|
| Aceh | 20.5 | 15.7 | 41.5 | 5.2 | 8.6 | 20.3 |
| North Sumatra | 20.8 | 14.9 | 42.5 | 5.4 | 7.2 | 17.1 |
| West Sumatra | 15.4 | 12.6 | 39.2 | 3.4 | 7.3 | 17.8 |
| Riau | 18.7 | 15.6 | 36.8 | 2.8 | 8.6 | 23.5 |
| Jambi | 23.9 | 13.5 | 37.9 | 3.6 | 8.2 | 23.0 |
| South Sumatra | 17.5 | 12.3 | 36.7 | 3.7 | 9.3 | 21.1 |
| Bengkulu | 16.2 | 14.8 | 39.7 | 3.5 | 9.7 | 23.7 |
| Lampung | 20.5 | 11.8 | 42.6 | 3.8 | 8.0 | 21.3 |
| Bangka Belitung | 19.8 | 10.2 | 28.7 | 3.2 | 9.4 | 21.2 |
| Riau Islands | 20.0 | 12.3 | 26.3 | 4.2 | 9.2 | 25.4 |
| DKI Jakarta | 18.2 | 10.2 | 27.5 | 3.1 | 9.3 | 17.6 |
| West Java | 18.9 | 10.9 | 35.3 | 3.8 | 10.8 | 21.6 |
| Central Java | 17.8 | 11.1 | 36.7 | 3.8 | 9.7 | 23.2 |
| DI Yogyakarta | 5.2 | 9.4 | 27.3 | 3.0 | 9.4 | 22.6 |
| East Java | 18.4 | 11.4 | 35.8 | 3.4 | 11.2 | 29.8 |
| Banten | 12.7 | 13.8 | 33.0 | 3.8 | 9.7 | 27.4 |
| Bali | 6.9 | 8.8 | 32.6 | 3.3 | 8.8 | 10.1 |
| West Nusa Tenggara | 9.3 | 11.9 | 45.2 | 7.5 | 12.2 | 19.1 |
| East Nusa Tenggara | 27.4 | 15.5 | 51.7 | 5.8 | 15.5 | 45.5 |
| West Kalimantan | 20.6 | 18.7 | 38.6 | 3.7 | 14.4 | 29.7 |
| Central Kalimantan | 18.6 | 12.4 | 41.3 | 5.6 | 13.7 | 21.6 |
| South Kalimantan | 14.7 | 12.8 | 44.2 | 5.7 | 10.1 | 27.4 |
| East Kalimantan | 29.9 | 11.6 | 27.6 | 3.1 | 10.8 | 27.5 |
| North Sulawesi | 17.3 | 9.9 | 34.8 | 3.7 | 8.0 | 22.6 |
| Central Sulawesi | 19.7 | 9.4 | 41.0 | 8.5 | 16.8 | 32.6 |
| South Sulawesi | 17.2 | 11.0 | 40.9 | 3.7 | 12.4 | 31.2 |
| North Sulawesi | 21.0 | 11.4 | 42.6 | 5.5 | 9.4 | 23.5 |
| Gorontalo | 25.1 | 11.7 | 38.9 | 7.8 | 13.2 | 18.5 |
| West Sulawesi | 15.5 | 48.0 | 10.8 | 7.0 | 11.9 | 20.2 |
| Maluku | 31.0 | 16.2 | 40.6 | 7.0 | 11.1 | 34.3 |
| North Maluku | 35.9 | 12.2 | 41.1 | 6.0 | 11.6 | 24.7 |
| West Papua | 36.1 | 15.4 | 44.7 | 8.5 | 11.0 | 25.1 |
| Papua | 41.0 | 14.8 | 40.1 | 10.9 | 15.6 | 37.2 |
| Indonesia | 18.7 | 12.1 | 37.2 | 11.5 | 10.2 | 24.2 |

Source: BKP (2016); MoH RI (2012; 2013a; 2013b)

PUN: Proportion of undernourished population (%)

CST: Proportion of stunting among under-five-year-old children (%)

CWA: Proportion of wasting among under-five-year-old children (%)

CM Percentages of mortality of under-five-year-old children

LBW: Percentages of babies with low birth weight (<2,500 g)

CED: Percentages of pregnant women with Chronic Energy Deficiency

in Indonesia (Table 2), such as undernourished population and pregnant women with chronic energy deficiency, under-five-year-old children with stunting, wasting and infants with Low Birth Weight (LBW). Moreover, the mortality in under-five-year-old children is also high.

The analysis results showed Bali province had the highest score, and Papua had the lowest score compared to other provinces. It is in line with the results of the Food Security and Vulnerability Atlas (FSVA) 2015, where the province of Bali had no food insecure areas, and Papua has the highest priority areas for food insecurity compared to other provinces (BKP 2015). The rank of evaluation score for the food and nutrition security level based on the outcome of each province are prsesnted in Table 2.

Based on the table above, the provinces of Bali, DI Yogyakarta and DKI Jakarta had the highest scores indicating that the food and nutrition security level based on outcome indicators is better than other provinces. It can be seen from the low prevalence of undernourished population, pregnant women with Chronic Energy Deficiency (CED) and the low rates of under-five-year-old children with stunting and wasting. The food and nutrition security level in these three provinces are also indicated by the low percentage of infants with LBW in 2013. This condition could be due to better access to adequate health service and food availability so that nutrition problems are lower than in other provinces. This condition will trigger a low mortality rate for infants and under-five-year-old children, so that the ultimate goal of developing food and nutrition security can be achieved, which is to create better quality of active and competitive human resources especially in development country (Suryana *et al.* 2016).

The provinces of West Papua, NTT and Papua had the lowest evaluation scores compared to other provinces. The low level of food and nutrition security based on the outcome indicators of the three provinces can be influenced by the high proportion of undernourished people, pregnant women with chronic energy deficiency and other health problems in babies and under-five-year-old children (stunting, wasting, LBW and mortality rate). In addition, the high score of NTT province is due to the fact that many areas are categorized as vulnerable and highly vulnerable due to the low level of public health quality (lack of sanitation and access to clean water) (Tono *et al.* 2016). The results of this study are consistent with the research conducted by Ismail *et al.* (2016) where the implementation of nutrition programs in Papua and West Papua has not been optimal and is running according to the planned program.

Based on the results of the FSVA 2015, the provinces of Papua, West Papua and East Nusa Tenggara are included in the priority areas for food insecurity and none of the provinces are categorized as food secure. It is in accordance with the results obtained in this study. The high rates of stunting, wasting and undernourished in West Papua, East Nusa Tenggara and Papua are influenced by the low quality and less variety of food consumed by the community and the lack of socialization about the importance of health in the community (BKP 2009). In addition, the level of hunger or chronic lack of energy in pregnant women can cause nutrition problems e.g infants with low birth weight (Warsini *et al.* 2016). This then leads to stunting during future growth (Supriyanto *et al.* 2018). It is in line with the research conducted by Palupi *et al.* (2013) where stunting, wasting and undernourished are influenced by low levels of energy and protein intake in individuals, both children and adult.

The results of this study indicated that food and nutrition security in Indonesia, especially based on the outcome indicators, should receive more attention from the government, especially in eastern part of Indonesia. According to Nurhemi *et al.* (2014), western part of Indonesia as a whole has better conditions than other regions due to infrastructure support and the support of public awareness on food and nutrition security when compared to other regions, especially in eastern part of Indonesia. Thus, the results indicated that there is a need to improve nutrition sensitive and specific programs implementation, so that the goals of developing food and nutrition security in equitable manner in Indonesia can be achieved.

## CONCLUSION

Evaluation of the food and nutrition security level based on outcome indicators was carried out using six indicators employing a method modified from the GHI. Based on the evaluation of the food and nutrition security level outcome indicators, all provinces in Indonesia

Table 2. Evaluation scores and food and nutrition security levels based on outcome indicators

| No | Province | Score | Category |
|---|---|---|---|
| 1 | Bali | 73.02 | Moderate |
| 2 | DI Yogyakarta | 70.24 | Moderate |
| 3 | Jakarta | 66.98 | Moderate |
| 4 | West Sumatra | 64.96 | Moderate |
| 5 | Bangka Belitung | 64.81 | Moderate |
| 6 | North Sulawesi | 64.16 | Moderate |
| 7 | South Sumatra | 62.16 | Moderate |
| 8 | Central Java | 61.67 | Moderate |
| 9 | West Java | 61.58 | Moderate |
| 10 | Banten | 61.14 | Moderate |
| 11 | Riau Islands | 61.04 | Moderate |
| 12 | Riau | 61.01 | Moderate |
| 13 | Lampung | 60.83 | Moderate |
| 14 | Bengkulu | 59.91 | Moderate |
| 15 | Jambi | 59.30 | Moderate |
| 16 | East java | 59.09 | Moderate |
| 17 | North Sumatra | 58.22 | Low |
| 18 | East Kalimantan | 58.14 | Low |
| 19 | South Sulawesi | 57.14 | Low |
| 20 | North Sulawesi | 56.56 | Low |
| 21 | Aceh | 56.55 | Low |
| 22 | West Nusa Tenggara | 56.29 | Low |
| 23 | South Kalimantan | 55.56 | Low |
| 24 | Central Kalimantan | 55.11 | Low |
| 25 | West Sulawesi | 54.93 | Low |
| 26 | West Kalimantan | 51.54 | Low |
| 27 | Gorontalo | 51.43 | Low |
| 28 | North Maluku | 48.98 | Low |
| 29 | Central Sulawesi | 46.26 | Low |
| 30 | Maluku | 43.87 | Low |
| 31 | West Papua | 42.48 | Low |
| 32 | East Nusa Tenggara | 39.22 | Low |
| 33 | Papua | 31.44 | Very Low |
| | Indonesia | 47.26 | Moderate |

(100%) have a low level of food security. It shows Indonesia still has a fairly high level of nutrition problems, where the higher the evaluation value, the better the evaluation of food and nutrition security level of the province. The provinces of Bali, DI Yogyakarta and DKI Jakarta achieved the highest food and nutrition security levels, while the provinces of West Papua, East Nusa Tenggara and Papua were the lowest in food and nutrition security levels compared to other provinces. It shows that nutrition programs implementation in increasing food and nutrition security, must be improved in all regions of Indonesia, and prioritized on the eastern part of Indonesia. Based on the results of this study, more attention should be put on programs to improve nutritional problems, such as stunting, wasting, reducing mortality rate of under-five-year-old children, reducing the number of pregnant women with CED and alleviating undernourished population. Underlying factors leading to food insecurity in certain areas mentioned need to also be evaluated in future studies.

## ACKNOWLEDGEMENT

We thank to Food Security Agency, Ministry of Agriculture of the Republic of Indonesia, Statistics Indonesia and Ministry of Health the Republic of Indonesia for the access of data in this research.

## AUTHOR DISCLOSURES

The authors have no conflict of interest.

## REFERENCES

[BAPPENAS] Badan Perencanaan Pembangunan Nasional. 2015. Rencana Pembangunan Menengah Nasional Tahun 2015–2019. Jakarta (ID): Bappenas.

[BKP] Badan Ketahanan Pangan. 2015. Kajian Kerawanan Pangan Nasional, Kerjasama BKP dan BPS. Jakarta (ID): Kementan RI.

[BKP] Badan Ketahanan Pangan. 2009. Peta Kerentanan dan Ketahanan Pangan Tahun 2009. Jakarta (ID): DKP dan WFP

Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, Mathers C, Rivera J. 2008. Maternal and child undernutrition: Global and regional exposures and health consequences. Lancet 371(9608):243–260. https://doi.org/10.1016/S0140-6736(07)61690-0.

Bruce Furness BW, Simon PA, World Cm, Asarian-Anderson J. 2004. Prevalence and predictors of food insecurity among low-income households in Los Angeles County. Public Health Nutr 7(6):791–794. https://doi.org/10.1079/PHN2004608.

[DKP] Dewan Ketahanan Pangan. 2016. Kebijakan Strategis dan Rencana Aksi Nasional Pangan dan Gizi 2016–2019. Jakarta (ID): Dewan Ketahanan Pangan

[DKP/Kementan/WFP] Dewan Ketahanan Pangan, Kementerian Pertanian, Word Food Programme. 2015. Peta Ketahanan dan Kerentanan Pangan Indonesia 2015. Jakarta (ID): DKP, Kementen, WFP

Fanzo J. 2014. Strengthening the engagement of food and health systems to improve nutrition security: Synthesis and overview of approaches to address malnutrition. Glob Food Sec 3(3–4):183–192. https://doi.org/10.1016/j.gfs.2014.09.001.

[FAO] Food and Agriculture Organization f The United Nations. 1996. World Food Summit: Rome Declaration on World Food Security. Rome (IT): FAO.

[FAO] Food and Agriculture Organization of The United Nations. 2005. Voluntary Guidelines to Support the Progressive Realization of the Right to Adequate Food in the Context of National Food Security. Rome (IT): FAO.

[FAO] Food and Agriculture Organization of The United Nations. 2006. The Right to Food in Practice. Implementation at the National Level. Rome (IT): FAO.

[FAO] Food and Agriculture Organization of The United Nations. 2012. Coming to Terms with Terminology: Food Security, Nutrition Security, Food and Nutrition Security, Food and Nutrition Security, Report of the 39th session of the Committee on World Food Security (CFS). Rome (IT): FAO.

[FAO] Food and Agriculture Organization of The United Nations. 2014. Procedure for Monitoring The Right to Food. Right to Food Handbooks 5th. Rome (IT): FAO.

[FAO/IFAD/WFP] Food and Agriculture Organization of the United Nations, International Fund for Agricultural

Development, World Food Programme. 2014. The State of food insecurity in the world 2014: Strengthening the enabling environment for food security and nutrition. Rome (IT): FAO.

Godfray HCJ, Garnett T. 2014. Food security and sustainable intensification. Philosophical Transaction of the Royal Society B: Biological Sciences 369(1639):1–10. https://doi.org/10.1098/rstb.2012.0273.

[IFPRI] International Food Policy Research Institute. 2014. Global Hunger Index: The Challenge of Hidden Hunger. Washington DC (USA): IFPRI.

Ismail Z, Kartasurya MI, Mawarni A. 2016. Analisis implementasi program penanggulangan gizi buruk di puskesmas wilayah kerja dinas kesehatan Kota Sorong Provinsi Papua Barat. Jurnal Manajemen Kesehatan Indonesia 4(1):20–26. https://doi.org/10.14710/jmki.4.1.2016.20-26.

Keino S, Plasqui G, de Borne BV. 2014. Household food insecurity access: A predictor of overweight and underweight among Kenyan women. Agric Food Secur 3(2):1–8. https://doi.org/10.1186/2048-7010-3-2.

[MoH RI] Ministry of Health Republic of Indonesia. 2002. Keputusan Menteri Kesehatan Nomor:920/Menkes/SK/VIII/2002 Tentang Klasifikasi Status Gizi Anak Bawah Lima Tahun (BALITA). Jakarta (ID): MoH RI.

[MoH RI] Ministry of Health Republic of Indonesia. 2012. Profil Kesehatan Indonesia 2012. Jakarta (ID): MoH RI.

[MoH RI] Ministry of Health Republic of Indonesia. 2013a. Profil Kesehatan Indonesia. Jakarta (ID): MoH RI.

[MoH RI] Ministry of Health Republic of Indonesia. 2013b. Riset Kesehatan Dasar 2013. Jakarta (ID): MoH RI.

Maricic M, Bulajic M, Dobrota M, Jeremic V. Redesigning the global food security index: A multivariate composite i–distance indikator approach. International Journal of Food and Agricultural Economics 4(1): 69–86. doi: 10.22004/ag.econ.231376.

Ng Marie, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, Mullany Erin C, Biryukov S, Abbafati C, Abera SF *et al.* 2014. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: A systematic analysis for the global burden of disease study 2013. Lancet 384 (9945):766–781. https://doi.org/10.1016/S0140-6736(14)60460-8.

Nurhemi, Soekro SRI, Suryani G. 2014. Working paper no.4 Pemetaan Ketahanan Pangan di Indonesia: Pendekatan TFP dan Indeks Ketahanan Pangan. Jakarta (ID): Bank Indonesia.

[OECD] Organization For Economic Co-Operation And Development. 2008. Handbook on Contructing Composite Indicators: Methodology and User Guide. OECD

Palupi E, Sulaeman A, Ploeger A. 2013. World hunger, malnutrition and brain development of children. J Future of Food: Journal on Food, Agriculture and Society 1(2):46–56.

Pangaribowo EH, Gerber N, Torero M. 2013. Food and nutrition security indicators: A review. ZEF Working Paper Series 108. Boon, Germany: Center for Development Research (ZEF). Germany (DE): University of Bonn.

Santeramo FG. 2015. On the composite indikators for food security: Decisions matter! Food Rev Int 31(1):63–73. https://doi.org/10.1080/87559129.2014.961076.

Supriyanto Y, Paramashanti BA, Astiti D. 2018. Berat badan lahir rendah berhubungan dengan kejadian stunting pada anak usia 6–23 bulan. Jurnal Gizi dan Dietetik Indonesia 5(1):23–30. http://dx.doi.org/10.21927/ijnd.2017.5(1).23-30.

Suryana A, Arifin B, Hardinsyah, Achadi EL, Atmawikarta A, Martianto D, Hermanto, Sastraatmadja E, Lukman AS, Darmawiredja MR *et al.* 2016. Kebijakan Strategis Rencana Aksi Pangan dan Gizi Tahun 2016–2019. Jakarta (ID): Sekretariat Dewan Ketahanan Pangan.

Susanty NM, Margawati A. 2012. Hubungan derajat stunting, asupan zat gizi dan sosial ekonomi rumah tangga dengan perkembangan motorik anak usia 24-36 bulan di wilayah kerja Puskesmas Bugangan, Semarang. J Nutr College 1(1):327–336. https://doi.org/10.14710/jnc.v1i1.736.

Tono T, Juanda B, Barus B, Martianto D. 2016. Kerentanan pangan tingkat desa di Provinsi Nusa Tenggara Timur. J Gizi Pangan 11(3):227–236. https://doi.org/10.25182/jgp.2016.11.3.%25p.

Ulfani DH, Martianto D, Baliwati YF. 2011. Faktor-faktor sosial ekonomi dan kesehatan masyarakat kaitannya dengan masalah gizi underweight, stunting dan wasted di Indonesia: Pendekatan ekologi gizi. J Gizi Pangan 6(1):59–65. https://doi.org/10.25182/jgp.2011.6.1.59-65.

von Grebmer K, Bernstein J, Hossain N, Brown T, Prasai N, Yohannes Y, Towey O, Foley C, Patterson F, Sonntag A *et al*. 2017. Global Hunger Index: The Inequalities of Hunger. Washington DC (USA): International Food Policy Research Institute.

Warsini KT, Hadi H. Nurdiati DS. 2016. Riwayat KEK dan anemia pada ibu hamil tidak berhubungan dengan kejadian stunting pada anak usia 6–23 bulan di Kecamatan Sedayu, Bantul, Yogyakarta. Jurnal Gizi dan Dietetik Indonesia 4(1):29–40.

[WHO] World Health Organization. 2010. Nutrition Landscape Information System (NLIS) Country Profile Indicators. Geneva (CH): WHO.

[WHO] World Health Organization 2015. Nutrition targets and indicators for the Post-2015 sustainable development goals accountability for the measurement of results in nutrition: A technical note. http://www.unscn.org/files/Publications/Post_2015_ Nutrition_Targets and_ Indicators_final_ March_2015_website_.pdf [Accessed 2nd December 2016].

*Available online: http://journal.ipb.ac.id/index.php/jgizipangan*
*Accredited based on DGHE, Republic of Indonesia No. 28/E/KPT/2019*
*ISSN 1978-1059 EISSN 2407-0920*

***J. Gizi Pangan, March 2021, 16(1):11-20***
*DOI: 10.25182/jgp.2021.16.1.11-20*

# Household Food Insecurity is Associated with Undernutrition among Primary School Children in Aden Governorate, Yemen

**Shadha Anwar Ahmed Esmail[1], Roslee Rajikan[1*]**
[1]Dietetic Program, Faculty of Health Science, Universiti Kebangsaan Malaysia,
Kuala Lumpur 50300, Malaysia

## ABSTRACT

Food insecurity is typically linked with undernutrition. However, there is little published data available on the association between household food insecurity and undernutrition status of the primary school children aged 6–12 years in Aden, Yemen. The purpose of this research was to analyse the association between household food insecurity and the undernutrition status of the children. A cross-sectional study was carried out among primary school children from grades I to VI in the government schools (n=525). A simple questionnaire, face-to-face interview with parents, and Radimer/Cornell hunger and food insecurity tool were utilized for the data collection. Anthropometric measurements (weight & height) of the children were also recorded. Upon analysis, 70% of the surveyed children came from a food secure household, whilst 30% experienced some type of food insecurity. Education level of the father ($p<0.03$), employment of the mother ($p<0.00$), overall household income ($p<0.01$), income per capita ($p<0.01$) and number of working persons per household ($p<0.00$) were all significant variables associated with food insecurity among these households. Results also showed that the frequency of underweight, stunting and wasting among the children was 19%, 17% and 10%, respectively. Significant associations were found between household food insecurity and the state of being underweight, stunting and wasting. Importantly, the association between household food insecurity and undernutrition status continued even after adjustment for significant variables. In conclusion, household food insecurity was significantly associated with undernutrition status of the primary school children in Aden's Governorate, Yemen.

**Keywords**: food insecurity, nutritional status, primary school children

## INTRODUCTION

Food insecurity is characterized by a reduction in food intake and disruption of the eating pattern due to lack of money in the household or lack of the food resources, which persist, for a long period resulting in malnutrition. This phenomenon is more obvious among children and women (Unisa *et al*. 2016; FAO/IFAD/UNICEF/WFP/WHO 2019). FAO (2012) defined food security as "A situation that exists, when secure access to an appropriately nutritious diet is coupled with a sanitary environment, adequate health services and care, in order to ensure a healthy and active life for all household members".

The studies of association between household food security and undernutrition, food consumption inadequacy, decreased cognitive and educational success, and psycho-social difficulties among children are numerous (Hackett *et al*. 2009; FAO 2012; Ihab *et al*. 2015). However, in Yemen studies of association between food insecurity and undernutrition among low socio-economic households are limited (Saaka & Osman 2013).

Yemen is a desert country in the Middle East on the southern tip of the Arabian Peninsula and it consists of 22 governorates and five islands. Sana'a is the political capital of Yemen, and Aden is the economic capital (Factbook 2016). Since 1990, the two countries (South and North Yemen) formally unified as the Republic of Yemen and a southern secessionist movement and the transitory civil war in 1994 had been quickly suppressed (Day 2010), which resulted in the exclusion of South Yemen and specifically Aden in many studies.

[*]**Corresponding Author:** tel: +603-92897511, email: roslee@ukm.edu.my

In Yemen, specifically in Aden, there is no a single study conducted on the association between nutritional status among school children and household food insecurity. In addition, among the rational to carried out this study is that nearly one third of school children in Aden governorate found to be malnourished where high prevalence of underweight (23.4%), stunting (16.7%) and wasting (19.3%) were reported (MOPHP/ UNICEF/FMF 2015). Moreover, studies on household food insecurity have been conducted widely across Yemen (Kabbani & Wehelie 2005; IFPRI 2012), nevertheless, these studies neither included Aden governorate nor school children nor the association with health status of low socio-economic school children. In addition, the majority of undernutrition studies focused on children under five years and overlooking the primary school children group (Eshaq *et al*. 2017; Dyer 2018).

Food insecurity might be a significant contributing factor of undernutrition and the core variable of undernutrition among low socioeconomic households. Thus, identifying the association of household food insecurity and children undernutrition will assist in planning and implementation of proper interventions to prevent or reduce undernutrition among school children. Findings from this study will also provide a reliable and valid resources for similar studies and for the on-going researches on ways to improve nutritional status among school children with food insecurity. Hence, this study was aimed to identify the association of food security and undernutrition among primary school children in Aden's governorate and to explore the contributing aspects and outcomes of food insecurity among households in this governorate.

## METHODS

### Design, location, and time

A cross-sectional study was carried out amongst primary school children enrolled in the grades I to VI in government schools, located at the seven districts of Aden governorate from January to May 2013. Aden governorate is a coastal region covering a total area of 1,114 $km^2$, and has a population of 751,800. Similarly, to other part of Yemen, the majority of population are young, 48% are under 15 years, and the median age is 18.1 years. Aden has a lower than an average poverty level of 17% among its 16,500 registered households, while food insecurity with moderate hunger of 20–30% (WFP 2012). The economy of the city depends on its seaport, and it has the highest rate of unemployment (28%) in the country (CSO 2011).

### Sampling

Aden consists of seven districts (Al-Mansura, Al Mualla, Al-Shaikh Othman, Altawahi, Crater, Dar Sad and Khormaksar); each district has multiple schools (Total 72 primary Schools). Lists of government schools within each district were provided by the Education office and one school was selected randomly by simple random sampling technique from each district. Schools were selected according to the inclusion criteria (i.e. government schools and mixed gender schools).

Subjects were randomly selected from the seven schools. Sample sizes was calculated through the simplified formula for proportions and 680 children were then selected. These children were considered of low socioeconomic level, because only children of low socioeconomical level enrolled in the governmental schools (UNICEF 2016).

A total of 680 questionnaires and consent forms were administered to the randomly slecetd students, by the researcher with the help of the teachers (14 students in each grade/school). Next day, the researcher recollected the questionnaire. Survey data was excluded from analysis when surveys had missing information, student failed to return the questionnaire, or when the parents did not give their consent. Twins or siblings from the same household were also excluded from the study to prevent duplication of household data. After exclusion, 525 subjects were included in the study, representing 76% of the respondents. The parents of these children were then approached and requested for a personal interview. Personal interviews were done during house visits by the researcher and the assistant. This research was authorized by the Yemeni Medical Council (Reference number 84521).

### Data collection

Data was collected by administering the socio-demographic questionnaire to students from grade I–IV in each selected school. Each questionnaire had an informed consent form

which requires participants' parents to sign after understanding the purpose of the study. The questionnaire consisted of two parts: (A) general information about the participant such as age, level of study and anthropometric measurements such as weight, height and BMI, and (B) information on the family such as education of parents, number of children in the house, household size, employment status of the parents, total household income and expenditures. After collecting the questionnaires, anthropometric measurements (weight and height) were taken and compared with growth charts (De Onis 2007) using computer application Anthro-plus software for Windows 10.

Weight and height of the children were used to compute age-and sex-specific Z-scores to obtain statistics on underweight, wasting, and stunting. Weight for Age Z-score (WAZ) was used as an indicator for underweight, Height-for-Age Z-score (HAZ) was used as an indicator for stunting (chronic malnutrition), and Weight-for-Height Z-score (WHZ) was used as an indicator for wasting (acute malnutrition). Z-scores were calculated based on the median values of the WHO Reference Population. The children were categorized into three groups, (i) Z-scores below -2 standard deviations (SD) of the WHO Reference Population medians i.e. malnourished, (ii) Z-scores above -2 SD and below +2 SD i.e. normal, and those above +2 SD were overweight/obese. Three consecutive readings were obtained for each measurement, and the mean was recorded.

The parents were approached for interview through phone numbers provided on the questionnaire. The researcher and the assistant then approached parents' houses, according to the parents' time of convenience. Household food security was measured utilizing the Radimer/Cornell hunger and food insecurity tool (Radimer *et al*. 1992). This tool consisted of 12 items (Table 1) that were translated into the Arabic language. The tool was tested via face,

Table 1. Radimer/Cornell hunger and food insecurity tool

| | |
|---|---|
| | Household level |
| 1. | Do you stress whether your food will go out prior to you obtain money to purchase more? |
| 2. | I lacked the foods that I required to create a meal and I did not have money to obtain more food. |
| 3. | The food that I purchased simply did not last and I did not have money to obtain more. |
| 4. | I stress over where the following day's food is going to come from. |
| | Individual level |
| 5. | I cannot manage to consume the way I should. |
| 6. | Can you manage to consume properly? |
| 7. | How frequently are you starving, but you do not eat because you cannot manage sufficient food? |
| 8. | Do you consume less than you believe you should because you do not have sufficient money for food? |
| | Child level |
| 9. | I cannot provide my child (ren) a balanced meal because I cannot afford that. |
| 10. | I cannot manage to feed my child (ren) the way I believe I should. |
| 11. | My child (ren) is/are not consuming sufficient because I just cannot provide sufficient food. |
| 12. | I know my child (ren) is/are starving sometimes, but I just cannot provide more food. |

To categories the intensity of food insecurity; Food secure: Negative response to all items; Household insecure: Positive response to one or more items (1–4) but not to adult or child level items; Individual insecure: Positive response to one or more of items (5–8) but not to items (9–12); Child hunger: Positive response to items (9–12)

construct as well as content for validity and items reliability, respectively. The reliability test produced a Cronbach's alpha of 0.87. During each interview, the 12 questions were answered by one of the parents, predominantly the mothers with the absence of other adults at home, hence; it was found that the presence of other adults could distort the reliability of the answers (Mohamadpour *et al*. 2012). The household food insecurity tool involves four components: amount of the food, fineness of the food, food adequacy, and assurance of obtaining food. The household was considered as food secure when the answers given by the interviewee were "not true" or "never". Conversely, they were food insecure when the answers were "sometimes" or "always".

**Data analysis**

All the statistical analyses were carried out using the Statistical Package for Social Sciences version 20 (SPSS Inc., Chicago, IL, USA). Descriptive statistics using mean±SD (standard deviation) were, firstly carried out and were utilized to compare the food-secure and food-insecure household according to their demographic, socio-economic, and anthropometric variables. Chi-square test and t-test were used for categorical and continuous variables in comparing differences between the food secure and insecure households. While, logistic regression was used in both the binary and multinomial analysis to find the association between malnutrition and household's food insecurity. Significance level was set at $p<0.05$.

## RESULTS AND DISCUSSION

**Household food insecurity**

Households were categories into one of four food insecurity categories using the Radimer/Cornell tools. Seventy percent (n=367) of the households were food secure, and 30% (n=158) were food insecure. Eighty-one households or 15% had actually been encountered the lowest serious degree of food insecurity and were categories as "household food insecure." These households were lacked foods and unsure of their capability to provide the food, and may have adjusted the quality of the family member diet. Another 8% experienced individual or adult type of food insecurity and 7% experienced child hunger (Table 2). Which indicate parents could not get enough amount of food or good quality food for their children.

Our finding showed a much lower compared to food security survey carried out in Yemen in 2013, which declared that 48% of households could be categorized as food insecure (WFP 2014). However, the household food insecurity reached more than 60% after the escalation of conflict in 2015 causing an immediate appeal for urgent humanitarian assistance (WFP 2017). The increasing prevalence of food insecure households was attributed to political instability and an increase in food prices. Despite of humanitarian assistance more than 20 million (67%) were food insecure in Yemen (WFP 2020).

Considering the difference in our finding compared to the more comprehensive national review on food insecurity prevalence, this might be due to the fact that our instrument relied on qualitative indicator. The Radimer/Cornell 12 item questionnaire was found to be a highly reliable tool for assessing food insecurity in household with children (Tutunchi *et al*. 2020). Eventhough the Radimer/Cornell hunger tool had high reliability and developed in perspectives to women, who had experienced hunger, the tool is a qualitative tool. This makes the reporting subjective and may lead toward reporting bias, where mothers may be ashamed to admit their household problem. Therefore, future studies could consider utilizing objective tools such as the Household Dietary Diversity Score (HDDS) in combination with qualitative tool to reduce or prevent the possible bias that may arise. Ashby *et al*. (2016) in their systemic review found that other tools such the Cornell Child Food Security Measure, the CCHIP tool, the Hager two-item screen, the Girard four-point tool, the Kuyper past

Table 2. Prevalence of food security among the households (n=525)

| Category of food security | n | % |
|---|---|---|
| Food secure | 367 | 69.9 |
| Household food insecure | 81 | 15.4 |
| Individual food insecure | 41 | 7.8 |
| Child hunger | 36 | 6.9 |

food security tool, the Household Food Security Access Scale and the Townsend Food Behavior Checklist can also be utilized to determine food insecurity. All the tools measure food insecurity in regard to accessibility to food on individuals or households albeit at varying level of consistency and validity. In addition, the Household Food Security Survey Module (HFSSM) and its variation are recommended by Department of Agriculture (USDA) to measure household food security (Marques *et al*. 2015). However, FSSM might not totally record the extent and magnitude of food security, as its measurement is restricted to one dimension of food security (Marques *et al*. 2015; Ashby *et al*. 2016).

**Association of the household characteristics and food security**

A total of 525 households were included in this study. Majority of the fathers were in the 41–80 years old age group, whereas, the majority of mothers were in the age group 15–40 years (Table 3).

In this study, parents in the food insecure households were much more educated contrasted to previous studies (Othman 2014; Al-Sonini 2015) carried out in Yemen. In agreement with this study, Arzhang *et al* (2019) in their study found that higher education of father's was associated with household insecurity. Moreover, Abdullah *et al*. (2019) reported that higher parent's education is associated with a food secure household. Large family size might explain the high-level of food insecurity among highly educated fathers in the present study. This study also found that large household size (62%), high percentage of unemployed mothers (88%), and households which had only one working person (71%) were all significantly associated with food insecurity.

Mother's employment, overall household income and income per capita in the households with food insecurity showed significant mean differences with those with food insecurity ($p<0.00$; $p<0.01$; $p<0.01$). Many previous studies have reported an association between the mother's employment and household food security, in relation to fathers being the only breadwinner for the family, providing food and shelter to his family members. In agreement with the present study, Shariff *et al*. (2008) reported an association between employment of the mother and household food security, they explained that working mothers contributed to the household income and food expenditure thus preventing household food insecurity.

This study also found that the number of employed persons per household had a significant association with the household food insecurity. The proportions of households with multiple working persons were higher among secure households compared to insecure households. This finding is consistent with Ihab *et al*. (2015), because they observed that the addition of one more employed member per household resulted additional income that reduced food insecurity.

Hence, education level of the fathers, employment of the mothers, total monthly income, income per capita and the number of working persons per household were found to have a significant association with food insecurity among households.

**Undernutrition status**

The anthropometric characteristics of the Yemeni children, who were the subject of this study were provided in Table 4. The overall prevalence of underweight among children was 19%, whilst the prevalence of stunting was 17% and the wasting was 10%. Overall, the mean value for weight was 27.2±7.28 kg and for height was 129.4±14.67 cm. There was a significant mean difference between food-secure and food-insecure children in terms of HAZ ($p<0.00$). This finding is in agreement with a study carried out by Ihab *et al*. (2015) reported that household food insecurity was associated with chronic undernutrition of the school children.

**Association of household insecurity and undernutrition status**

Among the result of this study, the household food insecurity is a significant predictor of the undernutrition (stunting, wasting and underweight) among school children in Aden, Yemen. The association remain significant after adjustment. The covariates in the multiple logistic regression model included education level of the fathers, employment of mothers, number of working persons in the household and total income. Children in food-insecure households had a higher risk for underweight, stunting and wasting compared with children in food secure households ($p<0.05$) (Table 5). The results showed that school children in food insecure

Table 3. Sociodemographic-economic features of food secure and insecure household (n=525)

| Characteristics | Food secure (n=367) | | Food insecure (n=158) | | p |
|---|---|---|---|---|---|
| | n (%) | Median±SD | n (%) | Median±SD | |
| Age in years (father) | | 43±8.94 | | 41 ±11.27 | 0.25 |
| 20–40 | 143 (39.0) | | 74 (46.8) | | |
| 41–80 | 224 (61.0) | | 84 (53.2) | | |
| Age in years (mother) | | 38±6.20 | | | |
| 15–40 | 257 (70.0) | | 124 (78.5) | 35±6.38 | 0.76 |
| 41–80 | 110 (30.0) | | 34 (21.5) | | |
| Education level (father) | | 3.0±1.12 | | 3.0±1.25 | 0.03* |
| No formal education | 63 (17.2) | | 36 (22.8) | | |
| Primary & secondary school | 182 (49.6) | | 66 (41.8) | | |
| Diploma/tertiary foundation | 122 (33.2) | | 56 (35.4) | | |
| Education level (mother) | | 2.00±1.04 | | 2.00±1.00 | 0.56 |
| No formal education | 107 (29.2) | | 43 (27.2) | | |
| Primary & secondary school | 201 (54.8) | | 94 (59.5) | | |
| Diploma/tertiary foundation | 59 (16.1) | | 21 (13.3) | | |
| Number of children | | 4.00±1.84 | | 5.00±1.88 | 0.95 |
| 1–3 | 125 (34.1) | | 59 (37.3) | | |
| 4–6 | 190 (51.8) | | 75 (47.5) | | |
| ≥7 | 52 (14.1) | | 24 (15.2) | | |
| Household size | | 7.00±2.56 | | 8.00±2.32 | 0.22 |
| 3–6 | 140 (38.1) | | 50 (31.6) | | |
| 7–10 | 188 (51.2) | | 98 (62.0) | | |
| ≥11 | 39 (10.7) | | 10 (6.3) | | |
| Employment (fathers) | | | | | 0.08 |
| Working | 287 (78.2) | | 118 (74.7) | | |
| Not working | 80 (21.8) | | 40 (25.3) | | |
| Employment (mothers) | | | | | 0.00* |
| Working | 62 (16.9) | | 19 (12.0) | | |
| Housewife | 305 (83.1) | | 139 (88.0) | | |
| Total household income (USD)** | | 336±263.2 | | 293±213.0 | 0.01* |
| 0–300 | 51 (13.9) | | 31 (19.6) | | |
| 301–>1000 | 173 (47.1) | | 73 (46.2) | | |
| Income per capita (USD)** | | 51±45.38 | | 42±36.05 | 0.01* |
| 0–150 | 233 (63.5) | | 110 (69.6) | | |
| 151–300 | 94 (25.6) | | 38 (24.1) | | |
| Working /household | | | | | 0.00* |
| None | 26 (7.1) | | 18 (11.4) | | |
| One | 237 (64.6) | | 112 (70.9) | | |
| More than one | 104 (28.3) | | 28 (17.7) | | |
| Monthly household expenditure (USD)** | | 434±232.4 | | 409±246.4 | 0.55 |
| 0–300 | 20 (5.4) | | 14 (8.9) | | |
| 301– >1000 | 91 (24.8) | | 48 (30.4) | | |

*p<0.05; **1 USD=215Ry
Chi-square t-test

Table 4. Undernutrition status of school children in Yemen (n=525)

| Anthropometric Index | Food secure (n=367.70%) | | Food insecure (n=158.30%) | | Overall (n=525) | | p |
|---|---|---|---|---|---|---|---|
| | (%) | Mean±SD | (%) | Mean±SD | (%) | Mean±SD | |
| WAZ | | 1.94±0.22 | | 1.51±0.50 | | 1.82±0.38 | 0.00[a] |
| Underweight[*] | 19( 5.2) | | 77 (48.7) | | 96 (18.5) | | |
| Normal[**] | 348 (94.8) | | 81(51.3) | | 424 (80.5) | | |
| Overweight[***] | 0 (0) | | 2 (0.8) | | 5 (0.9) | | |
| HAZ | | 1.94±0.23 | | 1.58±0.49 | | 1.86±0.37 | 0.00[a] |
| Stunting[*] | 21 (5.7) | | 66 (41.8) | | 87 (16.7) | | |
| Normal[**] | 346 (94.3) | | 92 (58.2) | | 438 (83.3) | | |
| WAH | | 1.96±0.19 | | 1.75±43 | | 1.89±0.30 | 0.01[a] |
| Wasting[*] | 14 (3.8) | | 39 (24.7) | | 53 (10.1) | | |
| Normal[**] | 353 (96.2) | | 119 (75.3) | | 462 (89.9) | | |

[*]Underweight/stunting/wasting: <-2 SD; [**]Normal: >-2 SD - <+2 SD; [***]Overweight/obese: >+2 SD; [a]Independent t-test

households had 17 (AOR=17.44; CI:10.67–31.24) times more risk to be underweight than those in the food secure household. Similarly, children in the food insecure household had 11 (AOR=11.98; CI:7.01–20.67) times more risk to be stunted compared to children in the food secure household. In addition, the wasting in food insecure households was 9 (AOR=9.12; CI:5.11–16.03) times greater than among children in the food secure household.

This study is important, because it reveals a significant association between household food insecurity and undernutrition among children. In agreement with this study, Hackett *et al*. (2009) in Antioquia, Colombia, reported a high level of underweight, stunted and wasted children among food insecure households and a significant association between food insecurity status, stunting and underweight with no association with wasting. Likewise, Ihab *et al*.

Table 5. Association of household food insecurity and undernutrition of the children (n=525)

| Nutritional status & type of household | Simple logistic regression | | | Multiple logistic regression | |
|---|---|---|---|---|---|
| | OR (95% CI) | p | B | AOR[*] (95% CI) | p |
| Underweight | | | | | |
| Food secure | 1 | | | 1 | |
| Food insecure | 17.41 (9.93–30.39) | 0.00 | 2.857 | 17.44 (10.67–31.24) | 0.02 |
| Stunting | | | | | |
| Food secure | 1 | | | 1 | |
| Food insecure | 11.82 (6.87–20.32) | 0.00 | 2.470 | 11.98 (7.01–20.67) | 0.01 |
| Wasting | | | | | |
| Food secure | 1 | | | 1 | |
| Food insecure | 8.26 (4.33–15.75) | 0.00 | 2.112 | 9.12 (5.11– 16.03) | 0.04 |

[*]Adjusted for education level of the fathers; employment of mothers; number of working persons in the household and total income

CI: Confidence Interval

B: This is the coefficient for the constant (also called the "intercept") in the null model

(2015) reported that household food insecurity was associated with underweight as well as stunting while, wasting did not show a significant association with food insecurity status among school children in Malaysia. Contrary, Mumena (2016), reported no association between food insecurity and any anthropometric measures.

Radimer/Cornell food security instrument was useful in determining food security in household or individuals. However, it can be complimented with the measurement of Dietary Diversity Indicator, recommended by FAO (FAO 2010), which assess nutritional adequacy of individuals diets as well as the economic ability of a household to access a variety of food.

When considering the results of this study it should be bear in mind that this research was subject to some limitations. Firstly, this study was cross-sectional, so there has actually been no follow-up and; consequently, there was no possibility for subjects to leave the study. Secondly, the sample was restricted to one area of Yemen.

## CONCLUSION

This study found a significant association between household food insecurity and undernutrition among primary school children in Aden, Yemen. The father's education level, mother's employment, monthly household income and the number of working persons in the household were all significant variables associated with undernutrition thus considered as covariate in further analysis. The novel outcome of this study was that nutritional status among children within the governmental schools was associated with their household food insecurity, even after adjusting for the covariates, indicating that household food insecurity is a major contributor of malnutrition among school children in Aden schools.

## ACKNOWLEDGEMENT

The authors would like to thank the administration, children and families of schools for their support and cooperation in this research.

## AUTHOR DISCLOSURES

The authors have no conflict of interest.

## REFERENCES

Al-Sonini NAA. 2015. The effect of socio-economic factors on the health indicators in Yemen. J Nat Sci Res 5(13):140–146.

Abdullah A, Zhou D, Shah T, Ali S, Ahmad W, Din IU, Ilyas A. 2019. Factors affecting household food security in rural northern hinterland of Pakistan. J Saudi Soc Agric Sci 18(2):201–210. https://doi.org/10.1016/j.jssas.2017.05.003.

Arzhang P, Gargari BP, Sarbakhsh P, Farzaneh H. 2019. Household food insecurity and associated factors among rural and urban high school students in Kurdish population of Iran. Prog Nutr 21(2):56–64. doi:10.23751/pn.v21i2-S.6320.

Ashby S, Kleve S, McKechnie R, Palermo C. 2016. Measurement of the dimensions of food insecurity in developed countries: A systematic literature review. Public Health Nutr 19(16):2887–2896. doi:10.1017/S1368980016001166.

[CSO] Central Statistical Organization. 2011. Statistical Yearbook 2011. Sana'a (YM): CSO.

Day S. 2010. The Political Challenge of Yemen's Southern Movement. Washington DC (USA): Carnegie Endowment for International Peace.

De Onis M, Onyango AW, Borghi E, Siyam A, Nishidaa C, Siekmanna J. 2007. Development of a WHO growth reference for school-aged children and adolescents. Bull World Health Organ 85:660–667. doi: 10.2471/blt.07.043497.

Dyer O. 2018. Yemen: Number of children under 5 who have died from malnutrition may be as high as 85 000, says save the children. BMJ 363:k4949. https://doi.org/10.1136/bmj.k4949.

Eshaq AM, Fothan AM, Jensen EC, Khan TA, Al-Amodi AA. 2017. Malnutrition in Yemen: An invisible crisis. The Lancet 389 (10064):31–32. https://doi.org/10.1016/S0140-6736(16)32592-2.

Factbook. 2016. Yemen demographics profile 2016. http://www.indexmundi.com/yemen/demographics_profile.html [Acecessed 8th November 2016].

[FAO] Food and Agriculture Organization. 2010. Guidelines for Measuring Household and

Individual Dietary Diversity. Rome (IT): FAO.

[FAO] Food and Agriculture Organization. 2012. The State of Food Insecurity in the World 2012: Economic Growth is Necessary but nor Sufficient to Accelerate Reduction of Hunger and Malnutrition. Rome (IT): FAO.

[FAO/IFAD/UNICEF/WFP/WHO]. Food and Agriculture Organization, International Fund for Agricultural Development, United Nations International Children's Emergency Fund, World Food Program, World Health Organization. 2019. The State of Food Security and Nutrition in the World 2019. Safeguarding Against Economic Slowdowns and Downturns. Rome (IT): FAO.

Hackett M, Melgar-Quiñonez H, Alvarez MC. 2009. Household food insecurity associated with stunting and underweight among preschool children in Antioquia, Colombia. Rev Panam Salud Públ 25:506–510. doi: 10.1590/s1020-49892009000600006.

[IFPRI] International Food Policy Research Institute. 2012. Managing Transition in Yemen. An Assessment of the Costs of Conflict and Development Scenarios for the Future. Washington DC (USA): IFPRI.

Ihab AN Rohana AJ, Wan Manan WM, Wan Suriati WN, Zalilah MS, Mohamed Rusli A. 2015. Assessment of Food Insecurity and Nutritional Outcomes in Bachok, Kelantan. J Nutr Food Sci 5(3):373. http://dx.doi.org/10.4172/2155-9600.1000373.

Kabbani N, Wehelie Y. 2005. Measuring Hunger and Food Insecurity in Yemen. Labour Economics Sessions of the 11th Annual Conference of the Economic Research Forum for the Arab Countries, Iran and Turkey (ERF). Working Paper 0419.5:1–20.

[MOPHP/UNICEF/FMF]. Ministry of Public Health and Population, United Nations Children's Fund, Field Medical Foundation. 2015. Nutrition and Mortality Survey in Aden Governorate, Yemen, 8–13 August report. Aden (YE): MOPHP, UNICEF, FMF.

Marques ES, Reichenheim ME, de Moraes CL. 2015 Household food insecurity: A systematic review of the measuring instruments used in epidemiological studies. Public Health Nutr 18(5):877–892. doi:10.1017/S1368980014001050.

Mohamadpour M, Sharif ZM, Keysami MA. 2012. Food insecurity, health and nutritional status among sample of palm-plantation households in Malaysia. J Health Popul Nutr 30(3):291–302. doi: 10.3329/jhpn.v30i3.12292.

Mumena WA. 2016. Food security and nutritional health of school-aged children in two Caribbean countries [Thesis]. Montreal: McGill University.

Othman N. 2014. A comparison between poverty index and wealth index in analyzing prevalence of malnutrition in Yemeni children [Thesis]. Yemen: Sana'a University.

Radimer KL, Olson CM, Greene JC, Campbell CC, Habicht JP 1992. Understanding hunger and developing indicators to assess it in women and children. J Nutr Educ 24(1):36S–44S. https://doi.org/10.1016/S0022-3182(12)80137-3.

Saaka M, Osman SM. 2013. Does household food insecurity affect the nutritional status of preschool children aged 6–36 months? Int J Popul Res 304169:1–12. https://doi.org/10.1155/2013/304169.

Shariff ZM, Bukhari SS, Othman N, Hashim N, Ismail M, Jamil Z, Kasim SM, Paim L, Samah BA, Hussein ZAM. 2008. Nutrition education intervention improves nutrition knowledge, attitude and practices of primary school children: A pilot study. Int Electron J Health Educ 11:119–132.

Tutunchi H, Ebrahimi-Mameghani M, Asghari-Jafarabadi M, Farrin N, Tabrizi S, Vaghef-Mehrabany E, Ostadrahimi A. 2020. Is the modified household food security survey (HFSS) questionnaire a practical tool for screening food insecurity? Evidence from northwest of Iran. BMC Public Health 20:883. https://doi.org/10.1186/s12889-020-09014-8.

[UNICEF] United Nations Children's Fund. 2016. Annual Report 2015 Yemen. New York (USA): UNICEF.

Unisa S, Chattopadhyay A, Fulpagare P, Sinha A. 2016. Food Security and Nutritional Status of Children in Maharashtra. IIPS Working Paper No. 12. India (IN): International Institute for Population Sciences.

[WFP] World Food Programme. 2012. The State of Food Security and Nutrition in Yemen. Report June 2012. Rome (IT): WFP.

[WFP] World Food Programme. 2014. School feeding programs. Roma: World Food Program. documents.wfp.org/stellent/groups/public/documents/resources/wfp281540.pdf. [Accessed 3rd December 2016].

[WFP] World Food Programme. 2017. State of Food Insecurity in Yemen. Report April 2017. Rome (IT): WFP.

[WFP] World Food Programme. 2020. Emergency Dashboard - Yemen Report Dec 2020. Roma (IT): WFP.

*Available online: http://journal.ipb.ac.id/index.php/jgizipangan*
*Accredited based on DGHE, Republic of Indonesia No. 28/E/KPT/2019*
*ISSN 1978-1059 EISSN 2407-0920*

***J. Gizi Pangan, March 2021, 16(1):21-30***
*DOI: 10.25182/jgp.2021.16.1.21-30*

# Acculturation-Related Factors of Dietary Pattern Changes among Indigenous Adolescents in Mt. Arayat, Philippines

**Mark Spencer K. Barcena[1*], Anna Teresa O. Orillo[1], Clarissa B. Juanico[1], Arvin Paul P. Tuaño[1,2]**

[1]Institute of Human Nutrition and Food, College of Human Ecology,
University of the Philippines Los Baños, College, Laguna 4031, Philippines
[2]Institute of Chemistry, College of Arts and Sciences,
University of the Philippines Los Baños, College, Laguna 4031, Philippines

## ABSTRACT

This study aimed to determine the levels of dietary acculturation and factors affecting acculturation-related changes in dietary patterns of 15 adolescents in an indigenous community in Mt. Arayat, Central Luzon, Philippines displaced after the eruption of Mt. Pinatubo in 1991. Mixed-methods sequential explanatory design (using modified scales) was employed to measure dietary acculturation; index analyses to evaluate dietary patterns; and focus group discussion to determine factors leading to dietary acculturation. Majority was found to be bicultural (93.33%) and the mean dietary pattern index score was 69.40 implying a need for dietary improvement. Moderate to high levels of dietary acculturation were observed on the traditional food block, while low to moderate levels were observed towards the dominant food block. Various psychosocial factors driving dietary choices cumulatively affect dietary patterns of adolescents experiencing acculturation in this study, including but not limited to: 1) the neighboring communities' ethnocultural composition facilitates acculturation primarily through language fluency; 2) prevalence of discrimination exerts an external pressure to adopt host culture for social acceptance; 3) economic need for integration to sustain day-to-day activities exists; 4) religious feasts and gatherings centered on foods previously unknown to them have been introduced; 5) food selection behavior shifts due to acquired experiences of food whether sensory or cognitive; and 6) their attitudes towards assimilation majorly characterizes the gradual internalization of host culture.

**Keywords**: acculturation, adolescents, dietary acculturation, dietary change, dietary pattern

## INTRODUCTION

Changes in behavioral patterns have been happening over the past few decades and these have been brought by constant intercultural contact between cultural groups facilitated by the process of acculturation. According to Satia (2010), acculturation is the process by which a minority group adopts the cultural patterns of the dominant host group and this process is both multidimensional and complex as it also enables the adoption of dietary patterns of the host group more specifically through the aspect of dietary acculturation.

Dietary acculturation occurs in a dynamic manner. It does not only happen linearly, but several studies suggest that dietary acculturation can also happen bi-dimensionally, i.e., immigrants may either retain their traditional ways or consume new foods (Satia 2010). As it is affected by different factors, dietary acculturation results in changes in immigrants' attitudes and beliefs about food, taste preferences, food purchasing, and even food preparation behaviors, thus, leading ultimately to changes in dietary patterns (Satia-Abouta 2003).

Several studies have reported acculturation process in various contexts of immigrant populations: Filipino Americans in North Carolina and New Jersey as studied by Serafica (2011), and Vargas and Jurado (2015) respectively; Southeast Asians in South Korea by Lee *et al.* (2017); South Asians in Canada by Lesser *et al.* (2014); and the Hispanic/Latino youths in the United States by Arandia *et al.* (2018). Some also studied acculturation in the context of indigenous peoples in the world such as that of Holmes and Clark (1992) investigating

[*]**Corresponding Author:** tel: +639171779927, email: mkbarcena@up.edu.ph

the indigenous peoples of Venezuela's Amazon Territory, the Dogrib Indians of Canada by Ritenbaugh *et al.* (1995), and the indigenous peoples of Chile by Schnettler *et al.* (2013).

The Pinatubo indigenous peoples in Luzon, Philippines belong to the oldest population of indigenous peoples of the country, the Negritos, believed to be the first dwellers of the archipelago. An estimated 10,000 members of this indigenous group lived in the areas of Mt. Pinatubo in Central Luzon, in the mountain ranges of Tarlac, Zambales, and Pampanga (and also Bataan). However, the Mt. Pinatubo eruption in 1991 displaced these populations in the nearby lowlands, later finding resettlements (Seitz 1998). This has changed the food environment landscape of the indigenous community, confronted with overlapping food systems that include primarily market-based foods, opposite to their traditional food system. Since the dispense of urban transitions, non-agricultural enterprises and establishments, where industrial services are offered, dominated the food landscape implicating agriculture, food production, and the entirety of food systems (Satterthwaite *et al.* 2010). Thus, this has brought major changes in diet demands, influencing acculturation trajectories in these indigenous populations. However, dietary acculturation happening in the context of indigenous populations in the Philippines remains unexplored, especially those that are internally displaced from their traditional environments.

Studies focusing on acculturation-related dietary pattern shifts of these indigenous populations will help in further understanding the current and continually evolving food preferences, food systems, food preparation practices and behaviors in these communities that may lead to the development of programs and interventions geared towards addressing their needs. This study aimed to investigate the possible associations between levels of acculturation, dietary acculturation, and dietary patterns of indigenous adolescents in Mt. Arayat, Central Luzon, Philippines.

## METHODS

### Design, location, and time

A cross-sectional study design was used in this study with an explanatory sequential mixed-methods approach to assess the acculturation-related changes in dietary patterns from a group of adolescents aged 13–19 in an indigenous community in Mt. Arayat, Central Luzon, Philippines. The study reported here was conducted from October to November in 2019.

### Sampling

Total population sampling was employed in the study with a total of 18 adolescents recruited. However, three respondents refused and did not give consent for the interview.

### Data collection

Qualitative and quantitative methods of data collection were used. Four questionnaires were answered through personal interviews. A focus group discussion (FGD) was conducted to discuss existing dietary habits (knowledge, attitudes, and values) in relation to dietary intake using an FGD guide.

Research background, objectives, and methods, particularly the research instruments, were presented and discussed with the community leader, chieftain, and the community's council of elders, in their native language before consent was obtained for the study. Participation of the respondents in the study was strictly voluntary. While the community elders provided assistance during the interview sessions with the recruited adolescents, measures to reduce social desirability bias were undertaken such as cross-referencing of data and communicating response confidentiality. Moreover, participants were reassured of complete anonymity throughout the process.

***Socioeconomic and demographic data.*** The following set of information was collected: age, sex, income, geographical characteristic, educational level, marital status, number of children as well as migration-specific data including years of residency in the community.

***Acculturation.*** A modified questionnaire derived from the Acculturation, Habits, and Interests Multicultural Scale for Adolescents (AHIMSA) as reported by Arandia *et al.* (2018) was used to measure level of acculturation. The modified scale was a 5-item questionnaire with four response options: 1) Dominant Culture; 2) Traditional Culture; 3) Both; and 4) Neither, measuring four factors including food, language, music, and clothing.

Frequencies of responses were counted for each scale item to compute for subscale scores

used in classifying respondents into one of the four acculturation categories: Assimilated (i.e., high dominant culture orientation based on "Dominant Culture" responses); Separated (high traditional culture orientation based on "Traditional Culture" responses); Integrated (bicultural orientation based on "Both" responses); and Marginalized (neither of the orientation based on "Neither" responses). The modified questionnaire was pre-tested and had a calculated Cronbach's alpha coefficient of 0.69.

***Dietary acculturation.*** The level of dietary acculturation was determined using a modified scale adapted from the Dietary Acculturation Questionnaire for Filipino Americans (DAQFA) as reported by Serafica *et al.* (2013). The modified scale consisted of two different subscales: the traditional food block and the dominant food block. The scale was a list of 13 food and dietary behavior items reflecting both the traditional and dominant culture food choices and eating patterns, i.e., an 8-item dominant food block and a 5-item traditional flood block.

Responses were collected through a 5-point Likert-type scale (0-Never; 1-Sometimes; 2-One to three times a month; 3-One to two times a week; 4-Three to four times a week; and 5-Daily). Scores were computed by summing the responses. Any score of more than 28 in the dominant block was considered high, 20–28 moderate, and scores below 20 were considered low. On the traditional block, any score more than 15 was considered high, 10–15 moderate, and scores below 10 were considered low. The calculated Cronbach's alpha of the modified scale was 0.81 for the traditional food block and 0.89 for the dominant food block.

***Dietary intake and pattern.*** Multiple 24-h food recalls were used to record quantitative information of foods and beverages consumed through multiple-pass methods. All foods and beverages consumed were categorized according to the identified dietary components in the index-based analysis designed to reflect individual dietary pattern determining adherence to the Nutritional Guidelines for Filipinos (NGF).

Dietary intake was based on the average of two 24-h food recalls scored according to the age-specific recommendations outlined in the Daily Nutrition Guide Pyramid (DNGP) for Filipino Teens in the identified dietary components: a) food variety; b) rice and alternatives; c) fish, meat and poultry; d) milk and milk products; e) fruits and vegetables; f) sweets and sugars; g) fats and oils; h) sodium; and i) alcohol.

Total score ranged between 0–100, with a higher score indicating better dietary pattern. Each component was scored out of ten, with 0 indicating unmet recommended amounts, and 10 indicating met dietary recommendations. Scores were proportioned between the maximum and minimum scores based on dietary intake. A total score of more than 80 was considered good, 51–80 needs improvement, and scores less than 51 were considered poor, as adopted from the Healthy Eating Index of the United States Department of Agriculture (USDA-FNS 2018).

**Data analysis**

Transcribed interview data were coded and subjected to thematic analysis. On the other hand, quantitative data analyses were conducted using STATA 12 (StataCorp LLC, TX USA). Descriptive statistics was used to summarize socioeconomic and demographic characteristics of the respondents as well as the acculturation, dietary acculturation, and dietary pattern index scores. Point-Biserial Correlation Analysis was employed to variables of nominal and ratio levels (acculturation and dietary acculturation; acculturation and dietary pattern) while Pearson's Correlation Analysis was employed to variables of both ratio level (dietary acculturation and dietary pattern).

## RESULTS AND DISCUSSION

**Analysis of quantitative data**

***Sample characteristics.*** The sociodemographic and economic characteristics of the participants are presented in Table 1. The total sample ($N$=15) consisted of eight male participants and seven female participants. A greater number of respondents were from the younger adolescents ages 13 and 14 (total of 6). All of the respondents were born in the community. Only two of the respondents have graduated from elementary (13.33%) and only one proceeded to secondary education. Two of the respondents are married (13.33%) and one of them already has a child (6.67%). The monthly income of all the respondents was estimated to be less than 10,000 Philippine pesos (100%).

***Levels of acculturation and dietary acculturation.*** Acculturation levels are presented

Table 1. Sociodemographic and economic characteristics of indigenous adolescents in Mt. Arayat, Central Luzon, Philippines

| Variable | Number of adolescents (*n*) | Relative frequency (%) |
|---|---|---|
| Gender | | |
| Male | 8 | 53.33 |
| Female | 7 | 46.67 |
| Geographical characteristics | | |
| Nayon/Barangay | 15 | 100.00 |
| Age (in years) | | |
| 13 | 3 | 20.00 |
| 14 | 3 | 20.00 |
| 15 | 2 | 13.33 |
| 16 | 1 | 6.67 |
| 17 | 1 | 6.67 |
| 18 | 1 | 6.67 |
| 19 | 4 | 26.67 |
| Level of education | | |
| Elementary level | 13 | 86.66 |
| Elementary graduate | 1 | 6.67 |
| Highschool level | 1 | 6.67 |
| Marital status | | |
| Single | 13 | 86.67 |
| Married | 2 | 13.33 |
| Number of child | | |
| 0 | 14 | 93.33 |
| 1 | 1 | 6.67 |
| Family income | | |
| <10,000 | 15 | 100.00 |

in Table 2. Almost all of the adolescents were found to be integrated (93.33%) except for one assimilated adolescent (6.67%). No adolescent was found to be either separated or marginalized. Foods eaten at home and the language often used by the respondents both came from the dominant and traditional cultures. Majority of them celebrated a combination of holidays and feasts originating from both cultures. However, most of them listened to songs (60%) and wore clothes (86.67%) of the dominant culture.

On the other hand, dietary acculturation categorical scores showed that majority of the respondents had high and moderate levels of dietary acculturation (46.67%) particularly to the traditional food block which reflected traditional food choices and eating patterns of the indigenous group. However, most of them had moderate levels specific to the dominant food block (66.67%) which consisted of modern food choices and eating patterns. The mean traditional dietary acculturation score was 15.20±4.77 on a scale of 0–25 and the dominant dietary acculturation score was 20.93±4.80 on a scale of 0–40. Table 3 shows the distribution analysis of each dietary acculturation scale items comprising the different food blocks. Majority of the adolescents often consumed foods from the traditional food block while some items of the dominant food block were rarely-to-never consumed by the indigenous adolescents. Interestingly, dominant items 2 and 3 and traditional item 4 had been consumed on a daily basis by the majority of the indigenous adolescents in this study while dominant items 1 and 6 were never consumed (Table 3).

***Dietary pattern scores.*** Only one of the participants had a dietary pattern found to be of 'good' status (6.67%) according to the index analysis conducted while the remaining adolescents were found to be of 'needs improvement' status (93.33%). The mean dietary pattern of score was 69.40±9.23 on a scale of 0–100 classified as 'needs improvement'.

***Correlation between acculturation, dietary acculturation, and dietary pattern.*** A very weak, positive linear relationship between acculturation and traditional dietary acculturation ($r_{pb}$=0.156$^{ns}$) and a weak, positive linear relationship between

Table 2. Acculturation categories of indigenous adolescents in Mt. Arayat, Central Luzon, Philippines

| Category | Number of adolescents (*n*) | Relative frequency (%) |
|---|---|---|
| Assimilated | 1 | 6.67 |
| Integrated | 14 | 93.33 |
| Separated | 0 | 0.00 |
| Marginalized | 0 | 0.00 |
| Total | 15 | 100.00 |

Table 3. Dietary acculturation items per block of indigenous adolescents in Mt. Arayat, Central Luzon, Philippines

| Block | Item | Never | | Rarely | | 1–3/month | | 1–2/week | | 3–4/week | | Daily | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *n* | % | *n* | % | *n* | % | *n* | % | *n* | % | *n* | % |
| Traditional | 1) Locally grown rice & rice alternatives | 3 | 20.00 | 3 | 20.00 | 2 | 13.33 | 6 | 40.00 | 2 | 13.33 | 2 | 13.33 |
| | 2) Ethnic foods & dishes | 0 | 0.00 | 4 | 26.67 | 3 | 20.00 | 5 | 33.33 | 1 | 6.67 | 2 | 13.33 |
| | 3) Hunted meat sources | 2 | 13.33 | 2 | 13.33 | 2 | 13.33 | 5 | 33.33 | 2 | 13.33 | 0 | 0.00 |
| | 4) Locally grown vegetables | 0 | 0.00 | 0 | 0.00 | 1 | 6.67 | 4 | 26.67 | 0 | 0.00 | 10 | 66.67 |
| | 5) Locally grown fruits | 0 | 0.00 | 1 | 6.67 | 2 | 13.33 | 5 | 33.33 | 2 | 13.33 | 5 | 3.33 |
| Dominant | 1) Sweets, cakes or pies | 4 | 26.67 | 10 | 66.67 | 0 | 0.00 | 1 | 6.67 | 0 | 0.00 | 0 | 0.00 |
| | 2) Milk products, shakes or ice cream | 0 | 0.00 | 6 | 40.00 | 1 | 6.67 | 0 | 0.00 | 2 | 13.33 | 6 | 40.00 |
| | 3) Packaged or pre-prepared foods | 0 | 0.00 | 2 | 13.33 | 1 | 6.67 | 3 | 20.00 | 3 | 20.00 | 6 | 40.00 |
| | 4) Canned goods | 1 | 6.67 | 3 | 26.67 | 1 | 6.67 | 6 | 40.00 | 2 | 13.33 | 1 | 6.67 |
| | 5) Sugar-sweetened or carbonated drinks | 0 | 0.00 | 5 | 33.33 | 3 | 20.00 | 4 | 26.67 | 3 | 20.00 | 0 | 0.00 |
| | 6) Fastfood restraurants | 3 | 20.00 | 10 | 66.67 | 1 | 6.67 | 1 | 6.67 | 0 | 0.00 | 0 | 0.00 |
| | 7) Fries, hotdogs or other western snacks | 0 | 0.00 | 1 | 6.67 | 4 | 26.67 | 7 | 46.67 | 2 | 13.33 | 1 | 6.67 |
| | 8) Packed ingredients from supermarkets | 1 | 6.67 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 14 | 93.33 |

acculturation and dominant dietary acculturation ($r_{pb}$=0.3418$^{ns}$) were observed. Although statistically insignificant, these probable relationships signify that as the adolescents move towards an integrative acculturation path, the shift in cultural pattern towards biculturalism affects positively the processes of both the blocks of dietary acculturation characterized by traditional and dominant food items and practices. Also, a weak, statistically insignificant, positive linear relationship was found between acculturation and dietary patterns ($r_{pb}$=0.3112$^{ns}$) signifying that integration or biculturalism tended to impact the diet of the indigenous adolescents through inclusion of more food items, thereby increasing diet diversity.

The adolescents' dietary patterns were positively correlated with the traditional block of dietary acculturation ($r$=0.3484$^{ns}$). However, a negative correlation was observed between dietary pattern and the dominant block of dietary acculturation ($r$=–0.3659$^{ns}$). While these correlations were not found to be of statistical significance, these relationships can possibly explain the finding that although more food items were included in their diet, the components of the traditional food block remained to be its main constituent.

Correlational analysis of the various parameters in this study showed no statistically significant correlations but tended to have associations as supported by the data gathered. This may be due to other psychosocial and economic factors that were in play engendering contextual effects and moderating associations between parameters, thereby affecting dietary patterns. As discussed by Fox *et al.* (2017), sociocultural circumstances in which acculturation happens may alter health outcomes while other factors may also moderate the relationships constituted in the causal pathway between acculturation and health. Thus, studying such psychosocial and economic factors warrants further investigation in terms of the extent by which internalization of dominant culture, loss of traditional culture, and cultural orientations affect health outcomes.

**Analysis of qualitative data**

Given that no statistically significant correlations were established among acculturation, dietary acculturation, and dietary patterns of the indigenous adolescents in this study, the quantitative associations identified have been further studied through an in-person focus group discussion. The factors influencing the lack of significant statistical correlations were explained by the qualitative findings.

***Qualities of the pre-disaster indigenous dietary pattern.*** The indigenous community currently residing in Mt. Arayat in Central Luzon, Philippines, firstly inhabited the mountain slopes of Mt. Pinatubo, which offered excellent opportunities for hunting and gathering. Traditionally, the dietary pattern of this indigenous community was embedded within an egalitarian, communal eating system with tribe members working together from food procurement up to the preparation of meals. The primary foods consumed were naturally outsourced. These included locally grown fruits, vegetables, and tubers while most of their meat sources came from wild pigs, fishes, frogs, snakes, and even fruit and mountain bats.

No advanced cooking methods and techniques were used in the improvement of sensory characteristics and qualities of foods prepared by this indigenous community. No condiments and spices were added. Even salt was rarely used since the procurement of such could only be made through barters or purchases from the lowland communities. The natural abundance of foods for survival had allowed the indigenous communities of Mt. Pinatubo to thrive on their own, however, limiting the diversity of their diets.

**Non-directed dietary change among the indigenous community members**

After the Mt. Pinatubo eruption in June 1991, many of the indigenous communities in Mt. Pinatubo had been internally displaced into different evacuation centers in Pampanga, Central Luzon, Philippines. Relief efforts initiated by different government and non-government organizations supplied all the basic necessities needed for their survival. Relief packs distributed were composed of canned goods, instant noodles, rice grains, and other emergency products. These relief packs had permanently shifted not only the dietary patterns of the indigenous communities from Mt. Pinatubo, but also their traditional ways of life.

As a result, new patterns of culture emerged due to the indigenous communities' intercultural contact with the lowlanders. Kuhlein and Receveur (1996) categorized such changes in cultural patterns to be non-directed – a consequence of environmental events such as shifts in climate, natural disasters, weather patterns, military conflict or other political or social upheavals. Thus, the indigenous communities of Mt. Pinatubo had undergone such non-directed change in dietary patterns by which alterations in the availability of foods and the delocalization of food supplies completed the presentation of a new culturally complex set of highly industrial and modernized influences on food and diet.

**Acculturation-related forces affecting non-directed changes in dietary patterns**

***Neighboring communities' ethnocultural composition.*** According to Sökefeld (1999) as cited in Fox *et al.* (2017), individuals must be contemplated as elements of communities and cultures forming culturally unique reciprocal relationships due to individual and community interactions. Due to non-isolation of this ethnic enclave, as a result of geographic displacement, this indigenous community was found to be highly surrounded by their dominant lowlander counterparts at present – the Kapampangans/ Tagalogs. With this, cultures of origin were being displaced in consequence of sustained interactions with the dominant culture. Some characteristics of the neighboring community could explain the possible influence of ethnocultural composition to the changes in dietary patterns, i.e., 1) the ability to speak host-community language hastens the acquisition of dietary behaviors as language is necessary for the access of foods in lowland markets; 2) participation to the culture of the neighboring community disengages members of the indigenous community to participate in their traditional activities on food and culture; and lastly, 3) disparity on wanted and actual neighborhood contexts may further obligate the acquisition of host culture dietary patterns.

***Discrimination and social acceptance.*** Discrimination is often directed towards indigenous peoples from the majority of populations, and sometimes, even from social

institutions. With perceived discrimination, Lindert *et al.* (2008) explained that it becomes an important acculturative stressor and predictor of acculturation orientations and outcomes, contributing even psychological distress to victims. This has put pressure on the need to assimilate. Furthermore, food-based discrimination also occurs with regard to the consumption of extinct foods like wild birds, snakes, and bats. This resulted in a systematic shift of cultural standards from traditional to a more Westernized form of subjective quality.

***Need for integration.*** The relocation of this indigenous group into the communities of lowlanders had significantly decreased their access to land resulting in a proportionate decline in planting and harvesting activities causing a reduction in the density and variety of foods for consumption. Consequentially, purchasing and consuming of foods available in the lowland markets remained to be one of the alternatives to meet their food needs. The socioeconomic status of the indigenous community predetermined the ability to purchase and procure foods offered in the market. While indigenous community members continued to purchase foods, food affordability still had reduced the choices of foods they could actually purchase. This was congruent to the results found by Ekaningrum *et al.* (2017) where they studied the associations between nutrient density, food prices, and nutritional status of elementary school children. In the study, it was found that energy density was negatively correlated to food prices. This was also evident in the case of indigenous adolescents studying in the lowland as it was found that some of the adolescents opted for empty-calorie snacks as these were cheaper. While exposure to foods available in the lowland was high, the ability to acquire them and make as components of their dietary patterns was still low. Moreover, facing this economic gap and inequality, the indigenous community members would then grab job and employment opportunities offered in lowland communities reinforcing host-culture exposure, resulting in the acquisition of lowland food patterns.

***Religious influences.*** The indigenous community of Mt. Arayat had been converted into Christianity since 2002. The change in religious identity into a more Western demarcation not only implicated their former spiritual culture, but also various habitual dietary customs. While dietary rules were less formally regulated in Christianity, it still deeply governed many religious feasts like Lent, Easter, and Christmas. The celebration of these occasions was tantamount to the celebration of foods ascribed to them, actualizing religious faith. Reaffirming this, it was found that religion remained to be a significant influential determinant in peoples' behavior, consumption patterns, and dietary choices (Fuccillo *et al.* 2016).

***Transition in food selection behavior.*** The process of food selection remains to be dependent on food availability, even overlapping the concepts of food acceptance, rejection, and preferences (Lau *et al.* 1984). Food selection happens through acquired experiences, socio-cultural engagements, and environmental exposures. However, the sensory quality of food can also influence food preferences. Because traditional foods of the indigenous community generally have simple and natural flavors, the participants were likely to prefer purchased foods as these have more rich and distinct flavors.

***Attitude towards assimilation.*** Berry (1997) modeled acculturation as a dynamic process that can happen bi-dimensionally. It can involve both the process of acquisition or avoidance of host culture and the retention or loss of heritage culture. Assimilation, as a cultural orientation, is often characterized by the acquisition of host culture and the concurrent loss of heritage culture. As Berry (2005) indicated, the attitude by which the community responds favorably or unfavorably towards assimilation can modify the extent of host culture exposure and internalization. In the case of the indigenous community in Mt. Arayat, their accepting attitudes towards assimilation led to the gradual internalization of host culture practices and identity. And remarkably, such degree of favorable response specified an acculturation trajectory subsequently changing the community's dietary patterns.

**Integration of quantitative and qualitative findings**

Degrees of association between levels of acculturation and dietary acculturation in relation to changing dietary patterns were identified. These relationships were further expounded by the qualitative factors that governed them. While acculturation was found to be positively associated

with both the food blocks of dietary acculturation, the correlations varied in relatively wide degrees. Explaining the stronger correlation observed between acculturation and dietary acculturation – dominant food block ($r_{pb}$=0.1561$^{ns}$), the bicultural orientation of the indigenous adolescents (*N*=14; 93.33%) advanced into an extent of host culture acquisition introducing further the eating patterns and food choices of the dominant population. Due to better job opportunities in lowland communities, as well as the fluency of host languages, which facilitated the easier access to foods available in lowland markets, these have increased the adolescents' exposure to the host culture thereby impairing retention of traditional food patterns. The transition in food selection behaviors, particularly on food desirability, as well as the presence of religious influences on foods as celebratory components of religious feasts and gatherings, confirmed the positive correlation between acculturation and dietary patterns ($r_{pb}$=0.3112$^{ns}$). Thus, there exists linearity in the relationships related to acculturation instigating the process of dietary acculturation, thereby effecting the change in dietary patterns.

However, since it was noted that a positive relationship between the components of the traditional food block of dietary acculturation and dietary patterns ($r$=0.3484$^{ns}$) existed among adolescents from this indigenous community, this indicated that while there were changes in food and eating behaviors of the adolescents potentially oriented towards the food culture of the dominant society, foods readily available from their natural environment similar to their traditional food practices still mainly constituted their dietary intake, although in relatively decreased amount and utility. Moreover, the negative relationship between the dominant food block of dietary acculturation and dietary patterns ($r$=–0.3659$^{ns}$) strengthened the observation that food purchasing power greatly limited their alternative access to obtain and consume foods from lowland markets such as milk, meat, and fruits. Hence, while it was found that the processes of acculturation and dietary acculturation continually happen in a gradual manner, these were still hindered chiefly by the socioeconomic status of the indigenous adolescents in this study.

With these aggregated data, dietary change as a consequence of geographical displacement and psychosocial factors in an acculturative process can be viewed from either of the following positions: as a positive change on a much-improved Western mode of food production and consumption particularly as an increase in diet diversity, or as a negative change with Western food production and consumption delocalizing traditional food patterns. Studies on acculturation showed that increased consumption of fats and sugars and less on fruits and vegetables led to a higher body mass index (Serafica 2011; Vargas & Jurado 2015) and higher risks of ill-health and chronic diseases due to the major gap in indigenous peoples' relationship to food led to indigenous food insecurity and health changes (Skinner *et al.* 2016).

However, it was also purported that the modernization of diet has neither caused a deterioration nor a notable improvement in dietary patterns (Arandia *et al.* 2018). In fact, while food variety has essentially increased due to the introduction of foods previously excluded from their diets such as essential fats and oils, sugar and sweets, and milk and other milk products, the quantity of fruits, vegetables, and meat products being consumed, was still at levels that had a reducing impact on the total dietary pattern index scores of the indigenous adolescents. Such levels, however, were attributed to the decreased land use and access, disparate from the traditional food pattern of this indigenous community under study. Nevertheless, the emerging accultured trajectory of biculturalism has driven dietary benefits integrating both traditional and modern food patterns.

## CONCLUSION

The examination of the process of acculturation of the indigenous adolescents in Mt. Arayat, Central Luzon, Philippines included in this study indicated how dietary pattern changes were contingent on various contextual factors. While no statistically significant correlations were found between the levels of acculturation, dietary acculturation, and dietary patterns in the study, the probable relationships found provided an understanding on how acculturation prompts the events of dietary acculturation thereby changing dietary patterns, and how psychosocial and economic forces both contribute to these processes being investigated. Moreover, these factors could be the bases of various personal

and community decisions to consume new foods and become culturally significant components of individual dietary patterns of acculturated and internally displaced populations. This study led to an important viewpoint of integrating contexts in which dietary changes occur, i.e., the development of nutrition and other health programs must tailor-fit the setting of target populations, including acculturated indigenous communities. Biculturalism in indigenous communities, as opposed to the unidimensional perspective, and the health effects of acculturation warrant further investigation

In addition, further comparative and longitudinal studies may also be conducted among various indigenous communities in the Philippines in order to determine effects of acculturation-related dietary changes on indicators of health status, as well as to test the moderating and mediating effects. Methodological work is also essential to the design of various unbiased and culture-specific instruments and methods to accurately gather and measure data such as acculturation and dietary acculturation scales, and index analysis for Filipino dietary patterns.

## ACKNOWLEDGEMENT

We are grateful to the indigenous adolescents who participated in this study and to the leaders of their communities who gave permission and consent for this investigation. We acknowledge the technical assistance of Joana Rose M. Vergara, university researcher at the Agricultural Systems Institute, College of Agriculture and Food Science of the University of the Philippines Los Baños and of Eulalie D. Dulnuan, faculty member and Director of the Ifugao Rice Terraces – Globally Important Agricultural Heritage System Research and Development Center of the Ifugao State University.

## AUTHOR DISCLOSURES

The authors have no conflict of interest.

## REFERENCES

Arandia G, Sotres-Alvarez D, Siega-Riz AM, Arredondo EM, Carnethon MR, Delamater AM, Gallo LC, Isasi CR, Marchante AN, Pritchard D *et al.* 2018. Associations between acculturation, ethnic identity, and diet quality among U.S. Hispanic/Latino youth: Findings from the HCHS/SOL youth study. Appetite 129:25–36. https://doi.org/10.1016/j.appet.2018.06.017.

Berry JW. 1997. Immigration, acculturation, and adaptation. Appl Psychol 46(1):5–34. https://doi.org/10.1111/j.1464-0597.1997.tb01087.x.

Berry JW. 2005. Acculturation: Living successfully in two cultures. Int J Intercult Relat 29(6):697–712. https://doi.org/10.1016/j.ijintrel.2005.07.013.

Ekaningrum AY, Sukandar D, Martianto D. 2017. Association between nutrient density, food price, and nutritional status among Pekayon 16 Pagi elementary school children. J Gizi Pangan 12(2):139–146. http://dx.doi.org/10.25182/jgp.2017.12.2.139-146.

Fox M, Thayer ZM, Wadhwa PD. 2017. Acculturation and health: The moderating role of socio-cultural context. Am Anthropol 119(3):405–421. https://doi.org/10.1111/aman.12867.

Fuccillo A, Sorvillo F, Decimo L. 2016. Law, religions and food choices. Calumet-Intercult L Humanit Rev (2):1–25.

Holmes R, Clark K. 1992. Diet, acculturation and nutritional status of Venezuela's Amazon territory. Ecol Food Nutr 27(3–4):163–187. https://doi.org/10.1080/03670244.1992.9991242.

Kuhlein HV, Receuver O. 1996. Dietary change and traditional food systems of indigenous peoples. Annu Rev Nutr 16:417–442. https://doi.org/10.1146/annurev.nu.16.070196.002221.

Lau D, Krondl M, Coleman P. 1984. Psychological Factors Affecting Food Selection. New York (US): Plenum Press.

Lesser I, Gasevic D, Lear SA. 2014. The association between acculturation and dietary patterns of South Asian immigrants. PLOS One 9(2):e88495. https://doi.org/10.1371/journal.pone.0088495.

Lee EJ, Lee KR, Lee SJ. 2017. Study on the change and acculturation of dietary pattern of Southeast Asian workers living in South Korea. Appetite 117:2013–213. doi: 10.1016/j.appet.2017.06.022.

Lindert AT, Korzilius H, Van de Vijer FJR, Kroon S, Arends-Tóth J. 2008. Perceived discrimination and acculturation among Iranian refugees in the Netherlands. Int J Intercult Relat 32(6):578–588. https://doi.org/10.1016/j.ijintrel.2008.09.003.

Ritenbaugh C, Szathmary E, Goodby S, Feldman C. 1995. Dietary acculturation among the Dogrib Indians of the Canadian Northwest territories. Ecol Food Nutr 35(2):81–94. https://doi.org/10.1080/03670244.1996.9991478.

Satia JA. 2010. Dietary acculturation and nutrition transition: An overview. Appl Physiol Nutr Metab 35(2):219–223. http://dx.doi.og/10.1138/H10-007.

Satia-Abouta J. 2003. Dietary acculturation: Definition, process, assessment, and implication. Int J Hum Ecol 4(1):71–86.

Satterthwaite D, McGranahan G, Tacoli C. 2010. Urbanization and its implications for food and farming. Philos Trans R Soc Lond B Biol Sci 365(1554):2809–2820. http://dx.doi.org/10.1098/rstb.2010.0136.

Schnettler B, Miranda H, Mora M, Lobos G, Viviani J, Sepúlveda J, Orellana L, Denegri M. 2013. Acculturation and consumption of foodstuffs among the main indigenous people in Chile. Int J Intercult Relat 37(2):249–259. https://doi.org/10.1016/j.ijintrel.2012.08.003.

Seitz S. 1998. Coping strategies in an ethnic minority group: The Aeta of Mount Pinatubo. Disasters 22(1):76–90. https://doi.org/10.1111/1467-7717.00076.

Serafica RC. 2011. Dietary consumption of fat, sugar, fruits and vegetables, dietary acculturation and anthropometric indicators among Filipino Americans in North Carolina [Dissertation]. Honolulu: University of Hawaii at Mānoa.

Serafica RC, Lane SH, Ceria-Ulep CD. 2013. Dietary acculturation and predictors of anthropometric indicators among Filipino Americans. Sage Open 3(3):2158244013495543. http://dx.doi.org/10.1177/2158244013495543.

Skinner K, Pratley E, Burnett K. 2016. Eating in the city: A review of the literature on food security and indigenous people living in urban spaces. Societies 6(2):7. http://dx.doi.org/10.3990/soc6020007.

Sökefeld M. 1999. Debating self, identity, and culture in anthropology. Curr Anthropol 40(4):417–448.

[USDA-FNS] United States Department of Agriculture-Food and Nutrition Service. 2018. How the HEI is scored. https://www.fns.usda.gov/how-hei-scored [Accessed 14th September 2019].

Vargas P, Jurado LF. 2015. Dietary acculturation among Filipino Americans. Intl J Environ Res Public Health 13(1):16. https://doi.org/10.3390/ijerph13010016.

*Available online: http://journal.ipb.ac.id/index.php/jgizipangan*
*Accredited based on DGHE, Republic of Indonesia No. 28/E/KPT/2019*
*ISSN 1978-1059 EISSN 2407-0920*

***J. Gizi Pangan, March 2021, 16(1):31-38***
*DOI: 10.25182/jgp.2021.16.1.31-38*

# Glycemic Index Values of Rice Varieties that are Commonly Available in Markets in Bangladesh

**Enamul Kabir[1], Md Tofazzal Hossain[1], Mohammad Anowar Hossain[1], Shuma Rani Ray[1], Muhammad Javidul Haque Bhuiyan[1*]**
[1]Department of Biochemistry and Molecular Biology, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

## ABSTRACT

Glycemic Index (GI) of six common rice varieties in the local markets of Bangladesh was assessed and categorized in this study to investigate manipulative varietal performance for the time being. After overnight fasting, each of ten selected healthy non-diabetic volunteers (males and females in ratio of 1:1) was fed with reference food (50 g glucose) and test foods (50 g carbohydrate-containing different rice varieties) in every two days intervals. After feeding, glucose levels (mmol/l) were measured at 0, 15, 30, 45, 60, 90 and 120 minutes. Incremental Area Under Curve (IAUC) of reference food and test food (avoiding the area beneath the baseline of reference food) was calculated to measure GI values. Amylose content (%) of different test foods was measured from the standard curve obtained from the spectrophotometric analysis after alcoholic-alkaline gelatinization that was followed by acidification and iodine mixing. The result showed that the GI values were 59.7±3.4; 50.5±2.6; 57.8±2.8; 51.3±2.3; 56.9±3.9 and 44.6±2.1, while the amylose content (%) were 23.6±0.6; 26.7±0.9; 21.3±0.7; 28.3±1.1; 22.2±2.3 and 29.8±1.5 for Nizershail, BRRI Dhan 29, Chinigura, Kalijira, Hybrid Hera Dhan 12 and Sworna, respectively. Moreover, the existing inverse relationship between the GI values and amylose content in this study was similar to other researchers' findings. Categorization of the test foods based on the observed GI values ranked Sworna, BRRI Dhan 29 and Kalijira as low GI rice varieties that could be beneficial for consumption by diabetics as well as healthy individuals.

**Keywords**: Bangladesh, glycemic index, market, rice varieties

## INTRODUCTION

Rice is not only a staple food in Bangladesh, but also a major cereal foodstuff for about half of the world's population. It is noteworthy that starch as a major constituent (about 72% to 75%) of rice directly raises the postprandial blood glucose and insulin response in mammals (Hewson-Hughes *et al.* 2011). So, rice-based carbohydrate foodstuffs consumption should be judicially performed in diabetic individuals for controlling diabetes.

Diabetes mellitus has become a leading cause of death and disability worldwide. Moreover, diabetes-related complications like cardiovascular disease, peripheral artery disease, retinopathy, nephropathy and depression could be the risk factors, especially for the South Asian people (Safita *et al.* 2016). According to a meta-analysis (from 2001 to 2010), the incidence of diabetes had substantially increased from 5% to 9% among the Bangladeshi adults (Saquib *et al.* 2012). Such increasing trend might create an unhealthy population, which could be a burden rather than a resource for this country in the long run.

Management of diabetes is most critical and even could be difficult sometimes to be accomplished due to traditional lifestyle. Many people are not quite ready to compromise with their conventional carbohydrate intake, maintain a disciplined daily life with regular exercise, and expense extra money for medication. Various carbohydrate foodstuffs show different range of effects on the blood glucose level and hormonal response after having a meal. Thus, it is important to consider not only the quantity, but also the quality of carbohydrate foodstuffs while considering diabetes management. Low Glycemic Index (GI) rice varieties could be a good choice in this regard (Pinhero *et al.* 2016).

[*]**Corresponding Author:** tel: +8801718084131, email: mjhbhuiyan@bau.edu.bd

On the contrary, high glycemic index foodstuffs are associated with the development of type 2 diabetes (Bhupathiraju *et al.* 2014).

Generally, GI gives an idea about how fast the body converts the carbohydrate foodstuffs into glucose. This term was firstly introduced by Jenkins *et al.* (1981), who proposed carbohydrates' ranking based on a scale from 0 to 100 according to the postprandial impact on blood glucose level. High GI foods (≥70) are rapidly digested, absorbed and metabolized, resulting in increased blood glucose level. On the contrary, low GI foods (≤55) improve the metabolic variables in diabetic, hyperlipidemic or even in healthy individuals by prolonging satiety (GI newsletter 2019). Amylose content, an inherent chemical property in the starch structure, could be another influential factor to interpret the observed GI values in this study, since it exhibits an inverse relationship with GI values (Jeevetha *et al.* 2014). In this context, for the betterment of diabetes management, we included six commonly consumed rice varieties that are available in markets in Bangladesh (like Nizershail, BRRI Dhan 29, Chinigura, Kalijira, Hybrid Hera Dhan 12 and Sworna) in this study to assess their GI values and categorize them accordingly. The GI values of BRRI Dhan 29 and Chinigura from these selected rice varieties were assessed before in previous experiments. However, over time the varietal purity of all these varieties is in doubt. So, we chose the common varieties readily available at the local market to assess the real situation of the GI values of selected varieties.

## METHODS

### Design, location, and time

In vivo experiment was conducted in the Food Bioscience Laboratory of Department of Biochemistry and Molecular Biology, Bangladesh Agricultural University, from July 2018 to June 2019.

### Sampling

Ten healthy non-diabetic volunteers (males and females in ratio of 1:1) of different ages ranging from 22 to 45 years were recruited in this study. The subjects who had normal body weight (BMI that ranges from 18.5 to 24.9 kg/m$^2$ as per WHO recommendation) and were free from any illness, food allergy, and medications were included. They were requested to maintain a regular diet and activity schedule throughout the experiment. The study protocol was approved by the Diabetic Association of Bangladesh (DAB-HT73/2018) following the guideline described in the Declaration of Helsinki. Before participation, all the subjects were well informed and their written consents were taken as well.

### Data collection

***Test foods***. Six rice varieties of different types like local variety (Nizershail), high-yielding variety (BRRI Dhan 29), aromatic variety (Chinigura, Kalijira), hybrid variety (Hybrid Hera Dhan 12), and inbred variety (Sworna) were taken in this experiment to assess their GI values. All these common verities were purchased from the local market. Aromatic varieties were non-parboiled as well as fine, while the other varieties were parboiled and coarse. Fifty grams available carbohydrate-containing rice of each variety was cooked for 21±1 minutes in an electric rice cooker (rice and water ratio was 1:3). The cooked rice was kept in the open air for 30 minutes to reach room temperature and was finally served to each of the subjects. It took around 10 minutes to ingest the test food from the first bite. The performance of each test food was measured only once. During testing, the subjects were encouraged to be acquainted with minimum physical activity.

***Proximate analysis of test foods.*** Standard protocols (AOAC 2019) were followed and calculations were performed accordingly to determine the proximate parameters. All the samples were oven-dried (at 105°C) until constant weights were achieved for moisture content (%) determination as follows:

$$\left(\frac{Initial\ weight\ of\ crucible - Final\ weight\ of\ crucible}{Weight\ of\ sample}\right) \times 100$$

With the help of usual non-enzymatical method, ash content was measured. Dry samples were further kept in muffle furnace for five hours ignition at 600°C to assess ash content (%) using the following formula:

$$\left(\frac{Initial\ weight\ of\ crucible - Final\ weight\ of\ crucible}{Weight\ of\ sample}\right) \times 100$$

Dietary fiber content (%) was estimated by AOAC (2019) method and the percentage was calculated as follows: $\frac{Loss\ of\ weight}{Weight\ of\ sample} \times 100$ . Micro-

Kjeldahl apparatus was used to determine the percent N followed by protein content (Saez-Plaza *et al.* 2013) using this formula:

$$\%Nitrogen = \left( \frac{(TS - TB) \times Normality\ of\ acid \times meq\ of\ N)}{Weight\ of\ sample} \right) \times 100$$

where, TS=titer value for sample, TB=titer value of the blank, and meq of N=0.014, and thus, finally: $\%Protein = \%Nitrogen \times 5.5 (Conversion\ factor)$ . In the Soxhlet apparatus, 250 g ground material (80 mesh) of each rice variety was taken to determine the fat content. The extraction was performed on a water bath for six hours with 500 ml n-hexane as extracting solvent. After the oil extraction, the excess solvent was distilled off under reduced pressure in a rotary evaporator. Total available carbohydrate content (%) was measured using the formula according to FAO (2004) as follows:

$$100 - (\%Moistur + \%Ash + \%Protein + \%Fiber + \%Fat)$$

***Reference food.*** Fifty grams of glucose (Glucon-D, Heinz India Pvt. Ltd, India) was dissolved in 200 ml water and was used as the reference food. Performance of reference food on blood glucose level was measured every two days before assessing the test foods performance to avoid the carry-over effect (Brouns *et al.* 2005). On the other hand, at least ten days were maintained as washout period between two test foods' trials.

***Blood glucose measurements.*** After 10–12 hours overnight fasting, the subjects were ready to be incorporated with the testing process in the morning. Fasting blood glucose levels (mmol/l) were measured at 20 minutes and 0 minute before the consuming the food (both reference food and test food) and their mean values was fixed as the baseline value. After having the meal at 15, 30, 45, 60, 90 and 120 minutes, blood glucose levels were again measured. Blood glucose level measurement was performed by pricking finger using a glucometer (Bioland, Model: G-423E, China).

***Glycemic index calculation.*** The incremental area under curves (IAUC) for the blood glucose level variation during the testing of reference (glucose) and test (rice varieties) foods was calculated geometrically in the MS-Excel-2007 program by trapezoid rule ignoring the area beneath baseline value of reference food (FAO/WHO 1998). IAUC of reference foods were always assumed to be 100. Compare with the reference food, the converted value from respective IAUC of test foods were calculated, indicating their subsequent GI values. After having all the GI values, GI classification was performed accordingly (Jenkins *et al.* 1981).

***Determination of amylose content (%).*** Amylose content (%) was estimated according to the established procedure (Duan *et al.* 2012). Finely powdered 10 mg test sample was taken into Erlenmeyer flask with 1 ml 95% ethanol and 9 ml 1N NaOH, warmed for 5 minutes in water bath to be gelatinized with the starch and made up the volume with distilled water to 100ml. Five ml of this solution was acidified (1ml 1N acetic acid) with iodine solution (2 ml) and made the volume up to 100 ml, allowed to keep for 20 minutes before taking optical density reading. For standard amylose solution, 100 mg anhydrous rice amylose (JT Baker Chemical Co. Phillips-Burge, New Jersey, USA) was taken to prepare 100 ml stock solution with 10 ml 95% ethanol and 90 ml 1N NaOH. From the stock solution, 0.25 mg%, 0.5 mg%, 0.75 mg%, 1 mg%, 1.25 mg%, 1.5 mg%, 1.75 mg%, and 2 mg% working solutions were prepared along with acidification (acetic acid) and mixing iodine solution. Optical density was measured using a UV spectrophotometer (Renonlab, Model-722G, China) at 625nm and used to prepare a standard curve accordingly. From the standard curve, test samples' amylose content (%) were subsequently calculated.

**Data analysis**

Statistical analysis was performed by using the SPSS (version 11.0.1, USA) software. Data were presented with mean, Standard Deviation (SD), Standard Error (SEM), statistical significance of $p<0.01$ and $p<0.05$. Since, the data were normally distributed, the significant difference among the GI values of test foods was tested by generalized linear model (Shapiro-Wilks statistics). Amylose content in different test foods was grouped using Duncan's Multiple Range Test (DMRT).

## RESULTS AND DISCUSSION

**Observation of study subjects**

The anthropometric measurements like height, weight, BMI, fasting blood glucose level, and blood pressures were recorded at fasting conditions (shown in Table 1).

Table 1. Demographic characteristics of study subjects (n=10)

| Characteristics | Mean ±SD |
|---|---|
| Age (Years) | 35.9±7.56 |
| Body weight (kg) | 55.63±4.98 |
| Height (m) | 1.63±0.052 |
| BMI (kg/m$^2$) | 21.15±2.13 |
| Fasting glucose level (mmol/l) | 5.3±0.5 |
| Blood pressure | |
| Systolic (mmHg) | 115±8.55 |
| Diastolic (mmHg) | 73±10.12 |

Values are shown as mean with standard deviation
BMI: Body Mass Index

No statistical significance was observed among the demographic characteristics and the GI values, IAUC values as well as amylose content. Since the residual effects were found normal the data are not included here.

**Nutrient composition and cooking properties of test rice varieties**

The selected rice varieties were procured from the local market to assess the manipulative varietal performance, specially related the GI content. Their nutrient compositions are shown in Table 2.

**Variations in blood glucose level (mmol/l) with different rice varieties**

Blood glucose level (mmol/l) fluctuations for 2 hours after consuming different test foods (rice varieties) along with reference food (glucose) are presented in Figure 1 (a–f). Data were presented as mean±SEM. There was no significant difference between the responses of test foods and reference foods at 0 minute. The baseline value for each test food was fixed by glucose level of reference food at 0 minute. Above this baseline value, both the reference food and test foods showed a varied significance level as $p<0.01$ and $p<0.05$. For all cases, at 120 minutes, no significant variations in blood glucose levels were obtained as expected.

**Calculation of GI values and their categorization**

Table 3 indicates the calculated summation of IAUC (mmol/l.min) for each test food. The mean±SD of different rice varieties ranged from 112.1±6.3 to 185.3±12.7 mmol/l.min. GI values are also presented as mean±SD. From the table we got that low GI rice varieties were BRRI Dhan 29, Kalijira, and Sworna.

**Amylose content (%)**

Amylose content (%) in each test food is presented in Figure 2 as mean±SD. The lowest amylose content (%) was observed to be 21.3±0.7 in Chinigura and the highest was 29.8±1.5 in Sworna. According to the range test (DMRT), all the test foods were grouped. High amylose content rice varieties were BRRI Dhan 29, Kalijira, and Sworna. On the other hand, Nizershail, Chinigura and Hybrid Hera Dhan 12 were grouped as low amylose content rice varieties.

In this experiment, we involved different types of rice varieties. From these rice varieties,

Table 2. Proximate composition and cooking properties of different test foods

| Rice variety | Moisture (%) | Ash (%) | Dietary fiber (%) | Fat (%) | Protein (%) | Available carbohydrate (%) | Rice (g) cooked per serving | Cooking time (min) |
|---|---|---|---|---|---|---|---|---|
| Nizershai | 11.6 | 1.57 | 1.2 | 2.8 | 6.7 | 76.13 | 65.7 | 20 |
| BRRI Dhan 29 | 11.3 | 1.43 | 1.2 | 1.9 | 6.99 | 77.18 | 64.8 | 21 |
| Chinigura | 12.3 | 1.38 | 1.3 | 2.3 | 6.24 | 76.48 | 65.4 | 20 |
| Kalijira Hybrid Hira | 12.8 | 1.02 | 0.9 | 2.31 | 7.1 | 75.87 | 65.9 | 22 |
| Dhan 12 | 12.5 | 1.29 | 1.0 | 2.1 | 6.69 | 76.42 | 65.4 | 22 |
| Sworna | 13.8 | 1.81 | 1.4 | 4.12 | 8.8 | 70.07 | 71.4 | 21 |

According to the available carbohydrate content different amount of rice varieties was calculated before serving to the subjects for further analysis

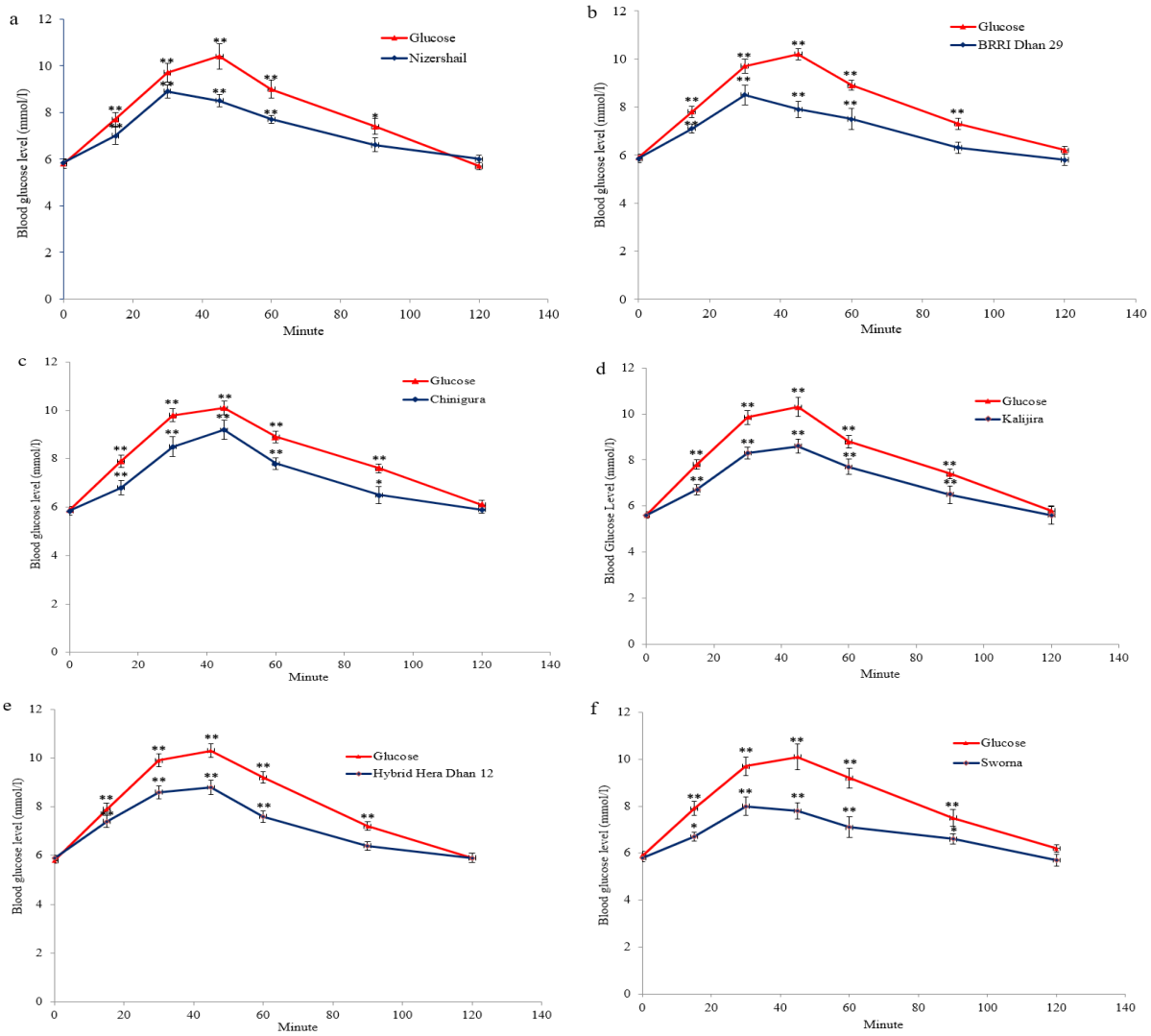


Figure 1. (a–f): Blood glucose level (mmol/l) variations at different time points after 2 hours of glucose (reference food) and rice (test food) consumption: Figures a; b; c; d; e and f indicates glucose responses of Nizershail; BRRI Dhan 29; Chinigura; Kalijira; Hybrid Hera Dhan 12; and Sworna with * of $p<0.05$ and ** of $p<0.01$ respectively

Chinigura and Kalijira were non-parboiled and the others were parboiled. The result showed that BRRI Dhan 29, Kalijira and Sworna rice were low GI ranked rice varieties. Again, these varieties had high amylose content subsequently. A significant association between high GI foodstuffs and type 2 diabetes prevalence has been exhibited previously (Bhupathiraju *et al.* 2014).

People of this country are most likely large consumer of rice which ultimately enhances diabetes. Moreover, inclusion of high GI rice in regular diets could be further more devastating for managing diabetes. Rice cultivation in different geographical regions may involve a varied range of grain morphology, water absorption, macronutrients, dietary fiber and amylose content (Bhonsle & Sellappan 2010). These properties may further be acquainted with various ranges of GI values (Kaur *et al.* 2016). Researchers revealed that parboiled rice tended to show decreased glycemic response compared with non-parboiled rice (Pathiraje *et al.* 2010). The formation of resistant starch, as well as

Table 3. Categorization of different rice varieties based on GI rankings

| Rice Variety | Reference food IAUC mmol/l min | Test foods IAUC mmol/l min | GI | GI Class |
|---|---|---|---|---|
| Nizershail | 244.2±20.1 | 145.8±12.4 | 59.7±3.4 | Medium |
| BRRI Dhan 29 | 248.7±18.9 | 125.6±8.7 | 50.5±2.6 | Low |
| Chinigura | 270.9±22.2 | 156.5±11.3 | 57.8±2.8 | Medium |
| Kalijira | 305.6±19.7 | 156.7±9.5 | 51.3±2.3 | Low |
| Hybrid Hera Dhan 12 | 325.4±5.3 | 185.3±12.7 | 56.9±3.9 | Medium |
| Sworna | 251.1±16.3 | 112.1±6.3 | 44.6±2.1 | Low |

GI was obtained from IAUC variations of test foods in respect of their subsequent reference foods
Values are expressed as mean±SD; GI: Glycemic Index; IAUC: Incremental Area Under Curve

rice parboiling, gave rise to retrogradation of starch, which could be the reason behind such phenomenon (Wang *et al.* 2015).

Moreover, several factors such as starch types and their physical bindings with other food components, combinations of different contents of protein, fat, organic acids and their salts could contribute of GI values variations. It is already revealed that rice structure, for example, its coarse and fine forms, might express different GI value ranges. Usually fine rice (like white Bashmati) has low GI (Ranawanna *et al.* 2009) compared with coarse rice (brown Basmati) because of having more amylose: amylopectin ratio (Swetha 2019). The straight-chain form of starch is the amylose that does not gelatinize during cooking. Such depleted gelatinization caused low blood glucose and insulin level compared with fully cooked rice (Jung *et al.* 2009). In another study, a

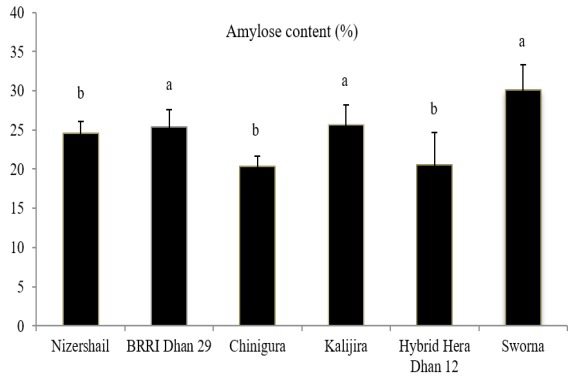


Figure 2. Amylose content (%) in different rice varieties; Data (mean±SD) are grouped into two classes by Duncan's Multiple Range Test

high GI value was observed to be associated with a low (20%) amount of amylose (Bhupathiraju *et al.* 2014).

In this study, an inverse relationship existed between the GI value and the amylose content of different rice varieties, which was similarly observed by Meera *et al.* (2019). High amylose content in the starch structure could slow down the digestion rate (Li *et al.* 2020). Compared with the amylopectin structure, the amylose structure has a huge number of hydrogen bonds between the glucose units. Such more bindings could make the amylose more resistant to the digestive enzyme activity (Hong *et al.* 2018). On the contrary, the high amylopectin content are more prone to enzymatic action as compare to low amylose content (Xu *et al.* 2017). The observed GI values in this study could be further verified by the obtained amylose content, which established the inverse relationship.

## CONCLUSION

In this in vivo investigation, six rice varieties that are commonly available in markets were taken into study. According to the classification of different GI groups, we could conclude that low GI rice varieties like BRRI Dhan 29, Kalijira and Sworna would be beneficial for different therapeutic controls in diabetic as well as normal individuals. Moreover, their amylose contents were subsequently higher, establishing an inverse proportion respective to their GI values.

The classification and recognition of the selected rice varieties of this study as low-GI

and medium-GI foods would help consumers choose rice and rice based food products with a low glycemic response, thereby lowering and/or resisting the development diabetes. The grain quality of rice depends on the variation in production technology, preservation processes, cooking methods, and several other factors. Thus, it provides further scope to explore GI variation among different situation.

## ACKNOWLEDGEMENT

This research work was conducted by the grant provided by Bangladesh Agricultural University Research System (BAURES project no. 2018/563 AU-GC). The authors are grateful to the selected volunteers and the physician Dr. Md. Shafiqul Haque of Mymensingh Medical College & Hospital for their contribution regarding the experiment.

## AUTHOR DISCLOSURES

In this study, the authors have no conflict of interests.

## REFERENCES

[AOAC] Association of Official Analytical Chemists. 2019. Official Methods of Analysis (21st edition). Washington DC (USA): AOAC.

Bhonsle SJ, Sellappan K. 2010. Grain quality evaluation of traditionally cultivated rice varieties of Goa, India. Receant Res Sci Technol 2:88–97.

Bhupathiraju SN, Tobias DK, Malik VS, Pan A, Hruby A, Manson JE, Willett WC, Hu FB. 2014. Glycemic index, glycemic load and the risk of type 2 diabetes: Results from 3 large US cohorts and an updated meta-analysis. Am J Clin Nutr 100(1):218–232. https://doi.org/10.3945/ajcn.113.079533.

Brouns F, Bjorck I, Frayn KN, Gibbs AL, Lang V, Slama G, Wolever TM. 2005. Glycemic index methodology. Nutr Res Rev 18(1):145–171. https://doi.org/10.1079/NRR2005100.

Duan DX, Donner E, Liu Q, Smith DC, Ravenelle F. 2012. Potentiometric titration for determination of amylose content of starch – A comparison with the colorimetric method. Food Chem 130(4):1142–1145. https://doi.org/10.1016/j.foodchem.2011.07.138.

[FAO/WHO] Food Agriculture Organization/ World Health Organization. 1998. Carbohydrates in human nutrition. Report of a joint FAO/WHO expert consultation. FAO Food Nutr 66:1–140.

[FAO Newsroom] Food Agriculture Organization Newsroom. 2004. Rice is life. Food and Agricultural Organization of the United Nations, Rome, Italy. http://www.fao.org/newsroom/en/focus/2004/36887/index.html [Accessed 12th February 2020].

GI Newsletter. 2019. "About glycemic index." Boden institute of obesity, nutrition, exercise and eating disorders and charles perkins centre at the university of Sydney. The University of Sydney. http://www.glycemicindex.com/about.php [Accessed 7th January 2021].

Hewson-Hughes AK, Gilham MS, Upton S, Colyer A, Butterwick R, Miller AT. 2011. The effect of dietary starch level on postprandial glucose and insulin concentrations in cats and dogs. Br J Nutr 106(S1):105–109. https://doi.org/10.1017/S0007114511001887.

Hong J, Zeng XA, Buckow R, Han Z. 2018. Structural, thermodynamic and digestible properties of maize starches esterified by conventional and dual methods: Differentiation of amylose contents. Foods Hydrocoll 83:419–429. https://doi.org/10.1016/j.foodhyd.2018.05.032.

Jeevetha S, Nisak MYB, Ngan HB, Ismail A, Azlan A. 2014. Relationship between amylose content and glycemic index of commonly consumed white rice. IOSR Journal of Agriculture and Veterinary Science 7(9):12–18. doi:10.9790/2380-07931218.

Jenkins DJ, Wolever TM, Taylor RH, Barker H, Fielden H, Baldwin JM, Bowling AC, Newman HC, Jenkins Al, Goff DV. 1981. Glycemic index of foods: A physiological basis for carbohydrate exchange. Am J Clin Nutr 34(3):362–366. https://doi.org/10.1093/ajcn/34.3.362.

Jung EY, Suh HJ, Hong WS, Kim DG, Hong YH, Hong IS, Chang UJ. 2009. Uncooked rice of relatively low gelatinization degree

resulted in lower metabolic glucose and insulin responses compared with cooked rice in female college students. Nutr Res 29(7):457–461. https://doi.org/10.1016/j.nutres.2009.07.002.

Kaur B, Ranawana V, Henry J. 2016. The glycemic index of rice and rice products: A review, and table of GI values. Crit Rev Food Sci Nutr 56(2):215–236. https://doi.org/10.1080/10408398.2012.717976.

Li N, Guo Y, Zhao S, kong J, Qiao D, Lin L, Lin Q, Zhang B. 2020. Amylose content and molecular-order stability synergistically affect the digestion rate of indica rice starches. Int J Biol Macromol 144:373–379. https://doi.org/10.1016/j.ijbiomac.2019.12.095.

Meera K, Smita M, Haripriya S, Sen S. 2019. Varietal influence on antioxidant properties and glycemic index of pigmented and non-pigmented rice. J Cereal Sci 87:202–208. https://doi.org/10.1016/j.jcs.2019.03.005.

Pathiraje PMHD, Madhujith WMT, Chadrasekara A, Nissanka SP. 2010. The effect of rice variety and parboiling on in vivo glycemic response. Tropical Agricultural Research 22(1):26–33.

Pinhero RG, Waduge RN, Liu Q, Sullivan JA, Tsao R, Bizimungu B, Yada RY. 2016. Evaluation of nutritional profiles of starch and dry matter from early potato varieties and its estimated glycemic impact. Food Chem 203:356–366. https://doi.org/10.1016/j.foodchem.2016.02.040.

Ranawanna DV, Henry CJK, Lightowler HJ, Wang D. 2009. Glycemic index of some commercially available rice and rice products in Great Britain. Int J Food Sci Nutr 60(Supp 4):99–110. https://doi.org/10.1080/09637480802516191.

Saez-Plaza P, Michalowski T, Navas MJ, Asuero AG, Wybraniec S. 2013. An overview of the Kjeldahl method of nitrogen determination. Part 1. Early history, chemistry of the procedure and the titrimetric finish. Crit Rev Anal Chem 43(4):178–223. https://doi.org/10.1080/10408347.2012.751786.

Safita N, Islam SMS, Chow CK, Niessen L, Lechner A, Holle R, Laxy M. 2016. The impact of type 2 diabetes on health related quality of life in Bangladesh: Results from a matched study comparing treated cases with non-diabetic controls. Health Qual Life Outcomes 14(1):129. https://doi.org/10.1186/s12955-016-0530-7.

Saquib N, Saquib J, Ahmed T, Khanam MA, Cullen MR. 2012. Cardiovascular diseases and type 2 diabetes in Bangladesh: A systematic review and meta-analysis of studies between 1995 and 2010. BMC Public Health 12(1):434. https://doi.org/10.1186/1471-2458-12-434.

Swetha S. 2019. Which rice is best for a diabetic? Glycemic index analysis (part-1). Upgrade my food: making food fast healthy and fun. https://www.upgrademyfood.com/which-rice-is-best-for-a-diabetic-glycemic-index-analysis-part-1/ [Accessed 1st January 2019].

Wang S, Li C, Copeland L, Niu Q, Wang S. 2015. Starch retrogradation: A comprehensive review. Compr Rev Food Sci Food Saf 14(5):568–585. https://doi.org/10.1111/1541-4337.12143.

Xu J, Kuang Q, Wang K, Zhou S, Wang S, Liu X, Wang S. 2017. Insights into molecular structure and digestion rate of oat starch. Food Chem 220:25–30. https://doi.org/10.1016/j.foodchem.2016.09.191.

*Available online: http://journal.ipb.ac.id/index.php/jgizipangan*
*Accredited based on DGHE, Republic of Indonesia No. 28/E/KPT/2019*
*ISSN 1978-1059 EISSN 2407-0920*

***J. Gizi Pangan, March 2021, 16(1):39-46***
*DOI: 10.25182/jgp.2021.16.1.39-46*

# Development of Stunting Early Detection Kit for Children under Two Years: Validity and Reliability

**Aphrodite Nadya Nurlita[1], Maria Wigati[1], Mubasysyir Hasanbasri[1], Jumarko[2], Siti Helmyati[3,4*]**

[1]Department of Biostatistic, Epidemiology, and Population Health, Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University, Yogyakarta 55281, Indonesia
[2]Seyegan Public Health Center, Seyegan, Sleman Yogyakarta 55561, Indonesia
[3]Department of Nutrition, School of Health Nutrition, Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University, Yogyakarta 55281, Indonesia
[4]Center for Health and Human Nutrition, Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University, Yogyakarta 55281, Indonesia

## ABSTRACT

This study aimed to determine validity and reliability of the new developed Stunting Early Detection Kit (SEDEK). This study was a cross-sectional study. A total sample of 30 children under two years from a Posyandu in Seyegan, Yogyakarta, was involved in the study. Every child was measured using SEDEK and infantometer-WHO Length for Age Growth Chart as the gold standard to find out its validity. Validity was determined by sensitivity, specificity, and predictive value. Reliability in this study was measured by intra-rater reliability, by comparing the first measurement and the second measurement from a rater using SEDEK. The intra-rater reliability determined using the Intraclass Correlation Coefficient (ICC). The results showed no significant difference between length measurements using SEDEK and the gold standards ($p>0.05$). The SEDEK sensitivity was 80%, specificity 85%, positive predictive value 72.7%, negative predictive value 89.5%. SEDEK reliability is demonstrated by ICC of 0.781. However, this study suggest that the current SEDEK version has not met the required sensitivity and positive predictive value of more than 80% so that it can be used as a detection tool. Further research is needed to improve the quality of SEDEK so that the SEDEK improved version can be used at the community-based health facilities level.

**Keywords**: aged 0–24 months, nutrition screening tool, reliability, stunting, validity

## INTRODUCTION

Stunting is considered one of the biggest nutritional problems that affects 21.9% or 149 billion children under five in 2018 globally (UNICEF/WHO/The World Bank 2019). Based on Basic Health Research 2018, the prevalence of stunting in children under five years was 30.8%, while the target prevalence as stated in the National Medium-Term Development Plan (RPJMN) is 28% (MoH RI 2018).

Stunting defined as child's length or height according to their age is below -2 SDs of the WHO child growth standards median (de Onis & Branca 2016). In addition to their physical growth faltering, stunted children may also have impaired cognitive function, poor motor skills, decreased physical capacity, and neurodevelopment, and even reduced productivity and cause economic loss in the future (Prendergast & Humprey 2014; Stewart 2013; Renyoet *et al.* 2016). Therefore, it is important detect stunting earlier especially in children under two years old to prevent negative consequences.

Early detection of stunting can be done at Community Based Health Post or commonly known as Posyandu in Indonesia, this can done by empowering Posyandu cadres or health volunteers (Adistie *et al.* 2018). However, this is not an easy task, since health volunteers in Posyandu mostly are not health care workers it can affect the accuracy of early stunting detection results. Research conducted by Adistie *et al.* (2018), Fuada *et al.* (2014), and Hadi *et al.* (2019) showed that cadres have been less accurate in measuring and evaluating

[*]**Corresponding Author:** tel: +6227454775, email: siti.helmyati@gmail.com

the growth measure Length-for-Age Z score (LAZ). These inaccuracies are possibly caused by several reasons, including lack of training so that cadres become less skilled, non-routine length measurements so that cadres are not accustomed, difficulties in plotting the growth curve when assessing LAZ, or the quality of length measurement tools that don't comply with WHO standards (Adistie *et al.* 2018; de Onis & Branca 2016; Fuada *et al.* 2014)

Some posyandu do not have a length measurement tool that complies with WHO standards. For Posyandu that do not have infantometers, the child's length is measured using microtoise, tailor measuring tape, metline, measuring instruments made of wood, or other measuring devices developed before. Some of the measuring instruments that have been developed are portable height measuring instruments, multifunctional measuring instruments, and growth mats. However, these tools have several weaknesses, such as difficulty in ensuring child position correctly. These tools validity's also unknown and these tools are not developed with instruments to interpret length measurement results (Amareta *et al.* 2016; Basset & Ruel-Bergeron 2012; Sinaga *et al.* 2018).

To solve those problems, a nutrition detection or screening that meets the easily understood and fast-to-use criteria must be developed. Furthermore, these tools must produce valid and reliable results. Validity is described as tools accuracy to detect the "true" value of the measurement. Reliability show tools consistency to measure what will be measured (Gleason *et al.* 2010; Jamaiyah *et al.* 2010; Sinaga *et al.* 2018). A valid detection or screening tool will help provide preventive action more quickly to prevent future growth failures (Maxim *et al.* 2014).

Based on the identified problems, the researchers aimed to determine the quality of the newly developed Stunting Early Detection Kit (SEDEK). The researchers highlight SEDEK validity and reliability based on sensitivity, specificity, positive predictive value, and negative predictive value to detect the "true" value of the measurement. This research is essential so that SEDEK, an early detection tool that will be developed, can be a precise and accurate early stunting detection tool. It is expected that the use of SEDEK can help health workers take stunting preventive action quickly and precisely.

## METHODS

### Design, location, and time

The design of this study was cross-sectional. The research was conducted in Kamal Wetan, Seyegan, Sleman, Yogyakarta in January 2020 until March 2020.

### Sampling

The study population was all of the children registered at Posyandu Kamal Wetan, Seyegan, Yogyakarta. According to Murti (2011), the subjects involved in testing the newly developed measuring instrument were 20–30 people. Subjects involved in this study were as many as 30 children. The criteria were children aged 0 to 24 months, registered as members of Posyandu Kamal Wetan, and the parents willing to provide consent for their children participation in this study.

### Tool design

The development of SEDEK begins with designing a length mat and a nutritional status disc. SEDEK's length mat is made of thick, strong, and safe plastic material with a size of 120x20 cm. It was inspired by the existing infantometer but with some innovation. There is a semicircular head brace at the top of the mat to put the child's head, while at the bottom, there are footrests. On the mat, there is an illustration depicting the child's position when measured. The growth measurement mats have a measurement scale up to 100 cm with an accuracy of 1 mm.

SEDEK's length mat comes with a nutritional status disc. SEDEK's nutritional status disc has two sides. The blue side to interpret boys LAZ and the pink side for female LAZ. On both sides, there is a large circle that shows children's age and a smaller circle to determine their nutritional status. Determination of these numbers refers to the WHO-2005 Length-for-Age Child Growth Standards.

The prototype of SEDEK's design was then discussed with nutritionists, anthropometrists, and design experts to be evaluated. Based on the evaluation results, the first design was then redesigned. Some improvements made were the illustration's change to make it more attractive and more clear depiction of the child’s position. The writing of the stunting category on the disc was made clearer, and the scale on the mat was printed

thicker. The second design was then discussed again with nutritionists, anthropometrist, and design expert where it was then approved by those experts and used in this study. SEDEK Growth Mat and Nutritional Status Discs used in this study are presented in figure 1.

**Data collection**

There are two step to determine stunting in children. First children's length need to be measured and then intepret the length measurement result to Length-For-Age Z Score (LAZ). The length was obtained by measuring length with SEDEK's length mat and infantometer, while LAZ was obtained using the SEDEK's nutritional status disc and the WHO-2005 length-for-age Child Growth Standard chart. Infantometer and the WHO-2005 length-for-age Growth Chart are the gold standards. The data on the children's age were obtained from interviews with parents/ guardians.

There were two stations to measure the child's length which were attended by one operator in each station. The first station used to measure child's length using SEDEK and the other one use to measure the child's length using Kenko® Infantometer with an accuracy of 0.1 cm. Each child was measured twice with each tool, with an interval between measurement about 5 untill 10 minutes or until the baby was calmer to be measured.

To use the SEDEK for measurement two operators were needed. One operator as a rater who was responsible for ensuring the child's position and took the measurement, while the other as an assistant helped the rater to hold the child's position and recorded the measurement to minimize recall bias.

Before taking the child's length measurement, the mat should be stretched on a dry, flat surface. The rater must ensure that the mat was straight and not wavy. Hat or headdress, shoes, and other thick clothing were removed from the child. The child was then placed on their back on the mat with the head attached to the top of the headboard. A rater stood on the side of the mat and ensures the position of the baby's body was straight, the back was attached to the mat, and the position of the child's feet was perpendicular to the footboard with the toes pointing upwards, while the assistant stood on the side of the top of the child's head to hold the child's chin and cheeks.

To measure the child's length, the child's legs should be straight thus their knee were pressed gently and the footboard was slide towards the child's feet. The rater who stood on the sides of the mat should ensure that the footboard was attached perpendicular to the child's feet. After that, the rater reads the child's length while the assistant recorded the child's length

The results of the length measurement were interpreted using the nutritional status disc. To operate it, first, the rater should determined the child's age (in months), the rotated the small circle according to the child's age. When the child's body length was within the range of numbers in the normal category, then the child's body length


Figure 1. Stunting early detection kit (SEDEK)

was normal, whereas when the child's body length was less than the number in the stunting category, then the child was considered as stunted.

**Data analysis**

Data analysis was performed using STATA version 12. Difference in mean of data from children's length measurements using SEDEK and infantometers were tested using a t-test. The t-test are significant if the $p<0.05$ at the 95% confidence level.

A validity test was used to determine the accuracy of stunting detection kits compared to the gold standard. The validity analysis was done by performing a cross-tabulation table between the gold standard and the SEDEK. The cross-tabulation displayed the sensitivity, specificity, Positive Predictive Value (PPV), and Negative Predictive Value (NPV) of the SEDEK in comparison to the gold standard.

The consistency was measured by intra-rater reliability using ICC. An ICC coefficient of less than 0.5 indicated poor reliability, 0.5–<0.75 indicated moderate reliability, good reliability was indicated by an index between 0.75 and 0.9, and values greater than 0.90 indicated excellent reliability (Koo & Li 2016). This study was approved by the Ethics Commission of the Faculty of Medicine, Public Health, and Nursing with Number KE / FK / 0004 / EC / 2019.

## RESULTS AND DISCUSSION

The subject were 30 children aged 0–24 months from Padukuhan Kamal Wetan, Seyegan. Most of the subject were female (63.33%). The youngest subject were 3 months old and the oldest were 23 months old (Table 1).

Table 1. Subject characteristic

| Characteristic | n | % |
|---|---|---|
| Sex | | |
| Boy | 11 | 36.67% |
| Girl | 19 | 63.33% |
| Age | | |
| 0–12 months | 15 | 50% |
| 13–24 months | 15 | 50% |

**Children length's measurement**

Stunting is determined by measuring the length of the subject's body first then interpreting the measurement results to length-for-age nutritional status. As seen in Table 2, 30 measurement taken by the two measurement tools, only 1 (3.33%) measurement presented the same results and the remaining measurement were not similiar.

Table 3 shows that the mean difference of length measurment is 0.03 cm. The mean of children length measured using SEDEK is 72.32±6.26 cm, while the mean using the infantometer is 72.29±6.26 cm. The t test result showed that the differences in measurement between the gold standar and the SEDEK was not significantly different ($p>0.05$).

The difference can be caused by systemic errors, such as imperfect calibration of the

Tabel 2. Difference of measurement between SEDEK and infantometer

| Delta (cm) | n | % |
|---|---|---|
| -2.00–2.50 | 0 | 0 |
| -1.60– -2.00 | 0 | 0 |
| -1.10– -1.50 | 2 | 6.67 |
| -0.60– -1.00 | 3 | 10 |
| -0.10– -0.50 | 9 | 30 |
| -0.05–0.10 | 0 | 0 |
| 0.0–0.0 | 1 | 3.33 |
| 0.05–0.10 | 3 | 10 |
| 0.10–0.50 | 7 | 23.33 |
| 0.60–1.00 | 2 | 6.67 |
| 1.10–1.50 | 2 | 6.67 |
| 1.60–2.00 | 0 | 0 |
| 2.10–2.50 | 1 | 3.33 |
| Total | 30 | 100.00 |

* SEDEK: Stunting early detection kit

Table 3. Child's length measurement using SEDEK and infantometer

| | SEDEK | Infantometer | Mean Difference (95% CI) | *p |
|---|---|---|---|---|
| | Means±SD (cm) | Means±SD (cm) | | |
| Lenght | 72.32±6.26 | 72.29±6.26 | 0.03 (-0.26–0.33) | 0.7951 |

*Based on t-test; SEDEK: Stunting early detection kit

measurement tool (Mony *et al.* 2016). In addition, techincal difficulties to keep the child still and stretched during the assement should also be taken into account (Jamaiyah *et al.* 2010).

**Validity of stunting early detection kit (SEDEK)**

The SEDEK was compared with the infantometer and WHO-2005 length-for-age Child Growth Standard chart as the gold standard. Stunting measurement using the SEDEK found that 11 of 30 subjects were considered short based on their or stunted (36.67%). Meanwhile, the remaining 19 subjects had normal nutritional status. However, the gold standard measurement found fewer stunted children (33.33%).

The World Health Organization (WHO) recommends the use of an infantometer and WHO-2005 length-for-age Child Growth Standard chart to detect stunting in children under two years old (WHO 2008). However, limitations of using those tools are, it requires skilled workers to ensure accuracy (Fuada *et al.* 2014; Hadi *et al.* 2019).

Cross-tabulation displayed in Table 4, found that the sensitivity value of SEDEK is 80% and the specificity is 85%. This sensitivity value means those children who were identified as stunting using SEDEK, 80% of them were also identified as stunted by infantometer. Meanwhile, the specificity value is 85% reflects the number of children identified as non stunted was also identified as non stunted by the infantometer. Analysis of the positive predictive value showed that 72.7% of children who were detected stunted is actually stunting and the negative predictive value showed that 89.5% of children who were not identified as stunted are actually did not have linear growth disorder based on their LAZ score.

However, ideally, a good early detection tool or screening tool should have sensitivity, specificity, and predictive value of more than 80% (Glascoe 1991). The analysis shows that SEDEK has a good validity (sensitivity 80%, specificity 85%, PPV 72.7%, and NPV 89.5%). However, the sensitivity and PPV are lower than the specificity and NPV. Low sensitivity and positive predictive values indicate many false-positive cases. High false-positive cases can lead to unnecessary treatment, while high false-negative cases can cause delayed preventive actions (Sudja *et al.* 2019). In this study, we found 3 children who misclassified as stunted (false-positive) and 2 children who misclassified as normal (false-negative). The number of false-positive cases can be minimized by testing the

Table 4. Validty of SEDEK

| | | Length-for-age based on infantometer | | Total (n) |
|---|---|---|---|---|
| | | Stunting (n) | Normal (n) | |
| Length-for-age based on SEDEK | Normal | 2 | 17 | 19 |
| | Stunting | 8 | 3 | 11 |
| | Total | 10 | 20 | 30 |
| Se: 80%; Sp: 85%; PPV: 72.7%; NPV: 89.5% | | | | |

*Se:Sensitivity; Sp:Specificity; PPV:Positive Predictive Value; NPV:Negative Predictive Value
SEDEK: Stunting early detection kit

tool in areas with a higher prevalence of stunting (Trevethan 2017).

Several studies that aim to develop and test the accuracy of early detection tools in Indonesia have been previously studied. A study by Sinaga *et al.* (2018) in North Sumatera which developed a wall growth chart showed a high validity (sensitivity 91%, specificity 92%, PPV 82%, and NPV 98%). Another similar study by Sudja *et al.* (2019) which develop a wall KMS (Kartu Menuju Sehat) shows sensitivity 66%, specificity 73.6%, PPV 73.6%, and NPV 90.3%. Compared to the two studies, SEDEK has lower sensitivity, specificity, and predictive value. This might be due to the difference in the age group of children. The wall KMS developed by Sinaga *et al.* (2018) and Sudja *et al.* (2019) was tested in children aged 4 to 5 years and 6 to 12 years, while SEDEK was studied in children aged 0 to 24 months. As mentioned before, measuring children's length can be more difficult for keeping children position still and stretched (Jamaiyah e*t al.* 2010)

**Reliability of stunting early detection kit (SEDEK)**

Intra-rater reliability shows agreement between measurement by the same measurer (Gleason *et al.* 2010). Intraclass Correlation Coefficient (ICC) was used to determine the agreement between the two measurements. The ICC of the first measurement and the second measurement is 0.781. This shows that there is a good agreement between the first measurement and the second measurement of the same rater. A similar study by Jamaiyah *et al.* (2010), in Malaysia, which measures reliability of a length measurement tools in children under two years old, showed excellent reliability with an ICC value of 0.9. This could be due to the better measurement technique or more skilled rater.

According to Hashemi-Nejad *et al.* (2013) intra-rater reliability could be affected by an error in reading scales, changes in the subject's position, or rater experiencing fatigue because repeated measuring. Reliability can be improved through periodical training and standardizing measurement procedures (Mony *et al.* 2016). Standardizing measurement procedures can be done by doing repeated measurement with more than three times on 10 to 20 subjects. The measurement results were then compared with the results of measurements made by an anthropometrist (de Onis *et al.* 2004).

The SEDEK mat material was also not ideal, whenever it is rolled for too long, a roll mark will appear which causes wavy texture and the length become less straight for the next measurement. Rater should straighten the length mat before using it. Therefore further research is needed related to the material selection for SEDEK.

The present study is the first study to develop and test the validity and reliability of an early stunting detection kit for children under two years old in Indonesia. However, this study has several limitations in the sample selection and the tool's reliability measurement. The subject determination in screening tool tests for validity and reliability should considers the prevalence of the disease (Zaidi *et al.* 2016). However in this study, there is no available data of the stunting prevalence in Kamal Wetan Village, therefore subject determination used the minimum sample size of 30 subjects. Moreover, the time interval for reliability of the measurement in this study is too close and measurements were only taken twice. According to Hockenberry and Wilson (2018) and Streiner *et al.* (2015) measuring children's length should ideally be done three times with the interval between measurement is between two to fourteen days. It makes further research necessary to improve the quality of SEDEK. This study should also be done in areas with higher stunting prevalence. This study also did not examine the inter-rater and test-retest reliability which also affects the quality of SEDEK.

The findings from this research imply the need further research and practice. To develop stunting early detection kits or screening tools, it is advisable to consider the stunting prevalence in the population being tested as well as the level of skill from the cadre or user in using such tools. It is important for the tool's validation and reliability testing so that the final tool can be well utilized in community-based facilities settings.

## CONCLUSION

The validity test of SEDEK is determined by its sensitivity, specificity, and predictive value. Compared to the standard infantometer, SEDEK has a sensitivity of 80%, specificity 85%, positive predictive value 72.7%, and

negative predictive value 89.5%. The intra-rater reliability of SEDEK indicated by the ICC value is 0.781, which means SEDEK utilization shows a good agreement between the first and second measurement by the same operator. However, based on its current validity and reliability test result, SEDEK has not yet been recommended as a stunting detection tool for children aged 0–24 months. Several limitations that affect SEDEK's validity and reliability are the number of subjects involved and the measurement of its reliability as well as the material quality of the mat. Further research is needed to improve the accuracy and quality material of SEDEK so that the SEDEK can utilized in larger community settings.

## ACKNOWLEDGEMENT

This study is supported by *Hibah Penelitian Terapan Unggulan Perguruan Tinggi* (PTUPT), Ministry of Research, Technolofy, and Higher Education no.1826/UN1/DITLIT/DIT-LIT/PT/2020 on behalf of Siti Helmyati.

## AUTHOR DISCLOSURES

The authors have no conflict of interest.

## REFERENCES

Adistie F, Lumbantobing VBM, Maryam NNA. 2018. Pemberdayaan kader kesehatan dalam deteksi dini stunting dan stimulasi tumbuh kembang pada balita. Media Karya Kesehatan 1(2). https://doi.org/10.24198/mkk.v1i2.18863.

Amareta DI, Arum P, Hikmah F. 2016. Peningkatan keterampilan kader dalam pengukuran panjang badan bayi sebagai upaya deteksi dini stunting di wilayah kerja puskesmas sumbersari. J-Dinamika Jurnal Pengabdian Masyarakat 1(1):9–13. https://doi.org/10.25047/j-dinamika.v1i1.128.g134.

Basset L, Ruel-Bergeron J. 2012. Promoting Healthy Child Growth and Development: Advances and Opportunities for Community-Based Nutrition Programs in Central America. Washington (USA): The World Bank.

de Onis M, Onyango AW, Broeck JVD, Chumlea WC, Martorell R. 2004. Measurement and standardization protocols for anthropometry used in the construction of a new international growth reference. Food and Nutrition Bulletin 25(Suppl 1):S27–S36. https://doi.org/10.1177/15648265040251S104.

de Onis M, Branca F. 2016. Childhood stunting: A global perspective. Matern Child Nutr 12(S1):12–26. https://doi.org/10.1111/mcn.12231.

Fuada N, Salimar, Irawati A. 2014. Kemampuan kader posyandu dalam melakukan pengukuran panjang/tinggi badan balita. Indonesian Journal of Health Ecology 13(3):229–239.

Glascoe FP. 1991. Developmental screening: Rationale, methods, and application. Infants & Young Children 4(1):1–10.

Gleason PM, Harris J, Sheean PM, Boushey CJ, Bruemmer B. 2010. Publishing nutrition research: Validity, reliability, and diagnostic test assessment in nutrition-related research. J Am Diet Assoc 110 (3):409–419. https://doi.org/10.1016/j.jada.2009.11.022.

Hadi A, Alfridsyah A, Affan I. 2019. Efektifitas deteksi stunting menggunakan KMS dinding indeks TB/U pada anak usia 4–5 tahun di Sekolah PAUD. Aceh Nutrition Journal 4(1):70–74. https://doi.org/10.30867 /action.v4i1.160.

Hashemi-Nejad N, Choobineh A, Baneshi MR, Jafari-Roodbandi A. 2013. Intra-observer and Inter-observer reliability in direct anthropometry. Int J Occup Hyg 5(2):82–88.

Hockenberry MJ, Wilson D. 2018. Wong's Nursing Care of Infants and Children - E-Book. Missouri (USA): Elsevier Health Sciences.

Jamaiyah H, Geeta A, Safiza MN, Khor HL, Wang NF, Kee CC, Rahmah R, Ahmad AZ, Suzana S, Chen WS *et al*. 2010. Reliability, technical error of measurements and validity of length and weight measurements for children under two years old in Malaysia. Med J Malaysia 65(Supplement A):131–137.

Koo TK, Li MY. 2016. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. J Chiropr Med 15(2):155–163. https://doi.org/10.1016/j.jcm.2016.02.012.

[MoH RI] Ministry of Health Republic of Indonesia. 2018. Situasi Balita Pendek (*Stunting*) di Indonesia. Jakarta (ID): MoH RI.

Maxim LD, Niebo R, Utell MJ. 2014. Screening tests: A review with examples. Inhalation Toxicology 26(13):811–828. https://doi.org/10.3109/08958378.2014.955932.

Mony PK, Swaminathan S, Gajendran JK, Vaz M. 2016. Quality assurance for accuracy of anthropometric measurements in clinical and epidemiological studies [Errare humanum est = to err is human]. Indian J Community Med 41(2):98–102. https://doi.org/10.4103/0970-0218.173499.

Murti B. 2011. Validitas dan Reliabilitas Pengukuran. Matrikulasi Program Studi Doktoral Fakultas Kedokteran. Surakarta: Universitas Negeri Sebelas Maret.

Prendergast AJ, Humphrey JH. 2014. The stunting syndrome in developing countries. Paediatr Int Child Health 34(4):250–265. https://doi.org/10.1179/2046905514Y.0000000158.

Renyoet BS, Martianto D, Sukandar D. 2016. Potensi kerugian ekonomi karena stunting pada balita di Indonesia tahun 2013. J Gizi Pangan 11(3):247–254. https://doi.org/10.25182/jgp.2016.11.3.%p.

Sinaga HT, Alfridsyah BS, Hadi A. 2018. A simple nutrition screening tool for detecting stunting of pre-schoolers: Development and validity assessment. Pakistan J Nutr 17(5):236–241. https://doi.org/10.3923/pjn.2018.236.241.

Stewart CP, Iannotti L, Dewey KG, Michaelsen KF, Onyango AW. 2013. Contextualising complementary feeding in a broader framework for stunting prevention. Maternal & child nutrition 9(S2):27–45. https://doi.org/10.1111/mcn.12088.

Streiner DL, Norman GR, Cairney J. 2015. Health Measurement Scales: A Practical Guide to Their Development and Use. Oxford (UK): Oxford University Press.

Sudja S, Sitanggang B, Shagti I, Purnawan AI. 2019. Sensitivity (Se) and specificity (Sp) anthropometric wall chart (Awc) Tb/U for detecting stunting on children aged 6–12 Years. KnE Life Sciences. 210–221. https://doi.org/10.18502/kls.v4i15.5761.

Trevethan R. 2017. Sensitivity, specificity, and predictive values: Foundations, pliabilities, and pitfalls in research and practice. Front Public Health 5:307. https://doi.org/10.3389/fpubh.2017.00307.

[UNICEF/WHO/The World Bank] United Nations International Children's Emergency Fund/World Health Organization/The World Bank. 2019. Levels an Trends in Child Malnutrition: Key Findings of the 2020 Edition of the Joint Child Malnutrition Estimate. Geneva (CH): WHO.

[WHO] World Health Organization. 2008. Training Course on Child Growth Assesment. Geneva (CH): World Health Organization.

Zaidi SMH, Waseem HF, Ansari FA, Irfan M, Fahim S. 2016. Sample Size Estimation of Diagnostic Test Studies in Health Sciences. Proceedings of 14th International Conference on Statistical Sciences (page 239-246), 14–16th March 2016. Pakistan (PK): University Karachi.

*Available online: http://journal.ipb.ac.id/index.php/jgizipangan*
*Accredited based on DGHE, Republic of Indonesia No. 28/E/KPT/2019*
*ISSN 1978-1059 EISSN 2407-0920*

***J. Gizi Pangan, March 2021, 16(1):47-56***
*DOI: 10.25182/jgp.2021.16.1.47-56*

# Knowledge on Nutrition Labels for Processed Food: Effect on Purchase Decision among Indonesian Consumers

**Anna Vipta Resti Mauludyani[1*], Zuraidah Nasution[1], Muhammad Aries[1], Rimbawan[1], Yusra Egayanti[2]**

[1]Department of Community Nutrition, Faculty of Human Ecology, IPB University, Bogor 16680, Indonesia
[2]Directorate of Processed Food Standardization, Indonesia Food and Drug Authority, Jakarta 10560, Indonesia

## ABSTRACT

This study was conducted to observe the relationship between consumers' knowledge on nutrition labels and the purchasing behavior for processed food products among Indonesian consumers. A cross-sectional study was conducted in August–September 2018 in five different cities of three provinces (Jakarta, Bogor, Depok, Tangerang, and Bekasi). Data were obtained from 400 adult consumers by self-administered questionnaires. The results showed that almost 70% of consumers in Indonesia check food labels; however, from that number only 37.5% paid attention to the nutrition label of a food product prior to making a purchase decision; this was most probably due to their knowledge on nutrition labels that was still poor, as shown by the mean score of 7.7 out of 14 questions (55%). In terms of food groups, milk and dairy products were deemed important by the consumers and the nutrition labels were often checked. When it comes to making a purchase decision, almost all of the consumers (96.0%) had decided to buy food products with nutrition labels as compared to those without. Furthermore, when compared to similar products also bearing nutrition labels, consumers deemed the claims of low fat (28.7%) and low sugar (22.6%) as a sign that the products are healthier and have a better nutrition profile. Knowledge on nutrition labels (OR=1.139; 95% CI:1.016–1.276; p=0.025) and purchase decision on products with nutrition labels (OR=3.426; 95% CI:1.220–9.623; p=0.019) were significantly associated with purchase decision for healthier processed food. This study has shown the importance of increasing consumers' knowledge on nutrition labels in order to achieve a larger impact on food selection, nutrition, and health.

**Keywords**: consumers knowledge, food label, nutrition claim, nutrition label, purchase behavior

## INTRODUCTION

A consumer's decision to purchase a packaged food product is affected by many aspects i.e. taste, quality, convenience and ease of use. Several other factors have been listed as having the potential to increase the likelihood of purchase i.e. price, perceived healthiness, and tastiness of the product (Steinhauser *et al.* 2019). One of the aspects that could affect consumer purchase decision are food labels. A food label is an important tool for consumers to get information on the food product that is contained within the package, which eventually might affect their decision in purchasing the product. A study found that some consumers actually put importance on food labels and read them before making final purchase decisions, where the level of importance varied significantly based on gender, age, food habit, and location (Kumar & Kapoor 2017). However, although 90% of consumers read food labels, the majority only checked for the manufacturing date or expiry/ best before date (Vemula *et al.* 2014).

One of the aspects of a food label is nutrition information, which can come in the form of nutrition labels and nutrition and health claims. Of the 90% of consumers who read food labels, only one-third actually checked nutrition information and ingredients; while those who did not often read nutrition information was due to most consumers either lacking nutrition knowledge or that they found the information to be too technical to understand (Vemula *et al.* 2014). Similarly, a study found that nutrition information on food labels is often underutilized by consumers and having prior nutrition knowledge would actually help consumers to

[*]**Corresponding Author:** tel: +628561164494, email: anna-vipta@apps.ipb.ac.id

know how to use the information on nutrition labels appropriately, to understand them, and to eventually make healthy decisions based on the information (Miller & Cassady 2015). Interestingly, another study reported that younger consumers considered that product attributes that had implications on health were important (Kumar & Kapoor 2017). Among consumers who do read nutrition labels, they would tend to pay more attention to food products with health claims on the label and were more likely to purchase that particular product (Steinhauser *et al.* 2019).

A study reported a strong relationship between nutrition label viewing and food purchase decisions. Nutrition labels were viewed more when the healthfulness of a product is 'ambiguous'; therefore, consumers spent more time viewing nutrition labels on 'meal' items such as soup, pizza and yogurt. It was also observed that consumers spent more time in viewing nutrition labels on food products they eventually purchased compared to foods that they decided not to purchase (Graham & Jeffery 2011). Meanwhile, consumers who were pursuing specific dietary goals were seen to make more comparisons of nutrition labels before making purchase decisions. The more nutrition knowledge these consumers had and the more motivated they were in terms of their dietary goals, the more detailed they were in reading nutrition labels. Interestingly, knowledge on nutrition was found to be the middle agent that mediated between motivation of a healthier life and accuracy in the decision making process in terms of purchasing packaged food products (Miller & Cassady 2012).

In Indonesia, interestingly, decision-making at the household level when it came to purchasing a food product was found to be dominated by non-nutrition aspects, such as socioeconomic status, family member requests, feelings about the food product, and the halal issue (Rachmi *et al.* 2018). Unfortunately, there is a lack of attention given to nutrition information on food labels, which was mostly due to the lack of good knowledge on nutrition (Kurnia *et al.* 2016). Stronger consumer attention has been placed on the halal logo and it has been identified as a major influence in purchase decision, especially among the younger generation (Siregar & Alam 2018). Interestingly, the halal logo is actually not mandatory for all processed food products marketed in Indonesia as it is only required for certain products; whereas the items mandatory to be displayed on a food label are product name, ingredients list, net weight, name and address of manufacturer or importer, manufacturing date and code, expiry date, and permit number (Indonesia Food and Drug Authority 2018). And since 2019, it has actually been mandatory for all processed food products marketed in Indonesia to have a nutrition information panel or nutrition label containing total energy, total fat, saturated fat, sugar and salt (sodium) content of the food product (Indonesia Food and Drug Authority 2019). However, there has been a lack of published reports that have addressed the issue of nutrition knowledge, nutrition label viewing, and purchase decision among consumers in Indonesia in order to get a better picture of the factors affecting their purchase behavior. Therefore, this study was conducted to investigate the relationship between the knowledge on nutrition labels and purchase behavior for packaged food products among consumers in Indonesia.

## METHODS

### Design, location, and time

This cross-sectional study was conducted in August–September 2018. The study was conducted in five different cities of three provinces (Jakarta, Bogor, Depok, Tangerang, Bekasi).

### Sampling

400 male and female subjects from five different cities (Jakarta, Bogor, Depok, Tangerang, Bekasi) were selected to participate in this research. The number of subjects was calculated using the Slovin Formula based on the population of the five cities, which was 31,689,592 people (Citisabc 2018) with a confidence level of 95% ($\alpha$=0.05). In each city, 80 subjects were selected in supermarkets and public places using quota sampling. Subjects who were within the age range of 18–60 years, literate, and willing to participate in the study in these locations were included until a pre-determined number (80 subjects) was reached.

### Data collection

Data were collected using a self-administered questionnaire. There were four parts in the questionnaire, namely characteristics of subject (sex, age, occupation, education level,

income), label reading behavior, knowledge on nutrition labels, and consumer purchase decision. Data on the frequency of reading labels and categories of food product labels checked were obtained to assess label reading behavior. There were 14 true-false questions on the components of food labels to assess knowledge on nutrition labels. Purchase decision was assessed through questions on concerns for purchasing, purchase decision for product with nutrition labels, and purchase decision for healthier products. Content validity of the questionnaire was approved by a panel of experts from the academia of IPB University and professionals from the Indonesia Food and Drug Authority and the WHO Country Office of Indonesia. The questionnaire was also tested for reliability, resulting in a Cronbach's-Alpha of 0.6 after it was pre-tested on 30 subjects with similar characteristics.

**Data analysis**

Data from the questionnaires were collected in accordance with the manual for data entry. With regards to knowledge on nutrition labels, each correct answer was scored as 1; while a wrong answer was scored as 0, resulting in a total score of 0–14. Bivariate analyses using Spearman's Rank Correlation were conducted to correlate the characteristics of the subject on both knowledge on nutrition labels and purchase decision. Univariate, bivariate and multivariate (logistic regression) analyses were conducted using IBM SPSS Statistics Version 22.

## RESULTS AND DISCUSSION

**Characteristics of subjects**

Among 400 subjects who participated in this study, 314 of them (78.50%) were female. Furthermore, more than one-third were university students and employees (37.5% and 36.0%, respectively), while 59.8% of them were university graduates. Almost half of the respondents (49.3%) had an income between IDR 500,000 and 2 million. The characteristics of the subjects are shown in Table 1.

**Label reading behavior**

According to Sumarwan (2011), the behavior of reading product labels is part of consumer behavior that will encourage them to buy, use, and evaluate a product. Previous studies

Table 1. Characteristics of subjects

| Characteristics of subjects | n | % |
|---|---|---|
| Sex | | |
| Male | 86 | 21.5 |
| Female | 314 | 78.5 |
| Age (mean±SD) | 27.8±9.8 | |
| Occupation | | |
| University student | 150 | 37.5 |
| Housewife | 102 | 25.5 |
| Employee | 144 | 36.0 |
| Unemployed | 4 | 1.0 |
| Education level | | |
| Elementary school | 5 | 1.2 |
| Junior high school | 26 | 6.5 |
| Senior high school | 130 | 32.5 |
| University | 239 | 59.8 |
| Monthly income | | |
| <IDR 500,000 | 26 | 6.5 |
| IDR 500,000–2 millions | 197 | 49.3 |
| >IDR 2–5 millions | 101 | 25.3 |
| >IDR 5–10 millions | 51 | 12.7 |
| >IDR 10 millions | 25 | 6.2 |

show that the majority of consumers perform this activity before they buy or use a product/service (Kumalasari & Sjafei 2013; Ruwani *et al.* 2014).

As shown in Table 2, results of this study showed that the majority of subjects rarely read food labels and only 25.3% stated that they read food labels frequently. This number is near to the result of a meta-analysis (Sumarwan *et al.* 2017), which reported that only about 30% of consumers frequently or often read product labels.

The type of food product also seemed to influence the consumer's label reading behavior. It is known from a previous study that people only commonly read the labels of certain food products (Ruwani *et al.* 2014). In this study, the types of food product nutrition labels that people commonly read and checked were milk and dairy products, beverages, and ready-to-eat savories. The labels of these three types of products were commonly read and checked by 45 to 73% of subjects. The least read label was that of composite foods. Similarly, Sumarwan *et al.* (2017) reported that the labels of milk products were the most read label by the consumers, where the decision to read and check food labels was determined by exposure to advertisements, the internet, and knowledge gained from school.

**Knowledge on food and nutrition label**

As shown in Table 3, most (74.8% and 63.0%) of the subjects mentioned the halal logo and expiry date as components of a food label. More than half (53.3%) of them were also familiar with list of ingredients. However, other components of a food label were less known by the subjects.

Among all the statements regarding food labels, the statement with the least number of correct answers was "all processed food products must have a nutrition label". The Indonesian Food and Drug Authority has recently made nutrition labels mandatory for all packaged food products

Table 2. Label reading behavior

| Label reading behavior | n | % |
|---|---|---|
| Frequency of reading food labels | | |
| Always | 21 | 5.3 |
| Often | 101 | 25.3 |
| Rarely | 277 | 69.4 |
| Product category of nutrition label checked | | |
| Milk and dairy products | 294 | 73.5 |
| Beverages | 194 | 48.5 |
| Ready-to-eat savories | 183 | 45.8 |
| Cereals and cereal products | 150 | 37.5 |
| Bakery products | 109 | 27.3 |
| Confectionery | 82 | 20.5 |
| Meat and meat products | 62 | 15.5 |
| Sweeteners | 42 | 10.5 |
| Fats, oils and emulsions | 38 | 9.5 |
| Fish and seafood products | 37 | 9.3 |
| Salts, spices, soups, sauces, salads, protein products | 37 | 9.3 |
| Edible ices | 23 | 5.8 |
| Fruits and vegetables, seaweed, nuts and seeds | 19 | 4.8 |
| Eggs and egg products | 17 | 4.3 |
| Composite foods | 7 | 1.8 |

Table 3. Knowledge on the components of a food label

| Components of food label | n | % |
|---|---|---|
| Halal logo | 299 | 74.8 |
| Expiry date | 252 | 63.0 |
| List of ingredients | 213 | 53.3 |
| Name of the product | 121 | 30.3 |
| Net weight or net content | 56 | 14.0 |
| Name and address of the manufacturer or importer | 56 | 14.0 |
| Distribution permit number | 20 | 5.0 |
| Date and code of production | 17 | 4.3 |
| Origins of certain food ingredients | 9 | 2.3 |

since 2019, while this study was conducted prior to when the regulation was enacted.

Almost all subjects (95.8% and 92.0%, respectively) understood the purpose of a nutrition label, which is to give information about the nutrient content of a product, and that sodium is essentially table salt. On the contrary, only about one-fourth of subjects had specific knowledge on the cut-off points for claims of specific nutrients, such as in the following statements: "a low fat product can only contain less than 3 g/100 g of fat" and "sugar content may not be included in the nutrition label of a food product if the amount is less than 1 g/serving size". Similarly, only a low proportion of the subjects were aware that the statement "high fiber" is a nutrition claim (Table 4).

Table 5 shows that higher age ($r=0.272$; $p<0.001$) and income ($r=0.165$; $p=0.001$) of subjects was associated with better knowledge of nutrition labels. Similar results were found in Jackey *et al.* (2017) and Cannoosamy *et al.* (2014). This implies that older and wealthier subjects are more likely to be exposed to health or nutrition-related news.

**Purchase decision**

Table 6 shows that most (69.5%) Indonesian consumers considered product price as the main determinant for purchase decision. This was also found in Indian and Hispanic consumers (Campbell 2013; Vemula *et al.* 2014; Kumar & Kapoor 2017). More than one-third were also concerned about expiry date (41.8%) and the halal logo (38.8%). Among all the components of a food label, the expiry date was always checked by most of the consumers (Davies *et al.* 2010). Awareness of the halal logo was also seen in other Muslim countries, such as Malaysia (Muhamad *et al.* 2017). This study also found that about a third of Indonesian consumers were also concerned about the product's nutrition profile (37.5%) prior to making a purchase. This number was quite similar to another study in India (Vemula *et al.* 2014). Nutrition awareness motivates consumers to read the nutrition profile before purchasing. This finding was not only seen among older adults who have to manage their diet in relation with the chronic diseases they have, such as hypertension and diabetes, but also among youths (Miller & Cassady 2012; Kumar & Anand 2016).

Most of the respondents (69.4%) stated that they rarely read food labels, which is similar to the results of another study by Graham and Laska in 2012. Among the nutrition information provided on the label, Indonesian consumers were mostly concerned about fat, sugar, and protein. Similarly, Indian consumers were more concerned with information regarding fat and sugar (Vemula *et al.* 2014; Kumar & Kapoor 2017). Among all food groups, most of the consumers (73.5%) checked the nutrition profile of dairy products and analogues. The nutrition profile of beverages and ready-to-eat savories were also checked by almost half of consumers (48.5% and 45.8%, respectively).

Almost all of the consumers (96.0%) had decided to buy food products with nutrition labels because they considered them better than

Table 4. Knowledge on nutrition labels

| No. | Knowledge on nutrition labels | n | % |
|---|---|---|---|
| 1 | The purpose of a nutrition label is to give information about the nutrient content of a product (T) | 383 | 95.8 |
| 2 | Sodium content represents the salt contained in a food product (T) | 368 | 92.0 |
| 3 | Energy, carbohydrate, protein, fat, and sodium are nutrients that are required to be included on a nutrition label (T) | 354 | 88.5 |
| 4 | Nutrition claims on a food product must be in accordance with the nutrient content of the product (T) | 320 | 80.0 |
| 5 | Serving size is the amount of food normally consumed in one meal (T) | 290 | 72.5 |
| 6 | The reference for nutrition labels in Indonesia is the Recommended Dietary Allowance (RDA) (T) | 275 | 68.8 |
| 7 | The level of adequacy of daily nutritional needs is indicated by the percentage of RDA (T) | 260 | 65.0 |
| 8 | The RDA has a similar value for all individuals (F) | 236 | 59.0 |
| 9 | There are differences between nutrition claims and health claims (T) | 223 | 55.8 |
| 10 | The statement “low fat” is a nutrition claim (T) | 214 | 53.5 |
| 11 | Sugar content may not be included in the nutrition label if it is less than 1 g per serving size (T) | 110 | 27.5 |
| 12 | A food product can be claimed as a low fat product if the fat content is less than 3 g per 100 g (T) | 100 | 25.0 |
| 13 | The statement “high fiber” is not a nutrition claim (F) | 99 | 24.8 |
| 14 | All processed food products must have a nutrition label (F) | 7 | 1.8 |
| | Total score (mean±SD) | 7.7 ± 2.3 | |

T: True as correct answer; F: False as correct answer

similar products without nutrition labels. Most of them (78.8%) also decided to buy more healthy products within a similar group of products. Nutrient claims of low fat (28.7%) and low sugar (22.6%) were considered healthier by consumers. Jacobs *et al.* 2011 also found that ‘low in fat’ was considered most important by about 70% of supermarket consumers in South Africa, which might indicate poor knowledge on nutrients in general.

Table 7 shows that knowledge of nutrition labels (OR=1.139; 95% CI:1.016–1.276; p=0.025) and purchase decision on products with nutrition labels (OR=3.426; 95% CI:1.220–9.623; p=0.019) were significantly associated with purchase decision for more healthy processed foods. Subjects with better knowledge on nutrition labels had higher awareness to choose products with nutrition labels compared to those without. Furthermore, based on their perceptions, they were able to select which products are considered healthier compared to other similar products. Subjects with better nutrition knowledge saw beyond the nutrition and health claims which later allowed them to make purchasing decisions (Steinhauser *et al.* 2019). Similar results were found in previous studies regarding maternal milk products (Damayanti & Rimbawan 2016) and other various food products (Mhurchu *et al.* 2018).

Table 5. Association between the characteristics of subjects and knowledge on nutrition labels

| Characteristics of subjects | r | p |
|---|---|---|
| Age | 0.272 | <0.001* |
| Education level | 0.044 | 0.383 |
| Income | 0.165 | 0.001* |

*Spearman’s rank correlation p<0.05

Table 6. Concerns related to purchase decision, nutrition label and healthier products

| Purchase decision | n | % |
|---|---|---|
| Concerns in making purchase decision | | |
| Price | 278 | 69.5 |
| Expiry date | 167 | 41.8 |
| Halal logo | 155 | 38.8 |
| Nutrition profile | 150 | 37.5 |
| Packaging | 119 | 29.8 |
| Name of brand | 112 | 28.0 |
| Taste | 94 | 23.5 |
| Ingredients | 40 | 10.0 |
| Preference | 38 | 9.5 |
| Net weight | 26 | 6.5 |
| Past experience | 13 | 3.3 |
| BPOM logo | 8 | 2.0 |
| Concern on components in a nutrition label | | |
| Fat | 221 | 55.3 |
| Sugar | 179 | 44.8 |
| Protein | 173 | 43.3 |
| Carbohydrate | 130 | 32.5 |
| Vitamin C | 85 | 21.3 |
| Vitamin A | 84 | 21.0 |
| Energy | 67 | 16.8 |
| Sodium | 53 | 13.3 |
| Calcium | 32 | 8.0 |
| Iron | 12 | 3.0 |
| Saturated fat | 7 | 1.8 |
| Cholesterol | 4 | 1.0 |
| Dietary fiber | 3 | 0.8 |
| Purchase decision for product with nutrition label | 384 | 96.0 |
| Purchase decision for healthier products with a better nutrition profile compared to other similar products | 314 | 78.5 |
| Perception on what constitutes a healthier product | | |
| Low fat | 90 | 28.7 |
| Low sugar | 71 | 22.6 |
| High protein | 39 | 12.4 |
| Balanced nutrition | 35 | 11.1 |
| High calcium | 28 | 8.9 |
| High vitamin | 16 | 5.1 |
| Low sodium | 12 | 3.8 |

BPOM: *Badan pengawasan obat dan makanan* (National agency of drug and food control)

Table 7. Factors associated with purchase decision for healthier food

| Factors | OR | 95% CI | p |
|---|---|---|---|
| Sex-female | 1.440 | 0.807–2.572 | 0.218 |
| Age | 0.997 | 0.968–1.027 | 0.841 |
| Education level-university | 0.884 | 0.520–1.501 | 0.647 |
| Income >IDR 2 millions | 0.895 | 0.509–1.575 | 0.702 |
| Frequent label reading | 0.894 | 0.270–2.965 | 0.855 |
| Knowledge on nutrition label | 1.139 | 1.016–1.276 | 0.025* |
| Concerned about nutrition labels for purchase decision | 1.238 | 0.717–2.138 | 0.443 |
| Concerned about fat in nutrition profile | 1.231 | 0.748–2.026 | 0.414 |
| Concerned about sugar in nutrition profile | 0.813 | 0.487–1.356 | 0.427 |
| Concerned about sodium in nutrition profile | 1.159 | 0.558–2.407 | 0.691 |
| Purchase decision on products with nutrition labels | 3.426 | 1.220–9.623 | 0.019* |

* Logistic regression $p<0.05$; $r^2=0.427$

## CONCLUSION

The knowledge on food and nutrition labels of Indonesian consumers was still poor. Most consumers considered product price prior to making a purchase decision. Consumers were also concerned about expiry date, the halal logo and nutrition facts presented on the label. In terms of nutrition labels, consumers in Indonesia were mostly concerned about fat, sugar, and protein. Almost all of the consumers chose products with nutrition labels than products without. Most had also decided to buy more healthy products, which was deemed as low in fat and sugar. Higher knowledge regarding nutrition labels and purchase decision on products with nutrition labels was significantly associated with purchase decision for more healthy processed food. This study suggests the importance of programs aimed at increasing the awareness of consumers relating to nutrition labels and claims in order to have an optimum impact in achieving the objective of public policy related to food, nutrition, and health.

## ACKNOWLEDGEMENT

The authors wish to thank the World Health Organization Country Office for Indonesia, represented by Sugeng Eko Irianto, who sponsored the funding of this study and was involved in designing the study. Appreciation is also given to the Directorate of Processed Food Standardization, Indonesia Food and Drug Authority that were involved in the planning of the study and data collection.

## AUTHOR DISCLOSURES

The authors declare that there is no conflict of interest with other person or institution.

## REFERENCES

Campbell J. 2013. Antecedents to purchase intentions for Hispanic consumers: A"local" perspective. Int Rev Retail Distrib Consum Res 23(4):440–455. https://doi.org/10.1080/09593969.2013.796565.

Cannoosamy K, Pugo-Gunsam P, Jeewon R. 2014. Consumer knowledge and attitudes toward nutritional labels. J Nutr Educ Behav 46(5):334–340. https://doi.org/10.1016/j.jneb.2014.03.010.

Citisabc. 2018. Jakarta. Citisabc. https://www.citiesabc.com/city/jakarta/ [Accessed 9th February 2021].

Damayanti R, Rimbawan R. 2016. Pengetahuan, persepsi, dan sikap ibu hamil terhadap klaim gizi kaitannya dengan keputusan pembelian produk susu ibu hamil. J Gizi Pangan 11(1):1–8.https://doi.org/10.25182/jgp.2016.11.1.%p.

Davies P, MacPherson K, Froud E. 2010. Evidence review of public attitude towards and use of general food labelling. http://citeseerx.ist.psu.edu/viewdoc/download;jsessionid=956DE357C4B45410F288E2AFAB94A660?doi=10.1.1.557.8405&rep=rep1&type=pdf [Accessed 12th September 2020].

Graham DJ, Jeffery RW. 2011. Location, location, location: Eye-tracking evidence that consumers preferentially view prominently positioned nutrition information. J Am Diet Assoc 111(11):1704–1711. https://doi.org/10.1016/j.jada.2011.08.005.

Graham DJ, Laska MN. 2012. Nutrition label use partially mediates the relationship between attitude toward healthy eating and overall dietary quality among college students. J Acad Nutr Diet 112(3):414–418. https://doi.org/10.1016/j.jada.2011.08.047.

Indonesia Food and Drug Authority. 2018. Peraturan Badan Pengawasan Obat dan Makanan Nomor 31 Tahun 2018 Tenatng Label Pangan Olahan. Jakarta (ID): BPOM RI.

Indonesian Food and Drug Authority. 2019. BPOM Regulation Number 22 Year 2019 about Nutritional Value Information on Processed Food Labels. Jakarta (ID): BPOM RI.

Jackey BA, Cotugna N, Orsega-Smith E. 2017. Food label knowledge, usage and attitudes of older adults. J Nutr Gerontol Geriatr 36(1):31–47. https://doi.org/10.1080/21551197.2017.1280868.

Jacobs SA, de Beer H, Larney M. 2011. Adult consumers' understanding and use of information on food labels: A study among consumers living in the Potchefstroom and Klerksdorp regions, South Africa. Public Health Nutr 14(3):510–522. https://doi.org/10.1017/S1368980010002430.

Kumalasari H, Sjafei NJ. 2013. Analyzing the effect of health and appearance consciousness on intention to calculate calorie information if displayed at fast food restaurant menu. Journal of Business Strategy Execution 5(2):104–130.

Kumar N, Anand S. 2016. The attitude of Indian youth toward nutrition: Factors, segments, and implications. J Food Prod Mark 22(8):967–985. https://doi.org/10.1080/10454446.2015.1121421.

Kumar N, Kapoor S. 2017. Do labels influence purchase decisions of food products? Study of young consumers of an emerging market. Br Food J 119(2):218–229. https://doi.org/10.1108/BFJ-06-2016-0249.

Kurnia P, Wardhani DTK, Hariyani R. 2016. Consumer attitudes, nutrition knowledge, and use of nutrition information on the labels of packaged drinks among adolescents in Surakarta, Indonesia. Proceeding International Conference on Health and Well-Being (page 253–264), 27–28th May. Surakarta (ID): Faculty of Health Science & Faculty of Psychology Universitas Muhammadiyah Surakarta.

Mhurchu CN, Eyles H, Jiang Y, Blakely T. 2018. Do nutrition labels influence healthier food choices? Analysis of label viewing behaviour and subsequent food purchases in a labelling intervention trial. Appetite 121:360–365. https://doi.org/10.1016/j.appet.2017.11.105.

Miller LMS, Cassady DL. 2012. Making healthy food choices using nutrition facts panels. The roles of knowledge, motivation, dietary modifications goals, and age. Appetite 59(1):129–139. https://doi.org/10.1016/j.appet.2012.04.009.

Miller LMS, Cassady DL. 2015. The effects of nutrition knowledge on food label use. A review of the literature. Appetite 92:207–216. https://doi.org/10.1016/j.appet.2015.05.029.

Muhamad N, Leong VS, Md Isa N. 2017. Does the country of origin of a halal logo matter? The case of packaged food purchases. Review International Business and Strategy 27(4):484–500. https://doi.org/10.1108/RIBS-06-2017-0049.

Rachmi CN, Hunter CL, Li M, Baur LA. 2018. Food choices made by primary carers (mothers/grandmothers) in West Java, Indonesia. Appetite 130:84–92.https://doi.org/10.1016/j.appet.2018.08.005.

Ruwani A, Retnaningsih R, Simanjuntak M. 2014. Nilai dan tipe konsumen rumah tangga dan kaitannya dengan perilaku pembelian produk makanan kemasan. Jurnal Ilmu Keluarga Konsumen 7(1):48–57. https://doi.org/10.24156/jikk.2014.7.1.48.

Siregar R, Alam A. 2018. Halal label on food products by MUI (Indonesian Ulama

Council) and students purchasing decision of Faculty of Business and Economic Universitas Muhammadiyah Surakarta. Journal of Islamic Economic Laws 1(1):1–30. https://doi.org/10.23917/jisel.v1i1.6163.

Steinhauser J, Janssen M, Hamm U. 2019. Who buys products with nutrition and health claims? A purchase simulation with eye tracking on the influence of consumers' nutrition knowledge and health motivation. Nutrients 11(9):2199. https://doi.org/10.3390/nu11092199.

Sumarwan U. 2011. Perilaku Konsumen. Bogor (ID): Ghalia Indonesia.

Sumarwan U, Simanjuntak M, Yuliati LN. 2017. Meta-analysis study: Reading behavior of food products label. Journal Consumer Sciences 2(2):26–40. https://doi.org/10.29244/jcs.2.2.26-40.

Vemula SR, Gavaravarapu SM, Mendu VVR, Mathur P, Avula L. 2014. Use of food label information by urban consumers in India–a study among supermarket shoppers. Public Health Nutr 17(9):2104–2114. doi:10.1017/S1368980013002231

*Available online: http://journal.ipb.ac.id/index.php/jgizipangan*
*Accredited based on DGHE, Republic of Indonesia No. 28/E/KPT/2019*
*ISSN 1978-1059 EISSN 2407-0920*

***J. Gizi Pangan, March 2021, 16(1):57-62***
*DOI: 10.25182/jgp.2021.16.1.57-62*

# The Effect of Roselle (*Hibiscus sabdariffa*) Extract on Malondialdehyde Level in Rat Liver

**Fadhilah Sharfina Alyani[1], Retno Yulianti[1*], Maria Selvester Thadeus[1]**
[1]Faculty of Medicine, University of Pembangunan Nasional "Veteran" Jakarta,
South Jakarta 12450, Indonesia

## ABSTRACT

This study aimed to determine the efficacy of roselle flower extract in reducing the Malondialdehyde (MDA) level in rats after induction of 20% ethanol. This experimental study used a post-test design on 24 male white rats, Wistar strain which were grouped into six type of treatment. The K1 group was given daily aquadest only, K2 was given 20% ethanol. K3 was given 20% ethanol and vitamin C, K4 was given 20% ethanol and 250 mg/kgBW/day roselle flower extracts, K5 was given 20% ethanol and 500 mg/kgBW/day roselle flower extract, K6 was given 20% ethanol and 750 mg/kgBW/day roselle flower extract. Each group received treatment for 30 days. At the time of termination, the rat's liver was collected and the liver's MDA level was examined. One Way Anova test and the Post Hoc Tukey test were used for data analysis. There was a decrease in MDA levels (3.1578±0.37 ng/ml) in K4 compared to K2 as well as to K5 and K6 with higher extract concentrations. Thus, despite its benefit as antioxidant, excess of flavonoid compounds undergoing oxidation will produce a metabolite compound that can damage the endogenous antioxidant. Hence, 250 mg/kgBW/day roselle flower extract given daily can reduce MDA levels in mice induced with 20% alcohol.

**Keywords**: antioxidant, ethanol, malondialdehyde, roselle

## INTRODUCTION

Alcoholic beverages have become inseparable part of human civilization. Many traditional drinks in Indonesia such as *tuak*, *sopi*, *arak,* and *badeg* are consumed by local communities as part of their local tradition (Riskiyani *et al.* 2015). According to Riskesdas (MoH RI 2018), 4.6% of the population consumed alcoholic drinks and the highest prevalence was found in East Nusa Tenggara (NTT) province, which is 17.7%.

The type of alcoholic drinks accessed were traditional alcoholic drinks (38.7%), beer with (29.5%), wine (21.6%) and whiskey (3.8%) respectively. In Indonesia, there are many types of alcohol with various ethanol levels. According to Presidential Regulation of the Republic of Indonesia no 74 year 2013, alcohol beverages are divided based on the ethanol levels: Group A with 1%–5% ethanol level, group B with 5%–20% ethanol level, and group C with 20%–55% ethanol level.

Excessive alcohol consumption can cause various health problems both in the short and long term. These include central nervous system disorders, cardiovascular disorders and digestive disorders as well as psychological disorders that can cause changes and distortions of an individual's behavior and minds so that it can endanger the individual and others (Tritama 2015).

In metabolism process, alcohol is converted to acetaldehyde. The acetaldehyde formed is oxidized in the liver. Alcohol metabolism in the liver cells (hepatocytes) cause an increase of free radicals that react with poly unsaturated fatty acids leading to lipid peroxidation which produce Malondialdehyde (MDA). This triggers oxidative stress in the liver tissue (Zakhari 2006; Ayala *et al.* 2014)

Oxidative stress in the body caused by free radicals due to Lipid peroxidation reactions can be neutralized by endogenous or exogenous antioxidants. Many Indonesian natural ingredients contain antioxidants with various types of active ingredients and can be obtained at affordable prices (Werdhasari 2014). One of such plants is roselle (*Hibiscus sabdariffa* L.).

[*]**Corresponding Author:** tel: +6287884946602, email: retnoyulianti@upnvj.ac.id

roselle cultivation can be found in the low and highlands. According to research by Hidayah (2011) the highest antioxidant activity came from the roselle found in the lowlands.

Roselle petals is often used in food processing, it contains anthocyanin which gives color to the roselle petals and is believed to have antioxidant activity that can neutralize free radicals (Nurnasari & Khuluq 2017). Anthocyanins belong to flavonoids group which can act as antioxidant. The conjugated double bond system in anthocyanin helps in capturing free radicals (Ulilalbab *et al.* 2015). In addtion to anthocyanins, roselle petals also contain beta-carotene, vitamin C, thiamine, riboflavin, niacin and flavonoids (Mardiah *et al.* 2009).

Ulialbab *et al.* (2015) reported that roselle extract has the ability to reduce levels of malondialdehyde. Dianasari and Fajrin (2015) was using roselle extracts of 250 mg/kgBW/day, 500 mg/kgBW/day, and 750 mg/kgBW/day doses in diabetic mice, the results obtained at doses of 500 mg/kgBW/day and 750 mg/kgBW/day had antidiabetic activity. Further, Zuraida *et al.* (2015) reported that roselle extract can reduce MDA levels and increases catalase enzyme levels in rats exposed to Carbon Tetrachloride, and Pramita (2014) reported that roselle extract can reduce MDA levels in rat eyes and can increase SOD levels in rat eyes that have been exposed to 300 rad gamma radiation. Therefore, the researchers were interested in investigating the efficacy of roselle extract at doses of 250 mg/kgBW/day, 500 mg/kgBW/day, and 750 mg/kgBW/day levels on malondialdehyde level in ethanol induced rats' liver.

## METHODS

### Design, location, and time

The research was held in Pharmacology Laboratorium Medicine Faculty of Padjajaran University from July to December 2019. The study was conducted based on ethical treatment agreement from Ethics Comission, UPN Veteran Jakarta. This experimental study used a post test-only control group design. The study was conducted at the Pharmacology Laboratorium with treatments to one or more experimental groups. The results were then compared with the control group.

### Material and tools

The subjects of this study were 24 male white rats (*Rattus norvegicus*) Wistar strain obtained from the Pharmacology and Therapy Laboratory of the Faculty of Medicine, Padjajaran University, Bandung. The mice were aged 2–3 month old with a body weight of 250–300 grams. Mice which were ill before treatment and had any anatomic abnormalities were excluded from the study.

The tools used in this study were: spectrophotometer, centrifugator, micropipette, 1.5 ml and 2 ml microtube, filter paper, and sample tubes.The material used in this study were roselle flower extract (*Hibiscus sabdariffa* L.), ethanol 20% solution which were fed to the rats everyday for 30 days. The type of extraction used was multilevel maceration with water solvents. The extract dosage used were 250 mg/kgBW/day, 500 mg/kgBW/day, 750 mg/kgBW/day. The doses was chosen according to Zuraida *et al.* (2015) where the study found that 250 mg/kgBW and 500 mg/kgBW of roselle extract were able to reduce MDA level in rats' blood induced with carbon tetracloride. Meanwhile the dose of 750 mg/kBW in this research used to determine the lethal dose. Moreover, other antioxidant used in this study were vitamin C at a dose of 1.8 mg/day (Christijanti *et al.* 2011).

### Procedures

### Extraction

Roselle flower extract was made from dried roselle petals. Twenty five grams of roselle petals macerated with water in 250 ml Erlenmeyer and covered with aluminum foil. Then, stored in the refrigerator for at least 24 hours. After 24 hours, it was filtered (Oktiarni *et al.* 2016). Examination of the characteristics of the extract identified the chemical content of the roselle flower extract included alkaloids, saponins, phenolics, flavonoids, triterpenoids, and glycosides.

### Intervention

The treatment was divided into six groups, four rats were assigned per group: in the negative control group/ normal (K1) rats were given standard feed and aquades; in the positive control group I (K2) rats were given standard feed and 20% ethanol as much as 2 ml/day; in the positive control group II (K3) rats were given standard feed, 20% ethanol as much

as 2 ml/day, and vitamin C dose 1.8 mg/day; in the treatment group rats given 20% and roselle flower extract with differenet dosages namely in K4 rats were given roselle flower extract 250 mg/kgBW/day, in K5 rats were given roselle flower extract 500 mg/kgBW/day, and in K6 rats were given roselle flower extract 750 mg/kgBW/day. In groups K2, K3, K4, K5, and K6 rats were given ethanol 20% every day for 30 days. Each the roselle extract and vitamin C was given one hour after the administration of ethanol 20% orally. The rats were terminated on the last day after the 30 days of intervention. The mice were anesthetized before being terminated. The anesthetic substance used was ketamine injected intraperitoneally with a dosage of 75–100 mg/kgBW. The administration of ketamine was done in an early stage of euthanasia process because it causes quick unconsciousness about three to five seconds after injection (AVMA 2013).

**Measurement of malondialdehyde**

The liver were weighed as much as 10 mg then crushed until smooth and put in the appendorf tube; 100 cc distilled water was then added. Homogenate was added 100 µl of 100% Trichloroacetic Acid (TCA) solution, thiobarbiturate Na 1%, and HCl 1 N 250 µl. The mixture was centrifuged until homogeneous and incubated for 20 minutes at 100°C. After that, centrifuged at 3500 rpm for 10 minutes. The results were read on a spectrophotometer with a wavelength of 532 nm. The results of the spectrophotometer were converted into MDA standard curves (Fitria *et al.* 2015).

The standard curve was made to find out the relationship between the concentration of the solution and the absorbance value so that the concentration of the sample can be measured. Tetreaethoxypropane (TEP) solution was used to create the MDA standard curve. MDA standard curves were made by reacting TEP in various concentrations with 0.67% thio-barbituric acid (TBA). The standard Tetraethoxypropane (TEP) solution used was 10.0; 20.0; 40.0; 60.0; 80.0; 100.0 and 120.0 µl; distilled water was added until each volume reached 250 µl. After that, 1.25 ml of Trichloroacetic acid (TCA) 20% and 0.5 ml of Thiobarbituric Acid (TBA) 0.67% were added and solution was shaken until homogeneous. All samples were heated for 30 minutes at 100°C and cooled immediately (Agustini 2017).

**Phytochemical tests**

Phytochemical tests was done to determine the content of the active composition in roselle petals extract. Roselle extract was dissolved in each special solvent to determine the content in the extract. The tests carried out included alkaloid tests, flavonoid tests, tests saponin, tannin test, and triterpenoid test. For alkaloid test, the steps included roselle extract of 0.1 g reacted with 10 ml of chloroform and a few drops of ammonia. The chloroform fraction wass separated and acidified with a few drops of concentrated $H_2SO_4$ and divided into 3 test tubes, then Dragendorf reagents, Meyer reagents, and Wagner reagents were added.

In the flavonoid test, roselle extract was added with 0.1 mg and 0.4 magnesium tablets ml of amyl alcohol (a mixture of 37% hydrochloric acid and 95% ethanol by volume) and 4 ml of alcohol then the mixture was shaken. The steps for saponin test detected by foam testing in hot water. Extract was heated and then the foam was taken. Stable foam during 10 minutes and did not disappear with the addition of 1 drop of HCl 2%. The steps of tanin test, extract as much as 1 g added with 10 ml of distilled water and then bring to a boil. After cooling the filtrate was added with FeCl3 1%. And the last step were the triterpenoid and steroid test. Extract as much as 1 g was dissolved with 25 ml of hot ethanol 50°C, then filtered into porcelain dish and dried. The residue was dissolved with ether and transferred into a test tube, then 3 drops of anhydrous acetic acid and 1 concentrated $H_2SO_4$ were added. Extracts with purple or red color indicated the presence triterpenoids and green or blue extracts indicated steroids (Syafitri *et al.* 2014).

**Data analysis**

Data were analyzed using the One way ANOVA test with a significance level set at 0.05 to determine whether there were differences in MDA levels in all groups. Post-Hoc test was conducted following the ANOVA test to determine the differences in each group. Data were analyzed using SPSS 21 software.

## RESULTS AND DISCUSSION

**Phytochemical test**

The qualitative phytochemical test results of roselle flower extract revealed that the

extract used in the study contained antioxidant compounds as shown in Table 1. The qualitative phytochemical test showed that roselle flower extract contained flavonoid, saponin, phenolic, triterpenoid, glycoside, and alkaloids and roselle flower did not contain tannin and steroid. Previous research has reported that roselle flowers contains chemical properties including anthocyanin, beta-carotene, vitamin C, thiamine, riboflavin, flavonoids and niacin (Aisiyah *et al.* 2017). Anthocyanin, a flavonoid, is a natural antioxidant and is the red pigment of roselle flowers (Aisiyah *et al.* 2017). The long conjugated double bond system in anthocyanins is thought to capture free radicals by breaking down the propagation chain of free radicals, where all hydroxyl groups (OH) in ring B can contribute or act as electron or hydrogen donors so that cleaning or interception of free radicals occurs (Priska *et al.* 2018). In addition to anthocyanins as antioxidants, other phytochemical compounds contained in roselle flower such as saponin, alkaloid, triterpenoids, glycoside, and phenolics also have function as antioxidants and can be used as antibacterials (Nurnasari & Khuluq 2017). However, we did not find Tannin and Steroid in the roselle extract. The tannin content may decrease with increasing extraction time. This is because all the compounds contained, especially tannins, will be extracted and mixed with solvents (Sukardi *et al.* 2007). Other study also found that roselle flower petals, whether they are fresh or extracted with ethanol did not contain any steroid compounds (Hayati *et al.* 2012).

Table 1. Phytochemical test

| Phytochemical Test | Results |
|---|---|
| Flavonoid | + |
| Saponin | + |
| Tannin | - |
| Phenolic | + |
| Triterpenoid | + |
| Steroid | - |
| Glycoside | + |
| Alkaloid | + |

**Malondialdehyde measurement**

Data were analyzed using one way ANOVA test. The results obtained a significance value of 0.001. This means the extract given has an effect on liver malondialdehyde level induced with 20% ethanol.

Table 2 indicates data from the average liver MDA level in each group assessed from the rats' liver tissue taken after 30 days of treatments. The differences in the mean MDA levels for each group, ranged from 2.4 ng/ml to 3.73 ng/ml. Data analysis using One Way Anova showed that there was a significant difference in malondialdehyde levels between groups ($p=0.001$; $\alpha=0.05$). The lowest average MDA level was found in K3 (2.4334±0.17), the group treated with vitamin C. This is because vitamin C acts as potent antioxidant by acting as an electron donor to ward off free radicals (Lieberman & Peet 2018). This group is the reference to determine the efficacy of roselle extract compared to a well-known or standardize antioxidant which is the vitamin C. The average MDA level in K4, given roselle extract of 250 mg/kgBW/day is 3.1578±0.37 and it showed a statistically non-significant difference with the K3. This supports the fact that roselle extract of 250 mg/kgBW/day can work as good as vitamin C. This is in line with research by Zuraida *et al.* (2015) which showed that roselle extract at a dose of 250 mg/kgBW/day in rats exposed to carbon tetrachloride was able to reduce MDA levels. This might due to the combination of anthocyanin or flavonoid compounds contained in roselle flowers. The flavonoid compounds in the roselle flower are able to ward off free radicals through

Table 2. Differences of average levels of malondialdehyde

| Group | Treatment | MDA Level±SD (ng/ml) | p* |
|---|---|---|---|
| K 1 | Negative control | 3.5668±0.48$^{b}$ | 0.001 |
| K 2 | Positive control 1 | 3.6830±0.32$^{b}$ | |
| K 3 | Positive control 2 (Vitamin C) | 2.4334±0.17$^{a}$ | |
| K 4 | Roselle extract 250 mg/kgBW/day | 3.1578±0.37$^{a}$ | |
| K 5 | Roselle extract 500 mg/kgBW/day | 3.6053±0.54$^{b}$ | |
| K 6 | Roselle extract 750 mg/kgBW/day | 3.7306±0.28$^{b}$ | |

One way ANOVA; a and b: Post Hoc Tukey with significant difference; MDA: Malondialdehyde

the process of radical scavenging by giving one hydrogen atom from the group to react with free radicals (Zuraida *et al.* 2015). As shown in Harun *et al.* (2017) that administration of tempeh which contains flavonoids to rats can reduce the level of malondialdehyde.

The highest average MDA is at K6 with an average of 3.7306±0.28, which is the group treated with roselle extract at a dose of 750 mg/kg/BW. It also shows that the average K5 and K6 are higher than K4, which means that each additional dose can cause an increase from the average MDA. It means that dose of 500 mg/kgBW/day and 750 mg/kgBW/day was less effective in neutralizing free radical. According to Lemmens *et al.* (2014), flavonoid compounds undergoing oxidation will produce a metabolite compound that can damage the endogenous antioxidant glutathione (GSH). The effect of the damage to endogenous antioxidants is thought to cause a decrease in intracellular antioxidant action which causes the Reactive Oxygen Species (ROS) formed to react with hepatocyte cell molecules so that the lipid peroxidation process still occurs and a high MDA is instead produced (Lemmens *et al.* 2014).

In addition, there is no significant difference between K5 and K6 with K1 and K2. This shows that the K1 and K2 rats were already under stress, the stress increased the formation of free radicals. The formation of Reactive Oxygen Species (ROS) or active free radicals cause excessive lipid peroxidation reactions between ROS and polyunsaturated fatty acids contained in the hepatocyte cell membrane wall. This causing damage to the structure and function of the hepatocyte cells. The final product of the lipid peroxidation process is an increase in the levels of malondialdehyde (MDA) (Ayala *et al.* 2014).

## CONCLUSION

The qualitative phytochemical test showed that roselle flower extract contained flavonoid, saponin, phenolic, triterpenoid, glycoside, and alkaloids as anti oxidants but did not contain tannin and steroid. The administration of roselle flower extract 250 mg/kgBW/day for 30 days to the rats' liver malondialdehyde level induced by 20% ethanol was comparable to the administration of Vit C 1.8 mg/day as the standard antioxidant. While higher dossage of roselle flower extract 500 mg/kgBW/day and 750 mg/kgBW/day did not show comparable efficacy in reducing the rats' liver MDA levels.

## ACKNOWLEDGEMENT

This paper and the research reported would not be completed without the exceptional support of my lecturers and also the authors are grateful for the support from Medical Faculty, University of Pembangunan Nasional "Veteran" Jakarta.

## AUTHOR DISCLOSURES

The authors have no conflict of interest.

## REFERENCES

Agustini NWS 2017. Kemampuan pigmen karoten dan xantofil mikroalga *Porphyridium crunetum* sebagai antioksidan pada domba. Informatika Pertanian 26(1):1–12. http://dx.doi.org/10.21082/ip.v26n1.2017.p1-12.

Aisiyah S, Harjanti R, Nopiyanti V. 2017. Pemanfaatan bunga rosella (*Hibiscus sabdariffa* L.) sebagai bahan alami untuk upaya preventif dan promotif kesehatan bagi masyarakat nusukan Banjarsari Surakarta. Abdimas Unwahas 2(1):5–8. http://dx.doi.org/10.31942/abd.v2i1.1786.

[AVMA] American Veterinary Medical Association. 2013. Guidelines for the Euthanasia of Animal: 2013 Edition. Schaumburg (US): AVMA.

Ayala A, Muñoz MF, Argüelles S. 2014. Lipid peroxidation: Production, metabolism, and signaling mechanisms of malondialdehyde and 4-hydroxy-2-nonenal. Oxid Med Cell Longev 2014:360438. http://dx.doi.org/10.1155/2014/360438.

Christijanti W, Utami NR, Iswara A. 2011. Efek pemberian antioksidan vitamin c dan e terhadap kualitas spermatozoa tikus putih terpapar allethrin. Biosaintifika: Journal of Biology & Biology Education 2(1):18–26. https://doi.org/10.15294/biosaintifika.v2i1.1148.

Dianasari D, Fajrin A. 2015. Uji aktivitas antidiabetes ekstrak air kelopak bunga rosella (*Hibiscus sabdariffa* L.) pada tikus dengan metode induksi aloksan. Jurnal Farmasi Sains dan Terapan 2(1):1–4. https://doi.org/10.33508/jfst.v2i1.812.

Hayati Z, Winda Y, Karmil TF, Azmy A. 2012. Anti-bacterial Activity of Roselle Flowers Extract (*Hibiscus sabdariffa* Linn) in Inhibiting Bacterial Growth Methicillinr Esistant *Staphylococcus aureus*. Proceedings of The 2nd Annual International Conference Syiah Kuala University 2012 & The 8th IMT-GT Uninet Biosciences Conference (page 416–420), 22–24 November 2012, Banda Aceh (ID): Syiah Kuala University.

Hidayah N. 2011. Pengaruh Ketinggian Tempat Tumbuh Rosella dan Jenis Bahan Rosella terhadap Aktivitas Antioksidan Teh Kombucha Rosella [Undergraduate Thesis]. Malang: UIN Maulana Malik Ibrahim.

Fitria NL, Lyrawati D, Handaru M. 2015. Efek pemberian asam alfa lipoat terhadap kadar MDAdan gambaran histologi pada hati tikus wistar jantan dengan diabetes melitus tipe 1. Jurnal Kedokteran Brawijaya 28(3):170–176. https://doi.org/10.21776/ub.jkb.2015.028.03.2.

Harun I, Susanto H, Rosidi A. 2017. Pemberian tempe menurunkan kadar malondialdehyde (MDA) dan meningkatkan aktivitas enzim superoxide dismutase (SOD) pada tikus dengan aktivitas fisik tinggi. J Gizi Pangan 12(3):211–216. doi: 10.25182/jgp.2017.12.3.211-216.

Lieberman M, Peet A. 2018. MARKS' Basic Medical Biochemistry. 5th Edition. Philadelphia (US): Wolters Kluwer.

Lemmens KJA, Vrolijk MF, Bouwman FG, Van de Vijgh WJF, Bast A, Haenen GRMM. 2014. The minor structural difference between the antioxidants quercetin and 4'o-methylquercetin has a major impact on their selective thiol toxicity. Int J Mol Sci 15(5):7475–7484. https://doi.org/10.3390/ijms15057475.

Mardiah SR, Rahayu A, Ashadi RW, Sawarni H 2009. Budi Daya dan Pengolahan Rosela: Si Merah Segudang Manfaat. Jakarta (ID): Agromedia.

Nurnasari E, Khuluq AD. 2017. Potensi diversifikasi rosela herbal (*Hibiscus Sabdariffa* L.) untuk pangan dan kesehatan. Buletin Tanaman Tembakau, Serat & Minyak Industri 9(2):82–92.

Oktiarni D, Khasanah SN, Adfa M, Nesbah N, Angasa E. 2016. Pengaruh boraks, asam dan basa terhadap pergeseran panjang gelombang ekstrak air bunga rosella (*Hibiscus sabdariffa* Linn.) Gradien: Jurnal Ilmiah MIPA 12(2):1187–1191.

Pramita R, Widodo CS, Juswono UP. 2014, Pengaruh ekstrak kelopak rosella (*Hibiscus sabdariffa* L.) pada aktivitas SOD dan MDA mata tikus (*Rattus wistar*) yang dipapar radiasi gamma. Natural B 2(4):375–379.

Priska M, Peni N, Carvallo L, Ngapa YD. 2018. Review: Antosianin dan pemanfaatannya. Cakra Kimia: Indonesian E-Journal of Applied Chemistry 6(2):79–97.

[MoH RI] Ministry of Health Republic of Indonesia. 2018. Hasil Utama Riskesdas. https://kesmas.kemkes.go.id/assets/upload/dir_519d41d8cd98f00/files/Hasil-riskesdas-2018_1274.pdf.pdf [Accessed 30th January 2020].

Riskiyani S, Jannah M, Rahman A. 2015. Aspek sosial budaya konsumsi minuman beralkohol (*Tuak*) di Kabupaten Toraja Utara. Media Kesehatan Masyarakat Indonesia 11(2):76–85. http://dx.doi.org/10.30597/mkmi.v11i2.520.

Sukardi S, Mulyarto AR, Safera W. 2007. Optimasi waktu ekstraksi terhadap kandungan tanin pada bubuk ekstrak daun jambu biji (*Psidii Folium*) serta biaya produksinya. Jurnal Teknologi Pertanian 8(2):88–94.

Syafitri NE, Bintang M, Falah S. 2014. Kandungan fitokimia, total fenol, dan total flavonoid ekstrak buah harendong (*Melastoma affine* D. Don). Current Biochemistry 1(3):105–115. https://doi.org/10.29244/cb.1.3.%25p.

Tritama TK. 2015. Konsumsi alkohol dan pengaruhnya terhadap kesehatan. Medical Journal of Lampung University 4(8):7–10.

Ulilalbab A, Wirjatmadi B, Adriani M. 2015. Ekstrak kelopak rosella merah mencegah kenaikan malondialdehid tikus wistar yang dipapar asap rokok JIFI 13(2):215–220.

Werdhasari A. 2014. Peran antioksidan bagi kesehatan. Indonesian Jurnal Biotek Medisiana Indonesia 3(2):59–68.

Zakhari S. 2006. Overview: How is alcohol metabolized by the body? Alcohol Res Health 29(4):245–254.

Zuraida Z, Yerizel E, Anas E. 2015. Pengaruh pemberian ekstrak rosella (*Hibiscus Sabdariffa* Linn) terhadap kadar malondialdehid dan aktivitas katalase tikus yang terpapar karbon tetraklorida. Jurnal Kesehatan Andalas 4(3):795–802. https://doi.org/10.25077/jka.v4i3.366.

Volume 16, Number Supplement 1, February 2021

ISSN 1978-1059
EISSN 2407-0920

# JURNAL GIZI DAN PANGAN
## JOURNAL OF NUTRITION AND FOOD

Vol. 16 No. Supp.1, February 2021

Supplementary Issue:

The 1st IPB International Conference on Nutrition and Food (ICNF) 2020

18–19 November 2020

1ST ICNF
IPB INTERNATIONAL CONFERENCE ON NUTRITION AND FOOD 2020

Published by:

Food and Nutrition Society of Indonesia

Department of Community Nutrition, Faculty of Human Ecology, IPB

Jurnal Gizi dan Pangan

Volume 16, Number Supplement 1, February 2021



9 771978 105189

**Jurnal Gizi dan Pangan**
**(Journal of Nutrition and Food)**

**ISSN : 1978-1059** **(printed)**
**EISSN : 2407-0920** **(electronic)**



Publication Frequency : Three times a year (March, July, and November)

Editorial Address : Secretariat of Jurnal Gizi dan Pangan (Journal of Nutrition and Food)
Department of Community Nutrition, Faculty of Human Ecology,
IPB University, Dramaga, Bogor 16680
Telephone : (0251)8621363
Email : jgp@apps.ipb.ac.id

**Jurnal Gizi dan Pangan (Journal of Nutrition and Food)** is routinely published three times per year since 2006 and received accreditation from Ministry of Research, Technology, and Higher Educational Decree Number 28/E/KPT/2019 in 26 September 2019. This journal focuses on research publications in the fields of nutrition and food encompasses topics related to biochemistry aspect, clinical nutrition, community nutrition, functional food, socio-economic, and regulation in nutrition and food information.

This supplement issue of the Indonesian Journal of Nutrition and Food features the presentations given at the "1st IPB International Conference on Nutrition and Food 2020 (ICNF 2020)" organized by the Department of Community Nutrition, IPB University in Bogor, Indonesia, which was held online on 18–19 November 2020.

These papers were reviewed by the Scientific Committee of ICNF 2020 before their presentation, but they did not undergo the conventional reviewing system of the Indonesian Journal of Nutrition and Food.

The Indonesian Journal of Nutrition and Food, Bogor, Indonesia

# EDITORIAL MESSAGE

The 1st IPB International Conference of Nutrition and Food 2020 (ICNF 2020) was the first international conference that is fully organized by the Department of Community Nutrition, IPB University. The event was aimed to be a platform where academia, researchers, private sectors and general public can get updates on nutrition and food, ranging from clinical nutrition, community nutrition, and food innovation topics.

The organizing committee of the ICNF 2020 had chosen to focus on Nutrition and Food Innovation for Better Life as the theme of the conference and there was a total of 97 oral and poster presentations delivered in the two-day online conference on 18–19 November 2020, coming from variety of countries.

The ICNF 2020 is supported by the Indonesian Journal of Nutrition and Food as one of the publishing partners to publish articles in original research paper format. In this supplement issue, there are articles that have been presented at the ICNF 2020 from the three main topics, with the authors varied from variety of academic and research institutions. We hope that this supplement issue can contribute as a source of scientific information in the field of nutrition and food for our readers.

Editor in Chief

Prof. Dr. Ir. Dodik Briawan, MCN

*ISSN 1978-1059*
*J. Gizi Pangan, Volume 16, Number Supp.1, February 2021*

# MANUSCRIPT REVIEWERS & EDITORS

Prof. Dr. Ir. Ali Khomsan, MS
(*Head of Scientific Committee ICNF 2020*)

Prof. Dr. Ir. Sri Anna Marliyati, M.Si

Prof. Dr. Ir. Dodik Briawan, MCN

Dr. Rimbawan Rimbawan

Dr. Ir. Budi Setiawan, MS

Dr. Ir. Cesilia Meti Dwiriani, M.Sc

Dr. dr. Mira Dewi, M.Si

Dr. Zuraidah Nasution, STP, M.Sc

Dr. agr Eny Palupi, STP, M.Sc

Anna Vipta Resti Mauludyani, SP, M.Gizi

dr. Karina Rahmadia Ekawidyani, M.Gizi

Muhammad Aries, SP., M.Si

Hana Fitria Navratilova, S.Gz., M.Sc

Purnawati Hustina Rachman, S.Gz., M.Gizi