9 772540 841009

MEDIA GIZI Indonesia

Departemen Gizi Kesehatan
Fakultas Kesehatan Masyarakat
Universitas Airlangga

Jurnal Ilmiah
MEDIA GIZI Indonesia
Accredited by SINTA Indonesia (SINTA 2)
SK DITJEN RISBANG KEMENRISTEKDIKTI RI NO 3/E/KTP/2019
(National Nutrition Journal)

p-ISSN 1693-7228
e-ISSN 2540-8410
Vol. 19 | No. 3 | Page 216 – 329 | September 2024

p-ISSN 1693 7228
e-ISSN 2540 8410

Media Gizi Indonesia
(National Nutrition Journal)

Volume 19 Number 3, Sept – Dec 2024

Mailing Address : Redaksi Media Gizi Indonesia
Departemen Gizi Kesehatan
Fakultas Kesehatan Masyarakat, Universitas Airlangga
Kampus C Unair, Jl.Mulyorejo Surabaya 60115
Telp : (031) 5964808/Fax: (031) 5964809

Media Gizi Indonesia (MGI) that has been published since 2004 is a scientific journal that provides articles regarding the results of research and the development of nutrition including community nutrition, clinical nutrition, institutional nutrition, food service management, food technology, current issues on food and nutrition. This journal is published once every 4 months: January, May, and September.

SUBSCRIPTION PRICE – does not include postage

IDR. 200.000,- for each copy

INTRODUCTION TO THE EDITOR

Media Gizi Indonesia (MGI) is a scientific journal published regularly every 4 months that provides articles regarding the research and the development of nutrition knowledge including community nutrition, clinical nutrition, institutional nutrition, food service management, food technology, and current issues on food and nutrition. Media Gizi Indonesia tries to always present a variety of scientific articles in the scope of Nutrition and Health.

This volume presents original research in the field of nutrition. The original research theme focuses on the benefits of local food that can have an impact on health and nutrition, some of them are the role of local food as a source of natural sweeteners that can hold the increment of blood sugar levels and the role of local food as an antioxidant in counteracting free radicals. In addition, stunting reduction is still a developing issue. For this reason, this edition of MGI presents some of the best research related to child nutrition concerning toddler growth and development and their nutritional profile. Furthermore, to present research related to child nutrition, this edition of MGI also presents research on adolescents and its relation to nutrition behavioral changes.

We do hope MGI scientific journals can leverage the development of a writing culture and communicative scientific studies as well as attract readers and writers to participate in MGI for future issues. Media Gizi Indonesia will maintain its role in providing current, relevant, and topical issues in food and nutrition. Hopefully, the works displayed by MGI can provide benefits and enrich the readers' knowledge...

Editorial Team

Volume 19 Number 3 Sept–Dec 2024

p-ISSN 1693 7228
e-ISSN 2540 8410

Media Gizi Indonesia
(National Nutrition Journal)

Table of Contents

ANALISA PROKSIMAT, INDEKS GLIKEMIK, DAN BEBAN GLIKEMIK PADA GULO PUAN: MAKANAN KHAS PAMPANGAN, SUMATERA SELATAN

Proximate Analysis, Glycemic Index, and Glycemic Load in Gulo Puan: A Culinary Investigation of a Traditional Dish from Pampangan, South Sumatra

Windi Indah Fajar Ningsih[1], Uthfi Aulia Fitriani[1*], Sari Bema Ramdika[1], Fatria Harwanto[1]
[1]Gizi, Fakultas Kesehatan Masyarakat, Universitas Sriwijaya, Indralaya, Indonesia
*Email: uthfi.aulia@gmail.com

ABSTRAK

Gulo puan adalah salah satu makanan khas yang berasal dari Pampangan, Sumatera Selatan. Gulo puan berbahan dasar susu kerbau dan gula pasir sehingga memiliki rasa manis dan gurih. Gulo puan dikonsumsi oleh masyarakat setempat sebagai camilan ataupun tambahan untuk memasak. Tujuan penelitian ini untuk menganalisa kandungan proksimat, indeks glikemik dan beban glikemik pada gulo puan. Penelitian ini merupakan penelitian kuantitatif yang bersifat eksperimental. Analisa proksimat dilakukan di laboratorium SIG sedangkan Analisa beban dan indeks glikemik dilakukan pada 15 orang yang dipilih menggunakan metode *purposive sampling*. Hasil uji proksimat dianalisa secara deskriptif sedangkan analisis data indeks glikemik dan beban glikemik menggunakan uji *Mann-Whitney*. Hasil analisa komposisi proksimat diketahui bahwa gulo puan memiliki kandungan total energi (417,44 kkal), karbohidrat (55,93%), lemak (16,65%), protein (10,25%), abu (1,64%), dan air (15,03%). Hasil penelitian menunjukkan perbandingan indeks glikemik gulo puan (88,69%) dan gula merah (95,05%) dengan perbedaan rata-rata yang bermakna (*p-value* 0,004 (< 0,05)). Perbandingan beban glikemik gulo puan (44,34%) dan gula merah (47,52%), dengan perbedaan rata-rata yang bermakna *p-value* 0,004 (< 0,05).

Kata kunci: Analisa Proksimat, Gulo Puan, Indeks Glikemik, Kadar Glukosa Darah

ABSTRACT

Gulo Puan, originating from Pampangan, South Sumatra, stands out as one of the region's specialties. Crafted from buffalo milk and sugar, Gulo Puan boasts a delightful combination of sweet and savory flavors. Locally embraced, this delicacy is commonly enjoyed as a snack or incorporated into various culinary preparations. This study's primary objective was to comprehensively analyze the proximate content, glycemic index, and glycemic load of Gulo Puan. Employing an experimental quantitative research approach, the proximate analysis took place in the GIS laboratory, while the study of glycemic load and glycemic index involved 15 participants selected through purposive sampling. The results of the proximate study, presented descriptively, revealed the following composition in Gulo Puan: total energy (417.44 kcal), carbohydrate (55.93%), fat (16.65%), protein (10.25%), ash (1.64%), and water (15.03%). Comparisons of glycemic index between Gulo Puan (88.69%) and brown sugar (95.05%) exhibited a statistically significant average difference (p-value 0.004 (<0.05)). Similarly, a comparison of glycemic load between Gulo Puan (44.34%) and brown sugar (47.52%) also demonstrated a significant average difference (p-value 0.004 (<0.05)).

Keywords: *Proximity Analysis, Gulo Puan, Glycemic Index, Blood Glucose Levels*

INTRODUCTION

Sugar is a significant concern for individuals with diabetes, leading them to steer clear of foods with a sweet taste derived from sugar. This avoidance stems from various forms of sugar, including granulated sugar and brown sugar, which can elevate the body's glycemic index level and glycemic load (Astuti & Maulani, 2017). Foods with a high glycemic index are linked to heightened blood glucose levels in patients with type II diabetes mellitus.

Despite sugar being commonly employed to enhance the flavor of dishes, such as the use of granulated sugar, it poses a challenge for individuals with diabetes due to its elevated glycemic index value and limited nutritional

 Received 26-11-2023, Accepted 27-08-2024, Published online 30-09-2024.

https://doi.org/10.20473/mgi.v19i3.216–225

content. Consequently, those with diabetes mellitus actively seek alternative sugars deemed safe for maintaining blood glucose levels.

The quantity of glucose in the bloodstream is called the blood glucose level. Typically, blood glucose levels are deemed normal when blood sugar test results fall within the 80 to 100 mg/dL range. According to Habib (as cited in (Ridwanto et al., 2021), blood glucose is a type of sugar present in the blood, originating from carbohydrates in food. Subsequently, these carbohydrates are stored as glycogen in the liver and muscles.

Brown sugar stands out as a favorable alternative to white sugar. This preference is attributed to the additional nutrients present in brown sugar, such as manganese, boron, nitrogen, and phosphorus. Brown sugar boasts higher zinc, iron, potassium, and magnesium concentrations than white sugar. Consequently, brown sugar is the preferred choice.

Protein plays a crucial role in determining the glycemic index of food. Foods with a high protein content exhibit a lower glycemic index than those with equivalent carbohydrate levels (Probosari, 2019). Among animal foods, milk and its derivatives stand out for their nutritional value, particularly their high protein content. Moreover, these products are readily available and widely consumed by the public (Suciati & Safitri, 2021). Exploring options with a higher protein content is essential to address the need for an alternative sugar with a lower glycemic index.

In South Sumatra, specifically in OKI Pampangan, a unique type of sugar known as gulo puan is produced. Gulo puan is crafted from buffalo milk and granulated sugar, with these ingredients heated over low heat for 4-5 hours until the milk undergoes caramelization. Residents commonly enjoy gulo puan as a snack or as an addition to various dishes, relishing its sweet and savory taste. Notably, gulo puan, derived from buffalo milk, renowned for its high nutritional value, holds the potential as a source of antioxidants (Miskiyah, 2011; Suciati & Safitri, 2021). According to Jenkins et al. (as cited in, foods with elevated protein and fat content exhibit a lower glycemic index than similar foods with lower protein and fat content. This characteristic positions gulo puan as a promising processed product with a high protein content. There is also optimism that gulo puan can be developed as an additional ingredient in food, imparting a sweet taste and serving as a viable alternative for individuals with diabetes mellitus. However, the current absence of data regarding the nutritional content, glycemic index, and glycemic load of gulo puan necessitates further investigation. In this research, we aim to conduct a proximate analysis of gulo puan and analyze its glycemic index and glycemic load compared to other sugars.

METHODS

This research constitutes a laboratory experimental study in which proximate analysis will be conducted on gulo puan. The objective is to compare the glycemic index and glycemic load of gulo puan with granulated and brown sugar.

Nutrient of gulo puan content analysis was performed at the laboratory of PT Saraswati Indo Genetech Bogor. The total energy and energy derived from fat were calculated using a specific method. The assessment of ash content employed the SNI 01-2891-1992 point 6.1 test method, while water content analysis utilized the SNI 01-2891-1992 point 5.1 test method. For carbohydrate analysis, the difference method was applied with the 18-8-9/MU/SMM-SIG test (calculation), total fat content was determined using the Weibull Test (18-8-5/MU/SMM-SIG point 3.2.2), and protein levels were measured through the Titrimetric Test (18-8-31/MU/SMM-SIG).

Gulo puan was obtained directly from the original gulo puan craftsmen in Pampangan village, and experimental assessments of glycemic index and glycemic load were conducted by administering glucose loads from gulo puan, granulated sugar, and brown sugar to respondents. The test protocol is outlined as follows:

The respondent selection was executed through the purposive sampling method. The criteria for selecting subjects were based on prior glycemic index research, as demonstrated in the study by (Ningrum et al., 2011), where ten respondents were deemed sufficiently representative for determining the glycemic index. For the present study, researchers selected 15 subjects who satisfied the predefined inclusion and exclusion criteria. Inclusions encompassed adults without health issues (aged 18-25), willing to

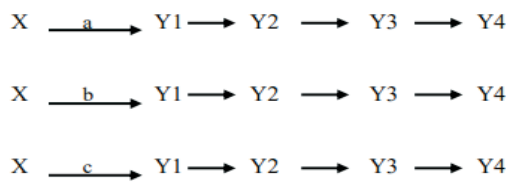


Figure 1. Research Stages

Note:
X: Initial measurement of blood glucose levels before administering the test foods
a: Treatment involving the administration of gulo puan as a test food
b: Treatment involving the administration of sugar as a test food
c: Treatment involving the administration of brown sugar as a test food
Y1: Measurement of blood glucose levels 30 minutes before administering the test foods
Y2: Measurement of blood glucose levels 60 minutes after administering the test foods
Y3: Measurement of blood glucose levels 90 minutes after administering the test foods
Y4: Measurement of blood glucose levels 120 minutes after administering the test foods

commit to three-week participation in the research, possessing a body mass index (BMI) within the range of 18.5 to 25.0, and lacking a history of glucose metabolism problems, diabetes, or food allergies. Exclusions were applied to respondents with a history of difficult-to-stop bleeding diseases or blood clotting issues, those taking excessively long to consume the test food, and those failing to attend scheduled research meetings.

This research was conducted for 3 weeks. Every week respondents will be given treatment. The treatment stages are as follows :

1. Before giving the test food, respondents were asked to fast for 10-12 hours at night, eat normal portions before fasting, and not do heavy activities.
2. The respondent came to biomedical laboratory once in a week in every morning then received treatment as: in the first week respondents were given granulated sugar treatment, in the second week they were given gulo puan and in the last week they were given brown sugar.
3. The respondent primary data for the study consisted of blood samples and blood glucose levels of the subjects measured at 0 (fasting blood), 30, 60, 90, and 120 minutes (after ate the test food). The blood sample was taken by researcher using portable glucose test.

The test foods (Gulo puan, granulated sugar, and brown sugar) will be dissolved in 200 mL of warm water to facilitate dissolution and consumption by the respondents. Respondents are instructed to complete the ingestion of the test foods within a 10-minute timeframe. Each portion of the test food should correspond to 50 grams of carbohydrates, resulting in the following quantities: granulated sugar (53.2 grams), puan sugar (92.6 grams), and brown sugar (54.4 grams). These amounts are determined based on the calculation of carbohydrate content according to TKPI 2017 (Indonesian food composition table of 2017).

The analysis and presentation of data regarding the nutritional content of gulo puan were conducted descriptively. For the glycemic index and glycemic load, the area under the curve was calculated using the trapezoid method both manually and with the Microsoft Excel program. The calculation of the area of a trapezoidal shape is determined by the formula:

$$\text{Area of trapezium} = \frac{number\ of\ parallel\ sides}{2} \times height \ldots (1)$$

To ascertain the values of the glycemic index (GI) and glycemic load (GL), calculations are performed using the following formula:

$$GI = \frac{x}{y} \times 100\% \ldots (2)$$

where;
x = the area under the blood glucose response curve after two hours of the test food
y = the area under the blood glucose response curve after two hours to a standard meal

$$GL = \frac{GI \times z}{100} \ldots (3)$$

where;
z = total carbohydrates in one serving of test food

In this research, statistical data analysis was conducted using Microsoft Excel. The normality of the data was assessed using the Shapiro-Wilk test due to the sample size being less than 50 individuals. Subsequently, the researcher employed the Independent T-test for normally distributed data and the Mann-Whitney test for data that did

not exhibit normal distribution (Suyanto & Gio, 2017).

All stages of this research received approval from the Sriwijaya University FKM Health Research Ethics Committee, as indicated by the letter with reference number 059/UN9.FKM/TU.KKE/2023, dated January 25, 2023.

RESULTS AND DISCUSSIONS

Nutritional Value of Gulo Puan

Gulo puan, a distinctive food originating from South Sumatra, is crafted from granulated sugar and buffalo milk and subjected to a 4-5 hour low-temperature heating process. An analysis of 100 g of gulo puan reveals an average total energy of 417.44 kcal, with 153.36 kcal derived from fat. The moderate ash content in gulo puan is 1.64%, demonstrating compliance with the ash content standards outlined in SNI 1-6237-2000. This standard dictates a maximum ash content of 2% for cane brown sugar (Erwinda & Susanto, 2014). Notably, ash content serves as a determinant for assessing metal contamination in food, and additionally, it acts as an indicator of food safety (Kristiandi et al., 2021).

The average water content in gulo puan is 15.03%, surpassing the water content in palm sugar, commonly known as molded and crystalline brown sugar, which stands at 10.28% and 3.64%, respectively (Ismail et al., 2020). Water plays a crucial role in determining food quality, as Ismail et al. (2020) emphasize.

Table 1. Proximate analysis of Nutritional Composition Gulo Puan

No	Parameter	Mean Result (%)
1.	Total Energy / 100 gr	417.44 kcal
2.	Energy from Fat / 100 gr	153.36 kcal
3.	Carbon	1.64
4.	Water	15.03
5.	Carbohydrate	55.93
6.	Total Fat	17.04
7.	Protein	10.10

Source : primary laboratory data (2023)

Riawan (as cited in Ismail et al., 2020) asserts that carbohydrate calculations are based on the remaining water, ash, protein, and fat content. In the case of gulo puan, the average carbohydrate content is 55.93%, indicating a lower carbohydrate content compared to molded and crystal palm sugar, which registers at 84.99% and 92.62%, respectively (Ismail et al., 2020). (Ismail et al., 2020) further note in their research that the carbohydrate content in food is linked to blood glucose response, providing insights into the glycemic index.

Gulo puan serves as an alternative sugar rich in both fat and protein. The average total fat content in gulo puan is 17.04%. In contrast, (Ismail et al., 2020) state that palm sap lacks fat. Gulo puan's protein content averages 10.10%, starkly contrasting the 0.41% protein content found in palm sap (Ismail et al., 2020). The elevated fat and protein levels in gulo puan can be attributed to buffalo milk, one of its key ingredients. Both protein and fa in food can influence the glycemic index. Simultaneously, increased protein content in food is believed to stimulate insulin secretion, contributing to regulating blood glucose levels (Arif et al., 2013; Ismail et al., 2020).

Higher fat content in food can slow down gastric emptying, consequently retarding the digestion process in the small intestine. Fat in food has a special taste that affects the deliciousness of the food. The PUFA content in food, including ω-3 and ω-6 fatty acids, prevents diabetes, obesity, atherosclerosis and autoimmune-inflammatory diseases (Simopoulos, 2016). Excessive amounts of cholesterol in the blood will cause accumulation or atherosclerosis which is the main trigger for stroke and coronary heart disease (CHD) and can increase the risk of obesity and result in decreased fitness and work productivity (Kushargina & Purnamasari, 2021; Permatasari et al., 2022). Therefore, it is necessary to pay attention to the choice of type of fat from the food consumed

Granulated Sugar Intervention

The presented graph depicts the intervention administered to 15 respondents, indicating an average fasting blood glucose level of 91.4 mg/dL. Subsequent measurements at 30, 60, 90, and 120 minutes reveal blood glucose levels of 136.73 mg/dL, 131 mg/dL, 112.73 mg/dL, and 92.46 mg/dL, respectively.

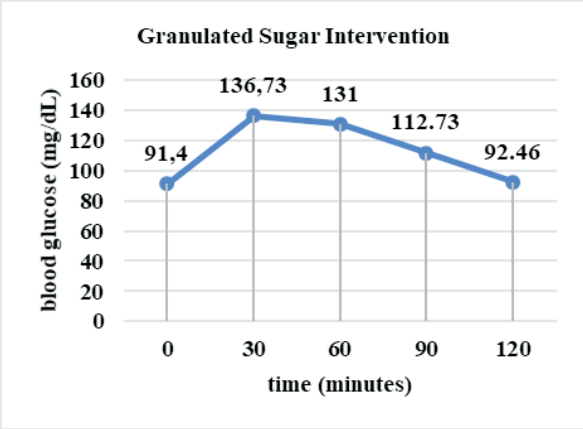


Figure 2. Granulated sugar intervention result.

These findings align with established theoretical principles positing a notable elevation in blood sugar levels after administering simple carbohydrates to respondents. However, the magnitude of this increase varies depending on the glycemic index and the quantity consumed (Fadhilah, 2012). Notably, simple carbohydrates and complex carbohydrates exhibit disparate glycemic indexes. Pujiastuti (2022) elucidated that simple carbohydrates can stimulate heightened insulin hormone production, thereby precipitating a rapid surge in blood sugar levels.

According to the research findings of (Novrian & Hajar, 2020), a statistically significant difference is evident in the blood glucose levels increase before and after administering sugar and honey. Blood glucose, the primary type of sugar in the bloodstream, is the body's principal energy source. Originating from consumed food, glucose can also be synthesized by the liver and muscles through the breakdown of glycogen stores into glucose. As elucidated by Novrian & Hajar (2020), blood glucose undergoes conversion into energy for utilization by all cells in the body. The hormones insulin and glucagon intricately regulate the mechanism of glucose control. Following a meal, increased glucose levels prompt elevated insulin secretion, stimulating the liver to store glucose as glycogen. This facilitates the saturation of cells, particularly in the liver and muscles, with glycogen. Surplus glucose, if present, is stored as fat.

Conversely, a decrease in blood glucose levels triggers a reduction in insulin secretion and an increase in glucagon secretion by the pancreas. Subsequently, the liver and muscles respond to this hormonal signal, leading to a depletion of glycogen stores and the subsequent breakdown of glycogen into glucose. This released glucose enters the bloodstream, maintaining blood glucose levels within the normal range (Novrian & Hajar, 2020).

Gulo Puan Intervention

The graph's findings illustrate that the elevation in blood glucose levels following the gulo puan intervention is comparatively lower than that observed with granulated sugar. This discrepancy can be attributed to the high protein content inherent in gulo puan. According to (Frid et al., 2005), adding 18 grams of whey protein to carbohydrate-containing foods facilitates expedited digestion and absorption. This, in turn, leads to an increase in plasma insulin concentration and a subsequent decrease in postprandial glucose levels. The fluctuations in postprandial blood glucose are intricately linked to satiety levels and food intake dynamics (Akhavan et al., 2011). Mayer's glucostatic theory (as cited in Akhavan et al., 2011) posits that alterations in blood glucose can influence changes in food intake. Hunger initiates when glucose levels are low, while a surge in glucose levels induces a sensation of fullness. Given the brain's dependence on glucose as an energy source, glucose concentration becomes a pivotal factor in appetite control (Marty et al., 2007).

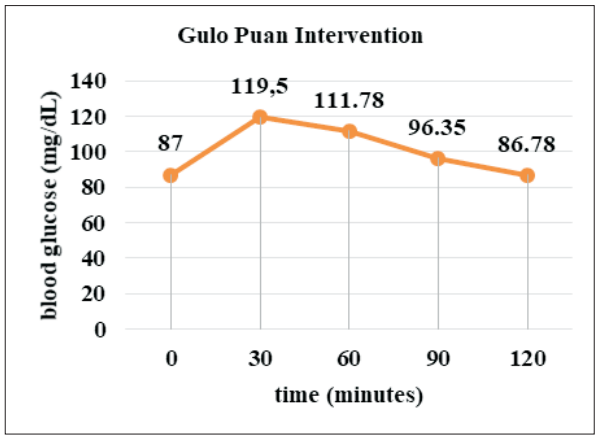


Figure 3. Gulo puan intervention result.

Confirming this perspective, (Van Meijl & Mensink, 2013) research asserts that the administration of high-protein milk can decrease postprandial blood glucose levels by 24%

compared to controls. Similar outcomes were reported by (Kung et al., 2018), wherein the high protein milk group exhibited a superior reduction in postprandial blood glucose, as indicated by the iAUC value, compared to the control group ($p < 0.005$). The advantage of milk protein lies in its capacity to stimulate insulin release, potentially modifying glucose absorption in tissues and mitigating postprandial blood glucose fluctuations (McGregor & Poppitt, 2013).

Brown Sugar Intervention

The elevation in postprandial blood glucose levels after ingesting brown sugar has been empirically substantiated to be comparatively less pronounced than the corresponding surge observed upon the consumption of granulated sugar. (Swastini et al., 2018) posit the potential of brown sugar as an agent with antidiabetic properties. Notably, Mody et al. and Merentek (as referenced in Swastini et al., 2018) contend that brown sugar contains calcium, which plays a crucial role in the glucose metabolism process facilitated by glucokinase. The antidiabetic activity of calcium has been shown to enhance insulin excretion, subsequently reducing blood glucose levels. This process induces changes in the ATP/ADP ratio, resulting in the closure of potassium ion channels and neutralization of cell membranes. Consequently, calcium channels open, allowing calcium to enter the cells. Merentek (as cited in Swastini et al., 2018) further asserts that an increase in intracellular calcium can translocate insulin granules to the membrane, facilitating insulin release into the bloodstream.

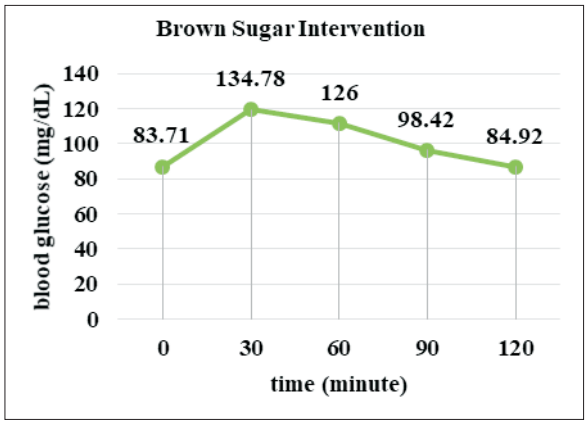


Figure 4. Brown sugar intervention result.

Suroso (as cited in Fajriansyah, 2020) asserts that consuming brown sugar is more advantageous for the body due to its derivation from natural ingredients and its production without the incorporation of significant chemicals. Moreover, brown sugar is rich in vitamins, which is attributed to its natural processing methods, ensuring that its inherent nutritional content remains preserved (Fajriansyah, 2020).

Swastini et al.'s research (2018) collected data regarding the fluctuations in blood glucose levels for each treatment across various test periods, namely 7, 14, 21, and 28 days. The conclusive measurements on day 28 and the difference test results assessing the decrease in blood glucose levels between day 0 and day 28 demonstrated a significant reduction in blood glucose levels compared to the negative control. Butcher's findings indicate that physiological responses to anxiety can impact endocrine function, explicitly affecting the hypothalamus and pituitary, resulting in an elevation of cortisol levels. This, in turn, produces an antagonistic effect on insulin function, leading to suboptimal blood glucose control and subsequent fluctuations in blood glucose levels during therapy (Swastini et al., 2018).

This observation aligns with Sujarwo's research (as cited in Fadhilah, 2012), indicating that elevated blood sugar levels are influenced by the consumption of carbohydrates, encompassing both simple and complex carbohydrates. These two categories of carbohydrates exhibit distinct glycemic indexes.

Glycemic Index

The presented tabular data delineates the glycemic indices of brown sugar and gulo puan, registering at 95.05% and 88.69%, respectively. The glycemic index classification entails three distinct categories: low glycemic index (<50), medium glycemic index (50-70), and high glycemic index (>70). Despite the marginal difference in numerical values, it is discernible that the glycemic index of gulo puan is 6.36% lower than that of

Table 2. Glycemic Index of the Intervention Food

Food	Glycemic Index (100%)	P- value*
Gulo Puan	88.69	0.004
Brown sugar	95.05	

brown sugar, albeit both substances fall within the high glycemic index category. The assessment of the difference between two independent means, conducted through the Mann-Whitney test, reveals non-homogeneous data variance for the two groups. This implies a statistically significant average distinction between the glycemic indices of gulo puan and brown sugar, corroborated by a calculated p-value of 0.004 ($p > 0.05$).

Gulo puan, characterized by a lower glycemic index, owes this attribute to its processing method and inherent composition, which influence absorption in the digestive tract and consequently impact blood glucose levels. The principle is that the food absorption rate correlates inversely with its glycemic index; thus, slower absorption results in a lower glycemic index. The heightened fat content in gulo puan contributes to its delayed absorption. This aligns with Probosari's research (2019), which elucidates that fatty foods can decelerate gastric emptying, impeding HCl secretion. Consequently, the fat content induces a more gradual blood glucose response, diminishing the glycemic index level.

In contrast to brown sugar, gulo puan is characterized by noteworthy protein content. The protein content emerges as a salient determinant exerting influence over the glycemic index of food, with an observed inverse relationship between higher protein content and lower glycemic index levels, as elucidated by Probosari (2019). The confluence of elevated protein content and diminished glycemic index levels in comestibles precipitates a moderated insulin secretion and a constrained glycemic response (Makris et al., 2011). Moreover, contributors to a subdued glycemic response encompass the gradual conversion of protein into glucose, resulting in a nominal protein-to-glucose transformation. Additionally, the hepatic breakdown of glycogen occurs without a simultaneous escalation in glucose release (Molitch et al., 2004).

This phenomenon is further influenced by the distinctive characteristics of proteins, particularly their capacity to elicit insulin secretion without concurrent elevation in blood glucose levels. Makris et al. (2011) contend that this occurrence is plausible due to the relatively weaker insulin secretion induced by the presence of protein compared to carbohydrates. Additionally, the digestive process of protein is known to stimulate the release of cholecystokinin, a hormone associated with heightened feelings of satiety. Consequently, proteins emerge as a macronutrient exerting a prolonged satiating effect compared to carbohydrates and fat (Makris et al., 2011).

This investigation showed that gulo puan and brown sugar exhibited relatively high glycemic index levels, possibly attributable to specific processing techniques. How food undergoes processing can significantly impact its glycemic index. Drawing insights from Amalia's research (as cited in Arif et al., 2013), it is observed that sweet corn subjected to different processing methods—namely boiling, sautéing, and roasting—demonstrates a heightened glycemic index in the case of grilled corn when compared to boiled and fried counterparts. This disparity arises due to the protracted exposure to high temperatures during processing, rendering the carbohydrate composition more readily digestible. This assertion is substantiated by (Eleazu, 2016), who contends in his study that roasting contributes to an elevated glycemic index in food compared to frying or boiling methods. This outcome is ascribed to the transformative gelatinization induced by high temperatures, causing a permanent alteration in the amylose-amylopectin structure. Consequently, the food becomes more susceptible to enzymatic digestion, resulting in a concomitant surge in blood sugar levels directly associated with a high glycemic index. The extended cooking duration of gulo puan, spanning 4-5 hours, may elucidate why, despite its protein richness, it sustains a high glycemic index level.

Glycemic Load

In the table, the highest glycemic load is attributed to brown sugar at 47.52%, whereas gulo puan exhibits a comparatively lower glycemic load of 44.34%. An evaluation employing the test of the difference between two independent means (Mann-Whitney) revealed a lack of homogeneity in the p-value of the data for the two groups.

Table 3. Glycemic load of the Intervention foods

Food	Glycemic Load (100%)	*P- value**
Gulo Puan	44.34	0.004
Brown sugar	47.52	

Notably, a significant average difference between the glycemic load of Gulo Puan and brown sugar was identified ($p = 0.004$, $p > 0.05$).

Glycemic load delineates the quantity of carbohydrates present in a food item, with each gram of carbohydrates capable of eliciting an increase in blood sugar levels. Consequently, glycemic load is intricately linked to two determining factors: the glycemic index and the serving size. The interplay between glycemic load and the size of food portions can impart varying effects on blood sugar response. This variability is notable when comparing foods with a high glycemic load consumed in small quantities versus those consumed in larger quantities. In this investigation, a standardized carbohydrate portion of 50 grams was employed for each sugar, equivalent to 92.6 grams for gulo puan and 54.4 grams for brown sugar.

The Ministry of Health of the Republic of Indonesia (KEMENKES RI) recommends a daily sugar intake of 5 tablespoons or 50 grams per person. Excessive consumption beyond this prescribed limit is anticipated to result in a heightened glycemic load, impacting an elevation in blood sugar levels. This is postulated to contribute to the elevated glycemic load observed in Gulo Puan. The rationale behind this assertion is that the portion administered during the test surpasses the stipulated recommendation. Consequently, a plausible scenario exists wherein the glycemic load of Gulo Puan could be categorized as moderate if adhering to the recommended portion size.

Brown sugar is a food ingredient with a higher glycemic content when juxtaposed with gulo puan. This discrepancy arises from distinct variations in food composition, influencing absorption within the digestive tract. In contrast, gulo puan manifests a lower glycemic load. Consuming foods with a low glycemic load can mitigate the pace of blood sugar absorption and inhibit pancreatic insulin secretion, consequently averting spikes in blood sugar levels (Idris et al., 2014).

The study by Idris et al. (2014) underscores that individuals exhibiting favorable glycemic load values comprise 50% of the patient cohort, mirroring the percentage observed in patients with unfavorable glycemic load values. However, the latter signifies that the most significant proportion, accounting for 95.7%, belongs to the subgroup of patients with inadequately controlled blood sugar levels. Hence, these findings illuminate a discernible and statistically significant relationship between the glycemic load of dietary intake and blood sugar levels in individuals with type 2 diabetes mellitus.

Foods characterized by a high glycemic load pose potential health risks, including obesity and diabetes. Therefore, heightened consumer awareness is imperative to ensure adherence to recommended daily limits. In a parallel vein, gulo puan can be safely consumed by individuals with diabetes, adhering to the specified portion of 50 grams, as endorsed by the Indonesian Ministry of Health.

Gulo puan, boasting a distinctive flavor reminiscent of sweet cheese, offers versatility as a beverage enhancer or a spread on bread (Shandy, 2022). Serving as an alternative sugar for individuals managing diabetes, gulo puan stands out as a nutritionally sound food product and holds promise as a primary or supplementary ingredient for locally inspired products in food development. This is exemplified by the research of (Yuliati & Hamzah, 2022), wherein gulo puan is featured as a critical component in the production of chocolate bars. Furthermore, investigations conducted by (Sartika et al., 2019) showcased the innovative transformation of gulo puan into Puan Candy. The utilization of gulo puan emerges as a means to augment food content with commendable nutritional value and as a strategy to enhance the allure of gulo puan as an emblematic culinary offering from Pampangan, South Sumatra.

There is a critical need to advocate for the significance of reading food packaging labels, as this endeavor is anticipated to assist individuals in transcending prevailing paradigms associated with degenerative diseases, particularly diabetes. Such paradigms often manifest as perceived limitations in the consumption of specific foods. Elevating consumer awareness regarding the interpretation of food labels can empower individuals to make informed choices about their dietary intake. This, in turn, is a proactive measure to mitigate the risk of blood sugar spikes associated with suboptimal food choices.

CONCLUSION

Based on the outcomes of comparative tests assessing the glycemic index and glycemic load of gulo puan, granulated sugar, and brown sugar, it is deduced that the average blood glucose levels of respondents before consuming gulo puan, granulated sugar, and brown sugar were 87 mg/dL, 91.4 mg/dL, and 83.71 mg/dL, respectively. After consumption, the average blood glucose levels of respondents experienced a peak increase in the 30th minute, reaching 119.5 mg/dL for gulo puan, 136.73 mg/dL for granulated sugar, and 134.78 mg/dL for brown sugar, followed by a gradual decline from the 60th to the 120th minute.

Gulo puan exhibits a lower glycemic index and load than brown sugar, accompanied by a statistically significant mean difference (p-value 0.004, < 0.05). Proximate composition analysis reveals that gulo puan boasts an energy content of 417.44 kcal/100 g, with 153.36 kcal attributed to fat. The ash and water content of gulo puan is recorded at 1.64% and 15.03%, respectively. Furthermore, gulo puan manifests higher levels of fat (16.65%) and protein (10.25%), coupled with lower carbohydrate content (55.93%) than brown sugar. Consequently, it emerges as a viable alternative sugar for individuals managing diabetes. However, the amount and processing as an alternative sugar must be considered, especially when combined with other high-fat foods.

ACKNOWLEDGEMENT

All authors declare that they have no conflicts of interest.

REFERENCES

Akhavan, T., Luhovyy , B.L., And Anderson, G.H. (2011). Effect Of Drinking Compared With Eating Sugars Or Whey Protein On Short-Term Appetite And Food Intake. International Journal Of Obesity, 35(4), Pp. 562–569.Available At: Https://Doi.Org/10.1038/Ijo.2010.163.

Arif, A., Budiyanto, A., & Hoerudin. (2013). Nilai Indeks Glikemik Produk Pangan Dan Faktor-Faktor Yang Mempengaruhinya. *Jurnal Litbang Pertanian*, *32*(3), 91–99.

Astuti, A., & Maulani, M. (2017). Pangan Indeks Glikemik Tinggi Dan Glukosa Darah Pasien Diabetes Mellitus Tipe Ii. *Jurnal Endurance*, *2*(2), 225–231. Https://Doi.Org/10.22216/Jen.V2i2.1956

Eleazu, C. O. (2016). The Concept Of Low Glycemic Index And Glycemic Load Foods As Panacea For Type 2 Diabetes Mellitus; Prospects, Challenges And Solutions. *African Health Sciences*, *16*(2), 468–479. Https://Doi.Org/10.4314/Ahs.V16i2.15

Erwinda, M. D., & Susanto, W. H. (2014). Pengaruh Ph Nira Tebu (Saccharum Officinarum) Dan Konsentrasi Penambahan Kapur Terhadap Kualitas Gula Merah. *Jurnal Pangan Dan Agroindustri*, *2*(3), 54–64.

Fadhilah, N. (2012). Pengaruh Konsumsi Gula Pasir Dan Gula Aren Terhadap Kadar Gula Dalam Darah Pada Penderita Diabetes Millitus Di Desa Bulokarto Kecamatan Gadingrejo Kabupaten Pringsewu Tahun 2010. *Jurnal Ilmiah Kesehatan*, *1*(1).

Frid, A. H., Nilsson, M., Holst, J. J., & Björck, I. M. E. (2005). Effect Of Whey On Blood Glucose And Insulin Responses To Composite Breakfast And Lunch Meals In Type 2 Diabetic Subjects. *American Journal Of Clinical Nutrition*, *82*, 69–75. Https://Doi.Org/10.1093/Ajcn/82.1.69

Idris, A. M., Jafar, N., & Indriasari, R. (2014). Pola Makan Dengan Kadar Gula Darah Pasien Dm Tipe 2. *Jurnal Mkmi*, *10*(4), 211–218. Https://Doi.Org/Https://Doi.Org/10.30597/Mkmi.V10i4.502

Ismail, Y. N. N., Solang, M., & D.Uno, W. (2020). Komposisi Proksimat Dan Indeks Glikemik Nira Aren. *Biospecies*, *13*(2), 1–9. Https://Doi.Org/10.22437/Biospecies.V13i2.8761

Kristiandi, K., Rozana, J., & Maryam, A. (2021). Analisis Kadar Air, Abu, Serat Dan Lemak Pada Minuman Sirop Jeruk Siam (Citrus Nobilis Var. Microcarpa). *Jurnal Keteknikan Pertanian Tropis Dan Biosistem*, *9*(2), 165–171. Https://Doi.Org/10.21776/Ub.Jkptb.2021.009.02.07

Kung, B., Anderson, G. H., Paré, S., Tucker, A. J., Vien, S., Wright, A. J., & Goff, H. D. (2018). Effect Of Milk Protein Intake And Casein-To-Whey Ratio In Breakfast Meals On Postprandial Glucose, Satiety Ratings, And Subsequent Meal Intake. *Journal Of Dairy Science*, *101*(10), 8688–8701. Https://Doi.Org/10.3168/Jds.2018-14419

Kushargina, R., & Purnamasari, T. A. E. (2021). Edukasi Bahaya Konsumsi Lemak Berlebih Dan Pemantauan Status Gizi Pegawai Sektor Formal Di Jakarta. *Amal Ilmiah : Jurnal Pengabdian*

Kepada Masyarakat, *3*(1), 40. Https://Doi.Org/10.36709/Amalilmiah.V3i1.19840

Makris, A. P., Borradaile, K. E., Oliver, T. L., Cassim, N. G., Rosenbaum, D. L., Boden, G. H., Homko, C. J., & Foster, G. D. (2011). The Individual And Combined Effects Of Glycemic Index And Protein On Glycemic Response, Hunger, And Energy Intake. *Obesityweek*, *19*(12), 2365–2373. Https://Doi.Org/10.1038/Oby.2011.145

Marty, N., Dallaporta, M., & Thorens, B. (2007). Brain Glucose Sensing, Counterregulation, And Energy Homeostasis. *Physiology*, *22*, 241–251. Https://Doi.Org/10.1152/Physiol.00010.2007

Mcgregor, R. A., & Poppitt, S. D. (2013). Milk Protein For Improved Metabolic Health: A Review Of The Evidence. *Nutrition&Metabolism*, *10*(46), 1–13. Https://Doi.Org/10.1186/1743-7075-10-46

Miskiyah. (2011). Kajian Standar Nasional Indonesia Susu Cair Di Indonesia. *Jurnal Standardisasi*, *13*(1), 1–7.

Molitch, M. E., Defronzo, R. A., & J.Franz, M. (2004). Nephropathy In Diabetes. *American Diabetes Association*, *27*(1), S79–S83. Https://Doi.Org/10.1007/S11428-023-01033-4

Ningrum, D. R., Nisa, F. Z., & Pangastuti, R. (2011). Indeks Glikemik Dan Beban Glikemik Sponge Cake Sukun Sebagai Jajanan Berbasis Karbohidrat Pada Subyek Bukan Penyandang Diabetes Mellitus. *Prosiding Seminar Nasional : Food Habit And Degenerative Diseases*, 248–261.

Novrian, F., & Hajar, S. (2020). Perbandingan Peningkatan Kadar Glukosa Darah Puasa Sebelum Dan Sesudah Pemberian Madu Hutan Dan Gula Pasir Mahasiswa Angkatan 2015 Fakultas Kedokteran Universitas Muhammadiyah Sumatera Utara. *Jurnal Ilmiah Simantek*, *4*(4), 146–152.

Permatasari, R., Suriani, E., & Kurniawan, D. (2022). Hubungan Kadar Kolesterol Total Dengan Tekanan Darah Pada Pasien HIpertensi Usian ≥ 40 Tahun. *Jurnal Labora Medika*, *6*, 16–21.

Probosari, E. (2019). PENGARUH PROTEIN DIET TERHADAP INDEKS GLIKEMIK. *Journal of Nutrition and Health*, *7*(1), 33–39.

Ridwanto, M., Astuti, D., & Dewinta, H. (2021). Hubungan Latihan Jasmani Dengan Kadar Glukosa Darah Pada Pasien Diabetes mellitus Tipe 2. *Jurnal Medika Indonesia*, *2*(2), 8–12.

Sartika, D., Saluza, I., & Roswaty, D. (2019). Branding Produk Gulo Puan dan Produk Inovasi Gulo Puan (Puan Candy) sebagai Makanan Khas Palembang dari Ogan Komering Ilir (OKI). *Prosiding Seminar Nasional II Hasil Litbangyasa Industri*, 212–220.

Shandy, A. (2022). Pengenalan Budaya Seni Kuliner Gulo Puan Daerah Palembang Melalui Video Interaktif. *JOURNAL OF MULTIMEDIA AND INFORMATION TECHNOLOGY*, *6*(2), 46–51. https://doi.org/10.46961/jommit.v6i2.639

Simopoulos, A. (2016). The FTO Gene, Browning of Adipose Tissue and Omega-3 Fatty Acids. *Lifestyle Genomics*, *9*(2–4), 123–126. https://doi.org/10.1159/000448617

Suciati, F., & Safitri, L. S. (2021). Pangan Fungsional Berbasis Susu dan Produk Turunannya. *Journal of Sustainable Research In Management of Agroindustry (SURIMI)*, *1*(1), 13–19. https://doi.org/10.35970/surimi.v1i1.535

Swastini, D. A., Shaswati, G. A. P. A., Widnyana, I. P. S., Amin, A., Kusuma, L. A. S., Putra, A. A. R. Y., & Samirana, P. O. (2018). Penurunan Kadar Glukosa Darah dan Gambaran Histopatologi Pankreas dengan Pemberian Gula Aren (Arenga pinnata) pada Tikus Jantan Galur Wistar yang Diinduksi Aloksan. *Indonesia Medicus Veterinus*, *7*(2), 94–105. https://doi.org/10.19087/imv.2018.7.2.94

Van Meijl, L. E. C., & Mensink, R. P. (2013). Effects of milk and milk constituents on postprandial lipid and glucose metabolism in overweight and obese men. *British Journal of Nutrition*, *110*, 413–419. https://doi.org/10.1017/S0007114512005314

Yuliati, K., & Hamzah, B. (2022). The Traditional Local Product Gulo Puan in Chocolate Bar Making. *International Journal of Science and Research (IJSR)*, *11*(2), 469–471. https://doi.org/10.21275/SR22205162931

NUTRIENT INTAKE AND PHYTATE-TO-ZINC MOLAR RATIO AMONG STUNTED AND NON-STUNTED CHILDREN IN MALANG CITY

Wardah Willyanti[1], Hadi Riyadi[1*], Zuraidah Nasution[1]
[1]Department of Community Nutrition, Faculty of Human Ecology, IPB University, Bogor, Indonesia
*Email: hadiri@apps.ipb.ac.id

ABSTRACT

Stunted is a condition of malnutrition caused by inadequate nutrient intake, especially in protein and zinc. Zinc deficiency can lead to impaired growth and increased risk of infectious disease due to inadequate zinc intake and low bioavailability of zinc in food. The purpose of this research was to analyze the nutrient intake and phytate-to-zinc molar ratio in children. This research was an analytical observational study with cross-sectional design. Children aged 6-59 months with stunted (n=61) and non-stunted (n=65) nutritional status were chosen by stratified random sampling in Ciptomulyo Health Center, Malang city. Nutrient and phytate intake were taken using 2x24 hour food recall method, while zinc bioavailability was calculated using phytate-to-zinc molar ratio. The difference of independent variables were analyzed using Independent t-test and Mann Whitney test. The result of this study showed that there were significantly different energy and protein adequacy levels (p=0.018; p=0.001) and phytate intake (p=0.016) among stunted and non-stunted children. On the other hand, fat, carbohydrate, and zinc adequacy level did not show any significant differences. Furthermore, there were no significant difference in phytate-to-zinc molar ratio in the two group (p=0.158) with more than half children had high phytate-to-zinc molar ratio category. In conclusion, the stunted and non-stunted children showed significant differences in energy, protein, and phytate intake, while their zinc intake was not significantly different resulting in similar phytate-to-zinc molar ratio between both groups. This study show that sufficient intake of zinc can help to lower phytate-to-zinc molar ratio regardless of nutritional status of children.

Keywords*: Nutrient intake, phytate intake, stunted children, zinc bioavailability*

INTRODUCTION

Stunted is a condition when children have Height for Age (HAZ) on < -2 SD (Minister of Health Republic of Indonesia No.2 of 2020 about Children Anthropometric Standard). The Indonesian Nutritional Status Survey (*Survey Status Gizi Indonesia/SSGI*) results in 2022 showed that 21.6% of children aged 0-59 months in Indonesia are experiencing stunted. Meanwhile, Malang city has stunted children's prevalence of 18%, close to average prevalence in East Java region as stated in percentage of 19.2%. This nutritional problem is currently becoming the focus of government program since stunted has negative impacts to children, in particular to their growth and development, including interference in children's cognitive development (Yadika et al., 2019). Children who are experiencing stunted, especially during their first 2 years of age, can experience brain and neurological development disorders resulted in decreases of IQ and learning achievement (Daracantika, 2021).

One of many causes of stunted is an inadequate food intake, especially in energy and protein. There are 46% of stunted children have insufficient protein intake (Ariati, 2019). (Damayanti et al., 2017) reported that children who have inadequate energy and protein intake are at risk from stunted exposure in 9.5 times and 10.6 times higher than children with adequate energy and protein intake. Protein is important macronutrient in the children's growth and development processes. Deficiency in protein will be resulted in decreasing the protein synthesis and degradation as well as linear growth failure (Tessema et al., 2018).

Protein insufficiency is often accompanied by zinc deficiency since zinc mostly found in animal protein foods such as red meat, seafood, poultry and dairy products. These nutrient has important role in the processes of cell and tissue growth,

 Received 24-11-2023, Accepted 31-05-2024, Published online 30-09-2024.

cell replication, bone formation, and regulation of protein synthesis (Gropper et al., 2009). Zinc deficiency in children is often associated with poor health, impaired growth, impaired intellectual development, and an increased risk of infectious diseases. These conditions can be caused by several reasons including low intake, low bioavailability, and zinc loss due to diseases such as diarrhea (Young et al., 2014). Research conducted by Losong & Adriani (2017) showed 85.71 % of stunted children have inadequacy zinc intake. Other research also showed that zinc intake < 77 % of the RDA is associated with the stunted incidence in children (Fatimah & Wirjatmadi, 2018).

Aside from the reason of low intake, zinc deficiency also can be caused by low zinc absorption. One of substances that able to inhibit zinc absorption is phytic acid. Phytic acid is a molecular form of phosphate storage mostly found in many types of cereal and plant protein foods where these substances unable to be absorbed inside small intestine. As a result, phytic acid will bind zinc and causing a zinc deficiency (Gropper et al., 2009).

From a study conducted in adults showed zinc absorption has negative correlation to phytate-to-zinc molar ratio (PA:Zn molar ratio) where zinc absorption would decrease by around 50% lower at an intake with an PA:Zn molar ratio value of 12-15 when compared to a diet with an PA:Zn molar ratio value of <5 (Gibson et al., 2018). Whereas other research by (Galetti et al., 2016) also showed the stunted children in Benin, West Africa had a low PA:Zn molar ratio value of 22.2. Unfortunately, there has not sufficient researches regarding the PA:Zn molar ratio in Indonesia as an indicator for determining zinc absorption due to limited sources of phytate data. Therefore, this research aimed to analyze nutrients intake and the PA:Zn molar ratio values in stunted and non-stunted children in Malang city.

METHODS

This research is an analytical observational study with a cross sectional design. The research was conducted from August to October 2023 in two sub-districts working area of Ciptomulyo Community Health Center, namely Ciptomulyo and Gadang Sub-districts of Malang City, East Java Province. These sub-districts had highest number of stunted children in Ciptomulyo Community Health Center.

The sample of this research was 126 children based on Lameshow et al. (1997) formula with the proportion between stunted and non-stunted children was 1:1. The selection of respondents was carried out by a stratified random sampling technique with strata division based on the children nutritional status which consist of stunted and non-stunted children (World Health Organization, 2006). As inclusion criteria for this study were: children with age of 6-59 months, not in a sick condition that involving regular medication like tuberculosis disease, cancer, HIV/AID, and autoimmune disease, and was willing to be a respondent during research process by signing the informed consent form by the children's parents.

The variables of this study were children' characteristics (age, gender, birth weight, history of exclusive breastfeeding, and caregiver), children's nutritional status (Height-for-Age Z-Score/ HAZ), nutritional intake (energy, protein, fat, carbohydrate, zinc), phytate intake and phytate-to-zinc molar ratio (PA:Zn molar ratio).

Data of children ages were classified into three categories: (a) 6-11 months, (b) 12-36 months, and (c) 37-59 months based on 2018 Indonesian Nutritional Adequacy Rate (*Angka Kecukupan Gizi/AKG)*, and the data of birth weight history divided into two categories: (a) Low Birth Weight/LBW (<2500 g) and normal birth weight (>2500 g). Whereas for caregiver data about who is taking care for the children daily was included mother, grandmother, baby sitter, and other family members.

The measurement of nutritional status (HAZ) was carried out by direct anthropometric measurement through lengthboard and microtoise. Children with Z-score value < -2 SD were categorized as stunted and children with Z-score value ≥ -2 SD were categorized as non-stunted. Nutrient and phytate intake were measured by 2 x 24 hours food recall method on weekdays and weekends. Then, the intake data was processed by Indonesian Food Table Composition 2017 database and Nutrisurvey 2007 application. The result of intake data then compared with

the 2018 Indonesian Nutritional Adequacy Rate (*Angka Kecukupan Gizi/AKG)*. Then, level of macronutrients adequacy (energy, protein, fat and carbohydrates) divided into five categories: (a) severe deficit (<70% RDA), (b) moderate deficit (70-79 % RDA), mild deficit (80-89% RDA), (d) normal (90-119% RDA) and (e) excessive (>120 % RDA) (WNPG, 2004). Whereas for data of zinc adequacy was divided into two categories based on Gibson (2005): (a) insufficient (<77 % RDA) and (b) sufficient (≥ 77 % RDA).

Phytate intake then analyzed through phytate database taken from FAO/IZiNCG (2018) whereas the Phytate to Zinc Molar Ratio (PA:Zn Molar Ratio) is calculated by following formula from FAO/IZiNCG (2018) as follow:

$$PA{:}\,Zn\ molar\ ratio = \frac{\frac{Phytate\ (mg)}{660\ (MW)}}{\frac{Zn\ (mg)}{65.38\ (AtW)}}$$

AtW: Atomic Weight
MW: Molar Weight

Next, the PA:Zn molar ratio value was then classified based on WHO/FAO (2004) into low (>15), medium (5-15) and high (<5) category.

Variable data then analyzed by SPSS 25 followed by Univariate analysis that carry out afterwards to observe the frequency distribution of each research variable, while data normality test will be done by Kolmogorov-Smirnov. For observing differences in nutrient intake, phytate and PA:Zn molar ratio in stunted and non-stunted children groups, a differential test analyzed by Independent T-Test if data research was normally distributed or by Mann Whitney Test if the data research was not normally distributed. Additionally, this research has received an approval from Health Research Ethic Committee, Faculty of Nursing, Airlangga University under approval number No:2952/KEPK.

RESULTS AND DISCUSSIONS

The Characteristic of Children

Total respondents of this research were 126 children, categorized into two groups: 61 stunted children and 65 non-stunted children. The characteristic of children is displayed in Table 1.

Table 1. Children characteristics in Malang City

Variable	Nutritional Status	
	Stunted n (%)	Non- Stunted n (%)
Age		
6-11 month	3 (4.92)	5 (7.69)
12-36 month	34 (55.74)	27 (41.54)
37-59 month	24 (39.34)	33 (50.77)
Gender		
Male	29 (47.54)	36 (55.38)
Female	32 (52.46)	29 (44.62)
Birth Weight		
Low Birth Weight	9 (14.75)	9 (13.85)
Normal	52 (85.25)	56 (86.15)
Exclusive Breastfeeding		
Yes	52 (85.25)	44 (67.69)
No	9 (14.75)	21 (32.31)
Caregiver		
Mother	55 (90.16)	51 (78.46)
Grandmother	4 (6.56)	10 (15.38)
Baby Sitter	1 (1.64)	1 (1.54)
Other Family Member	1 (1.64)	3 (4.62)

According to distribution of the respondents' characteristics, more than a half of stunted children (55.74 %) at aged 12-36 months, while most of non-stunted children (50.70%) at aged 37-59 months. Mostly of stunted children were female (52.46%) while non-stunted children were dominated by male children (55.38%). In this study, both stunted and non-stunted children were had normal birth weight by percentages of 85.25 % and 86.5 %.

For exclusive breastfeeding variable, 14.75 % of stunted children did not receive exclusive breastfeeding. On the contrary, non-stunted children who did not receive exclusive breastfeeding were twice as high as stunted children (32.31 %). Most children in both children groups are raised directly by their mothers.

Nutrients Intake

Food is one of many primary factors that able to determine children nutritional status. Children who tend to consume food that does not comply with food recommendations have possibility to increase the risk of malnutrition. In this study, the type of nutrients being analyzed were energy, protein, fat, carbohydrates and zinc.

The distribution of nutritional adequacy from stunted and non-stunted children is presented in Table 2. Almost half of stunted children had severely deficit energy adequacy (44.26%). On the other hand, more than 40% of non-stunted children had sufficient energy intake. For protein adequacy, more than half of stunted children (62.3%) and more than three quarters of non-stunted children (86.15 %) had excessive protein intake because majority of children respondents consumed formula milk as their daily source of protein. However, there are 18.03 % of stunted children experiencing a protein deficit.

The fat adequacy in stunted children fell into poor category because more than half of children have deficit intake (<90 % RDA). On the other hand, 36.92 % of non-stunted children consume sufficient fat and 16.92% have excessive fat intake. Meanwhile, in carbohydrate adequacy for both stunted and non-stunted children, most children experienced a severely deficit intake (62.29 % and 40 %).

In addition, this research also analyzed the micronutrient adequacy of zinc. In this study, more than half of stunted children (63.93%) and non-stunted children (64.62 %) had adequate zinc intake. Sufficient amount of zinc consumption able to promote children's growth since its role in cell and tissue growth, cell replication, bone formation, and regulation of protein synthesis (Gropper et al., 2009).

Table 2. Distribution of nutrition adequacy among stunted and non-stunted children

Nutrition Adequacy	Nutritional Status				p-value
	Stunted		Non-Stunted		
	n	(%)	n	(%)	
Energy Intake					
Severely Deficit	27	44.26	14	21.54	
Moderately Deficit	8	13.11	7	10.77	
Mildly Deficit	6	9.84	12	18.46	0.018[a]*
Normal	14	22.95	27	44.26	
Excessive	6	9.84	5	7.69	
Protein Intake					
Severely Deficit	3	4.92	0	0	
Moderately Deficit	6	9.83	1	1.54	
Mildly Deficit	2	3.28	1	1.54	0.001[a]*
Normal	12	19.67	7	10.77	
Excessive	38	62.3	56	86.15	
Fat Intake					
Severely Deficit	21	34.43	11	16.92	
Moderately Deficit	6	9.84	13	20	
Mildly Deficit	5	8.2	6	9.23	0.323[b]
Normal	16	26.23	24	36.92	
Excessive	13	21.31	11	16.92	
Carbohydrate Intake					
Severely Deficit	38	62.29	26	40	
Moderately Deficit	6	9.84	14	21.54	
Mildly Deficit	5	8.2	9	13.85	0.093[b]
Normal	10	16.39	13	20	
Excessive	2	3.28	3	4.61	
Zinc Intake					
Insufficient	22	36.07	23	35.38	0.937[b]
Sufficient	39	63.93	42	64.62	

[a]*Mann-Whitney Test, significant if p <0.05
[b] Independent T-Test, significant if p <0.05

The study showed there is a significant difference between energy and protein adequacy in stunted and non-stunted children ($p < 0.05$). This finding is similar to research by Damayanti, et al (2016) which showed there are significant differences in energy and protein adequacy in stunted and non-stunted children. In addition, other researches also reported there are statistically different between the energy and protein intake of stunted and non-stunted children. Children who consume low energy and protein will be at risk of being stunted 6 times and 4 times higher compared to children with adequate energy and protein intake (Fikawati et al., 2021).

In this research, stunted children had deficit of fat and carbohydrate intake that lead into energy deficiency. This condition caused by imbalance of feeding practice especially in energy intake. Based on recall data, stunted children in Malang City consume formula milk in high quantities and frequency. Therefore, their main food intake becomes inadequate. In addition, children also consume a lot of snacks with low nutritional content that make energy deficiency (unpublished data).

Protein is one of important macronutrients needed by children on their growth period. Protein functions as a builder for the body structures such as bones, muscles, and tissues. A deficiency in protein can decreasing protein synthesis and degradation of muscle protein resulted in linear growth failure of children. (Tessema et al., 2018) showed there was a positive relationship between protein intake and linear growth in children. Consumption high quality protein has a significant impact on gene expression, in particular to IGF-1 which has an important role in growth.

In this study, almost all children had adequate protein intake. However, more than half stunted children had deficit carbohydrate intake. As a result, insufficient of carbohydrate causing gluconeogenesis pathways, the process to form energy form non-carbohydrate sources. This resulted in protein cannot be used to growth process in children.

Whereas the adequacy of fat, carbohydrates and zinc showed no significant difference between stunted and non-stunted children. The present study also reported that there was no significant difference between zinc intake in stunted and non-stunted children (Van Stuijvenberg et al., 2015). Another study by Fikawati et al. (2021) also showed that there was no significant difference between zinc intake in stunted and non-stunted children. In that study, more than half of stunted and non-stunted children had adequate zinc intake (52.8% and 68.2%). This data is relevance with our research where more than half of stunted and non-stunted children had sufficient intake of zinc.

Based on the result of this research, the macronutrient intake, especially energy and protein can affect children nutritional status. However, as for zinc, it is not a risk factor for stunted in children because this study showed most of children's zinc intake was good. An inadequate energy and protein intake can increase global DNA methylation level significantly, where this condition occurs when children had stunted status. Meanwhile, lower intake of zinc had higher but no statistically significant in global DNA methylation level ($p = 0.043$) (Iqbal et al., 2019).

Phytate Intake

Phytate is a storage molecule form of phosphate found in many types of cereals and plant foods. Since phytic acid cannot be absorbed in small intestines due to inability to degrade in human body, as a result, it will bind several minerals such as zinc, iron, magnesium, calcium, potassium, manganese and copper. These resulted in deficiency of several micronutrients in human (Brouns, 2021).

The phytate intake from several developing countries in Asia tends to be higher than western countries. (Ma et al., 2007) reported the phytate intake in Chinese population was 1186 mg, higher than the average of American population (750 mg). However, in Indonesia, the average phytate intake for children in Pontianak city was 113.92 mg for stunted children and 100.88 mg for non-stunted children (Sari et al., 2016).

Table 3. Difference of phytate intake between stunted and non-stunted children

Phytate Intake (mg)	Nutritional Status		p-value
	Stunted	Non-Stunted	
Median (Q1, Q3)	114.46 (11.81; 1118.6)	168.17 (31.03; 1088.74)	0.016*

*Mann-Whitney Test, significant if $p < 0.05$

The median of phytate intake for stunted and non-stunted children in this study is presented in Table 3. Median phytate intake for stunted group is 114.46 mg, significantly lower than median phytate intake in non-stunted group (168.17 mg).

The previous study from Iqbal et al. (2019) in Bangladesh showed there is a significant difference in phytate intake between stunted and non-stunted children (p = 0.004). This study also has the result as same as our research. It suggests that condition may due to the absence of relationship between phytate intake and increase in global DNA methylation which occurs in stunted children.

In infants and children, the effect of phytate intake on zinc absorption was very low when zinc intake is controlled. An increase in phytate intake by 500 mg/day can reduce zinc absorption by 0.04 mg/day. This condition caused by gastric pH is higher in children than in adults (Miller et al., 2015).

Phytate-to-Zinc Molar Ratio

Zinc deficiency can be caused by inadequate intake and low of zinc absorption. The bioavailability of zinc is determined by three factors: (a) the individual's zinc status, (b) the amount of zinc intake, and (c) the availability of zinc that able to be absorbed from food (Gibson, 2020). Type of nutrient that role as enhancer for the zinc bioavailability is protein, because of amino acid from animal protein will retain zinc in body fluids (Roohani et al., 2013) Whereas, the substance that can inhibit the bioavailability are phytic acid, oxalate, and polyphenols (Gropper et al., 2009).

Animal protein like red meat, poultry, fish, egg, and seafood have a high content of zinc. Meanwhile, phytate is mostly found in plant foods such as cereals, legumes, roots, and nuts. The food sources of zinc and phytate that are consumed by children are explained in Table 4. Around 65.57% of stunted children had chicken as the primary animal protein source, with zinc content of 0.6 mg/100 g. Meanwhile, the most zinc source consumed by non-stunted children is egg (69.23%) which has 1 mg/100 g of zinc. Besides that, both groups of children had the same pattern of phytate intake, where all of the children consumed rice as their staple food. Cooked rice has phytate content of 39.38 mg/100 g. Moreover, tempeh is the second phytate source that is consumed by stunted and non-stunted children (32.79% and 46.15%).

Table 4. The top three food sources of zinc and phytate consumed by respondents

Food Source	Amount in Food (mg/100 g)	Respondents Who Consume the Food Source	
		Stunted n (%)	Non-Stunted n (%)
Zinc Source			
Egg	1[a]	37 (60.66)	45 (69.23)
Chicken	0.6[a]	40 (65.57)	36 (55.38)
Meatball	3.8[b]	33 (54.1)	26 (40)
Phytate Source			
Rice	39.38[c]	61 (100)	65 (100)
Tempeh	62.09[c]	20 (32.79)	30 (46.15)
Potato	40.48[c]	18 (29.51)	24 (36.92)

References: a. Indonesia Food Table Composition (2017)
b. Nutrisurvey Application 2007
c. FAO/IZiNCG. (2018)

In this study, children in Malang City tend to have high protein but low phytate consumption. More than half children consumed animal protein like egg and chicken as their protein sources. On the contrary, only 46.15% children that consumed phytate like tempeh as their protein sources. This result had similarity with the literature study by Idawati et al. (2023), showed that dietary pattern on Indonesia children tend to consume animal sources like egg and chicken nugget more often than plant source like tempeh, tofu, and nuts.

Phytate-to-Zinc molar ratio (PA:Zn Molar Ratio) is the indicator to determine the bioavailability of zinc. Distribution of PA:Zn molar ratio values is illustrate in Figure 1. It showed that more than half of stunted (62 %) and non-stunted group (52%) had a high category of PA:Zn molar ratio values (<5). Our suggest because the food sources of phytate consumed by children were reduce through many production processes. Rice for instance, as the staple food has gone through a grinding and washing process. Moreover, tofu and tempeh as the main source of vegetable protein also through a fermentation process (Brouns, 2021; Gupta et al., 2015).

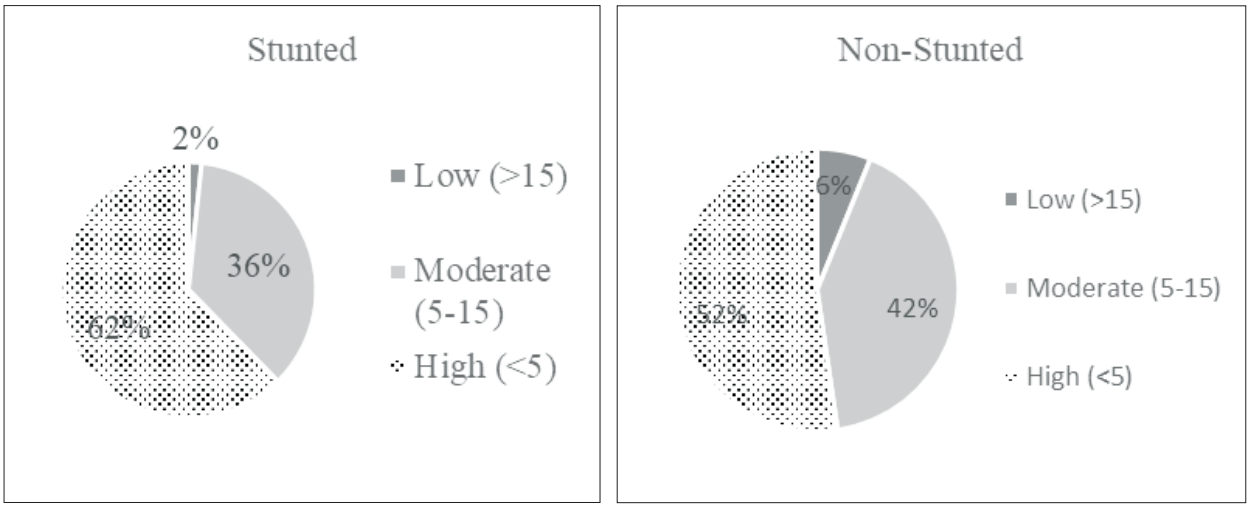


Figure 1. Distribution percentage of PA:Zn molar ratio category between stunted and non-stunted children

Table 5. Difference of PA:Zn molar ratio value

PA:Zn Molar Ratio	Nutritional Status		p-value
	Stunted	Non-Stunted	
Mean ± SD	5.32 ± 4.29	6.05 ± 4.67	0.158[a]

a Independent t-test, significant if $p < 0.05$

The average of PA:Zn molar ratio from the stunted children group was 5.32 ± 4.29 higher but no statistically different than non-stunted children group (6.05 ± 4.67) as explained in Table 5. At the contrast from research of Galetti et al. (2015) which showed the stunted children that caused by zinc deficiency had low PA:Zn Molar Ratio values (22.2 ± 4.8). In this study, in addition, the zinc intake from both groups had good category. However, it still unexplained whether stunted and non-stunted children have zinc deficiency because there is no biochemical markers data available.

The average of PA:Zn molar ratio value for both groups is considered into moderate category. According to the WHO & FAO (2004), if the PA:Zn molar ratio value is ranging from 5 – 15 % with diet type is a mixed diet, then percentage estimation for absorbed zinc will be 30 %. Thus, the zinc absorbed in the stunted group was 1.15 ± 0.56 mg and non-stunted group was 1.2 ± 0.62 mg.

CONCLUSION

In conclusion, energy, protein, and phytate intake are significantly different between stunted and non-stunted groups in Malang city, East Java. Most of stunted and non-stunted children have high PA:Zn molar ratio values (<5) because both groups consume sufficient amounts of zinc from chicken, egg, and meatballs. Further research can be performed to observe the influence of PA:Zn molar ratio on stunted children by analyzing biochemical markers to detect the presence of zinc deficiency. This study can be a consideration for policymakers regarding reducing stunting and infant and young child feeding, especially the adequacy nutritient intake in stunting risk population.

ACKNOWLEDGEMENT

We would like to gives sincere gratitude for the Educational Fund Management Institute (LPDP) for the given scholarship to completing this research as a part of thesis research.

REFERENCES

Ariati, L. I. P. (2019). Faktor-Faktor Resiko Penyebab Terjadinya Stunting pada Balita Usia 23-59 Bulan. *OKSITOSIN : Jurnal Ilmiah Kebidanan*, *6*(1), 28–37. https://doi.org/10.35316/oksitosin.v6i1.341

Brouns, F. (2021). Phytic Acid and Whole Grains for Health Controversy. *Nutrients*, *14*(1), 25. https://doi.org/10.3390/nu14010025

Damayanti, R. A., Muniroh, L., & Farapti, F. (2017). Perbedaan Tingkat Kecukupan Zat Gizi dan Riwayat Pemberian ASI Eksklusif pada Balita Stunting dan Non Stunting. *Media Gizi*

Indonesia, *11*(1), 61. https://doi.org/10.20473/mgi.v11i1.61-69

Daracantika, A. (2021). Systematic Literature Review: Pengaruh Negatif Stunting terhadap Perkembangan Kognitif Anak. *Bikfokes*, *1*(2).

Fatimah, N. S. H., & Wirjatmadi, B. (2018). Tingkat Kecukupan Vitamin A, Seng, dan Zat Besi serta Frekuensi Infeksi pada Balita Stunting dan Non Stunting. *Media Gizi Indonesia*, *13*(2), 168. https://doi.org/10.20473/mgi.v13i2.168-175

Fikawati, S., Syafiq, A., Ririyanti, R. K., & Gemily, S. C. (2021). Energy and protein intakes are associated with stunting among preschool children in Central Jakarta, Indonesia: A case-control study. *Malaysian Journal of Nutrition*, *27*(1), 081–091. https://doi.org/10.31246/mjn-2020-0074

Galetti, V., Mitchikpè, C. E. S., Kujinga, P., Tossou, F., Hounhouigan, D. J., Zimmermann, M. B., & Moretti, D. (2016). Rural Beninese Children Are at Risk of Zinc Deficiency According to Stunting Prevalence and Plasma Zinc Concentration but Not Dietary Zinc Intakes. *The Journal of Nutrition*, *146*(1), 114–123. https://doi.org/10.3945/jn.115.216606

Gibson, R. S. (2020). *Principles of Nutritional Assessment 3rd Edition: Zinc*. https://nutritionalassessment.org/zinc/

Gibson, R. S., Raboy, V., & King, J. C. (2018). Implications of Phytate in Plant-Based Foods for Iron and Zinc Bioavailability, Setting Dietary Requirements, and Formulating Programs and Policies. *Nutrition Reviews*, *76*(11), 793–804. https://doi.org/10.1093/nutrit/nuy028

Gropper, S. S., Smith, J. L., & Groff, J. L. (2009). *Advanced Nutrition and Human Metabolism* (5th ed.). Wadsworth, Cengage Learning.

Gupta, R. K., Gangoliya, S. S., & Singh, N. K. (2015). Reduction of Phytic acid and Enhancement of Bioavailable Micronutrients in Food Grains. *Journal of Food Science and Technology*, *52*(2), 676–684. https://doi.org/10.1007/s13197-013-0978-y

Idawati, I., Rosmawardiani, R., Ummi Salamah, Nasriah, N., & Dian Rahayu. (2023). Pemberian Makan Bayi dan Anak (PMBA) dengan Kejadian Stunting. *SEHATMAS: Jurnal Ilmiah Kesehatan Masyarakat*, *2*(3), 651–660. https://doi.org/10.55123/sehatmas.v2i3.2054

Iqbal, M. S., Rahman, S., Haque, M. A., Bhuyan, M. J., Faruque, A. S. G., & Ahmed, T. (2019). Lower intakes of protein, carbohydrate, and energy are associated with increased global DNA methylation in 2- to 3-year-old urban slum children in Bangladesh. *Maternal & Child Nutrition*, *15*(3), e12815. https://doi.org/10.1111/mcn.12815

Ma, G., Li, Y., Jin, Y., Zhai, F., Kok, F. J., & Yang, X. (2007). Phytate Intake and Molar Ratios of Phytate to Zinc, Iron and Calcium in the Diets of People in China. *European Journal of Clinical Nutrition*, *61*(3), 368–374. https://doi.org/10.1038/sj.ejcn.1602513

Miller, L. V., Hambidge, K. M., & Krebs, N. F. (2015). Zinc Absorption Is Not Related to Dietary Phytate Intake in Infants and Young Children Based on Modeling Combined Data from Multiple Studies. *The Journal of Nutrition*, *145*(8), 1763–1769. https://doi.org/10.3945/jn.115.213074

Roohani, N., Hurrell, R., Kelishadi, R., & Schulin, R. (2013). Zinc and Its Importance for Human Health: An integrative review. *Journal of Research in Medical Sciences*.

Sari, E. M., Juffrie, M., Nurani, N., & Sitaresmi, M. N. (2016). Asupan Protein, Kalsium dan Fosfor pada Anak Stunting dan Tidak Stunting Usia 24-59 Bulan. *Jurnal Gizi Klinik Indonesia*, *12*(4), 152. https://doi.org/10.22146/ijcn.23111

Tessema, M., Gunaratna, N., Brouwer, I., Donato, K., Cohen, J., McConnell, M., Belachew, T., Belayneh, D., & De Groote, H. (2018). Associations among High-Quality Protein and Energy Intake, Serum Transthyretin, Serum Amino Acids and Linear Growth of Children in Ethiopia. *Nutrients*, *10*(11), 1776. https://doi.org/10.3390/nu10111776

WNPG. (2004). *Ketahanan Pangan dan Gizi di Era Otonomi Daerah dan Globalisasi* (Widyakarya Pangan Dan Gizi VIII).

World Health Organization. (2006). *WHO Child Growth Standards*. WHO.

Yadika, A. D. N., Berawi, K. N., & Nasution, S. H. (2019). Pengaruh Stunting terhadap Perkembangan Kognitif dan Prestasi Belajar. *Medical Journal of Lampung University*, *8*(273–282).

Young, G. P., Mortimer, E. K., Gopalsamy, G. L., Alpers, D. H., Binder, H. J., Manary, M. J., Ramakrishna, B. S., Brown, I. L., & Brewer, T. G. (2014). Zinc Deficiency in Children with Environmental Enteropathy—Development of New Strategies: Report from An Expert Workshop. *The American Journal of Clinical Nutrition*, *100*(4), 1198–1207. https://doi.org/10.3945/ajcn.113.075036

https://doi.org/10.20473/mgi.v19i3.234–242

POTENTIAL OF NATURAL SWEETENER IN INDONESIA: A SYSTEMATIC REVIEW

Muhammad Agung Islamy
Department of Food Science and Technology, IPB University, Bogor, Indonesia 16680
Email: muhammadagungislamy@apps.ipb.ac.id

ABSTRACT

Natural sweetener is a food alternative to sugar obtained from nature through organic chemical processes that produce flavors and characteristics similar to sugar and synthetic sweeteners. This paper is made in the form of a systematic review to collect and identify data related to the potential of natural sweeteners in Indonesia. The writing was designed using PRISMA with PICO with outcomes of total solids, reducing sugar, Dextrose equivalent (DE), glycemic index (GI) as data selection methods. The data obtained showed 15 potential plants from 13 different articles or journals. After being classified, the majority of food ingredients are natural sweeteners of the saccharide type that have the potential to produce liquid sucrose, fructose syrup and glucose products. These product opportunities were selected based on plant commodities with the highest productivity such as cassava, corn, coconut, sugarcane, sweet potato, sago, taro, and sorghum from several regions such as West Java, Central Java, East Java, Riau, North Sumatra, West Sumatra, Lampung, South Sumatra, Central Kalimantan, West Nusa Tenggara, South Sulawesi, North Sulawesi, Gorontalo, Maluku, and Papua. The potential of natural sweeteners can be used directly in food products and can be utilized as raw materials in various food products such as ice cream, candy, syrup, jam, and canned beverages.

Keywords*: natural sweeteners, saccharide, glucose syrup, potential commodities, food product*

INTRODUCTION

Natural sweetener is currently one of the food ingredients that are starting to be widely used by some people. Natural and artificial or synthetic sweeteners play a large role in human energy needs and are very important for various food industries (Arshad et al., 2022) However, many sweeteners added by food manufacturers to food products are not ideal for all food industry applications. Among sweeteners, there are also compounds that have a sweet taste and do not contain (Priya et al., 2011).

Looking at the food issues that have developed in the world today, such as the emergence of nutritional transition patterns in the Southeast Asian region accompanied by a shift in the purchasing power of food products towards the need for sweeteners (Kusuma et al., 2022). This condition has brought many major changes of various food and nutrition policies for each country and is able to increase health awareness for each population (Drewnowski et al., 2019).

In addition, from another perspective or point of view The increase in economic development and urbanization has meant that traditional diets in developing Southeast Asian countries have shifted to a more varied diet that contains more animal protein, vegetables and fruit (Baker & Friel, 2014). Although natural sweeteners especially high potency intense sweetener are safe in use, they do not raise blood glucose or insulin significant which has an impact on reducing the potential for diabetes, and completely non-toxic and cause no distress or any other adverse side effects but some toxic effects of sweeteners (Jain et al., 2015).

Indonesia is the most populous country in Southeast Asia. The problem that arises due to these conditions is the high demand for food and beverages. Indirectly, sweeteners also experience high demand, both in the food industry and consumed by the public directly (Kasiamdari et al., 2019). This statement is supported by BPS data 2021 which notes that the amount of national sugar production of Indonesia and demand in 2020 experienced a large deficit, reaching 500,000 tons. This phenomenon demands a big solution to explore the potential of natural sweetener based on natural resources native to Indonesia.

 Received 26-12-2023, Accepted 22-05-2024, Published online 30-09-2024.

METHODS

a. Protocol registration
   The research protocol has been registered with the Open Science Forum (OSF) registry.
b. Design.
   Review in this systematic review was carried out in accordance with the Cochrane Handbook for Systematic Reviews of Interventions and then reported using the Preferred Reporting Items model in the form of PRISMA (Page et al., 2021).
c. Source of data search
   Data searches referring to Tawfik et al., (2019) was conducted electronically on several search engines such as, Pubmed, researchgate, and google scholar supplemented by manual reference searches of selected studies and reviews.
d. Data selection
   The data selection process refers to Cumpston et al., (2021) using PICO population = general population, intervention = saccharide sweeteners (sucrose, fructose, and glucose, comparator = protein and alcohol derived sweeteners, outcome = total solids, reducing sugar, Dextrose equivalent (DE), glycemic index (GI).
e. Data extraction
   Researcher will independently review and extract relevant data from each included journal. Extracted data includes study characteristics (e.g. location, type of ingredients, processing process). In addition, sample size, study design (randomized and non-randomized), duration of study time, and valid outcome data.
f. Result (outcome)
   The desired result is the selection of natural sweetener or natural sweetener that has the potential to be developed for each region in Indonesia based on the producing region of the raw material.

RESULTS AND DISCUSSIONS

The search for sugars or sweeteners from natural sources has led to the discovery of several substances that have a very sweet taste or are capable of altering the flavor (Jacob et al., 2016). About more than 150 plant materials in the world have been found to have a sweet taste because they contain a large number of sugar groups, polyols or other constituents that give a sweet taste response (Priya et al., 2011). Figure 1 shows the literature search and selection process of systematic review data.

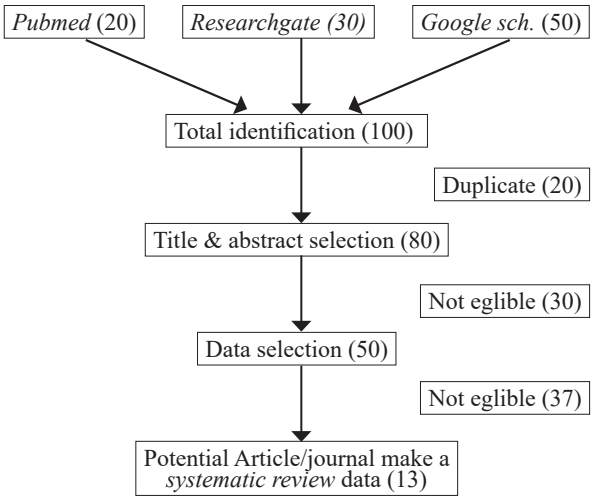


Figure 1. Selection data *systematic review.*

Of the 100 articles identified, 80 were selected based on title and abstract. 50 research literatures article/journal reviewed in full, 50 were excluded based on full article review.

The final results of articles or journals that meet the criteria focus keyword natural sweetener on research with natural sweetener products as the main topic. However, in the selection process, 20 articles or journals were found in the same search engine or referred to as duplication, 30 articles or journals that did not match the desired outcome, and 37 research articles or journals were in accordance with the outcome, but there were many misinformation that caused less support for the data generated. For this reason, in final stage, only 13 articles/journals were obtained to be used as systematic review data in this paper.

Arshad et al., (2022) explained that currently there have been many discoveries that focus on efforts to replace refined sugar with natural sweeteners from various potential resources that can be used in food applications, both in liquid forms. Natural sweeteners generally contain various bioactive compounds, and that can improve product characteristics. The antioxidant potential of sugar is also influenced by the level purification (Chéron et al., 2018)

Table 1. Variety of Indonesia's potential natural sweetener sources

Plants Name	Part Utilized	Sweetener compound	Analysis (*outcome*)				Literature refrence
			Total solid	Reducing sugar	Dextrose equivalent	Glycemic Index	
Coconut (*Cocos nucifera*)	Nira (Bunch of flowers)	Sucrose	73.5%	4.6%	18%	67	(Saraiva et al., 2023)
Sorghum (*Sorghum* spp.)	Seeds	Sucrose	80.3%	19.1%	57%	41	(Gillian Eggleston et al., 2022)
Sago (*Metroxylon sago*)	Stem (Starch)	Glucose	65%	50.4%	28.6%	40	(Budiyanto et al., 2019)
Cassava (*Manihot esculenta*)	Tuber (Flour & Starch)	Fructose & sorbitol	68%	32%	56%	46	(Permanasari & Yulistiani, 2017)
Sweet Potato (*Ipomoea batatas*)	Tuber (Pati)	Fructose & glucose	41%	38.1%	20%	63	(Mahmudatussa'adah, 2014)
Stevia (*Stevia rebaudiana*)	Leaf	Steviol	27.8%	5.8%	20%	0	(Marlina & Widiastuti, 2019)
Sugarcane (*Saccharum*)	Stem	Sucrose	65%	1.5%	15%	43	(G. Eggleston & Monge, 2005)
Aren (*Arenga pinata*)	Nira (Bunch of flowers)	Sucrose, dan fructose	80%	4.1%	15%	35	(Barlina et al., 2020)
Kersen (*Muntingia*)	Flowers	Glucose	37%	32.1%	4.6%	28	(Anjani et al., 2023)
Kawista (*Limonia acidissima*)	Fruit	Glucose	40%	35.2%	3.9%	33	(Anjani et al., 2023)
Trembesi (*Samanea saman*)	Fruit	Glucose	65%	34.4%	6.8%	29	(Anjani et al., 2023)
Lumbah (*Curculingo latifolia*)	Flower	Neoculin	45%	37%	8.1%	20	(Gusmalawati & Mayasari, 2017)
Corn (*Zea mays*)	Fruit (Starch)	Fructose	55%	78.4%	15%	55	(Mardawati et al., 2019)
Taro (*Colocasia esculenta*)	Tuber (Starch)	Glucose	4.9%	4.7%	96%	58	(Putra et al., 2015)
Gembili (*Dioscorea esculenta*)	Tuber (Starch)	Glucose	28.5%	26.6%	88.9%	75	(Hidayah et al., 2021)

Alternative sweeteners or sugars are sugar substitutes that resemble the characteristics of sugar in terms of flavor with less energy or caloric value (Drewnowski et al., 2019). Some sugar substitutes are natural and some are synthetic. Jain et al. (2015) explained that there is a division of natural sweeteners based on the constituent ingredients, components and structure of the sweetener compound. Based on Table 1, it can be classified sweetener compound as a type of carbohydrate sweetener and alcohol and polyol sweetener is the most dominant type of natural sweetener to be a high potency essence sweetener in Indonesia.

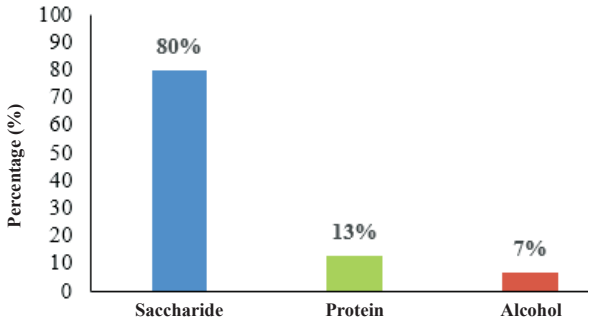


Figure 2. Classification of sweetener types

Based on Figure 1, it shows that most of the potential of natural sweeteners in Indonesia comes from the saccharide group which is part

of carbohydrates. Jain et al. (2015) explained that saccharide sweeteners are one of the sweeteners that have nutrients to supply calories in the form of carbohydrates, such as sucrose, fructose, and glucose (Figure 2). Sucrose was anciently found from the extraction of sugar cane in India since 6000 (Priya et al., 2011). Sucrose, commonly known as sugar, but more precisely -D-glucopyranosyl - D-fructofuranose side has been reported to have the highest production in the world and is sourced from a single, natural, organic chemical. Sugar is widely used when its association refers to sucrose (Cooper, 2006).

Over time, the utilization of sucrose from sugar cane began to shift due to its limited availability, to the potential for various diseases due to exceeding sugar consumption limits (Stull, 2016). Based on the analysis of two trials conducted by Wiebe et al. (2011) found that the use of sweeteners in the diet resulted in lower energy intake compared to carbohydrate groups such as sucrose, which was about 500 kcal/day lower for or 250 kcal/day. This is closely related to controlling obesity and diabetes.

Fructose can exist as a monosaccharide or as part of sucrose (Fattore et al., 2021). Fructose, or fruit sugar, is a monosaccharide commonly found in various plants and is one of the important blood sugars along with glucose and galactose, which can be directly absorbed into the bloodstream during digestion (Drewnowski et al., 2019). Unfortunately, not everyone has the same ability to absorb fructose. This condition is known as fructose malabsorption. This occurs because the small intestine is unable to absorb fructose, so it collects in the gastrointestinal tract. Some symptoms that are often complained of include indigestion, such as abdominal pain, diarrhea, and vomiting (Gillespie et al., 2023).

Rizkalla (2010) reported that fructose in food is less satiating and more lipogenic than other saccharides. However, not enough relevant data have been presented to explain the direct relationship between dietary fructose intake and health risk markers such as obesity and insulin resistance in humans. This concern is supported by Dornas et al. (2015) who showed that fructose may be a pre-disposing cause in the development of insulin resistance in association with the induction of hypertriglyceridemia. In addition to sucrose and fructose, the most easily encountered type of saccharide is glucose. Glucose is one of the carbohydrates known as simple sugar monosaccharides.

Glucose is taken from the Greek “glykys” which means sweet (Beeley, 2011). Glucose is found in many foods with high levels such as fruits, and honey which is the main free sugar circulating in human blood. Glucose is an important source of energy in cell function, and influences metabolic processes (Zhang et al., 2009). Glucose in starch molecules is the main energy reserve of plants consisting of thousands of linear glucose units. Another major compound composed of glucose is cellulose, which is also linear. Dextrose is a molecule of D-glucose (Ridhani & Aini, 2021).

Figure 3. shows the various characteristics of sweeteners from various natural resources in Indonesia. Each region has its own superior commodity according to the geographical location of the region. Characteristics that are commonly used to determine the quality of sweeteners include total solids analysis, reducing sugar, and dextrose equivalent. These quality parameters have been regulated in national standards for various sweetener products such as liquid sucrose sugar (SNI 8779: 2019), fructose syrup (SNI 2985: 2021), and glucose syrup (SNI 2978: 2021). Meanwhile, the glycemic index is a health parameter for those who consume these sweeteners.

In terms of total solids, Aren and sorghum had the highest total solids of 80%, while taro had the lowest total solids of 4.9%. (Weliana, 2019) explained, in general, total solids in fresh ingredients are lower than in products. It is suspected that the increase in total soluble solids

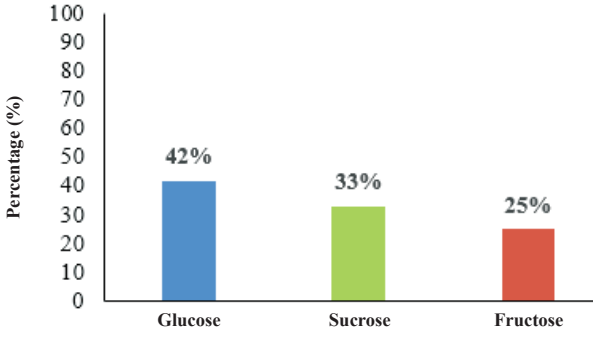


Figure 3. Classification of saccharide sweeten er types.

Table 2. SNI quality requirements for various sweetener products

Parameter	Product Standard		
	Sucrose liquid	Fructose syrup	Glucose syrup
Total Solid (%)	Min. 70	Min. 70	Min. 65
Reducing sugar (%)	-	Min. 55	Min. 50
Dextrose Equivalent (%)	Min. 30	Min. 30	Min. 20

of the product is due to the processing process and other additives that are able to bind a number of soluble particles in the mixture. Kusuma et al. (2022) reporting that total dissolved solids increase because free water is bound by particle material bound by stabilizing materials, so that the total soluble solids increase so as to reduce the sediment formed.

For the value of reducing sugar, Maize from corn obtained the highest value, which amounted to 78.4%. While the lowest value was obtained by Coconut with a value of 4.6%. Reducing sugars are a class of sugars (carbohydrates) that can reduce electron-receiving compounds (Wilberta et al., 2021). The ends of reducing sugars usually contain aldehyde or ketone groups. All monosaccharides such as glucose, fructose, and galactose are included as reducing sugars. The reducing sugar produced is closely related to enzyme activity (Istia'nah et al., 2020).

The dextrose equivalent value of taro was the highest at 96%, in contrast to kawista which had the lowest DE value at 3.9%. Dextrose equivalent (DE) is a quantity that expresses the total reducing value of starch or starch modified products in units of percent. Commercially, the use of high-carbohydrate materials such as starch as a natural sweetener is influenced by the DE value. Meriatna (2013) reported that the greater the DE indicates the greater the percentage of starch that turns into reducing sugar. In the process of processing glucose syrup in particular, maltodextrin will be formed from glucose syrup where starch has been enzymatically degraded from the glucoside bonds of starch which is characterized by a dextrose equivalent value. (Rayhani et al., 2018). In addition to the parameters that determine the quality of natural sweeteners, another factor that must be considered is the health impact when consumed.

The glycemic index is one of the right indicators to describe the speed of absorption of sugar in the glycogen (Barclay et al., 2021). Generally, foods that have a high GI will quickly raise sugar levels which make the pancreas work hard to produce insulin after eating (Arif et al., 2013). There are several types of plants that have

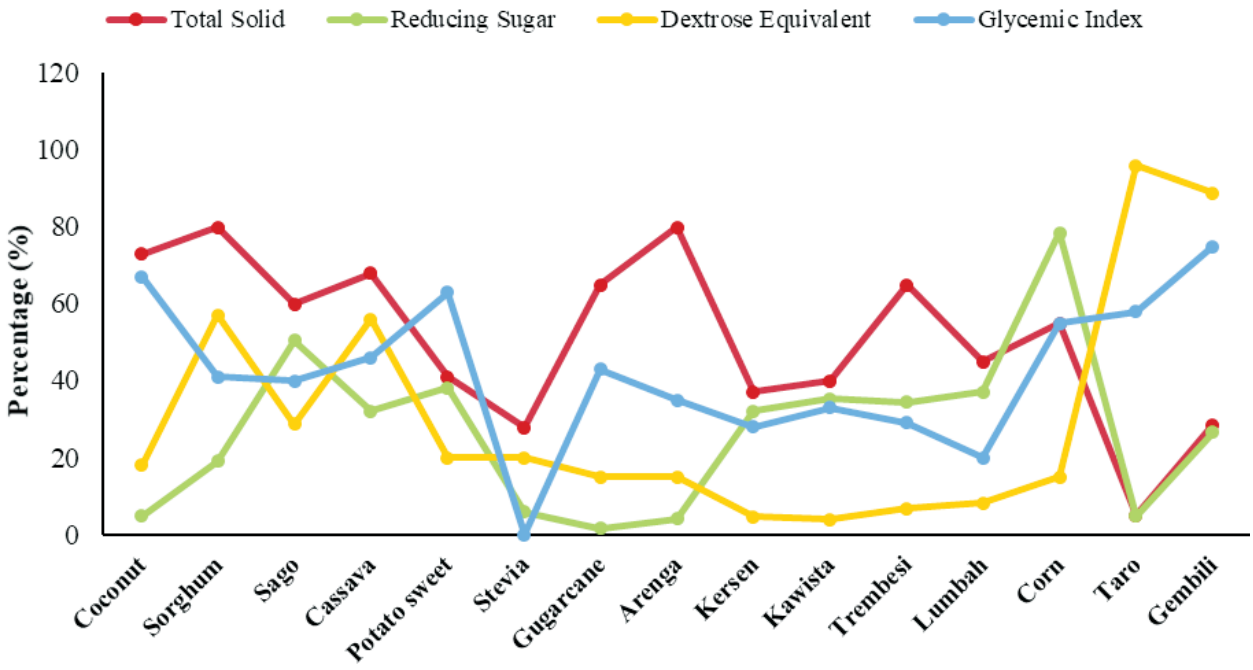


Figure 4. Results Analysis of natural sweetener potential in Indonesia by plant type

https://doi.org/10.20473/mgi.v19i3.234–242

low GI (<55), such as sorghum, sago, cassava, sugar cane, aren palm, kersen, kawista, trembesi, and lumbah.

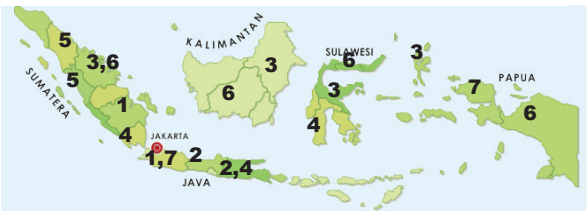
The great potential of natural sweeteners is also inseparable from the availability of its resources in nature. Suroso (2017) reported that the potential for food alternatives to become one of the important aspects of food security is currently very urgent to develop. In addition, food production is generally produced by areas that are food production centers. Meanwhile, food is needed by everyone who lives throughout the country, both production centers and food deficit areas (Hermanto, 2013).

Figure 3 shows the distribution map of the potential of natural sweetener industry in Indonesia based on raw materials. The potential center of natural sweetener raw materials is still in Java, followed by Sumatra and Sulawesi. The Ministry of Agriculture (2022) explained that the distribution of plant commodities cannot be separated from the geographical influence of soil, rainfall and altitude from sea level. Taufik et al. (2021) reported that the potential for food sources and the need for basic staple foods is still an unresolved problem. With the innovation of this natural sweetener development program, it can be handled by the sugar industry in the form of local natural sweeteners sourced from Regional Government reserves.

Table 3. Potential of the largest natural sweetener crops based on the largest amount of production (tons)

Plants Name	Year 2020	Year 2021
Cassava	18.345.810	17.054.648
Corn	12.928.940	13.414.921
Coconut	2.811.900	2.853.300
Sugarcane	2.133.650	2.344.930
Sweet potato	1.424.147	1.511.041
Sago	381.065	365.655
Taro	271.570	260.523
Sorghum	6.114	7.695

Source: Ministry of Agriculture Indonesia (2022)



Remarks
1: Cassava 2: Corn 3: Coconut
4: Sugarcane 5: Sweet potato 6: Sago
7: Taro 8: Sorghum

Figure 5. Potential of natural sweetener plants based on regions in Indonesia

CONCLUSION

Based on the results of the systematic review, 8 leading commodities were obtained, namely cassava, corn, coconut, sugar cane, sweet potato, sago, taro, and sorghum from several regions province such as: West Java, Central Java, East Java, Riau, North Sumatra, West Sumatra, Lampung, South Sumatra, Central Kalimantan, West Nusa Tenggara, South Sulawesi, North Sulawesi, Gorontalo, Maluku, and Papua.

The majority of the potential natural sweeteners are saccharides with liquid sucrose, fructose syrup and glucose products. Although some quality criteria do not meet SNI requirements, the potential to continue to be developed is still very large and can reduce dependence on the consumption of refined sugar and artificial sweeteners. The potential of natural sweeteners can be used directly in food products and can be utilized as raw materials in various food products such as ice cream, candy, syrup, jam, and canned beverages.

REFERENCE

Anjani, G., Kurniawati, D. M., Syauqy, A., Purwanti, R., Afifah, D. N., Meliasari, T. S., & Faizah, N. (2023). Potential of Local Fruits (Kersen (Muntingia calabura), Kawista (Limonia acidissima) and Trembesi (Samanea saman) as Sweetener with Low Glycemic Index and Glycemic Load. *Media Gizi Indonesia*, *18*(1), 82–93. https://doi.org/10.20473/mgi.v18i1.82-93

Arif, A. Bin, Budiyanto, A., & Hoerudin. (2013). Nilai Indeks Glikemik Produk Pangan dan Faktor-Faktor yang Memengaruhinya. *Jurnal Litbang Pertanian*, *32*(3), 91–99.

Arshad, S., Rehman, T., Saif, S., Rajoka, M. S. R., Ranjha, M. M. A. N., Hassoun, A., Cropotova, J., Trif, M., Younas, A., & Aadil,

R. M. (2022). Replacement of refined sugar by natural sweeteners: focus on potential health benefits. *Heliyon*, *8*(9). https://doi.org/10.1016/j.heliyon.2022.e10711

Baker, P., & Friel, S. (2014). Processed foods and the nutrition transition: Evidence from Asia. *Obesity Reviews*, *15*(7), 564–577. https://doi.org/10.1111/obr.12174

Barclay, A. W., Augustin, L. S. A., Brighenti, F., Delport, E., Henry, C. J., Sievenpiper, J. L., Usic, K., Yuexin, Y., Zurbau, A., Wolever, T. M. S., Astrup, A., Bulló, M., Buyken, A., Ceriello, A., Ellis, P. R., Vanginkel, M. A., Kendall, C. W. C., La Vecchia, C., Livesey, G., Brand-Miller, J. C. (2021). Dietary glycaemic index labelling: A global perspective. *Nutrients*, *13*(9), 1–22. https:// doi.org/10.3390/nu13093244

Barlina, R., Pasang, P., & Pradhana, A. Y. (2020). Karakteristik sirup nira aren pada beberapa konsentrasi total padatan terlarut. *Buletin Palma*, *21*(2), 110–116.

Beeley, J. A. (2011). Glucose and sugar. *British Dental Journal*, *211*(10), 446–447. https:// doi.org/10.1038/sj.bdj.2011.970

Budiyanto, A., Arif, A. B., & Richana, N. (2019). Optimization of Liquid Sugar Production Process from Sago (Metroxylon spp.). *IOP Conference Series: Earth and Enviro nmental Science*, *309*(1). https://doi. org/10.1088/1755-1315/309/1/012052

Chéron, J. B., Marchal, A., & Fiorucci, S. (2018). Natural sweeteners. *Encyclopedia of Food Chemistry*, 189–195. https://doi.org/10. 1016/B978-0-08-100596-5.21620-X

Cooper, J. M. (2006). Sucrose. *Optimising Sweet Taste in Foods*, 135–152. https://doi.org/10.1533/9781845691646.2.135

Cumpston, M. S., McKenzie, J. E., Thomas, J., & Brennan, S. E. (2021). Current practice in systematic reviews including the 'PICO for each synthesis' and methods other than meta-analysis: protocol for a cross-sectional study. *F1000Research*, *9*, 1–9. https://doi.org/10.12688/F1000RESEARCH.24469.1

Dornas, W. C., Lima, W. G. De, Pedrosa, M. L., & Silva, M. E. (2015). Health Implications of High-Fructose Intake. *Advance in Nutrition*, *1*, 729–737. https://doi.org/10. 3945/an.114.008144. These

Drewnowski, A., Tappy, L., Forde, C. G., McCrickerd, K., Tee, E. S., Chan, P., Amin, L., Trinidad, T. P., & Amarra, M. S. (2019). Sugars and sweeteners: science, innovations, and consumer guidance for Asia. *Asia Pacific Journal of Clinical Nutrition*, *28*(3), 645–663. https://doi.org/ 10.6133/apjcn.201909_28(3).0025

Eggleston, G., & Monge, A. (2005). Optimization of sugarcane factory application of commercial dextranases. *Process Biochemistry*, *40*(5), 1881–1894. https:// doi.org/10.1016/j.procbio.2004.06.025

Eggleston, Gillian, Triplett, A., Bett-Garber, K., Boue, S., & Bechtel, P. (2022). Macronutrient and mineral contents in sweet sorghum syrups compared to other commercial syrup sweeteners. *Journal of Agriculture and Food Research*, *7*(November 2021), 100276. https://doi.org/10.1016/j.jafr.2022.100276

Fattore, E., Botta, F., & Bosetti, C. (2021). Effect of fructose instead of glucose or sucrose on cardiometabolic markers: A systematic review and meta-analysis of isoenergetic intervention trials. *Nutrition Reviews*, *79*(2), 209–226. https://doi.org/10.1093/nutrit/nua 77

Gillespie, K. M., Kemps, E., White, M. J., & Bartlett, S. E. (2023). The Impact of Free Sugar on Human Health: A Narrative Review. *Nutrients*, *15*(4), 1–25. https:// doi.org/10.3390/nu15040889

Gusmalawati, D., & Mayasari, E. (2017). Karakteristik Fisikokimiawi Sari Buah Tapus (Curculigo Latifolia Dryand) Dengan Metode Ekstraksi Osmosis. *Jurnal Ilmiah Teknosains*, *3*(2). https://doi.org/10.26877/ jitek.v3i2.1883

Hermanto. (2013). Pengembangan Cadangan Pangan Nasional dalam Rangka Kemandirian Pangan. *Forum Penelitian Agro Ekonomi*, *31*(1), 1–13.

Hidayah, I. N., Mirratunnisya, M., Widiastuti, T., & Ferdiansyah, M. K. (2021). Karakteristik Gula Cair dari Umbi Gembili (Dioscorea esculenta) Terhadap Produk Roti Fungsional. *Jurnal Teknologi Pangan*, *15*(1), 37–44. https://doi.org/10.33005/jtp.v15i1.2718

Istia'nah, D., Utami, U., & Barizi, A. (2020). Karakterisasi Enzim Amilase dari Bakteri Bacillus megaterium pada Variasi Suhu, pH dan Konsentrasi Substrat. *Jurnal Riset Biologi Dan Aplikasinya*, *2*(1), 11. https://doi.org/10.26740/jrba.v2n1.p11-17

Jacob, M., Tripathi, A. M., Yadaf, G., & Sonali, S. (2016). Nutritive and Non-Nutritive Sweeteners: A Review. *International Journal of Oral Health and Medical Research*, *2*(5), 149–153.

Jain, T., Grover, K., & Scholar, P. D. (2015). Sweeteners in Human Nutrition. *International*

Journal of Health Sciences & Research (Www. Ijhsr.Org), *5*(May), 439. www.ijhsr.org

Kasiamdari, R. S., Ganies Riza, A., Heri, P., Christy, A., & Muhammad Fauzi, A. (2019). Genetic diversity of Indonesian's sugarcane varieties (saccharum officinarum) based on RAPD molecular markers. *Biodiversitas*, *20*(10), 3005–3010. https://doi.org/10.13057/biodiv/d201032

Kusuma, H. A., Lestari, N. A., & Christie, C. D. Y. (2022). Sifat Fisikokimia dan Komposisi Nutrisi Pada Gula Cair yang Diproses dengan Metode Vakum. *Jurnal Teknotan*, *16*(2), 115. https://doi.org/10.24198/jt.vol6

Mahmudatussa'adah, A. (2014). Komposisi Kimia Ubi Jalar (Ipomoea batatas L) Cilembu pada Berbagai Waktu Simpan sebagai Bahan Baku Gula Cair. *Pangan*, *23*(1), 53–64.

Mardawati, E., Harahap, B. M., Andoyo, R., & Wulandari, N. (2019). Karakterisasi Produk Dan Pemodelan Kinetika Enzimatik Alfa-Amilase Pada Produksi Sirup Glukosa Dari Pati Jagung (Zea mays). *Jurnal Industri Pertanian*, *1*(1), 11–20.

Marlina, A., & Widiastuti, E. (2019). Pembuatan Gula Cair Rendah Kalori Dari Daun Stevia Rebaudiana Bertoni Secara Ekstraksi Padat-Cair. *Industrial Research Workshop and National Seminar*, 149–154.

Meriatna, M. (2013). Hidrolisa Tepung Sagu Menjadi Maltodektrin Menggunakan Asam Klorida. *Teknologi Kimia Unimal*, *2*, 38–48. www.ft.unimal.ac.id/jurnal_teknik_kimia

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *The BMJ*, *372*. https://doi.org/10.1136/bmj.n71

Permanasari, A. R., & Yulistiani, F. (2017). Pembuatan gula Cair dari Pati Singkong dengan menggunakan Hidrolisis Enzimatis. *Fluida*, *11*(2), 9–14. https://doi.org/ 10.35313/fluida.v11i2.81

Priya, K., Gupta, V. R. M., & Srikanth, K. (2011). Natural sweeteners: A complete review. *Journal of Pharmacy Research*, *4*(7), 2034–2039.

Putra, K. A. W., Amna, H., & Gunam, B. W. I. (2015). Pengaruh Suhu dan Konsentrasi Enzim Amiloglukosidase pada Proses Sakarifikasi terhadap Produksi Gula Cair Pati Ubi Talas (Colocasia esculenta). *Rekayasa Dan Manajemen Agroindustri*, *3*(2), 130–139.

Rayhani, Z., Kurniasih, E., Savia, & Fadhilah, R. (2018). Classification of dextrose equivalent analysis maltodextrin starch seeds through enzymatic hydrolysis reaction. *IOP Conference Series: Materials Science and Engineering*, *420*(1). https:// doi.org/10.1088/1757-899X/420/1/ 012072

Ridhani, M. A., & Aini, N. (2021). Potensi Penambahan Berbagai Jenis Gula Terhadap Sifat Sensori Dan Fisikokimia Roti Manis: Review. *Pasundan Food Technology Journal*, *8*(3), 61–68. https://doi.org/ 10.23969/pftj.v8i3.4106

Rizkalla, S. W. (2010). Health implications of fructose consumption: A review of recent data. *Nutrition and Metabolism*, *7*(1), 82. https://doi.org/10.1186/1743-7075-7-82

Saraiva, A., Carrascosa, C., Ramos, F., Raheem, D., Pedreiro, S., Vega, A., & Raposo, A. (2023). Coconut Sugar: Chemical Analysis and Nutritional Profile; Health Impacts; Safety and Quality Control; Food Industry Applications. *International Journal of Environmental Research and Public Health*, *20*(3671). https://doi.org/10.3390/ ijerph20043671

Stull, A. J. (2016). Lifestyle Approaches and Glucose Intolerance. *American Journal of Lifestyle Medicine*, *10*(6), 406–416. https://doi.org/10.1177/1559827614554186

Suroso. (2017). Potensi dan Eksistensi Cadangan Pangan Masyarakat di Kabupaten Pati. *Jurnal Litbang Pertanian*, *13*(2), 127–138.

Taufik, A., Chaminra, T., Utami, I. R., Isnaad, A. D. P., Gaffar, D. E., & Rusman, M. (2021). Strategi Pemerintah Dalam Meningkatkan Ketahanan Pangan Pada Masa Pandemi Di Kabupaten Majene. *Kybernology : Journal of Government Studies*, *1*(2), 178–194. https://doi.org/10.26618/kjgs.v1i2.7192

Tawfik, G. M., Dila, K. A. S., Mohamed, M. Y. F., Tam, D. N. H., Kien, N. D., Ahmed, A. M., & Huy, N. T. (2019). A step by step guide for conducting a systematic review and meta-analysis with simulation data. *Tropical Medicine and Health*, *47*(1), 1–9. https://doi.org/10.1186/s41182-019-0165-6

Weliana. (2019). Formulasi Pati Singkong (Manihot Utillisima) Dan Gelatin Terhadap Sifat Fisikokimia Dan Organoleptik Marshmallow. *Jurnal UNTAN*, *01*, 1–12.

Wiebe, N., Padwal, R., Field, C., Marks, S., Jacobs, R., & Tonelli, M. (2011). A systematic review on the effect of sweeteners on glycemic response and clinically relevant outcomes. *BMC Medicine*, *9*(1), 123. https://doi.org/10.1186/1741-7015-9-123

Wilberta, N., Sonya, N. T., & Lydia, S. H. R. (2021). Analisis Kandungan Gula Reduksi Pada Gula Semut dari Nira Aren yang Dipengaruhi pH dan Kadar Air. *BIOEDUKASI: Jurnal Pendidikan Biologi*, *12*(1), 101. https://doi.org/10.24127/bio edukasi.v12i1.3760

Zhang, G., Ao, Z., & Hamaker, B. R. (2009). Controlling the delivery of glucose in foods. *Designing Functional Foods: Measuring and Controlling Food Structure Breakdown and Nutrient Absorption*, *1981*, 547–571. https://doi.org/10.1533/9781845696603.3.547

https://doi.org/10.20473/mgi.v19i3.243–248

EFFECTIVENESS OF ONLINE-BASED NUTRITION EDUCATION IN INCREASING KNOWLEDGE AND SELF-EFFICACY

Qonita Rachmah[1,2*], Nila Reswari Haryana[3], Mahmud Aditya Rifqi[1], Rian Diana[1], Dominikus Raditya Atmaka[1], Stefania Widya Setyaningtyas[1], Aliffah Nurria Nastiti[1], Asri Meidyah Agustin[1]

[1]Nutrition Department, Public Health Faculty, Universitas Airlangga, Surabaya, Indonesia
[2]School of Medicine and Dentistry, Griffith University, Queensland, Australia
[3]Nutrition Study Program, Engineering Faculty, Universitas Negeri Medan, Medan, Indonesia
Correspondence address: Qonita Rachmah
Email: qonita.rachmah@fkm.unair.ac.id

ABSTRACT

The latest COVID-19 pandemic has taught the importance of nutrition and immunity to prevent diseases, in which case the fatality rate exceeded 2.58%. Immunity is believed to be one of the critical efforts to prevent the spread of COVID-19. This is, for sure, inseparable from nutritional intake, exercise, and environmental factors. However, that needed to be better understood by many people. This study aims to assess the effectiveness of online-based nutrition education in increasing knowledge and self-efficacy to maintain a balanced nutritional intake and implement hygiene. Online-based nutrition education was done using video conference by Zoom conference and text-based education methods using Telegram. Each session is held for approximately two hours. Samples were all collected voluntarily, comprising an adult population aged 19 – 59. Knowledge and self-efficacy were measured using a structured questionnaire. In total, 217 samples were recruited. 92.2% of participants were female, the average age was 29 ± 10.04, 34.1% worked as civil servants, and the majority, 52.1%, came from East Java. Education with the digital learning method succeeded in increasing nutritional knowledge from a score of 55.9 to 91.8 ($p<0.000$) and significantly increasing self-efficacy of consuming balanced-nutritious food and self-efficacy of a clean and healthy lifestyle ($p<0.000$). In conclusion, online-based nutrition education proved effective in increasing knowledge and self-efficacy. Hence, program duplication with a broader range of subjects can be done nationally.

Keywords: *online nutrition education, nutrition, knowledge, self-efficacy*

INTRODUCTION

The COVID-19 pandemic, a global crisis that has persisted for over 2 years, has had far-reaching effects on various aspects of life, including a significant rise in mortality rates (Koh, 2021). The treatment of COVID-19 remains uncertain, and the rapid deterioration of health in affected individuals underscores the urgency of prevention. Therefore, it is imperative to optimize prevention efforts, particularly in the areas of nutrition and hygiene, as indicated by the 3M guidelines (Wearing masks, Washing hands, Avoiding crowds) (WHO, 2020).

More and more information is spreading about COVID-19, from *hoax* information to official and accurate information. This situation makes many people feel anxious and afraid, and many negative responses arise, such as obsession with hoarding medical devices and panic buying. It can have a psychosomatic impact due to a lack of knowledge of distinguishing accurate information and not. One piece of information often misused by the public is about proper nutrition during the COVID-19 pandemic (Ruani et al., 2023). For example, claims that certain foods can cure COVID-19, consumption of certain foods can aggravate and accelerate the transmission of COVID-19, and so on. Misinformation that spreads quickly can cause unrest in the community. For this reason, a valid source of information is needed and can be trusted by the public to reduce the level of concern and misperceptions of information about COVID-19.

Nutrition is crucial in COVID-19 prevention, starting from nutritional status and macronutrient requirements (Gombart, et al. 2020). A study in 2020 showed that the number of positive cases of COVID-19 was more prevalent in individuals with overweight or BMI >25 kg/m^2. In addition, obese and overweight patients also require more

 Received 05-12-2023, Accepted 13-08-2024, Published online 30-09-2024.

ventilators when confirmed positive, with a ratio of 47.1% in normal nutritional status and 73.7% in obese and overweight patients (Simonnet, A., 2020). This study confirmed that as the nutritional status increases, it can increase the risk of contracting COVID-19 due to immunodeficiency and the risk of becoming more severe when already infected (Alberca, et al. 2021). Meanwhile, malnutrition also increases the risk of infection because malnutrition is associated with decreased immune work, lymphoid tissue atrophy and increased immunodeficiency (Di Renzo, et al. 2020). Micronutrients, especially vitamins B complex, C, D, E, and zinc, are essential for the immune system (Gombart, et al. 2020). People need to know how to provide balanced nutrition regarding COVID-19 prevention so that they can apply it in their daily lives. This study aims to evaluate the effectiveness of online education about nutrition and COVID-19 to increase knowledge and self-efficacy.

METHODS

This study used a cross-sectional design to increase knowledge and self-efficacy through online methods, including Zoom conferences and telegram lectures. Since the COVID-19 pandemic, we have begun to adapt to online learning because there were physical distancing recommendations. To prevent the transmission of COVID-19, the delivery of information and direct counseling to the public needed to be improved. In detail, the webinar activities were carried out twice on July 9 and 16, 2020, from 10.00 to 12.00 local time with the online method using Zoom media. The materials provided in the webinar session covered COVID-19 and its influential factors, nutrition in COVID-19, and food safety during the COVID-19 pandemic. Each material was delivered for 30 minutes and continued with a question and answer session. In this webinar, participants also received an *e-booklet* containing information about nutrition during the pandemic.

Furthermore, the education using *Telegram* was text-based. One thousand one hundred sixty-seven participants followed this telegram-based education. The material presented in the lecture-telegram was the same as the webinar but delivered in text form. Material delivery in the text is more permanent because participants could follow the education at any time. The *Telegram* session was delivered for 60 minutes. The material presentation was delivered through images/slides and exposure via text. The participants considered this telegram-based nutrition education very useful because the material could be read repeatedly. After the presentation via text, the session continued with questions and answers. The Q&A was divided into three sessions, each about 20 minutes, with five questions in each session. The participants were enthusiastic about the Q&A session, as evidenced by the number of questions. Before and after the delivery of the material, pretests and posttests were also filled in via telegram to assess changes in the participants' knowledge of education. In addition to receiving material via text, participants were provided with a Nutrition and Immunity booklet during the COVID-19 Pandemic, which can be used as a guide or shared with other colleagues.

The knowledge questionnaire on the role of nutrition and immunity contained ten multiple-choice questions. The results of the nutrition knowledge questionnaire were then assessed and classified into 3 (three), i.e. poor knowledge (score <60), moderate knowledge (score 0-80) and good knowledge (score >80) (Khomsan, 2004). Meanwhile, the self-efficacy questionnaire was developed independently by the team consisting of 2 sets of questionnaires, i.e., the self-efficacy questionnaire to consume balanced nutrition during the COVID-19 pandemic and self-efficacy to follow health protocols to prevent COVID-19 (Rachmah, et al. 2021). The researchers themselves developed the two questionnaires that became the research instruments based on the nutrition education material provided to the target group. The questionnaire was filled in twice, that is, before and after being given a nutrition education intervention through the lecture method. Differences in pre-post test scores were analysed using the Pearson test (SPSS 26, IBM). This research has received an ethical certificate issued by the Health Research Ethics Committee, Faculty of Public Health Universitas Airlangga, with certificate number No. 20/EA/KEPK/2021.

RESULTS AND DISCUSSIONS

The first online education activity was attended by 229 participants, and the second activity was attended by 121 participants. The participants were mostly from the general public (non-medical), dominated by young and middle-aged adults distributed from the Talaud Islands to Mamuju.

Of the total participants, 217 participants completed the pre-post. Based on Table 1, the 1st webinar participants were primarily female (92.9%), with an average age of 29 years ± 10.04, and most occupations as students and civil servants (34.1%).

The results of nutrition knowledge before and after the online education session are presented in Tables 2 and 3. Respondents' knowledge scores increased significantly before and after the nutrition education session (p<0.000) (Table 2). With the positive results, this nutrition and immunity online education can be duplicated with broader community coverage.

The following results were obtained in the table of knowledge levels before and after education (Table 3). In the pre-test before education, more than half of the total respondents (52.7%) had poor scores (less than 60), while only 11 respondents (4.6%) had good scores. Then, after education, there was a significant change in results, which was more than three-fourths of the participants got a good score (>80) of 83.1%, while respondents with poor scores (<60) were only 5.1%.

Respondents' knowledge was significantly increased after being given online nutrition education. This was in line with previous studies among adults in Semarang, Indonesia (Tsani, et al. 2020). From the questions about nutrition and immunity knowledge, most respondents knew about the transmission of COVID-19, the importance of protein intake and how to maintain food safety. Protein is essential to form antibodies in white blood cells; with sufficient protein intake, the body can recognise which obstacles must be killed and cleaned from the body so that the body is not infected (natural killer cell) (Cruzat et al. 2018). However, knowledge about the role of micronutrients on immunity and food sources of micronutrients still needs to be improved. This can be seen from the low number of correct answers to questions 5, 5,6,7,8, and 9. The level of knowledge can determine a person's behaviour towards certain health behaviours, although it is not the only factor (Ajzen, 2002). Research by Azrimadaliza et al. (2021) also showed that respondents' knowledge and attitudes related to nutrition efforts in increasing body immunity during the COVID-19 pandemic were quite good. Still, the behaviour or implementation of nutrition in increasing body immunity during the COVID-19 pandemic was low.

Micronutrients can be supplied by a balanced diet, especially adequate consumption of fruits and vegetables (Ali&Tsou, 1997). Unfortunately, over 90% of Indonesian adults consume fewer vegetables and fruits or do not meet daily consumption recommendations (Indonesia Ministry of Health, 2019). Implementing balanced nutrition is a way to prevent COVID-19 prevention that

Table 1. Respondent Characteristic

Characteristic	n	%
Sex		
Men	17	7.8
Women	200	92.2
Age (years)		
Mean	29 ± 10.04	
Min - Max	18-60	
Occupation		
Private workers	13	6.0
Civil workers	74	34.1
Entrepreneur	3	1.4
Temporary workers	16	7.4
University Student	98	45.2
Students	1	0.5
Housewife	2	0.9

Table 2. Knowledge Level Before and After Education

	Before	After	P-value
Mean Score	55.9 ± 14.1	91.8 ± 15.9	0.000
Min-max	30 - 100	20 - 100	
Knowledge Level (n[(%])			
Good (> 80)	11 (5.1)	178 (82)	
Moderate (60-80)	34 (15.7)	21 (9.7)	
Poor <60	172 (79.3)	18 (8.3)	

needs to be implemented because daily intake affects nutritional status, and poor nutritional status can reduce immunity (Herzog & Rundles. 2015; de Heredia et al., 2012). Foods high in vitamin A are found in carrots, mangoes, papaya, green leafy vegetables; zinc is found in red beans, corn, shrimp, cowpeas, eel, soybeans, green beans; vitamin C is found in cashew fruit, guava, mango, banana, papaya; vitamin D is found in animal proteins such as skipjack, chicken eggs, milkfish, mullet, eel, quail eggs, fish eggs. Vitamin C acts as an antihistamine agent that can relieve flu symptoms such as sneezing, runny nose, and sinus swelling that can appear in people with COVID-19 (Carr & Maggini, 2017). Meanwhile, vitamin D plays a role in reducing the risk of infection by enhancing cellular immunity and reducing the cytokine storm caused by the innate immune system (Grant, et al. 2020). With different functions, all vitamins and minerals work simultaneously for an optimal immune system.

Table 4 shows the mean score of self-efficacy or self-confidence in eating nutritious, balanced foods and maintaining clean and healthy living behaviours.

Self-efficacy scores were obtained from each of the ten questions. Participants had very good self-efficacy in maintaining hygiene and sanitation and implementing health protocols during the pandemic, both before and after the education. The average score on each statement increased between 0 - 0.5 points. Despite the education, the statement to continue using a mask when leaving the house did not change. Still, the average score was 9.5, indicating that participants were particular to be able to do this. In addition, the statement to use a mask when leaving the house is the statement with the highest average score before and after education.

Table 4. The mean total self-efficacy score is for consuming balanced nutrition and healthy hygiene behaviour before and after nutrition education.

	Before	After	*P-value*
Consume Balanced Nutrition			
Mean ± SD	73 ± 14.87	81.06 ± 14.56	0.000
Min – max	33 – 100	39 – 100	
Healthy Hygiene Behavior and Health Protocols			
Mean ± SD	88 ± 11.66	90.68 ± 11.10	0.000
Min – max	39 – 100	43 – 100	

Respondents' self-efficacy was also increased after giving online nutrition education, which is parallel to previous studies using 6-week online nutrition education (Stark et al. 2011). Self-efficacy in consuming balanced nutrition consists of several questions, i.e., how confident are you in maintaining a balanced nutritional consumption pattern when income drops, at the beginning of the month, at the end of the month, when fruit prices rise, when animal side dish prices rise, when vegetable prices rise, when you are lazy to cook, when you are sick when eating time is limited, and when the corona outbreak is over. Participants' self-efficacy before the material was presented was good because they believed they could still consume balanced nutritional foods during the pandemic. The lowest score of respondents' confidence was obtained when eating time was

Table 3. Frequency of Respondents Who Answered Correctly

No	Question	Before [n(%)]	After [n(%)]
1.	Covid-19 Spreading	235 (99.2)	234 (98.7)
2.	The causes of overweight at risk of getting COVID-19	148 (62.4)	222 (93.7)
3.	Certain foods/ supplements that can treat COVID-19	198 (83.5)	232 (97.9)
4.	The role of proteins to prevent getting infected and eliminate COVID-19	231 (97.5)	233 (98.3)
5.	Foods containing zinc (Zn)	132 (55.7)	218 (92.0)
6.	Number of fruits (servings) to meet daily vitamin C requirement	52 (21.9)	212 (89.5)
7.	A higher source of vitamin A than carrots	56 (23.6)	207 (87.3)
8.	Vitamin D source foods	32 (13.5)	199 (84.0)
9.	Vitamins that affect natural killer cell productivity and activity	31 (13.1)	192 (81.0)
10.	How to maintain proper food safety during the COVID-19 pandemic	219 (92.4)	222 (97.9)

limited and the highest when the epidemic was over. From this result, it can be interpreted that when eating time is limited, consuming balanced nutrition will be more difficult. So, it does not close the chance for fast food to lead to the types of food most often consumed by the community. It can be said that participants consider nutritionally balanced food to take a long time to prepare. The average score in this statement increased by 0.9 points after education. However, respondents felt confident that after the outbreak, they were more satisfied with consuming balanced nutrition.

Statement of continuing to wash hands as often as possible when leaving the house was also the other highest statement after education. This is because the education also explained the difference between using soap and water and hand sanitisers during the pandemic. The statement with the highest point increase was to continue using hand sanitisers even though the price increased by 0.5 points. This shows that despite barriers to maintaining cleanliness, participants have the confidence/commitment to continue using hand sanitisers even though the price has increased.

CONCLUSION

Online education successfully proved its effectiveness, as evidenced by the increase in nutrition and immunity knowledge and self-efficacy in consuming balanced nutrition and healthy hygiene behaviors. Therefore, similar programs can be duplicated with the same approach so that more people understand the importance of nutrition in immunity. The Health Office of the Ministry of Health and related stakeholders can duplicate this activity.

ACKNOWLEDGEMENT (If Necessary)

We thank the Faculty of Public Health, Universitas Airlangga, for funding this research.

REFERENCES

Ajzen, I. (2002). Perceived behavioural control, self-efficacy, locus of control, and the theory of planned behaviour 1. *Journal of applied social psychology*, 32(4), 665-683. https://doi.org/10.1111/j.1559-1816.2002.tb00236.x.

Alberca, R. W., Oliveira, L. D. M., Branco, A. C. C. C., Pereira, N. Z., & Sato, M. N. (2021). Obesity as a risk factor for COVID-19: an overview. *Critical reviews in food science and nutrition*, 61(13), 2262-2276. https://doi.org/10.1080/10408398.2020.1775546

Ali, M., & Tsou, S. C. (1997). Combating micronutrient deficiencies through vegetables—a neglected food frontier in Asia. *Food policy*, 22(1), 17-38. https://doi.org/10.1016/S0306-9192(96)00029-2

Azrimadaliza, A., Khairany, Y., & Putri, R. (2021). Pengetahuan, Sikap dan Perilaku Gizi Keluarga dalam Meningkatkan Imunitas Selama Pandemi Covid-19. *Jurnal Ilmiah Kesehatan*, 20(1), 40-44. https://doi.org/10.33221/jikes.v20i1.883

Calder PC, Carr AC, Gombart AF, Eggerdorfer M. (2020). Optimal Nutritional Status for a Well-Functioning Immune System Is an Important Factor to Protect against Viral Infections. *Nutrients*; 4:1181. https://doi.org/10.3390/nu12041181

Carr AC dan Maggini S. (2017). Vitamin C and Immune Function. *Nutrients*. 9, 1211. https://doi.org/10.3390/nu9111211

Cruzat V, Rogero MM, Keane KN, Curi R, Newsholme P. (2018). Glutamine: Metabolism and Immune Function, Supplementation and Clinical Translation. *Nutrients*; 10(11):1564. https://doi.org/10.3390/nu10111564

de Heredia, F. P., Gómez-Martínez, S., & Marcos, A. (2012). Obesity, inflammation and the immune system. *Proceedings of the Nutrition Society,* 71(2), 332-338. https://doi.org/10.1017/S0029665112000092

Di Renzo, L., Gualtieri, P., Pivari, F. et al. COVID-19: Is there a role for immunonutrition in obese patient*?*. *J Transl Med* 18, 415 (2020). https://doi.org/10.1186/s12967-020-02594-4

Gombart, A. F., Pierre, A., & Maggini, S. (2020). A review of micronutrients and the immune system–working in harmony to reduce the risk of infection. *Nutrients*, 12(1), 236. https://doi.org/10.3390/nu12010236

Grant WB, Lahore H, Mcdonnell SL, Baggerly CA, French CB, Aliano JL, et al. (2020). Evidence that Vitamin D Supplementation Could Reduce Risk of Influenza and COVID-19 Infections and Deaths. *Nutrients*; 12:988. https://doi.org/10.3390/nu12040988

Herzog, R., & Cunningham-Rundles, S. (2015). Malnutrition, Immunodeficiency, and Mucosal Infection. In Mucosal Immunology, 1461-1479.

Academic Press. https://doi.org/10.1016/B978-0-12-415847-4.00074-4

Indonesia Ministry of Health. (2019). Studi Diet Total 2018. Jakarta: Indonesia Ministry of Health.

Khomsan A. 2002. Pangan dan Gizi Untuk Kesehatan. Jakarta: PT Raja Grafindo. Persada.

Koh, H. K., Geller, A. C., & VanderWeele, T. J. (2021). Deaths from COVID-19. *Jama*, 325(2), 133-134. doi:10.1001/jama.2020.25381

Rachmah, Q., Nindya, T. S., Aji, A. S., Pattimah, S., Rachmah, N., Maulana, N. I., ... & Astina, J. (2021). Peningkatan Pengetahuan Dan Self-Efficacy Upaya Pencegahan Covid-19 Melalui Edukasi Gizi Konvensional. *Media Gizi Indonesia*, 16(3), 273-279. https://doi.org/10.20473/mgi.v16i3.273–279

Ruani, M. A., & Reiss, M. J. (2023). Susceptibility to COVID-19 Nutrition Misinformation and Eating Behavior Change during Lockdowns: An International Web-Based Survey. Nutrients, 15(2), 451.

Simonnet, A., Chetboun, M., Poissy, J., Raverdy, V., Noulette, J., Duhamel, A., ... & Verkindt, H. (2020). High prevalence of obesity in severe acute respiratory syndrome coronavirus-2 (SARS- CoV-2) requiring invasive mechanical ventilation. *Obesity*, 28(7), 1195-1199. https://doi.org/10.1002/oby.22831

Stark, C. M., Graham-Kiefer, M. L., Devine, C. M., Dollahite, J. S., & Olson, C. M. (2011). Online course increases nutrition professionals' knowledge, skills, and self-efficacy in using an ecological approach to prevent childhood obesity. *Journal of nutrition education and behavior,* 43(5), 316-322. https://doi.org/10.1016/j.jneb.2011.01.010

Tsani, A. F. A., Nugroho, T. W., Ayustaningwarno, F., Dieny, F. F., & Kristiana, I. (2020). Providing online education to improve health and nutrition knowledge in security units during the pandemic (Covid-19). Jurnal Aisyah: *Jurnal Ilmu Kesehatan,* 5(2), 175-179. doi:10.30604/jika.v5i2.355

World Health Organization. (2020). *Tools to Fight COVID-19* [Online]. Geneva: World Health Organization. Available at: https://www.who.int/initiatives/act-accelerator (Accessed: 15 January 2022)

https://doi.org/10.20473/mgi.v19i3.249–258

THE EFFECT OF HEALTH BELIEF MODEL-BASED INTERVENTIONS TO INCREASE DIET QUALITY OF ADOLESCENTS

Anada Varenza Kisda[1], Ikeu Ekayanti[2*], Tiurma Sinaga[3]
Nutritional Science Post Graduate Study Program, Faculty of Human Ecology, IPB University Bogor
Departement of Community Nutrition, Faculty of Human Ecology, IPB University Bogor
E-mail: ikeu.ekayanti@gmail.com

ABSTRACT

The adolescent dietary quality in Indonesia remains subpar, with a substantial proportion of ≤ 95% of adolescents not consuming enough or any fruits and vegetables. The main objective of this research was to evaluate the impact of nutrition education programs based on the Health Belief Model (HBM) and conventional methods on the knowledge, attitudes, and eating habits of adolescents, with the ultimate goal of promoting healthy dietary practices. This study was a quasi-experimental study with a non-randomized control group pre and post-test design to 78 adolescents 13-15 years who met the inclusion criteria at the Bogor Regency Junior High School. Diet quality data was collected using 2x24 hours of food recall. The knowledge, attitude, and health belief model questionnaires that had been collected through questionnaires were then analyzed using SPSS version 25.0 using the Wilcoxon and paired t-test. There was no change in the quality diet in the health belief model and control groups with p-value > 0.05. However, there was an increase in knowledge and attitude in both groups with a p-value <0.05. Only three constructs that improved were vulnerability, seriousness and self-efficacy with p-value < 0.05. Perceived benefits, barriers and action cues did not increase with p-value > 0.05. Health belief model nutrition education methods can improve knowledge and attitude, but not give a change in behavior. Health belief model nutrition education method can improve knowledge and attitudes, but not changes in eating behavior. Further health belief model-based nutrition education programs are needed to increase motivation and willingness to act.

Keywords: *Health Belief Model, Diet Quality, Nutrition Education Intervention, Adolescents*

INTRODUCTION

The nutritional problems among adolescents in Indonesia are overnutrition and undernutrition caused by frequent consumption of snacks and sweet drinks only and not consuming enough fruit and vegetables (Arnelia 2015). The percentage of adolescents who consume less than 5 portions of fruits (95%), sweet foods consumption (45%), sweet drinks (59%), and salty foods (31%) (Balitbangkes 2018). Based on previous research conducted in Bogor, it was found that the quality of adolescent diet was still bad (60.5%) (Devie 2020). The diet quality of adolescents aged 12-19 years in West Java Province is also still bad (44.4%). (Agustina *et al.* 2020).

A poor quality diet happens because adolescents do not have a proper knowledge and self-awareness to consume a balanced nutritious food (Notoatmodjo 2010). Therefore, nutrition education intervention programs are needed to make changes in eating behavior. In Indonesia, many nutrition education interventions have been conducted to improve adolescents' knowledge, attitudes, and behavior toward balanced nutrition (Irnani, 2017). However, there still existed unsuccessful nutritional education programs that only increased the knowledge and attitude but not yet arrive to change the behavior. Previous research that provides nutrition education to adolescents in Jakarta can increase knowledge but not consumption of vegetables and fruits (Sekti 2019). The unchanging behavior is rooted in a lack of awareness, seriousness, and trust in balanced nutritious food without knowing the benefits and problems when not consuming balanced nutritious food, and insufficient time allocation for having nutritional education, also an unsupportive environment (Fathi *et al.* 2017). Therefore, it

 Received 19-11-2023, Accepted 31-07-2024, Published online 30-09-2024.

is urgent to create a learning model to increase the confidence of an individual to change his/her behavior and one example is a Health Belief Model (HBM).

HBM is a theoretical model for assessing individuals whether the person is able to do a follow up behavioral changes based on belief, so the next changing in behavior can be carried out further (Glanz *et al.* 2008). HBM has six main constructs for assessing an individual: (a) perceived susceptibility, (b) perceived severity, (c) perceived barriers, (d) perceived benefits, (e) self-efficacy or a person's belief to make behavioral changes, also (f) cues to action, or action that will be taken next to start making changes into healthy eating behavior (Becker 1974). The purpose of this study was to analyze the effect of nutrition education interventions based on the Health Belief Model (HBM) changes in eating behavior and improve the quality of adolescent diets in Bogor Regency.

METHODS

Study Design

The design of this research was a Quasi-Experimental Study with a non-randomized control group in pre and post-test design. This research was conducted from May 2023 to June 2023 on adolescents at Dramaga 2 Public Junior High School (*SMP Negeri 2 Dramaga*) and Ciomas 1 Public Junior High School (*SMP Negeri 1 Ciomas*) in Bogor Regency. This research was carried out in two separate classes, with each class comprising 84 students. By employing the Lameshow formula (1997), the total number of respondents was calculated and resulted in 78 individuals. The participants were subsequently divided into two groups: the intervention group, comprising 39 individuals, and the control group, comprising an additional 39 individuals. This research has been approved by the Research Ethics Commission of Bogor Agricultural Institute with approval number of 876/IT3.KEPMSM-IPB/SK/2023.

Subject's selection

The total respondents in this study were 78 respondents with inclusion criteria for sample study were 13–15 years adolescents who were in grade VIII, in healthy condition and willing to take part in the research from the beginning until completion. Meanwhile, exclusion criteria for sample study were ill student or those absent at least once during the intervention activity.

Research Procedures

First procedure of this research was preparing powerpoint media, videos, leaflets, also questionnaires of knowledge, attitudes, practices and a questionnaire of HBM, and then carrying out validity and reliability tests. Second procedure was collecting data on respondents' food consumption. Third procedure was implementing 4 meetings intervention program in one month, each lasting for 1.5 hours. Both intervention and control groups were given intervention using the same media, but the control group was not given the material of six construct of HBM. Every week the material provided for the research groups was different. In the first and fourth weeks, the baseline and end line data on knowledge, attitude and practice belonged to control group and the HBM questionnaire in the intervention group were collected. Questionnaires of pretest and post-test on knowledge will be given each week during the intervention program.

The topic and material of nutrition education intervention were differentiated for each week according to the balanced nutrition guidelines and IGS3 60 components, the recommendation for amount and portions of food for adolescents, the importance of consuming nutritious food, also providing examples of a balanced nutritional menu. On topic for intervention group that used HBM method, there was additional material given about the 6 main constructs perception of susceptibility where respondents become vulnerable to experience nutritional problems due to unbalanced nutrition eating behavior when did not comply to the recommendations, perception of severity feeling towards serious problems that would arise when they did not change into a good eating behavior, perception of barriers that make it difficult to change eating behavior, perception of benefits when changing into healthy and nutritious eating behavior, the self-efficacy or motivation exists within respondents so they are willing and able to change their behavior, as well as cues to act where the respondents have a way that can be done next so they can carry out recommendations for

consuming appropriate and nutritionally balanced foods.

Data Collection Method

Data of diet quality was collected by food recall method 2 x 24 hours in weekends and weekdays, The results of this 2x24 hour food recall will be converted into portions using the Food Exchange List II in the Balanced Nutrition guidelines (Kemenkes RI, 2014). After calculating the serving sizes, the items were sorted and assessed based on a three-tier scoring system: 0.5, and 10. This evaluation was conducted across six food categories: carbohydrates, plant-based protein, animal protein, fruits, vegetables, and dairy (excluding nutrients and non-communicable diseases) (Kusumawati 2019). After determining the overall score by adding up the values of the six food components, the next step is to classify them into categories: very good (≥85), quite good (70-84), moderate (55-69), less (40-54), and bad (≤40) (Amrin *et al.* 2014).

The questionnaire of knowledge consists of 15 multiple choice questions. The maximum score in respondents' knowledge is 100 and divided into three categories: (a) good category with score > 80, (b) moderate category with score of 60-80, and (c) poor category with score of <60 (Khomsan, 2022). Whereas the questionnaire of attitude consists of 10 statements by using 4 Points Likert scale answers; strongly agree, agree, disagree, and strongly disagree which will be classified in to good category if the score is > 75 %, or adequate category if the score is 56% - 75 % or poor category if the score is < 56 %. The last one is the questionnaire of eating behavior, consists of 10 questions which must be answered correctly and accordingly to what the respondent experiences, then classified as good when the score is > 75 %, or adequate when the score is 56-75 %, or poor when the score is < 56 % (Khomsan 2000).

The HBM questionnaire consists of 30 statements where each perception has five statements with 5 points Likert scale answers (strongly agree, agree, disagree and strongly disagree). The questionnaire underwent initial evaluation for reliability and validity, resulting in a Cronbach's Alpha value of 0.701, which exceeded the minimum acceptable threshold of 0.316 according to the table of critical values for Cronbach's Alpha. Then, it will be classified into good category when the score is 76 % - 100 %, or moderate category if the score is 60 % - 75 %, or low category if the score is <60 % (Hupnau 2019). Assessment for the respondents' nutritional status was measured by anthropometry data based on body mass index indicator to respondents' age (BMI/U or BMI to Age). Height measurement was taken by a stature meter with maximum measurement of 200 cm and accuracy of 0.1 cm whereas weight measurement was taken by a digital scale with a maximum measurement of 150 kg and an accuracy of 0.1 kg. After series of these measurements completed then the data were classified according to BMI/U.

RESULTS AND DISCUSSIONS

Characteristics of Respondents

Respondents of this study predominantly were female adolescents as stated by percentage of 53.8 % in HBM group and 53.8 % in the control group. Age of most respondents were 14 years old (82.1 % in the HBM group and 79.5 % in the control group). Majority respondents are always given moderate pocket money ranging from IDR 11,000 – 29,000/day (74.4%), whereas some respondents have a lot pocket money/high category > IDR 30,000 (17.9%) and the rest of respondents have low category pocket money < IDR 11,000 (7.7 %). Most respondents allocate their pocket money to buy food/drinks/snacks in the canteen during break times. Most respondents came from Sundanese tribe, where in the HBM group was 71.8 % and in control group was 79.5 %. Most adolescents in both groups have a normal nutritional status.

Description of Adolescents' Diet Quality

Quality of respondents' diet is a result which able to indicate individual food consumption or food intake whether he/she conforms to the food consumption recommendation or not. Quality of individual's diet will be considered as good when it meets the adolescent's nutritional needs. To assess whether individual food consumption meets or does not meet recommendations, an evaluation is necessary to measure the quality of food consumption, such as using Indeks Gizi Seimbang (IGS).

Table 1. Distribution of Respondents' Characteristics

Variable	Intervention (n=39)		Control (n=39)		Total		P value
	n	(%)	n	(%)	n	(%)	
Gender							
Male	17	43.6	18	46.2	35	44.9	0.821
Female	22	56.4	21	53.8	43	55.1	
Age							
13 years	3	7.7	6	15.4	9	11.5	0.198
14 years	32	82.1	31	79.5	63	80.8	
15 years	4	10.3	2	5.1	6	7.7	
Nutrition Status							
Under nutr.	11	28.2	10	25.6	21	26.9	
Normal	25	64.1	16	41	41	52.6	0.093
Over nutrition	2	5.1	12	30.8	14	17.9	
Obesity	1	2.6	1	2.6	2	2.6	
Pocket Money							
Low	3	7.7	4	10.3	7	9	0.222
Moderate	29	74.4	32	82.1	61	78.2	
High	7	17.9	3	7.7	10	12.8	
Tribe							
Sundanese	28	71.8	31	79.5	59	75.6	
Javanese	8	20.5	4	10.3	12	15.4	
Batavians	1	2.6	0	0	1	1.3	
Malay	1	2.6	0	0	1	1.3	0.572
Aceh	1	2.6	0	0	1	1.3	
Minang	0	0	1	2.6	1	1.3	
Batak	0	0	2	5.1	2	2.6	
Arab	0	0	1	2.6	1	1.3	

Based on the results of the difference test using the Wilcoxon test, the diet quality score in the HBM group and the conventional group found that there was no significant difference (p value>0.05) between the scores before and after the nutrition education intervention. Where before the intervention, in both groups, most respondents were in the poor diet quality category (97.4%), while after the intervention, the respondents' diet quality remained in the poor category (94.9%). This result is consistent with Khoeriah's research (2017), which found that both male and female adolescents have poor food consumption quality (70.1%). Similarly, Rahmawati's (2015) study on diet quality using IGS3-60 revealed that the majority of adolescents aged 13-18, regardless of gender, have poor diet quality (76.7%).

During adolescence, it's important to consume balanced and nutritious food to support growth and prevent future nutritional problems. Developing a habit of consuming balanced and nutritious food is necessary to improve the quality of the diet (Amalia *et al.* 2023). To ensure a high-quality diet, it is important to have a sufficient variety of food components that contribute to a balanced and nutritious diet. This includes adequate intake of vegetables, fruits, grains, fiber, protein, and iron (Dieny et al., 2021). (Dieny et al. 2021). Eating a balanced diet is crucial for nutritional status. Food consumption reflects both nutrient adequacy and variety. The average food consumption of adolescents in Indonesia varies, but it does not meet the daily intake needs, which should include a variety from each food group (meat/poultry/fish/eggs, milk/nuts, grain products, fruits, and vegetables) (Azzahra et al. 2023)

The Difference of Knowledge, Attitude and Behaviour of Adolescents in Before and After Intervention Program

Majority respondents of HBM group before intervention had sufficient knowledge (59%), then after the intervention there was a change in knowledge into good category (89.5%). The

Table 2. Categories Diet Quality of Adolescents Before and After Intervention Program

Food	Kelompok HBM		Kelompok Konvensional		Total	P Value
	n	%	n	%		
Sebelum						
Buruk (≤40)	37	94.9	39	100	97.4	0.942
Kurang (40-55)	2	5.1	0	0	2.6	
Sesudah						
Buruk	38	97.4	36	92.3	94.9	0.062
Kurang	1	2.6	3	7.7	5.1	

attitude of most respondents in HBM group before intervention were in the fair category (48.7%), then after intervention was increased into good category (94.9%). The behaviour before intervention in HBM group was also in fair category (51.3 %), and after intervention there was increase score into the good category (53.8%). It proves that after treated with intervention by employing HBM, this method was able to increase respondents' knowledge, attitude and practice at $p<0.05$. Someone who has good knowledge tends to feel more susceptible to nutritional problems so that later strategies or ways to reduce the risk will emerge (Noorbakhsh *et al.* 2017).

According to research of Naghashpour *et al* (2014), HBM method is able to increase the adolescents' knowledge and attitude about consuming type of foods that contains calcium. HBM method also can be used to understand behaviour related to health since HBM has 6 important constructs (perceptions of susceptibility, severity, benefits, obstacles, self-efficacy and cues to action) to make it able to influence adolescents knowledge and attitudes (Salem, 2018). In line with this theory, Keshani (2019) also found that nutrition education by HBM method through collaborative learning was able to increase adolescents' knowledge and attitudes towards dietary behaviour.

An increase also occurred in control group, in which before intervention, most respondents' knowledge was classified in moderate category (87.2 %) and after intervention there was an increase in respondents' knowledge into good category (94.9%). The respondents' attitude before intervention was 71.8 % and after intervention also increased into good category (87.2%). The respondents' behaviour before intervention was in 53.8% and after the intervention was in the good category (74.4%). In the conventional method, there was also an increase in adolescents' knowledge, attitude and practice regarding diet quality ($p<0.05$).

Table 3. Result of Knowledge, Attitude and Behaviour of Respondents

Variable	HBM (n=39)	Control (n=39)	*p value*
	Mean±SD	Mean±SD	
Knowledge			
Pretest	64.71±11.6	69.80±7.14	0.034*[b]
Postest	89.25±7.42	91.81±5.27	0.133
p value[a]	0.000*	0.000*	
Attitude			
Pretest	71.67±9.39	79.81±10.30	0.001* [b]
Posttest	84.55±7.76	84.36±7.92	0.851
p value[a]	0.000*	0.010*	
Practice			
Pretest	60±11.21	73.33±10.70	0.000*[a]
Posttest	75.64±8.38	78.71±6.90	0.721
p value[a]	0.000*	0.003*	

It confirmed that conventional nutrition education method also able to increase the adolescents' knowledge, attitude and practice regarding consuming balanced nutritious food and complying the suggested recommendations. According to Sofianita (2021), conventional nutrition education is still effective in increasing respondents' knowledge and attitude. Conventional nutrition education such as lectures also able in providing better understanding in a discussion or in answer questions session together with friends or teachers (Insani 2019).

Effectiveness of Health Belief Model Nutrition Education towards Diet Quality

The nutrition education through Health Belief Model (HBM) method has 6 constructs which there are only 3 perceptions are believed by respondents to change behaviour: the perception of susceptibility, perception of severity and self-efficacy.

The respondents' perception of susceptibility in before and after intervention was classified as moderate category (64.1 %) whereas the respondents' perception of severity after intervention was increased to good category (59 %). The respondents' self-efficacy after intervention also in a good category (74.4%). Although three constructs (perception of susceptibility, perception of severity and self-efficacy) were found in good category, different results occurred in perception of benefits, barriers and cues to action, where in before and after intervention, the perception of benefit still in moderate category (64.1%). Perception of barriers after intervention was also in the moderate category (89.7%) and cues to action was in the moderate category (53.8%).

The result of this study showed a significant change found in perception of susceptibility, severity and self-efficacy ($p<0.05$). The same study was conducted on students in Qom City, Iran, who felt that they were vulnerable to nutritional problems if they consumed unhealthy snacks too often (Fathi *et al.* 2017).

Table 4. Difference in HBM Constructs in Before and After Intervention Program

Variable	Before	After	*p* value
	Mean ± SD	Mean ± SD	
Perception of Susceptibility	75.08±6.11	81±10	0.001*
Perception of Severity	73±8.28	80.67±7.26	0.000*
Perception of Benefit	79.1±8.57	81.41±9.38	0.114
Perception of Barrier	79.1±8.57	81.41±9.38	0.285
Self-Efficacy	72.69±9.37	79.87±3.88	0.000*
Cue to action	75.26±6.06	77.82±6.86	0.102

Differential Test of *Wilcoxon* before and after intervention
**p value* <0.05

When someone considers him or herself vulnerable, he/she tends to seek further information about his/her health. However, when the respondent lose motivation to seek information related to nutrition that able to change his/her eating pattern, there will be decline and diversion into other preventions which according to the person is more susceptible to occur at this time (Tzeng dan Ho 2022). When one's self-efficiency or self-confidence increases, one tends to be able to make behavioral changes, one starts to maintain weight and starts a healthy diet (Saghafi-Asl *et al.* 2020).

In contrast, there were no significant changes in perceived benefit, perceived barrier and cues to action ($p>0.05$). Lack of perception of the benefits of students' eating habits also occurred among students in Romania. Lower perceptions of the students' benefits of food habits are due to the lack of information obtained by changing their dietary habits (Dumitrescu, 2021). Although the respondents' knowledge significantly increased after given the intervention, it also found that there were still respondents who did not know and understand about benefit that would occur if they change their diet, some problems they will encounter and their lack of willingness to make changes into a nutritionally balanced diet. While still in young age, it can influence the perception of perceived obstacle to make adolescents feel safe of their bodies that still healthy so they will not experience more serious effect in their future time (Tavakoli *et al.* 2016)

Changes in Diet Quality According to Food Components

Based on portion recommendation and amount of food consumption according to 2014 Balanced Nutrition Guidelines (PGS) for adolescents aged 13-15 years, the portion for male adolescents are ± 650 grams (61/2 portions) and portion for female adolescents are ± 450 grams (equivalent to 4 ½ portions) (Kemenkes RI, 2014)

The Balanced Nutrition Index (IGS) in this study evaluates the nutritional balance of adolescents' diets. The value obtained in the IGS food component is the sum of the food components. The results of dietary quality obtained in this study in the HBM group and the control group before and after the intervention did not show

significant changes (p value > 0.05). This also demonstrates that the quality of food consumption among adolescents in the HBM and conventional groups still needs to be higher or better than the recommendations of the Balanced Nutrition Index (IGS). Table 5 depicts the changes in diet quality based on food components in both groups before and after the intervention.

The results of diet quality in the HBM and control groups were based on food components that experienced an increase in only food sources of carbohydrates and animal protein. While the diet quality of other food groups did not improve, the t-test (Wilcoxon) results for the HBM group indicated that only carbohydrate foods and animal protein showed significant differences before and after the intervention, with p value <0.05. On the other hand, food groups such as vegetable protein, vegetables, fruit, and milk did not show significant differences, with p value >0.05.

Table 5. Difference in Diet Quality According to Food Components in Before and After Intervention Program

Variable	HBM (n=39)	*p value*[a]	Kontrol (n=39)	*p value*[a]
	Mean ± SD		Mean ± SD	
Carbohydrate				
Pretest	5.6±2.19	0.002*	6.96±2.05	0.001*
Posttest	7.8±3.81		8.46±2.6	
Animal				
Pretest	4.7±2.4	0.007*	4.5±1.8	0.008*
Posttest	6.9±3.71		7.1±2.2	
Vege.pr				
Pretest	1.8±2.3	0.166	1.56±1.7	0.289
Posttest	1.0±1.2		0.69±0.9	
Vegetable				
Pretest	0.84±0.5	0.111	0.62±0.65	0.685
Posttest	0.8±0.7		0.59±0.67	
Fruit				
Pretest	1.09±1.35	0.089	0.85±0.9	0.942
Posttest	0.67±1.0		0.83±1.1	
Milk				
Pretest	0.9±1.0	0.938	0.9±1.1	0.504
Posttest	0.86±1.36		0.79±0.8	
Total				

[a] Wilcoxon differential test in before and after intervention
[b] Score differential test between control and intervention groups
* p-value<0.05

These results showed majority of adolescents have met the recommended portion size, especially in the carbohydrate food component. According to result of 2 x 24 hours recall, the carbohydrate food source for adolescents were vary such as rice, noodles, vermicelli, bread, potatoes and corn. However, most consumed carbohydrate food component was rice. Carbohydrate foods, one of which is rice, are an average energy contributor of 40-80% of Indonesians (Kementan RI 2021). Carbohydrate food sources are a source of energy nutrients that body needs most and becomes type of food easy to obtain since the price is affordable, so Indonesian selecting rice as their staple food (Almatsier 2009). The result of this research is in line with research of Dewi (2023) and Rahmawati (2015) that stated the type of most consumed food groups by adolescents is carbohydrate food.

Food groups that have met other food consumption recommendations in the HBM and control groups include animal-based dishes. This is consistent with previous research indicating that adolescent animal food consumption almost meets the recommended level of 75.5%, despite not reaching daily nutritional adequacy. Meanwhile, 88.9% of people still consume less milk, and 69.1% consume fewer vegetable side dishes than recommended (Dewi 2023). According to Rahmawati (2015), adolescents using IGS3-60 should consume the following recommended servings for one meal per day like carbohydrate food: 3-4 servings (100 grams per portion), animal side dishes: 2-4 servings (50 grams per portion), vegetables: 2-4 servings (50 grams per portion), fruits: 2-3 servings (50 grams per portion) and milk: 200ml per glass (liquid milk) or 20 grams (milk powder).

The adolescents period (13-15 years of age) is the most important period in supporting body growth (Rahmawati 2015). The animal protein component was consumed more often, but the vegetable protein component had a different result, where it became the lowest food component most consumed by adolescents. Although vegetable side dishes have lower protein quality when compared to animal side dishes, the vegetable foods contain a higher proportion of unsaturated fat than animal foods. Plant-based foods contain isoflavones, fiber, anti-oxidants and anti-cholesterol which can

prevent non-communicable diseases (Yang *et al.* 2020).

Other important food components such as vegetable side dishes, vegetables and fruits did not meet the recommended amount and portions of the balanced nutrition guidelines. Other similar research also stated that adolescents of Indonesia have low consumption of vegetable side dishes, vegetables and fruit (Dewi 2023; Al-Jawaldeh *et al.* 2020). According to 2014 Balanced Nutrition Guidelines (PGS), the recommended amount and portion of vegetable consumption is 300 grams (equivalent to 3 portions) and 400 grams of vegetables (equivalent to 4 portions). Low vegetables and fruits consumption in adolescents in the long term will result in nutritional deficiencies in vitamins, minerals, and fiber as well as an acid-base imbalance in the body and increase risk in causing non-communicable diseases such as diabetes, heart disease, hypertension, cancer, stroke and others (Qibtiyah *et al.* 2021)

One of many reasons for low consumption of vegetable side dishes, vegetables and fruits among adolescents in Indonesia is minimum understanding about functional foods (superfoods) among adolescents even though Indonesia has developed many types of functional food with high nutritional content. For example, processed foods most widely known as plant foods are tempeh and tofu. Although tofu and tempeh have high nutritional value, people only know tempeh and tofu as snack dishes (Tamam 2022).

This is in line with result research where majority adolescents are very lacking in consuming functional foods (super foods) namely tempeh and tofu. Although most adolescents have good knowledge, especially for types of balanced nutritious food, some adolescents also do not understand the benefit of consuming tempeh for the health and body growth. It also shows they do not have any future clues to start consuming balanced nutritious food. According to Amaliah (2019), adolescents in Indonesia have heard about functional food, but do not know that components in functional food can reduce serious illness in the future. Motivation of adolescents to consume functional food also still at minimum level. Adolescents stated they would start consuming functional foods when they have extra money or if they had extra money, or if they experienced illness later in life.

According to research by Medeiros (2020), there are many influential factors contributed to the failure of nutrition education intervention in changing the eating behavior, such as external factors like schools that did not facilitate healthy canteen, lack of family support, and the very short duration of the intervention (≤ 1 year). To make a behavior change takes longer time and requires continuous effort to maintain good eating behavior. According to Yuksel *et.al* (2020), nutritional intervention education must use a multicomponent system focused on the main learning content and permanent learning design for school and supported by training for teachers so that after intervention given not only increase the knowledge but also able to grow the skills and attitudes of the adolescents.

This study has some limitations. Firstly, it cannot assess the effectiveness of nutrition education interventions using the Health Belief Model (HBM) method and conventional methods on changes in diet quality because it only collected data on 6 HBM constructs from one group, specifically at SMP Negeri 2 Dramaga. Secondly, this study was only conducted for four weeks (four meetings during the provision of nutrition education interventions) because the school had limited time.

CONCLUSION

Based on the study's findings, nutrition education interventions using the Health Belief Model method still failed to enhance the quality of adolescent diets. Although adolescents' knowledge and attitudes have improved, they still need to understand the benefits they will receive if they change their eating behavior. There is a need for a school nutrition education curriculum that should be implemented in school learning activities and further interventions on the consequences of good eating behavior in adolescents at risk of nutritional problems.

REFERENCES

[Kemenkes RI]. 2014. *Pedoman Gizi Seimbang*. Kementerian Kesehatan RI, editor. Jakarta (ID).

https://pergizi.org/pedoman-gizi-seimbang-2014-terbaru/.

Agustina R, Nadiya K, El Andini A, Setianingsih AA, Sadariskar AA, Prafiantini E, Wirawan F, Karyadi E, Raut MK. 2020. Associations of meal patterning, dietary quality and diversity with anemia and overweight-obesity among Indonesian schoolgoing adolescent girls in West Java. *PLoS One*. 15(4):1–19. doi:10.1371/journal.pone.0231519.

Al-Jawaldeh A, Taktouk M, Nasreddine L. 2020. Food Consumption Pattern and Nutrient Intakes of Children and Adolescent in the Eastern Mediterranean Region: A Call for Policy Action. *Nutrients*. 12(11):1–28. doi:10.3390/nu12113345.

Almatsier S. 2009. *Prinsip dasar ilmu gizi*. PT. Gramedia Pustaka Utama, editor. Jakarta.

Amalia NN, Filla Fithra D, Aryu C, Choirun N. 2023. Gizi indonesia. 46(1):43–56. doi:10.36457/gizindo.v46i1.761.

Amaliah I, David W, Ardiansyah A. 2019. Perception of Millennial Generation Toward Functional Food in Indonesia. *J Funct Food Nutraceutical*. 1(1):31–40. doi:10.33555/jffn.v1i1.11.

Amrin AP, Hardinsyah H, Dwiriani CM. 2014. Alternatif Indeks Gizi Seimbang Untuk Penilaian Mutu Gizi Konsumsi Pangan Pria Dewasa Indonesia. *J Gizi dan Pangan*. 8(3):167. doi:10.25182/jgp.2013.8.3.167-176.

Arnelia AH. 2015. *Perilaku Makan Khas Remaja*. Reksa, editor. Jakarta.

Azzahra A, Rizqi ER, Lasepa W. 2023. ASUPAN ENERGI DAN KUALITAS DIET DENGAN KEJADIAN THINNESS PADA SISWA SMAN 1 KAMPAR. 2(3):241–249.

Balitbangkes. 2018. *Riset Kesehatan Dasar Tahun 2018*. Volume ke-53. RI KK, editor. Jakarta: Badan Penelitian dan Pengembangan Kesehatan.

Becker MH. 1974. *The health belief model and personal health behavior*. Ed ke-2. Health education monographs, editor. New York.

Devie L. 2020. Hubungan Kualitas Diet Dengan Status Gizi Remaja di SMP Negeri 2 Bogor. Institut Pertanian Bogor.

Dewi NU. 2023. Peningkatan Literasi Gizi dan Dampaknya Pada Kualitas Diet Remaja Pada Rumah Tangga Rawan Pangan Di Wilayah Pascabencana. Institut Pertanian Bogor.

Dieny FF, Setyaningsih RF, Tsani AFA. 2021. Kualitas diet berhubungan dengan defisiensi besi pada atlet remaja putri Diet quality is related to iron deficiency among adolescent female athletes Abstrak Pendahuluan. 6(1):48–57.

Dumitrescu C, Iacob CI. 2021. Predicting Healthy Eating: Conscientiousness versus the Health Belief Model. *Rom J Appl Psychol*. 23(1):18–24. doi:10.24913/rjap.23.1.03.

Fathi A, Sharifirad G, Gharlipour Z, Hakimelahi J, Mohebi S. 2017. Effects Of A Nutrition Education Intervention Designed Based On The Health Belief Model (HBM) On Reducing The Consumption Of Unhealthy Snacks In The Sixth Grade Primary School Girls. *Int J Pediatr*. 5(2):4361–4370. doi:10.22038/ijp.2016.7567.

Glanz K, K. Rimer B, Viswanath K. 2008. *Health Behavior adn Health Education*. Wiley J, editor. San Francisco.

Hupnau RE. 2019. Analisis Faktor Yang Berhubungan Dengan Perilaku Ibu Dalam Pemenuhan Kebutuhan Nutrisi Pada Anak Usia Toddler Berdasarkan Teori Health Belief Model. Volume ke-5. Universitas Airlangga.

Insani HM. 2019. Pengaruh intervensi pendidikan gizi terhadap pengetahuan gizi, kebiasaan makan dan aktivitas fisik pada remaja [tesis].

Irnani, H. Sinaga T. 2017. In search of understanding: The case for constructivist classrooms. Virginia: Association for Supervision and Curriculum Development. *J Gizi Indones (The Indones J Nutr*. 26(2):58–64. doi:10.32382/mgp.v26i2.1231.

Kementan RI. 2021. *Analisis Ketahanan Pangan Tahun 2022*. Pertanian K, editor. Jakarta.

Keshani P, Kaveh MH, Faghih S, Salehi M. 2019. Improving Diet Quality Among Adolescents, Using Health Belief Model in a Collaborative Learning Context: A Randomized Field Trial Study. *Health Educ Res*. 34(3):279–288. doi:10.1093/her/cyz009.

Khomsan A. 2021. *Perubahan Perilaku Gizi*. Press I, editor. Bogor.

Khomsan IA. 2000. *Teknik pengukuran pengetahuan gizi*.

Kusumawati D. 2019. Pengaruh Intervensi Gizi Seimbang terhadap Perilaku Gizi, Status Gizi, dan Status Hidrasi Santri Pondok Pesantren Darusalam Bogor. IPB University. https://repository.ipb.ac.id/handle/123456789/97832.

Medeiros G, Azevedo K, Garcia D, Segundo VO, Mata Á. 2020. Effect of School-Based Food And Nutrition Education Interventions on The Food Consumption of Adolescents : a systematic review . *J Environ Res Public Heal*., siap terbit.

Noorbakhsh A, Mostafavi F, Shahnazi H. 2017. Effects of the educational intervention on some health belief model constructs regarding the prevention of obesity in students. *Int J Pediatr*. 5(8):5561–5570. doi:10.22038/ijp.2017.24632.2077.

Notoatmodjo. 2010. *Pendidikan dan Perilaku Kesehatan*. Jakarta: PT. Rineka Cipta.

Qibtiyah M, Rosidati C, Siregar MH. 2021. Perilaku Konsumsi Buah dan Sayur Pada Remaja. *J Gizi Kerja dan Produkt*. 2(2):51. doi:10.52742/jgkp.v2i2.12760.

Rahmawati,. Hardinsyah R. 2015. Pengembangan Indeks Gizi Seimbang Untuk Menilai Kualitas Konsumsi Pangan Remaja (13-15 Tahun) Di Indonesia. 11 September.

Saghafi-Asl M, Aliasgharzadeh S, Asghari-Jafarabadi M. 2020. Factors influencing weight management behavior among college students: An application of the Health Belief Model. *PLoS One*. 15(2):1–15. doi:10.1371/journal.pone.0228058.

Salem GM, Said RM. 2018. Effect of Health Belief Model Based Nutrition Education on Dietary Habits of Secondary School Adolescent Girls in Sharkia Governorate. *Egypt J Community Med*. 36(3):35–47. doi:10.21608/ejcm.2018.16330.

Sekti RM. 2019. Nutrition Education with Audiovisual Media on Fruit and Consumption of Junior School Students in East Jakarta. *J Ilm Kesehat*. 1(2):77–88. doi:10.36590/jika.v1i2.15.

Sofianita NI. 2021. Pengembangan Metode Pendidikan Gizi Pada Siswa Dan Orangtua Serta Pengaruhnya Terhadap Perilaku Konsumsi Sayur, Buah Dan Ikan. *Disertasi*. IPB. https://repository.ipb.ac.id/handle/123456789/108764.

Tamam B. 2022. Tempe: Pangan Lokal Unggul (Superfood) Khasanah Budaya Bangsa. *Indones Red Crescent Humanit J*. 1(1):41–48. doi:10.56744/irchum.v1i1.14.

Tavakoli HR, Dini-Talatappeh H, Rahmati-Najarkolaei F, Fesharaki MG. 2016. Efficacy of HBM-based dietary education intervention on knowledge, attitude, and behavior in medical students. *Iran Red Crescent Med J*. 18(11). doi:10.5812/ircmj.23584.

Tzeng SY, Ho TY. 2022. Exploring the Effects of Product Knowledge, Trust, and Distrust in the Health Belief Model to Predict Attitude Toward Dietary Supplements. *SAGE Open*. 12(1). doi:10.1177/21582440211068855.

Yang Y, He D, Wei L, Wang S, Chen L, Luo M, Mao Z. 2020. Association between diet-related knowledge, attitudes, behaviors, and self-rated health in Chinese adult residents: A population-based study. *BMC Public Health*. 20(1):1–8. doi:10.1186/s12889-020-08896-y.

Yuksel HS, Şahin FN, Maksimovic N, Drid P, Bianco A. 2020. School-based intervention programs for preventing obesity and promoting physical activity and fitness: A systematic review. *Int J Environ Res Public Health*. 17(1). doi:10.3390/ijerph17010347.

https://doi.org/10.20473/mgi.v19i3.259–267

A CASE CONTROL IN A SUB-URBAN AREA : MATERNAL HEIGHT AND NUTRITIONAL STATUS WITH THE INCIDENCE OF STUNTING AMONG TODDLERS

Nunung Cipta Dainy[1*], Walliyana Kusumaningati[1], Chica Riska Ashari[2], Rosyanne Kushargina[1]
[1]Faculty of Medicine and Health, Universitas Muhammadiyah Jakarta, Jakarta, Indonesia
[2]Faculty of Health Sciences, Universitas Muhammadiyah Prof. Dr. Hamka, Jakarta, Indonesia
*E-mail: nciptadainy@umj.ac.id

ABSTRACT

Indonesia is a country with a high incidence of stunting. In 2022, the prevalence of stunting in Bogor Regency was 24.9%, which was higher than the national average. The Padasuka subdistrict is recognized as a stunting locus area. Children's health is closely linked to the parenting style employed by their parents, particularly mothers. Therefore, this study aims to analyze the maternal factors contributing to the prevalence of stunting among toddlers. This study used an observational approach with a case-control design, conducted from December 2022 to August 2023 in Padasuka Village, Bogor Regency. Data collection encompassed anthropometric measurements, including the weight and height of toddlers and mothers, maternal characteristics such as age, education, and occupation, and nutritional status. The data were collected using questionnaires and interviews. The research sample consisted of 41 mothers of stunted toddlers (cases) and 41 mothers of normally developing toddlers (controls), resulting in a total of 82 participants. Bivariate analysis to explore the relationships between variables, as well as the chi-squared test and independent t-test to measure the differences in average height and nutritional status. The results of the analysis revealed that maternal height (p=0.000) and nutritional status (p=0.035) were significantly correlated with the incidence of stunting. In addition, there were notable differences in the average values of maternal height and nutritional status between the stunted group and the normally developing group with p-values of 0.038 and 0.040, respectively. Therefore, it can be concluded that maternal height and nutritional status contribute to the incidence of stunting among toddlers.

Keywords*: height, mother, nutritional status, stunting, urban*

INTRODUCTION

According to the World Health Organization (WHO), stunting is defined as a condition where a toddler's length or height falls below the age standard as measured on the standard deviation (SD) scale, placing them below the median length or height of the general population. Stunting occurs when a toddler's length or height falls below -2 SD from the median body length or height for their age as stipulated by the Indonesian Ministry of Health in 2018. This condition can manifest from before birth (in utero) until the age of 2 years, with visible symptoms typically emerging after the toddler reaches the age of 2 years. The age of 0-24 months is a critical period in a child's growth because malnutrition during this period can result in long-term and often irreversible consequences. Therefore, it is important to ensure that toddlers receive sufficient nutritional intake during this period to mitigate this risk (1).

Indonesia faces a significant problem of high incidence of stunting among its children. In 2022, the prevalence of stunting was 21.6%, indicating that more than one-fifth of Indonesian children experience stunting, a condition with serious implications for their health and overall development (2). In response to this issue, the government has formulated policies to address stunting, with focus areas (locus) at the village and subdistrict levels. The prevalence of stunting in West Java remains high at 20.2% (2). Within West Java, Bogor Regency boasts the largest population and bears a prevalence of stunting at 24.9%, higher than the national average (2).

Padasuka Village is designated as one of the stunting locus areas within Bogor Regency,

 Received 10-11-2023, Accepted 29-05-2024, Published online 30-09-2024.

as established by the 2021 Decree of the Bogor Regent. According to the 2021 Family Data Collection, the risk of stunting in Padasuka Village affects 2,013 families, or 41.7% of the population (3). This status underscores the urgency of addressing the issue of stunting in Padasuka Village as a top priority.

Padasuka Village consists of 14 community associations (*rukun warga*/RW) and has 18 integrated health service posts (*pos pelayanan terpadu*/*posyandu*) with a total of 96 cadres. In addition to these cadres, Padasuka Village has one family planning cadre and 23 family welfare program *(pemberdayaan kesejahteraan keluarga*/ PKK) cadres, and has formed a stunting reduction acceleration team (*tim percepatan penurunan stunting*/TPPS). The services provided by the integrated health service posts in Padasuka Village are administered under the supervision and guidance of the Laladon Community Health Center (*pusat kesehatan masyarakat*/ *puskesmas*). Padasuka Village covers an area of 132.8 ha, with boundaries adjoining Bogor City in the north, east, and southeast. This strategic location endows Padasuka Village with considerable economic potential. To the west and south, Padasuka Village shares borders with Dramaga Subdistrict and Tamansari Subdistrict, which are known for their potential agricultural lands. Padasuka Village benefits from easy access to transportation, with both urban public transportation and online-based alternatives available. The village's topography is marked by a dense population, amounting to 18,944 people. Of this population, 1,513, or 8% of the total population are babies and toddlers (4). Based on its characteristics, Padasuka Village falls into the suburban area category.

Maternal characteristics play an important role in influencing the incidence of stunting in children. These characteristics include diet, nutritional status, access to prenatal health services, and educational level. The health and nutritional status of a mother during pregnancy has a significant impact on fetal growth. Mothers who experience malnutrition, both undernutrition and overnutrition, can influence fetal growth, thereby increasing the risk of stunting in their children (5). In addition, the educational level of a mother can influence their knowledge and behaviors related to nutrition, healthcare, and family meal patterns. Mothers with lower educational levels may have limited knowledge about proper nutrition and optimal childcare (6–8).

Furthermore, the employment status of a mother can contribute to the incidence of stunting in their children (7). Mothers with busy work schedules or extended work hours may have limited time to provide adequate care to their children. This lack of time spent with children can affect the children's dietary intake, overall care, and attention. The employment status of a mother also influences her income level, which, in turn, affects access to the economic resources required to meet children's nutritional needs, such as nutritious food, clothing, healthcare, and adequate sanitation facilities. (8). Therefore, this study aims to analyze maternal characteristics contributing to the incidence of stunting in a suburban area, with the aim of tailoring intervention programs for more focused and impactful efforts in addressing the issue of stunting in the area.

METHODS

This study used an observational approach with a case-control study design, and was conducted from December 2022 to June 2023. This study involved activities such as field preparation, research instrument preparation, data collection, as well as data processing and analysis. This study was carried out in Padasuka Village, Ciomas Subdistrict, Bogor Regency. The tools utilized included writing and interview equipment, body scales, and microtoises to measure anthropometric data.

The minimum sample size was calculated using the sample size calculator for case-control studies available at sampsize.sourceforge.net. Information about the odds ratio (OR) value and the percentage of controls exposed to the variables of interest was entered into the software. According to Yanti (2022), with a minimum OR of 9.33, a power of 90%, and an alpha level of 5%, the minimum sample size required was 40 individuals per group or a total of 80 participants (9). The sample inclusion criteria were boys and girls aged 6-59 months residing in Padasuka Village, Ciomas Subdistrict, Bogor Regency, and their parents were willing to participate in this study. For the case group, the children had stunting nutritional status based on height-for-age with a Z-score of less

than -2.00. For the control group, the children had normal nutritional status based on height-for-age with a Z score of equal to or more than -2.00. Data on stunted children (cases) and normal children (controls) were obtained from the health center. Researchers took repeated height measurements at the time of the study. The exclusion criteria for this study were children who had congenital disabilities, physical and/or mental abnormalities, and a history of chronic diseases. Based on these criteria, the number of samples in each group was 41 individuals or a total of 82 participants. The sampling procedure is outlined in Figure 1.

In this study, the dependent variable was the nutritional status of toddlers, while the independent variables were their mothers' age at birth, height, nutritional status, educational level, and employment status. Measurement of the nutritional status of children and mothers was carried out at the time of the study. Children's nutritional status variables were categorized into normal and stunting (10), while mothers' nutritional status was categorized based on the IMT classification according to the Ministry of Health 2014 (11). Data obtained from interviews and measurements were tabulated, averaged, and subjected to descriptive analysis to assess the univariate data of each variable. The data used in the univariate analysis were the mean values and standard deviations. Subsequently, a correlation test was conducted using the chi-Square test, and a comparison test was conducted using an independent t-test to examine the differences in average age, height, and nutritional status between mothers in the case group and mothers in the control group. All statistical analyses were performed using SPSS 16 for Windows. This study received ethical approval from the Health Research Ethics Committe, Faculty of Medicine and Health, Universitas Muhammadiyah Jakarta (Certificate No.18/PE/KE/FKK-UMJ/II/2023).

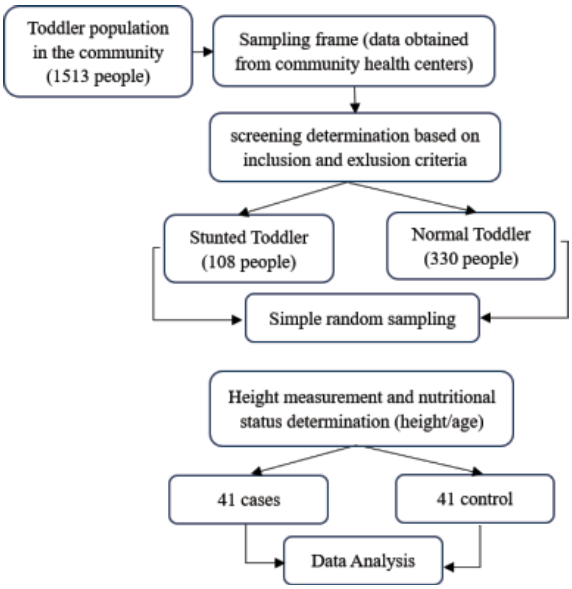


Figure 1. Sampling procedure.

RESULTS AND DISCUSSION

The characteristics of mothers of children under five in this study are presented in Table 1. A significant percentage of mothers in both the stunted (24.39%) and normal (26.82%) groups gave birth at an age considered risky. The age at which mothers gave birth ranged from 17 to 43 years. In terms of educational level, a majority of mothers in both groups had completed high school. More mothers in both gorups had higher education levels compared to those with only elementary and junior high school education levels. Regarding their employment status, most mothers in both were identified as housewives. When assessing the nutritional status of mothers in the stunted toddler group, it was observed that the majority (46.34%) had a normal nutritional status, while a smaller percentage (14.63%) exhibited poor nutritional status. In contrast, the majority of mothers (63.41%) in the normally developing toddler group fell into the fat category for nutritional status. In terms of maternal height, the majority of mothers (51.21%) in the stunted toddler group were shorter than 150 cm, while the majority of mothers (90.24%) in the normally developing toddler group had a height exceeding 150 cm.

Table 2 shows that 24.4% of stunted toddlers had mothers in the risky age category at birth. However, this number did not significantly differ from the normally developing toddler group (26.8%) with a p-value of more than 0.05. These results align with the research by Kiik & Nuwa (2021), which also found no significant relationship between maternal age and the incidence of stunting ($p = 0.611$) (12). This suggests that maternal age may indirectly influence the incidence of

Table 1. Characteristics of the participants

Variable	Nutritional status (height-for-age)			
	Stunting		Normal	
	n	%	n	%
Mother's age at giving birth				
At risk (<20 years or >35 years)	10	24.4	11	26.8
Not Risky (20-35 Years)	31	75.6	30	73.2
Mother's educational level				
Elementary school	5	12.2	4	9.7
Junior high school	3	7.3	8	19.5
Senior high school	22	53.6	17	41.5
College	11	26.8	12	29.3
Mother's employment status				
Housewife	33	80.5	34	82.9
Employee	8	19.5	7	17.1
Mother's nutritional status (BMI)				
Thin (BMI <18.5)	6	14.6	1	2.4
Normal (BMI 18.5-25.0)	19	46.3	14	34.1
Obese (BMI >25)	16	39.0	26	63.4
Mother's height				
<150 cm	21	51.2	4	9.7
≥150 cm	20	48.8	37	90.2

Table 2. the relationship between maternal age at delivery and the incidence of stunting

Variable	Nutritional status (height-for-age)				Total		p-value
	Stunting		Normal				
	n	%	n	%	n	%	
Risky (<20 or >35 y.o)	10	24.4	11	26.8	21	25.6	0.800 OR = 0.880
Not Risky (20-35 y.o)	31	75.6	30	73.2	61	74.4	
Mean ± SD	31.2 ± 5.9		30.8 ± 5.8				0.808
Total	41	100	41	100	82	100	

stunting (13). It is possible that when maternal age is considered risky, it may be mitigated by maternal knowledge about infant care procedures, resulting in healthy child growth and development. Typically, mothers in urban areas have good education and knowledge, making them more likely to adhere to recommended prenatal care practices, such as antenatal visits and exclusive breastfeeding (14).

However, these results are different from several previous studies. For example, the research by Susilowati et al. (2019) showed that 40.5% of mothers who gave birth at an age considered risky were in the stunted group, compared to 27.0% in the normal group (15). This suggests a higher incidence of mothers at an age considered risky during pregnancy in the stunted group compared to the normal group. Maternal age is associated with a baby's birth weight. Young mothers may not have fully developed reproductive organs and physiological functions, increasing the risk of giving birth to low birth weight (LBW) babies, which, in turn, has a risk of causing stunting (16). According to the research by Wemakor et al. (2018), children of teenage mothers were eight times more likely to experience stunting (AOR = 7.56; 95% CI [4.20-13.63]), three times more likely to be underweight (AOR = 2.9; 95% CI [1.04-8.04]), and 13 times more likely to be undernourished (AOR 12.78; 95% CI [4.69-34.81]), compared to children of adult mothers (13). Maternal age at risk also carries a higher risk of maternal and fetal mortality during pregnancy, childbirth, or the postpartum period (17). A study in Yogyakarta revealed that maternal age at birth was the most significant factor related to the incidence of stunting, with a 3.6 times higher risk of giving birth to a stunted child for mothers aged less than 20 years compared to those aged between 20 and 35 (18).

Young mothers often face challenges in ensuring adequate food intake, accessing clean water, and maintaining favorable environmental conditions. They may find themselves competing with the fetus they are carrying for essential nutrients. In addition, young mothers may not be psychologically prepared for postnatal care, or they may lack the financial resources required to support their child's growth and development. Furthermore, the reproductive organs of young mothers may not function optimally compared to mothers aged between 20 and 35. These factors can hinder the growth and development of their children, ultimately contributing to stunting (13,18,19). A systematic review study revealed that teenage mothers, especially those aged under 20 years, had a significantly higher risk of stunting when compared to mothers aged over 20 years, with an

OR ranging from 3.41 to 9.97 for ages 13-17 years. The risk of stunting increases by 50% for pregnant women aged 13 years and gradually decreases by 20% until the mother reaches 27 years. Thereafter, the likelihood of stunting rises again for mothers aged 35 years. Children born to young mothers are at a heightened risk of experiencing poor health conditions such as diarrhea, anemia, malnutrition, wasting, and even infant mortality, compared to children born to older mothers (19).

Pregnant women over 30 years of age may experience a decline in their ability to digest certain nutrients, which can cause imbalanced nutritional intake and increased susceptibility to ilnesses due to decreased immunity. In addition, older mothers may experience reduced stamina during pregnancy, which can diminish their enthusiasm for prenatal care (17,18). This condition can increase the risk of stunting in children. However, advancements in medical and health sciences, coupled with improved healthcare infrastructure, hace the potential to reduce the risk of pregnancy and childbirth complications in mothers at ages considered risky (16).

Education is a learning process for individuals to achieve higher knowledge and understanding regarding specific subjects. This knowledge can be obtained formally, shaping their thought patterns and behaviors (Seftianingtyas, 2020). As a result, educational level also plays an important role in determining one's receptiveness to knowledge. Generally, higher levels of education are expected to facilitate the acquisition of information, particularly concerning nutrition. This study categorized maternal education into primary education (elementary to high school) and higher education (tertiary education).

Table 3. The relationship between mother's educational level and the incidence of stunting

Mother's educational level	Nutritional status (height-for-age)				Total		p-value
	Stunting		Normal				
	n	%	n	%	n	%	
Primary education (Elementary – high school)	30	73.2	29	70.7	59	72.0	0.806 OR = 1.129
Higher education (tertiary education)	11	26.8	12	29.3	23	28.0	
Total	41	100	41	100	82	100	

The results showed that maternal education was not associated with children's nutritional status, specifically stunting ($p = 0.806$; $p > 0.005$) (Table 3). This suggests that maternal education is not a direct variable that influences stunting. This finding aligns with the research by Dewi et al. (2022), which found that maternal education indirectly influenced toddlers' nutritional status. This research also revealed that the majority of mothers (73.2%) with primary education had children with stunted nutritional status. This indicates that mothers with higher education levels tended to be able to mitigate the risk of stunting, in accordance with the notion that education serves as a conduit for learning and mastering knowledge and skills.

Educational level also plays a significant role in determining one's receptiveness to knowledge. Consequently, individuals with higher education levels are generally better equipped to absorb nutritional information. Dewi et al. (2022) revealed that toddlers with parents who had higher education tend to have better nutritional status, which can be attributed to their parents' knowledge, motivation, and influence in providing nutritious meals. Parental education plays an important role in determining the ease with which individuals can absorb and understand the nutritional knowledge they have acquired, subsequently informing their meal preparation and child-rearing practices. The pattern of food preparation is closely related to a mother's knowledge of food ingredients, such as sources of carbohydrates, protein, fat, vitamins, and minerals (Seftianingtyas, 2020).

In line with the research by Firdaus et al. (2021), educational level can influence one's nutritional knowledge and skills, particularly in managing family members' dietary choices, thereby contributing to family food diversity. According to Suharjo (2009), one of the causes of nutritional problems is the low educational level within communities, which can hinder the acceptance of knowledge provided. Through education, mothers are expected to be better prepared to create balanced family meal plans,

Table 4. The relationship between mother's employment status and the incidence of stunting

Mother's employment status	Nutritional status (height-for-age)				Total		p-value
	Stunting		Normal				
	n	%	n	%	n	%	
Housewife	33	80.5	34	82.9	67	81.7	0.775 OR = 0.849
Employee	8	19.5	7	17.1	15	18.3	
Total	41	100	41	100	82	100	

which are a cornerstone for improving family well-being. Moreover, Lette et al. (2019) revealed that higher maternal education levels are associated with better child nutritional conditions.

Work is related to socioeconomic conditions, particularly income. According to Khairunnisa and Ghinanda (2022), a family's income greatly influences the extent to which their primary and secondary needs are met, including the attention and affection children receive as well as access to food. When family income increases, it is common for a significant portion of it to be allocated to obtaining additional food. Thus, income emerges as the predominant factor in determining the quantity and quality of food (Aulia et al., 2020).

A family's ability to buy food depends on the magnitude of their income. Families with limited income often face difficulties in fulfilling their dietary requirements, particularly with respect to meeting essential nutritional needs. Generally, with an increase in income, the quantity and variety of food tend to improve. Moreover, income determines the selection of food purchased with additional resources. The higher the income, the larger proportion of the income being allocated to buying food (Aulia et al., 2020). In other words, it can be concluded that occupation is one of the determinants of meeting a family's nutritional needs. This is related to access to food, that is, a family's ability to buy food to meet their nutritional needs.

The results of this study showed that maternal employment status had no significant relationship with stunting ($p = 0.775$; $p > 0.005$) (Table 4). This suggests that maternal employment status is not a direct variable that influences stunting. However, it can be noted that the majority of working mothers had children with stunted nutritional status (53.33%). Working mothers often have more limited time to care for their children than non-working mothers. This can affect parenting patterns, especially dietary habits, which ultimately affect a child's nutritional status. When a mother's work hours extend from morning to evening, she may have limited opportunities to attend to her child's dietary and nutritional requirements (Fauzia et al., 2019). Furthermore, Khairunnisa and Ghinanda (2022) revealed that this situation can be exacerbated if the child is entrusted to a caregiver who may not necessarily understand proper feeding practices. Alpin (2021) supported these results by showing that non-working mothers could prevent their toddlers from experiencing poor nutritional status compared to working mothers.

Nutritional status is important for both mothers and children. This study examined the relationship between maternal nutritional status and the incidence of stunting in children. The classification of maternal nutritional status by the child's nutritional status is presented in Table 5. In the stunted toddler group, six mothers had an underweight nutritional status, while in the normally developing toddler group, only one mother had an underweight nutritional status. The statistical analysis results showed a relationship between maternal nutritional status and the child's nutritional status ($p < 0.05$). In addition, the data in Table 5 shows a difference in the average maternal BMI values. It can be noted that lower maternal BMI values are associated with the risk of stunting in toddlers ($p < 0.05$).

Table 5. The relationship between mother's nutritional status and the incidence of stunting

Mother's nutritional status (BMI)	Nutritional status (height-for-age)				Total		p-value
	Stunting		Normal				
	n	%	n	%	n	%	
Thin (BMI <18.5)	6	14.6	1	2.4	7	8.5	0.035*
Normal (BMI 18.5-25.0)	19	46.4	14	34.2	33	40.3	
Obese (BMI >25)	16	39.0	26	63.4	42	51.2	
Mean ± SD	24.3 ± 5.3		26.6 ± 4.4				0.040**
Total	41	100	41	100	82	100	

*significantly associated with $\alpha < 0.05$ using chi square test
**significantly different with $\alpha < 0.05$ using independent t-test

Stunting can result from various factors, particularly in the context of Indonesia, with maternal nutritional status being one of the significant contributors, alongside breastfeeding practices, complementary food introduction, and susceptibility to infections (20). Mothers with a low nutritional status are at a heightened risk of developing anemia, especially during pregnancy (21). Anemia in pregnant women can lead to low birth weight (LBW) in newborns (22) and is a risk factor for stunting in toddlers (23). Dietary intake also plays a crucial role in shaping nutritional status. For mothers, especially pregnant women, their intake can substantially impact their nutritional status and that of their children (24). Previous research findings showed that a mother's vegetarian diet had a significantly correlation with stunting and wasting in children (25). Improving maternal health through dietary intake can lead to improvements in maternal nutritional status and a reduction in the risk of stunting in children (26). In other words, maternal health interventions, including maternal health services and dietary diversification, can reduce the risk of stunting and wasting in children (26).

Maternal height is a well-known risk factor for stunting in children (24). The classification of the mother's height by the child's nutritional status is presented in Table 6. The results of this study showed that 57 mothers had a height of equal to and taller than 150 cm, while 25 mothers were shorter than 150 cm. Moreover, most of the mothers in the stunted toddler group had a height of shorter than 150 cm (51.2%). In contrast, the toddler group with normal nutritional status had mothers with a height of equal to and taller than 150 cm (69.5%). In other words, the average maternal height in the stunted toddler group was lower than the normally developing toddler group (Table 6). Subsequent t-test analysis showed that the heights were significantly different, with a p-value of less than 0.05. The statistical analysis results show that maternal height was significantly correlated to the incidence of stunting in children ($p < 0.05$; OR = 9.713). This indicates that mothers whose height was shorter than 150 cm have a nine times greater risk of having stunted children.

Table 6. The relationship between mother's height and the incidence of stunting

Mother's height	Nutritional status (height-for-age)				Total		p-value
	Stunting		Normal				
	n	%	n	%	n	%	
<150 cm	21	51.2	4	9.8	25	30.5	0.000* (OR = 9.713)
≥150 cm	20	48.8	37	90.2	57	69.5	
Mean ± SD	150.6 ± 5.2		152.8 ± 4.1				0.038**
Total	41	100	41	100	82	100	

*significantly associated with $\alpha < 0.05$ using chi square test
**significantly different with $\alpha < 0.05$ using independent t-test

The results of this study align with previous studies (20,23,24). In Indonesia, stunting in children is associated with premature birth, LBW, non-exclusive breastfeeding, maternal stunting, low maternal educational level, low household socioeconomic status, poor hygiene and sanitation, and limited access to health services, and residents in rural areas (20). Short mothers have a higher risk of experiencing intrauterine growth restriction (27), a condition leading to suboptimal fetal growth due to inadequate nutritional transfer from the mother to the fetus during pregnancy. Intrauterine growth restriction is associated with reduced birth weight in children (28), impeding linear growth as well as affecting brain and cognitive development (29), which ultimately increases the risk of metabolic syndrome (30). Intrauterine growth restriction can be prevented by ensuring the mother's nutritional status at a healthy level, particularly during pregnancy. Normal maternal nutritional status will support optimal fetal growth and prevent maternal anemia (31).

CONCLUSION AND SUGGESTION

Characteristics of mothers in urban areas that are related to the incidence of stunting are maternal nutritional status and height. Meanwhile, maternal age, educational level, and employment status are not related to the incidence of stunting in urban areas. Maternal nutritional status in the stunted toddler group corresponds to a lower average BMI value, indicating that mothers with a low nutritional status tend to have stunted toddlers. In addition, mothers who are shorter than 150 cm are 9.713 times more likely to have stunted toddlers.

The results of this study underscore the importance of stunting prevention programs, with a particular emphasis on improving the nutritional status of adolescent girls because linear growth peaks at adolescence, giving young women the opportunity to reach optimal height.

ACKNOWLEDGMENT

The authors would like to thank the Institute of Research and Community Service of Universitas Muhammadiyah Jakarta (LPPM UMJ) for the internal grant funding for the fiscal year of 2023. The authors also extend their gratitude to the Undergraduate Nutrition Study Program of the Faculty of Medicine and Health of Universitas Muhammadiyah Jakarta (UKK UMJ) for providing in-kind facilities to conduct this study. Finally, the authors wish to convey their appreciation to the residents of Padasuka Village, Ciomas Subdistrict, Bogor Regency, and the cadres, particularly Mrs. Sri Damayanti, for their invaluable assistance and unwavering support, which significantly contributed to the smooth data collection process in this study.

REFERENCE

Rahayu A, Yulidasari F, Putri AO, Anggraini L. Study Guide - Stunting dan Upaya Pencegahannya. Buku stunting dan upaya pencegahannya. 2018. 88 p.

SSGI. Hasil Survei Status Gizi Indonesia. Kementeri Kesehat Republik Indones [Internet]. 2022;1–99. Available from: https://promkes.kemkes.go.id/materi-hasil-survei-status-gizi-indonesia-ssgi-2022

BKKBN. Laporan Pendataan Keluarga (PK) 2021 [Internet]. Jakarta; 2021. Available from: https://portalpk21.bkkbn.go.id/laporan/tabulasi

AIPGI. Inisiasi Pemetaan Sosial dan Pendampingan Percepatan Penurunan Stunting di Kelurahan Padasuka Kabupaten Bogor. Bogor; 2022.

Wanimbo E, Wartiningsih M. Hubungan Karakteristik Ibu Dengan Kejadian Stunting Baduta (7-24 Bulan) Di Karubaga. J Manaj Kesehat Yayasan RSDr Soetomo. 2020;6(1):83.

Agustiningrum T, Rokhanawati D. Hubungan Karakteristik Ibu Dengan Kejadian Stunting Pada Balita Usia 24-59 Bulan Di Wilayah Kerja Puskesmas Wonosari I. Univ 'Aisyiyah Yogyakarta [Internet]. 2016;1–6. Available from: http://digilib.unisayogya.ac.id/2146/1/NASKAH PUBLIKASI.pdf

Safitri S, Purwati Y, Warsiti S, Keb M, Mat S. Tingkat Pendidikan dan Status Pekerjaan Ibu Dengan Kejadian Stunting pada Anak: Literature Review. Semin Nas Kesehat [Internet]. 2021;67(67):2021. Available from: http://digilib.unisayogya.ac.id/5649/

Fauzi Muhamad, Wahyudin A. Hubungan Tingkat Pendidikan dan Pekerjaan Ibu Balita dengan status gizi balita di Wilayah Kerja Puskesmas X Kabupaten Indramayu. Pros Semin Nas Kesehat [Internet]. 2020;2(1):13. Available from: http://ejurnal.stikesrespati-tsm.ac.id/index.php/semnas/article/view/257

Yanti N. Faktor - Faktor Yang Mempengaruhi Kejadian Stunting pada Anak Usia 2 - 5 Tahun di Puskesmas Ubud 1 Gianyar Prevalensi stunting di Provinsi Bali. 2022;2(1):26–34.

Kemenkes R. PERATURAN MENTERI KESEHATAN REPUBLIK INDONESIA NOMOR 2 TAHUN 2020 TENTANG STANDAR ANTROPOMETRI ANAK. 2020.

Kemenkes Rl. Peraturan Menteri Kesehatan Republik Indonesia Nomor 41 Tahun 2014 tentang pedoman gizi seimbang. 2014 p. 96.

Kiik SM, Nuwa MS. Maternal factors in stunting among vulnerable children. J Keperawatan Indones. 2021;24(2).

Wemakor A, Garti H, Azongo T, Garti H, Atosona A. Young maternal age is a risk factor for child undernutrition in Tamale Metropolis, Ghana. BMC Res Notes. 2018;11(1).

Suja MDD, Puspitaningrum EM, Bata VA. Tingkat Pendidikan Ibu dan Keberhasilan ASI Eksklusif di Perkotaan Indonesia: Analisis Data IFLS 5. J Keperawatan Sumba. 2023;1(2):71–9.

Susilowati, Astria Setiawan Y, Akbar Budiana T. Relationship of mother factors and stunting incidence in children (24-59 months) in Buniwangi Village, work area of Pagelaran public health center, Cianjur Regency. Third Int Semin Glob Heal. 2019;3(1).

Trisyani K, Fara YD, Mayasari AT, Abdullah. Hubungan faktor ibu dengan kejadian stunting. J Matern Aisyah (JAMAN AISYAH). 2020;1(3).

Wati EK, Wahyurin IS, Sari HP, Zaki I, Dardjito E. Stunting Incidence in Infant Related to Mother's History During Pregnancy. Kemas. 2022;17(4).

Kurniawati A, Sujiyatini, Saputro NT. Association of maternal age during pregnancy with stunting in children age 2-3 years. Inf dan Promosi Kesehat. 2022;1(2).

Astuti FD, Azka A, Rokhmayanti R. Maternal age correlation of stunting in children: Systematics review. J Matern Child Heal. 2022;7(4):479–448.

Beal T, Tumilowicz A, Sutrisna A, Izwardy D, Neufeld LM. A review of child stunting determinants in Indonesia. Matern Child Nutr. 2018;14(4):1–10.

Davidson SM, Mangalik G, Riswandha RI. Factors Affecting the Incidence of Anemia in Pregnant Women at Ampel and Gladagsari Public Health Center Boyolali Regency in 2019. PLACENTUM J Ilm Kesehat dan Apl. 2022;10(2):88.

Yin S, Zhou Y, Li H, Cheng Z, Zhang Y, Zhang L, et al. Association of maternal BMI during early pregnancy with infant anemia: A large Chinese birth cohort. Nutr Metab. 2020;17(1):1–8.

Podungge Y, Yulianingsih E, Porouw HS, Saraswati E, Tompunuh MM, Claudia JG, et al. Determinant factors of stunting in under-five children. Open Access Maced J Med Sci. 2021;9.

Hanum F. Khomsan A HY. Hubungan asupan gizi dan tinggi badan ibu dengan status gizi anak balita. J Gizi dan Pangan. 2019;9(1).

Headey DD, Palloni G. Stunting and Wasting among Indian Preschoolers have Moderate but Significant Associations with the Vegetarian Status of their Mothers. J Nutr. 2020;150(6):1579–89.

Kofinti RE, Koomson I, Paintsil JA, Ameyaw EK. Reducing children's malnutrition by increasing mothers' health insurance coverage: A focus on stunting and underweight across 32 sub-Saharan African countries. Econ Model. 2022;117.

Daniels SR. The Barker hypothesis. J Pediatr. 2016;173(March):1–3.

Varga O, Harangi M, Olsson IAS, Hansen AK. Contribution of animal models to the understanding of the metabolic syndrome: A systematic overview. Vol. 11, Obesity Reviews. 2010.

Tauber M. Final height and intrauterine growth retardation. Ann Endocrinol (Paris). 2017;78(2).

Barker DJP. The origins of the developmental origins theory. J Intern Med. 2007;261(5):412–7.

Neha, Rao SS, Shantharam Baliga B, Mithra P, Manjrekar P, Kamath N. Influencing variables for fetal growth in malnourished mothers: A nested case-control study. Clin Epidemiol Glob Heal. 2020;8(2).

THE RELATIONSHIP BETWEEN WATCHING MUKBANG AND STRESS LEVEL WITH EATING PATTERNS IN ADOLESCENTS

Salwa Salsabillah[1], Noerfitri[1]*
[1]Program S1 GIZI, STIKes Mitra Keluarga, Bekasi, Indonesia
*E-mail: noerfitri@stikesmitrakeluarga.ac.id

ABSTRACT

In adolescence, unhealthy eating habits are sometimes formed, because teenagers usually have preferred food choices. Many teenagers think that by eating a lot and having a full stomach, their nutritional needs are met. Unregulated eating habits can be affected by stress. The current trend is watching "mukbang", the stimulus generated in the form of sound can affect eating behavior. This study aims to determine the relationship between watching mukbang and stress levels and eating patterns in adolescents. The design of this study was a cross sectional study that was conducted at PB Soedirman Islamic High School in Bekasi. There were 138 people aged 16–18 years, who were selected by consecutive sampling. Data collection used the Mukbang Addiction Scale (MAS), Perceived Stress Scale (PSS), and FFQ. Based on the results of the Chi-Square statistical test, a p-value of 0.193 was obtained with an OR of 1.565 for the relationship between the habit of watching mukbang and eating patterns, and a p-value of 0.022 with an OR of 2.258 for the relationship between stress levels and eating patterns. The conclusion of this study is that there is no significant relationship between the habit of watching mukbang and eating patterns, and there is a significant relationship between stress levels and eating patterns in adolescents at PB Soedirman Islamic High School, Bekasi.

Key words*: eating patterns, mukbang, stress level, teeneger*

INTRODUCTION

Adolescence is a transitional period between childhood and adulthood, and during this period there are rapid changes in physical, cognitive, and behavioral development (Adriani and Bambang, 2016). Adolescents are a group of individuals who are in search of identity and who like to imitate and admire attractive idols. Dissatisfaction with one's appearance can determine the eating habits and nutritional status of most adolescents (Brown et al., 2017).

In adolescence, unhealthy eating patterns are sometimes formed because adolescents often have preferred food choices. Many adolescents feel that their nutritional needs can be met simply by eating a lot and filling their stomachs (Mardalena, 2017). According to the World Health Organization (2014), there has been a change in diet, namely increased consumption of fast food that is high in energy, high in fat and sugar, but low in vitamins, minerals, and other micronutrients. Based on Riskesdas (2018), it shows that the habits of Indonesian adolescents aged 15–19 years consume sugary foods, sugary drinks, and fatty/cholesterol/ fried foods more than once a day 41%, 56.43%, and 43.8%, respectively.

Irregular eating patterns can affect the nutritional status of adolescents, resulting in overnutrition or undernutrition (Kadir, 2016). According to Riskesdas (2018), the prevalence of very thin and thin adolescents aged 16–18 years in Indonesia based on BMI/A was 1.4% and 6.7%, respectively, while the prevalence of fat and obesity was 9.5% and 4%. In West Java Province, the prevalence of very thin and thin adolescents aged 16–18 years based on BMI/A is 1.4% and 5.6%, while the prevalence of fat and obesity is 10.9% and 4.5%. Meanwhile, in Bekasi City, the prevalence of very thin and thin adolescents aged 16–18 years based on BMI/A was 2.24% and 4.90%, while the prevalence of fat and obesity was 11.28% and 6.13% (Riskesdas, 2019).

Based on the results of research conducted by Marhama (2015), it shows that irregular eating habits can be influenced by stress. Stressed people tend not to pay attention to their diet, which can cause weight gain or loss. According to Syamsuddin (2017), the causes of stress in

 Received 15-11-2023, Accepted 27-08-2024, Published online 30-09-2024.

adolescents are many, including internal and external life demands that can put pressure beyond their abilities, which can cause physical or mental stress, reduced stamina, and emotional outbursts. Stress that often occurs in adolescents is caused by the need to learn and the perception of it as a distraction. Academic stress is caused by academic stressors sourced from the learning process (Rahmawati, 2015). This situation is a stressor for adolescents that can trigger stress that affects diet.

The results of research conducted by Aulia and Lilik (2018), show that media exposure can influence the eating choices of adolescents who are easily influenced by current trends, one of which is the broadcast of eating in large portions or mukbang (Margawati et al., 2020). Mukbang videos feature large amounts of food, usually done while chatting casually with viewers who are disseminated through social media (Strand and Sanna, 2020). Mukbang videos featuring large quantities of food, often prepared in the community, are disseminated through social media (Strand and Sanna, 2020). Attractive mukbang videos can arouse a person's appetite, influencing their eating behavior and food intake. This is in accordance with research conducted (Amalia et al., 2021), which shows that there is a relationship between viewing habits and changes in eating behavior in individuals who follow mukbang accounts on Instagram ($p = 0.003$). According to Saftarina and Devita (2016), a person's desire to eat can also be influenced by stimuli in the form of sound. If this stimulus affects eating behavior, it will become a risk factor for overeating (Margawati et al., 2020).

Based on the description above, the researcher is interested in conducting research related to "The Relationship between Watching Mukbang and Stress Level with Diet in Adolescents at PB Soedirman Bekasi Islamic High School." Researchers chose PB Soedirman Bekasi Islamic High School as the location to be studied, because it is strategically located near culinary places and has a variety of social, economic, and cultural backgrounds and lifestyles.

METHODS

This study is a community nutrition research with observational design and cross sectional design. The subjects in this study were students of PB Soedirman Islamic High School Bekasi. Subjects included adolescents aged between 16 - 18 years. The number of respondents in this study was 138. This research was conducted in March 2023. The sampling technique used was Non Probability Sampling using the Consecutive Sampling method. This research has passed the Health Research Ethics Committee of Muhammadiyah Prof. Dr. Hamka University (KEPKK-UHAMKA) at number : 23/03/02336.

Subject retrieval began by asking directly in class, then selecting subjects who fit the inclusion criteria to get 138 subjects. Inclusion criteria include students who are active as students from PB Soedirman Bekasi Islamic High School aged 16–18 years, students who are willing to become respondents, students who have watched mukbang in the past month, and students who are not sick. Exclusion criteria are sick subjects, students who are on a certain diet, and students who are not willing to fill out the questionnaire.

The study examined the independent variables of watching mukbang and stress levels, with eating patterns as the dependent variable. This research was conducted directly. Before filling out the questionnaire, the researcher gave informed consent for approval to become a research subject. Then the research subject was asked to fill out a questionnaire.

The watching mukbang was obtained using the MAS (Mukbang Addiction Scale) questionnaire, which assessed the addiction of watching mukbang over the past week. The questionnaire a list of eight types of habit of watching mukbang. The form has been validated for high school martia bhakti which is located in the same region. Habit of watching mukbang frequency was classified as frequently (0-4 times/week) or rarely (>4 times/week). This classification was based on modifications from research that also used a sample of college students (Fayasari et al., 2022). Stress level data was obtained using the PSS-10 (Perceived Stress

Scale-10) questionnaire. which assesses stress level over the past month. The form has been validated for high school martia bhakti which is located in the same region. The questionnaire a list of ten types of stress level. A PSS total score of twenty or greater than is considered severe, while a score less twenty is considered mild. This classification was based on modifications from research that also used a sample of high school students (Mulyono, 2020).

Eating patterns was collected using a food frequency questionnaire (FFQ), which assessed the frequency of consumption over the past month. . The form has been validated for high school martia bhakti which is located in the same region. A FFQ total score greater than two hundred and thirty five is considered enough, while a score of two hundred and thirty five or less is considered not enough (margawati et al., 2022).

Microsoft Excel and SPSS were used for data processing and analysis. Editing, coding, processing, and cleaning were the primary stages of data processing in this study. This study used univariate and bivariate analyses. Univariate analysis was used to determine the frequency distribution of subject characteristics (gender, grade, pocket money), watching mukbang, stress level, and student eating patterns. Bivariate analysis was used to determine the relationship between watching mukbang and eating patterns, using the Chi-Square test.

RESULTS AND DISCUSSIONS RESULTS

According of Table 1, it can be seen that the total sample of 138 people conducted a normality test on the age variable of all data that has been inputted. The normality test results obtained from the data are p-value > 0.05 which can be concluded that the data is not normally distributed. Therefore, the age variable uses the median and interquartile range indicators. The median age of adolescents is 16.00 years, with an interquartile range variation of 1 between 16.00 and 17.00.

Table 1. Subject Age

Variable	n	Median	*Interquartile Range*
Age	138	16.00	17.00 – 16.00

Table 2. Subject Characteristics

Subject Characteristics	n	(%)
Gender		
Male	33	23.9
Female	105	76.1
Grade		
X	69	50
XI	69	50
XII	0	0
Pocket Money		
High	128	92.8
Low	10	7.2
Total	**138**	**100**

The characteristics of the subjects, including gender, grade, and pocket money are shown in Table 2. According to the table, the majority were female 76.1%. Grade X and XI with a balanced number 50%. Students with high pocket money were 92.8% and students with low pocket money category were 7.2%.

According to Table 3, 55.1% of students watching mukbang frequently and 44.9% of students watching mukbang rarely. Based on the analysis, students of high school watching mukbang frequently. According to the researcher, a study stated that a mukbang can meet some of the psychological needs of individuals (Kircaburun et al., 2021). A person watching a mukbang can mitigate loneliness and social alienation in real life by making them feel emotionally connected to other viewers and Broadcast Jockey (Choe, 2019).

According to Table 3, 62.3% of students have severe stress level while the remaining 37.3% have mild stress level. Based on the analysis, most students at high school PB Soedirman Bekasi have a severe stress level. The causes of stress are different for everyone. Internal factors refer to factors that can cause stress in the individual itself, such as their physical condition, motivation, and personality type (Gamayanti et al., 2018). External factors usually come from outside the individual, like family, work, facilities, the environment, or a lecturer. (Sutjiato et al., 2015).

According to the researcher, it can be triggered by the many activities and basic tasks performed by students, which are also accompanied by learning activities. One of them at Islamic High School,

Table 3. Frequency Distribution of watching mukbang, stress level and eating patterns among PB Soedirman Bekasi Students

Variable	n	(%)
Watching Mukbang		
Frequently	76	55.1
Rarely	62	44.9
Stress Level		
Severe	86	62.3
Mild	52	37.7
Eating Patterns		
No Enough	74	53.6
Enough	64	46.4
Total	**138**	**100**

Table 4. Association between of Watching Mukbang and Stress Level with Eating Patterns

Variable	Eating Patterns				*p value*
	No Enough		Enough		
	n	(%)	n	(%)	
Watching Mukbang					
Frequently	44	57.9	32	42.1	0.193
Rarely	29	46.8	33	53.2	
Stress Level					
Severe	52	60,5	34	39.5	0.022
Mild	21	40.4	31	59.6	

PB Soedirman has implemented an independent curriculum where there is no longer a science, social, or language for grade X and the students are allowed to choose the subjects of the group of choice at grades XI and XII. Therefore, in grade X, they have to study all the topics of both the natural sciences and social sciences, as well as languages and religion, which includes reading and memorizing activities. When these activities are accompanied by tasks, the pressure on respondents tends to be greater. It's one of the factors that makes respondents feel stressed (Kemendikbud RI, 2022).

According to Table 3, 53.6% of students with no enough eating patterns, while 46.4% of students whitin an enough eating patterns. Based on the analysis, most students at high school PB Soedirman Bekasi have a no enough eating patterns. According to the researcher, though most teenagers have a good diet, the high consumption of high-sugar, low-fruit, and high-level junk foods can worsen the nutritional status of their future teenagers (Thania and Wardani, 2023). The irregular diet that is developing today is low-carbohydrate, low-raw-fiber, and high fat. This results in the body's intake of nutrients that are not in line with the needs of balanced nutrition. (Irfani and Noerfitri, 2021).

Based on Table 4, the Chi-Square test analysis revealed no significant association between the watching mukbang and eating patterns of high school PB Soedirman Bekasi (p=0.193). There was no significant association between watching mukbang and eating patterns because confounding factors were not examined, including genes, sleep duration, physical activity, psychological health problems, body preferences, family income, and parental education level. Watching mukbang may be an indirect factor affecting appetite, eating patterns, and nutritional status. (Thania and Wardani, 2023).

A study of Diponegoro University students showed that respondents enjoyed watching mukbang, but respondents did not want to buy food immediately after watching the video. In addition, pocket money has a greater impact on a person's eating habits as they tend to buy food in excess. Some people change their eating habits at the beginning of the month and save at the end of the month, thus making eating habits unstable and affecting access to food (Margawati et al., 2020).

One of the reasons people watch mukbang is as entertainment, the sounds produced during mukbang can provide a sensory response for some viewers that can lead to happiness (Choe, 2019; Pettit, 2019; Woo, 2018). Thus, they become more interested in the sounds produced by the act of eating in the consumption itself (Schwegler-Castañer, 2018). Watching mukbang can also provide viewers with an escape mechanism that the real world seeks with different social, and entertainment features, especially those videos where BJs talk and interact about their daily lives, which might distract viewers from their own real-life problems and unpleasant realities (Hong and Soejang, 2017).

According to the data obtained by researchers, the reasons why respondents watch mukbang are mostly for entertainment or personal satisfaction. A study of DKI Jakarta students found that 278

students (67.3%) watched mukbang videos while eating. They do it because they want to entertain themselves, pass the time, and get personal satisfaction (Fayasari et al., 2022). When one is stressed, one way to relieve stress is to watch mukbang videos, as watching someone eat can help relieve stress due to a fast-paced and highly competitive lifestyle, such as pressure in studying and public and work responsibilities. One can feel satisfied watching someone eat (Husna and Rashad, 2015).

Based on Table 3, the Chi-Square test analysis revealed a significant association between stress level and eating patterns in high school PB Soedirman Bekasi (p=0,022). Based on the results of the study, there is a relationship between respondents' eating behavior and their stress level. The higher the stress level, the more negative the eating behavior. There is evidence that stress can lead to eating disorders, manifested by decreased or increased appetite. People with certain characteristics tend to snack more and increase their overall food intake when they are stressed. An unsettled mood leads individuals to choose to escape by consuming large amounts of energy-dense foods, as food has been shown to produce feelings of comfort. Stress can also cause appetite to decrease as the mood does not support the body's food intake (Defie and Enny, 2018).

The stress response is divided into two categories: eustress and distress. Eustress is a positive response to stress, while distress is a negative response to stress. One of the common coping strategies for stress is eating. Often, individuals choose to eat not because they are hungry but to improve their mood and minimize discomfort due to stress. This is in accordance with previous research conducted by Gori and Kustanti (2019), which suggests that eating something during stress is a form of compensation that aims to relieve stress because it provides mental comfort.

There are two types of changes in eating behavior due to stress. Some people eat more when stressed (emotional eaters), and conversely, some people eat less or are not affected by stress (non-emotional eaters). A person under stress tends to lose their appetite or otherwise overeat, which will affect changes in their nutritional status. Stress can stimulate the release of norardenalin and corticosteroid-releasing hormone (CRH), which can decrease appetite, and cortisol, which can increase appetite. (Sominsky and Spencer, 2014).

The analysis showed that adolescents consumed carbohydrates, protein, and fiber from vegetables. However, the carbohydrate sources favored by adolescents turned out to have approximately the same nutritional content, such as noodles, white rice, white bread, and cookies. This finding is in line with Insani's (2019) research, which showed that rice, noodles, and potatoes are the staple foods most consumed by adolescents.

Adolescents at PB Soedirman Bekasi Islamic High School usually only consume certain types of protein, such as chicken, eggs, and cow's milk, which contain many growth-supporting nutrients and not much fat or sugar (Ministry of Health of the Republic of Indonesia, 2020). According to another study, tofu and tofu are the sources of vegetable protein most consumed by adolescents (Insani, 2019).

In terms of vegetable consumption, the adolescents in this study consumed a variety of vegetables, especially spinach, carrots, and kale. These vegetables tend to be easily available and cheap. Eating fruits and vegetables is important because they contain substances that help strengthen the immune system, such as vitamins A, B6, C, E, and folic acid. Vegetables are also rich in minerals and fiber that help maintain body and organ functions. Fruit consumption among adolescents varies widely (Ministry of Health, 2020). Bananas, oranges, apples, and papayas are the most consumed fruits. Fruits, especially colored ones, are rich in vitamins A and C, minerals, fiber, and antioxidants that are important for maintaining a healthy body (Kemenkes RI, 2020).

In addition, adolescents who participated in the study also frequently consumed high-sugar beverages such as tea and coffee. Weight gain and the risk of developing type 2 diabetes may be associated with consuming too much sugar (MOH, 2014). Adolescents also often consume foods that are low in nutrients, high in calories, and high in sodium. Fast food, or junk food, is a favorite in social situations because it tastes good, is served quickly, and is relatively cheap (Agustina et al., 2021). In addition, they can even be purchased through online applications. Too much junk food

can increase body fat and increase the risk of diabetes, obesity, cancer, coronary heart disease, and other diseases (Kemeskes RI, 2014; Riskesdas, 2018).

The diet carried out by most subjects is included in the deficient category, because subjects consume a lot of high-sugar drinks, consume less fruit, and consume a lot of junk food, which can reduce the quality of the subject's nutritional condition in the future (Thania and Wardani, 2023). Irregular eating habits that are now developing include a diet low in carbohydrates, low in crude fiber, and high in fat. This causes the absorption of nutrients received by the body to be inappropriate according to the principles of a balanced diet (Irfani and Noerfitri, 2021).

CONCLUSION

There is no significant relationship between watching mukbang and eating patterns in adolescents at PB Soedirman Bekasi Islamic High School, with a p-value of 0.193 ($p>0.05$). There is a significant relationship between stress levels and eating patterns in adolescents at PB Soedirman Bekasi Islamic High School, with a p-value of 0.022 ($p <0.05$). It is hoped that future researchers can expand the research site, add the duration of watching mukbang to the questionnaire, and add factors that affect research variables such as age, peer influence, social media, and socioeconomics.

ACKNOWLEDGEMENT

Thank you to the lecturers who have provided input, direction, and motivation for this research. Thanks to the school, all young men and women, and those who helped in this research.

REFERENCES

Adriani, M. & Bambang, W. (2016). The Role of Nutrition in the Life Cycle. First. Jakarta: Prenada Media.

Agustina, H., Andi. E.P., Hendsun H., Heiddy C.S., & Yohanes, F. (2021). Changes in Weight, Body Mass Index, and Nutritional Status between Before and During the COVID-19 Pandemic Due to Distance Learning. Journal of Medika Hutama, 9(1), 97 - 113.

Amalia, D. S., Rachmanida, N., Nazhif, G., Dudung, A., & Laras, S. (2021). The Relationship between Mukbang Watching Habits, Nutrition Knowledge and Stress Levels with Changes in Negative Eating Behavior in Mukbang Fans on Instagram Social Media. Journal of Nutrition College, 10(2), 105 - 111.

Aulia, L. & Lilik, N. Y. (2018). Family, Media, and Friend Factors in Food Selection in PPKU IPB Students. Journal of Family and Consumer Sciences, 11(1), 37 - 48.

Brown, J. E. (2017). Nutrition Through the Life Cycle Sixth Edition. www.cengage.com/highered. Accessed on August 31, 2022.

Choe, H. (2019). Eating together multimodally: Collaborative eating in mukbang, a Korean livestream of eating. Language in Society, 1 - 38.

Defie, R., & Enny, P. (2018). Relationship between Stress Level, Smoking Behavior and Energy Intake in College Students. Diponegoro Medical Journal, 7(2), 507 - 526.

Fayasari, A., Mirta, N. G. & Tri, A. K. (2022). Mukbang Watching Behavior and Food Preference in University Students in Jakarta. Journal of Health Sciences, 16(2), 220 - 227.

Gori, M., & Ch, Y. M. (2019). Qualitative Study of Emotional Eating Behavior of Iv Level Students of the Bachelor of Nursing Study Program at Stikes Bethesda Yakkum Yogyakarta in 2018. Journal of Health, 6(2), 88 - 98.

Hong, S. & Sojeong, P. (2017). Internet Mukbang (Foodcasting) in South Korea. *Internet Mukbang (Foodcasting) in South Korea*, 111 – 123.

Husna, H. & Rashad, Y. (2015). The Review of Mokbang (Broadcast Eating) Phenomena and Its Relations with South Korean Culture and Society', *International Journal of Management, Accounting and Economics*, *2*(5), 443 – 455.

Irfani, F. D. & Noerfitri. (2021). The Relationship of Body Image with Fat Intake and Exercise Habits during the Covid-19 Pandemic among Students of STIKES Mitra Keluarga Bekasi. Jurnal Mitra Kesehatan, 3(2), 52-59.

Insani, H. M. (2019). Analysis of Adolescent Food Consumption in the Viewpoint of Sociology. Sosietas, 9(1), 566-577.

Kadir, A. (2016). Eating Habits and Eating Pattern Disorders and their Effect on Adolescents' Nutritional Status', Journal of Educational Publications, 6(1), 49 - 55.

Ministry of Health, RI. (2014). Regulation of the Minister of Health of the Republic of Indonesia

Number 41 Year 2014. Jakarta: Ministry of Health of the Republic of Indonesia.

Ministry of Health, RI. (2020). Guidelines for Balanced Nutrition during the COVID-19 Period. Jakarta : Ministry of Health of the Republic of Indonesia.

Mardalena, I. (2017). Basics of Nutrition Science in Nursing. First Edition. Yogyakarta: New Library Press.

Margawati, A. Hartanti, S. W., Nur, A. F., & Miladita, I. S. (2020). The relationship between watching mukbang autonomous sensory meridian response videos, food craving and pocket money with food intake and nutritional status of university students', The Indonesian Journal of Nutrition, 8(2), 102 - 109.

Marhama, E. (2015). The Effect of Stress on the Diet of Final Year Students at the Faculty of Nursing, University of North Sumatra (USU). (Thesis). University of North Sumatra, North Sumatra.

Pettit, H. (2019). *Bizarre 'mukbang' YouTube trend sees women scoff 20,000-calorie McDonalds meals earning them millions—and is branded 'sexy turn on' by some fans, The Sun, April 7, 2019*. https://www.thesun.co.uk/tech/8801045/mukbang-youtube-trend-women-earn-millions/. Diakses pada 23 Mei 2023.

Rahmawati, W.K. (2015). The Effectiveness of Peer Support to Improve Self Discipline of Junior High School Students. Indonesian Counseling Journal, 2(1), 15 - 21.

Riskesdas. (2018). National Report of Riskesdas 2018. Jakarta: Agency for Health Research and Development.

Riskesdas. (2019). West Java Province Riskesdas 2018 Report. Jakarta : Health Research and Development Agency.

Saftarina, F. & Devita, W. (2016). The Effect of Rock Music in Increasing Appetite. Journal of Majority, 5(1), 28 - 32.

Spence, C., Mancini, M. & Huisman, G. (2019). Digital Commensality: Eating and Drinking in the Company of Technology. *Frontiers in Psychology*, 10(Oktober).

Strand, M. & Sanna, A. G. (2020). Mukbang and Disordered Eating: A Netnographic Analysis of Online Eating Broadcasts', *Culture, Medicine and Psychiatry*, 44(4), 586 – 609.

Thania, E., & Wardina, H. (2023). The Relationship of Mukbang Watching Habit between Appetite, Diet, and Nutritional Status of Jakarta College Students. Pro Health Scientific Journal of Health. 5(1), 324 - 331.

Woo, S. (2018). Mukbang is changing digital communications. *Anthropology Newsletter,* 59, 90 – 94

World Health Organization. (2014). *World Health Organization.* https://www.who.int/dietphysicalactivity/%0Achildhood_why/en/. Accessed on June 05, 2022.

https://doi.org/10.20473/mgi.v19i3.275–281

HEALTH STATUS OF ADOLESCENCE GIRLS BASED ON NUTRITIONAL STATUS ASSESSMENT AND CARDIORESPIRATORY ENDURANCE (VO_2MAX)

Dini Junita[1*], Agus Hendra Al Rahmad[1], Farah Fajarna[3]
[1]Prodi Sarjana Terapan Gizi dan Detetika, Jurusan Gizi, Poltekkes Kemenkes Aceh, Kampus Terpadu Jl. Soekaro-Hatta, Lampeuneurut, Aceh Besar, Aceh, Indonesia
[2] Jurusan Teknologi Laboratorium Medik, Poltekkes Kemenkes Aceh, Kampus Terpadu Jl. Soekaro-Hatta, Lampeuneurut, Aceh Besar, Aceh, Indonesia
E-mail corresponding author: dinijunitapoltekkesaceh@gmail.com *

ABSTRACT

Adolescent health sometimes still receives less attention, even though this age group has a high level of vulnerability to various nutritional and health problems. This study aims to determine the health status of adolescent girls including hemoglobin status, hydration status, and cardiorespiratory endurance (VO_2Max). Samples were taken using a total sampling technique with the criteria of not having a history of heart and lung disease, living in the girls' dormitory at Integrated Islamic High School Al-Fityan School Aceh in good health and being willing to be respondents, and 60 female students were obtained. Hemoglobin status was observed from the hemoglobin level in the blood sample, hydration status was defined based on the composition of body fluids as measured by Bioelectrical Impedance Analysis (BIA), VO_2Max value was calculated from pulse per minute in resting conditions. Data obtained from each variable was presented descriptively and tested for correlation using the Pearson 95% test. Based on the research results, in general, the majority of respondents can be concluded to have good nutritional status and cardiorespiratory endurance. However, 28.3% of respondents were still found with abnormal nutritional status, abnormal hemoglobin status of 28.3%, dehydration of 43.3% and 33.3% had low cardiorespiratory endurance. This research cannot prove the relationship between hemoglobin status and hydration status on cardiorespiratory endurance (p-value > 0.05). Periodic health status checks are required through the school health unit involving the Community Health Center or health workers to overcome existing problems in these four health status parameters.

Keywords: *Adolescence girl, Hemoglobin Status, Hydration status, Nutritional Status, VO_2Max*

INTRODUCTION

Adolescence is a period of significant development that begins with the onset of puberty and ends in the mid-20s. Consider how different a person at the age of 12 from the person he or she at age 24. The trajectory between those two ages involves a profound amount of change in all domains of development including biological, cognitive, psychosocial, and emotional. Adolescent health sometimes still receives less attention, even though this age group has quite high vulnerability to various nutritional and health problems. One of the fastest stages of human development is adolescence. Meanwhile many of the changes seem to occur in the same order every time, people differ in terms of when and how quick they change. These alterations are influenced by both internal (such as sex) and environmental (such as poor nutrition and an abusive environment) factors (WHO, 2020). Besides, micronutrient factors and fluid intake are also important to pay attention to support high activity and changes in body function. However, it is common among teenagers to ignore the role of micronutrients and fluid intake. The high level of activity they had causes the quality of teenagers' eating and drinking to be neglected. The impact that can arise during adolescence is micronutrient deficiency, one of it is anemia which characterized by low blood hemoglobin levels and also dehydration.

Hemoglobin plays a role in oxygen transport, 30 to 100 times the amount of oxygen dissolved in fluid or blood plasma is transported by hemoglobin. The high and low levels of hemoglobin, known as blood hemoglobin status, will determine the oxygen level in the blood. If the hemoglobin status

 Received 19-09-2023, Accepted 27-06-2024, Published online 30-09-2024.

in the blood is lower than normal, the amount of oxygen in the blood will also be lower and vice versa, if the hemoglobin status is higher than normal, the oxygen status in the blood will increase (Anggraeni L and Wirjatmadi RB, 2019). Several studies state that hemoglobin status in the blood, which is a parameter for anemia conditions, has a correlation with work productivity, physical and cognitive performance (Ghalda et al, 2019; Muzayyaroh M and Suyati S, 2018). So these conditions play a role in the performance, fitness and achievements of teenagers in their daily activities.

Apart from hemoglobin, hydration status is an important benchmark for adolescent conditions. Hydration is defined as fluid balance in the body and is an important requirement to ensure the metabolic function of body cells, so that dehydration in adolescents can inhibit metabolic processes which ultimately results in stunted growth. Lack of fluid intake can reduce body water by 2% or more, physical performance can be impaired. If not anticipated or treated, this condition can worsen and increase the risk of muscle heat cramps, fainting, heat exhaustion, and heat stroke which can be life threatening (Saharun Iso AT, 2016). Therefore, as important as hemoglobin status, hydration status in adolescents will also be seen in their performance or physical fitness.

Physical fitness is the ability of a teenager's body to carry out work or daily activities without feeling excessive fatigue, namely optimal energy reserves to overcome the existing physical workload (Ghalda et al, 2019). Fitness can be seen from cardiorespiratory endurance through measuring VO_2Max (Anggraeni L, Wirjatmadi RB, 2019). The aim of this study was to determine the description of hemoglobin status, hydration status and fitness condition of adolescent girls as seen from cardiorespiratory endurance. This research is important to carry out as a theoretical basis for preventive and promotive health efforts in adolescents regarding the role of nutrition and fluid intake in maintaining health and body performance. The following is the state of the art of this research, cardiorespiratory endurance seen from the VO_2Max value describes how a person's health condition, especially fitness, there are several factors that influence this condition, namely related to hemoglobin function in the form of heart, lung and blood vessel function, the process of delivering oxygen to tissues by erythrocytes. and the number of red blood cells and related blood volume which are related to a person's adequacy of body fluids (hydration status) (Siswanto, 2017; Anggraeni L and Wirjatmadi RB, 2019).

METHODS

This research was carried out at SMAIT AL-Fityan Aceh Besar with a population of 246 students with the data collection time being July–August 2023. Samples were taken using a total sampling technique with the criteria of not having a history of heart and lung disease, living in the girls' dormitory at Integrated Islamic High School Al-Fityan School Aceh in good health and being willing to be respondents, and 60 female students were obtained. This type of research is observational research with a cross-sectional design. The variables in this study are respiratory endurance, hemoglobin status, hydration status. Hemoglobin levels were measured using a digital Hb/ Quick-Check Hemoglobin System Ministry of Health RI AKL No: 20205312473, which has an Hb measurement range of 4.5-25.6 g/dL. Hemoglobin status was categorized as normal if the Hb value is 12-16 g/dL, abnormal if it is out of that range. Hydration status was measured using a Bioelectrical Impedance Analysis (BIA) digital scale, Serenity Body Fat/Hydration Monitor Scale type SRF 934, cardiorespiratory endurance (VO_2max value) was measured during normal activities referring to Meredith Juncker's theory with the formula VO_2 max = 15 x (heart rate). maximum: heart rate at rest). Maximum heart rate is obtained from the formula HRmax = 205.8 – (0.685 x age), while resting heart rate is calculated from the number of pulses during 1 minute in resting conditions. Furthermore, the VO_2Max results are categorized as normal if the value is greater or equal to 31 ml/kg/minute and low if it is less than 31 ml/kg/minute. The data obtained for each variable, namely hemoglobin status and hydration status as well as the dependent variable cardiorespiratory endurance, are then processed and presented tabularly and textually. The relationship

between hemoglobin status and hydration status on cardiorespiratory endurance was tested using the Pearson test. This research has gone through an ethical approval process by the Health Research Ethics Commission of the Aceh Health Polytechnic with number: LB.02.03/54/2023.

RESULTS AND DISCUSSIONS

Respondent Characteristics

The respondents in this study were all teenage girls who lived in the Al Fityan School Aceh dormitory. This is a consideration in determining research locations, aimed at reducing the possibility of bias due to other factors outside the research such as intake, rest patterns or physical activity. Apart from that, respondents have also gone through a screening process to meet the inclusion criteria, including being in good physical and mental health, having no history of chronic disease or heart disease, being willing to be a research respondent, having a blood sample taken by signing an informed consent. Based on these criteria, 60 female students met and were involved in this research. The ages of the female respondents who were respondents ranged from 14 years to 19 years, falling into the teenage and early adulthood age groups. Based on age data, the largest number of young women are in the middle adolescence age group (15-17 years old), namely 53 people (88.3%).

Assessment of nutritional status is carried out based on Body Mass Index parameters according to age (BMI-for-age) for ages less than 18 years, and Body Mass Index (BMI) parameters for ages 19 years. The data is then processed and categorized as normal if the BMI value according to age is in the z-score range -2 standard deviation to +1 standard deviation and BMI is in the range of 18.5-25 kg/m^2, and categorized as abnormal if BMI according to age <- 2 Standard Deviations or >+1 standard deviation and BMI is within, 18.5kg/m^2 or > 25 kg/m2. Based on anthropometric assessments of the nutritional status characteristics of the majority of respondents, 43 people (71.7%) had normal nutritional status, but there were still 17 respondents with abnormal nutritional status (both undernutrition and overnutrition) (28.3%).

Table 1. Characteristics of Respondents (n=60)

Variable	Category	Frequency	(%)
Age	Early adolescence (10-14 y.o)	1	1.7
	Middle adolescence (15-17 y.o)	53	88.3
	Late adolescence (18-19 y.o)	6	10
	Total	60	100
Nutritional status	Normal	43	71.7
	Abnormal	17	28.3
	Total	60	100.0

Nutritional status is a health condition resulting from interactions between food, the human body and the human environment. Nutritional status is the result of a balance between nutrients entering the human body and their utilization. Nutritional status is influenced by food consumption and the use of nutrients by the body. If the body receives sufficient nutrients and uses them effectively, it will achieve optimal nutritional conditions that lead to high levels of physical growth, brain development, work capacity, and general health. Malnutrition occurs if the body lacks one or more important nutrients. Excess nutrition occurs when the body receives nutrients in excess of its needs (Almatsier S, 2010). Basically, a person's nutritional status is determined based on food consumption and the body's ability to use these food substances. Normal nutritional status shows the quality and quantity of food to meet the body's needs (Amsi, Muhajirin, 2011). Several factors influence the nutritional status of adolescent girls, namely eating patterns, physical activity, body image, and depression (Rahayu TB and Fitriana, 2020).

Respondents in this study live together in a school dormitory so they may have eating patterns and physical activity that are not much different, but other factors such as body image, level of depression, genetics, history of nutritional status and other factors can of course also influence nutritional status of teenage girls when the research was conducted. The finding of data on nutritional status outside normal limits for 17 teenage girls can certainly provide input for schools in handling female students' nutritional problems early, so that they can be addressed and prevent negative

impacts on the health status of teenagers in the future.

Hemoglobin Status

Hemoglobin status is a parameter commonly used to detect anemia in adolescent girls which is indicated by a hemoglobin value <12 gr/dL, the normal hemoglobin value in adolescent girls is 12-16 gr/dL (Hermanto RA et al., 2020). Hemoglobin (Hb) status in this study was measured using the Nesco Multi / Quick-Check digital Hb check tool. Hemoglobin status data is categorized as normal if the hemoglobin value is in the range 12-16 g/dL, and categorized as abnormal if it is outside this range. Based on the data recap, the average hemoglobin value for female adolescents was 15.32 g/dL with a minimum value of 11.2 g/dL and a maximum value of 18.9g/dL. Based on the categorization of the results of measuring respondents' blood hemoglobin levels, it is known that the majority of respondents in this study had normal hemoglobin status, namely 43 people (71.7%) while the remaining 17 respondents had abnormal hemoglobin status (28.3%).

Based on the research results, it is known that on average young women have high hemoglobin levels or do not experience iron nutritional anemia, however, the cause of hemoglobin abnormalities above the normal range certainly needs to be studied. Hemoglobin is a protein found in red blood cells that contains iron. The function of Hb is to transport oxygen from the lungs throughout the body and carbon dioxide to the lungs to be exhaled. Due to certain conditions, hemoglobin levels in a person's body can be low or high. Low Hb levels cause anemia in young women, have a negative impact during the growing period, they are easily infected, resulting in reduced body fitness/freshness, decreased enthusiasm for learning/achievement, so that when young women become mothers-to-be they have a high risk of experiencing problems (Junita D and Wulansari A, 2021). Likewise, excessive Hb levels are a sign of the body's adaptation to exposure to health problems. Increased hemoglobin levels can be caused by several factors, including dehydration, exposure to cigarette smoke, being in a low-oxygen environment (altitude), lung disease and other pathologies (Fadila I, 2022). Regarding this risk, the high hemoglobin levels in young women in this study certainly need to be investigated further.

Hydration Status

Hydration status is defined as the balance of fluids in the body and is an important requirement to ensure the metabolic function of body cells, so that dehydration in adolescents can inhibit metabolic processes which ultimately results in stunted growth. Hydration status can be determined in several ways, such as looking at urine color indicators, calculating urine specific gravity, or measuring total body fluids (Sudrajat A et al., 2019). Hydration status in this study was measured using a digital Bioelectrical Impedance Analysis (BIA) body composition scale, Serenity Body Fat/ Hydration Monitor Scale type SRF 934.

Data on hydration status was categorized as dehydration if the results of the female adolescent's body fluid composition were less than 53%, and categorized as dehydration. not dehydrated if the body fluid composition result of a teenage girl is more equal than 53%. Based on the recapitulation of data obtained, the average body fluid composition value for young women is 52.39% with a minimum fluid composition value of 32.7% and a maximum value of 62.1%.

Based on the categorization of the results of measuring fluid composition, it is known that the majority of young women in this study were not dehydrated as many as 34 people (56.7%) while the remaining 26 people experienced dehydration (43.3%).

Table 2. Description of Respondents' Hemoglobin Status (n=60)

Hemoglobin Status	Frequency	(%)
Normal	43	71.7
Abnormal	17	28.3
Total	60	100

Table 3. Description of Respondents' Hydration Status (n=60)

Hydration Status	Frequency	(%)
Dehydrated	26	43.3
Not dehydrated	34	56.7
Total	60	100

https://doi.org/10.20473/mgi.v19i3.275–281

The state of hydration is a picture of the balance of water penetration into the body. Water balance is influenced by age, physical environmental conditions, food intake, fluid consumption, nutritional status, ecology, body fluid output, gender, knowledge and physical activity. Dehydration is the loss of large amounts of dissolved substances and water. Hydration status affects a person's health status, dehydration can cause the body to tire quickly, lack enthusiasm and inhibit physical work activities (Kusuma AD, 2020). The results of research by Ghalda et al, (2019) show that mild dehydration occurs more often in adolescents (49.5%) than adults (42.5%). Not much different from the prevalence of female teenagers in the study who experienced dehydration was 43.3%. This certainly needs to be a concern for future researchers to explore the factors that cause dehydration in adolescent girls, so that it can be controlled and adolescent girls avoid the bad effects caused by dehydration. Dehydration conditions cause a decrease in blood volume so that the heart works harder. This increases heat attacks, to keep blood pressure stable when blood volume decreases, blood vessels will also constrict and cause symptoms of dizziness (Siswanto, 2017). A person's fluid needs vary depending on several factors, including: metabolic rate, body weight and body size, environmental conditions, level of physical fitness, intensity and duration of physical exercise, as well as genetic factors (Sudrajat A et al., 2019).

Cardiorespiratory Endurance (VO_2Max)

The cardiorespiratory endurance (VO_2Max) of young women in this study was seen based on Meredith Juncker's theory, namely the result of comparing the maximum respiration value based on age with the respiration value at rest from pulse measurements. Cardiorespiratory endurance (VO_2Max) is categorized as good if the value is greater or equal to 31 and categorized as poor endurance if the value is below 31. Based on the data recap obtained, the average value of cardiorespiratory endurance for young women is 34.07 with a minimum value of 26.81 and a maximum of 47.14. Based on the cardiorespiratory endurance categorization, there were 40 young women (66.7%) with good cardiorespiratory endurance and the remaining 20 people had poor cardiorespiratory endurance (33.3%).

Table 4. Description of Respondents' Cardiorespiratory Endurance (n=60)

Cardiorespiratory Endurance	Frequency	(%)
Good	40	66.7
Poor	20	33.3
Total	60	100

Cardiorespiratory endurance is a description of the ability of the cardiovascular and respiratory systems to meet the oxygen needs of the muscles used during physical activity without experiencing excessive fatigue after completing the activity (Aditama MG, 2020). Cardiorespiratory endurance is a component of assessing physical fitness. Physical fitness is the ability of a teenager's body to carry out work or daily activities without feeling excessive fatigue, namely optimal energy reserves to overcome the existing physical workload (Ghalda et al, 2019). Cardiorespiratory endurance assessment to see a person's fitness can be measured through VO_2 max or aerobic capacity (Anggraeni L and Wirjatmadi RB, 2019). The lower the VO_2max value, the faster fatigue will come. VO_2max is the Maximal Oxygen Uptake Volume or maximum oxygen consumption, which is the highest amount of oxygen that a person can take in and utilize to produce aerobic energy (ATP) while breathing air during heavy or simple exercise. VO_2max shows the maximum volume of oxygen consumed by the body. The respiratory system brings oxygen from the air, the cardiovascular system transports oxygen and cells use oxygen in energy production (ATP).

Table 5. Relationship between hemoglobin status and hydration status on cardiorespiratory endurance

Variable	Cardiorespiratory Endurance				*p value*
	Good		Poor		
	n	(%)	n	(%)	
Hemoglobin Status					
Normal	29	48.33	14	23.33	0.839
Abnormal	11	18.33	6	10.00	
Hydration status					
Dehydation Not	16	26.67	10	16.67	0.461
dehydrated	24	40.00	10	16.67	

Several factors that can greatly influence the VO_2Max value include the function of the heart, lungs and blood vessels; the process of delivering oxygen to tissues by erythrocytes which involves the function of the heart to pump blood; blood volume; and the number of red blood cells in the diversion of blood from tissues which are then transported to working muscles. The VO_2max value is a description of the activity of the lungs' ability to take in oxygen, the heart's ability to pump blood, the ability of hemoglobin to distribute oxygen, the ability of muscles to get oxygen supply and the ability of mitochondria and body enzymes to produce energy (Sudiana IK, 2015).

The research results show that there are still 20 young women with low VO_2Max values, this can certainly affect the quality of health and also physical performance in daily life. Seeing the many factors that influence the value of cardiorespiratory endurance apart from cardiorespiratory function factors which have been eliminated from the inclusion criteria for this study, of course it is also necessary to investigate what is the main cause of this condition so that it can be overcome. The limitation of this research variable is that it is not able to prove the relationship between hemoglobin status and hydration status on the condition of low cardiorespiratory endurance in teenage girls (p-value > 0.05).

CONCLUSION

Based on the research results, in general, the majority of respondents can be concluded to have good nutritional status and cardiorespiratory endurance. However, respondents were still found with abnormal nutritional status of 28.3%, abnormal hemoglobin status of 28.3%, dehydration of 43.3% and 33.3% have low cardiorespiratory endurance. This research cannot prove the relationship between hemoglobin status and hydration status on cardiorespiratory endurance. Periodic health status checks are required through the school health unit involving the Community Health Center or health workers to overcome existing problems in these four health status parameters.

The research sample has gone through a more specific screening stage, namely female students who lived in girls' dormitories to avoid bias from lifestyle and eating patterns so that it was hoped that the research results could describe health conditions and nutritional status without any influence from other factors. However, the number of respondents from the screening results was 60 people, of course still not enough to describe the broader situation.

ACKNOWLEDGEMENT

We would like to thank the Aceh Ministry of Health Polytechnic for its moral and material assistance. Thank you to the Al Fityan Education Foundation for permission and cooperation in carrying out research. This research was carried out using funds sourced from the Aceh Ministry of Health Health Polytechnic DIPA funds for 2023.

REFERENCES

Aditama MG. (2020). Tingkat Daya Tahan Kardiorespirasi Atlet Renang Usia Remaja Di Club Satria Mataram Aquatic Kabupaten Sleman. Fakultas Ilmu Keolahragaan Universitas Negeri Yogyakarta.

Almatsier, Sunita. (2010). Prinsip Dasar Ilmu Gizi. Jakarta: Gramedia Pustaka Utama.

Amsi, Muhajirin. (2011). Gizi dan Makanan Sehat. Jakarta: Salemba Medika.

Anggraeni L, Wirjatmadi RB. (2019). Status Hemoglobin, Kebiasaan Merokok Dan Daya Tahan Kardiorespirasi (Vo2 Max) Pada Atlet Unit Kegiatan Mahasiswa Bola Basket. Media Gizi Indones. 2019;14(1):27–34.

Fadila I. (2022) . Catat! Ini 8 Penyebab Kadar Hemoglobin Terlalu Tinggi. Harian digital Hellosehat, diakses pada bulan September 2023. Link : 8 Penyebab Hemoglobin (Hb) Tinggi yang Perlu Diperhatikan (hellosehat.com)

Ghalda A, Gifari N, Nadiyah N. (2019). Pengetahuan, Status Hidrasi, Persen Lemak Tubuh, Kadar Hemoglobin, dan Kebugaran Atlet Senam. Gorontalo J Public Heal. 2019;2(2):170.

Hermanto RA, Kandarina BI, Latifah L. (2020). Hubungan Antara Status Anemia, Tingkat Aktivitas Fisik, Kebiasaan Sarapan Dan Depresi Pada Remaja Putri Di Kota Yogyakarta. Media Gizi Mikro Indones. 2020;11(2):141–52.

Junita D, Wulansari A. (2021). Pendidikan Kesehatan tentang Anemia pada Remaja Putri di SMA N 12 Kabupaten Merangin. J Abdimas Kesehat. 2021;3(1):41.

Kusuma AD. (2020). Penilaian Status Hidrasi. Jurnal Ilmiah Kesehatan Sandi Husada. 9(1):13-17. p-ISSN: 2354-6093 dan e-ISSN: 2654-4563 DOI: 10.35816/jiskh.v10i2.196.

Muzayyaroh M, Suyati S. (2018). Hubungan Kadar Hb (Haemoglobin) Dengan Prestasi Belajar Pada Mahasiswi Prodi D-III Kebidanan FIK UNIPDU Jombang. J Kesehat Kusuma Husada. 2018;220–5.

Rahayu TB dan Fitriana. (2020). Analisis Faktor-Faktor Yang Mempengaruhi Status Gizi Remaja Putri. Jurnal Vokasi Kesehatan. 6(1):46–51. Http://Ejournal.Poltekkes-Pontianak.Ac.Id/Index.Php/Jvk

Saharun Iso AT. (2016). PRINSIP UMUM PENATALAKSANAAN CEDERA OLAHRAGA HEAT STROKE Saharun. J Olahraga Prestasi. 2016;12(2):41–60.

Siswanto. (2017). Darah dan Cairan Tubuh. Diktat Fisiol Vet 1. 2017;1–49.

Sudiana IK. (2015). Konsumsi Oksigen Maksimal (Vo2 Maks) Dan Aktivitas Olahraga. J PENJAKORA [Internet]. 2015;2(2):76–87. Available from: https://ejournal.undiksha.ac.id/index.php/PENJAKORA/article/view/11485.

Sudrajat A, Mexitalia M, Rosidi A. (2019). Status hidrasi, tingkat kebugaran jasmani dan daya konsentrasi anak sekolah dasar. J Gizi Indones (The Indones J Nutr. 2019;7(2):109–13.

WHO. (2020). Adolescent Health and Development. Available online : Adolescent health and development (who.int).

INSIGHTS INTO CHILDHOOD MALNUTRITION: AN ANALYSIS ON FOOD VULNERABILITY AND STUNTING USING 2021 INDONESIAN NUTRITIONAL STATUS SURVEY DATA

Yulianty Sanggelorang[1*], F. Ari Anggraini Sebayang[2], Nancy S H Malonda[1], Adisti A. Rumayar[3]
[1]Laboratory of Health Nutrition, Public Health Sciences Study Program, Faculty of Public Health, Sam Ratulangi University, Manado, Indonesia
[2]English Department, Faculty of Humanities, Sam Ratulangi University, Manado, Indonesia
[2] Laboratory of Health Policy Administration and Health Promotion, Public Health Sciences Study Program, Faculty of Public Health, Sam Ratulangi University, Manado, Indonesia
Email: y.sanggelorang@unsrat.ac.id

ABSTRACT

Stunting, a consequence of childhood malnutrition, stems from various factors, including unaddressed food vulnerability during the critical early stages of life, from conception to 24 months. Early loss of developmental opportunities, particularly that in relation to height, leads to an irreversible inability to achieve optimal growth. This study aimed to analyze the relationship between food vulnerability and stunting among children aged 0-59 months in the East Bolaang Mongondow Regency. The research utilized secondary data from the 2021 Indonesian Nutritional Status Survey (INSS), encompassing all selected households with children under five within the census blocks. After applying appropriate weighting procedures, the sample size was 8,893. The study included anthropometric measurements (body height/length) and assessments of various indicators of household food vulnerability (the inability of an individual or a group of individuals to obtain sufficient and appropriate food for a healthy and active life). The findings revealed significant correlations (p-value < 0.05) between food vulnerability status and stunting. Children from the food-vulnerable group had a 4.661 times higher risk of experiencing stunting compared to those from the food-secure group. This study concludes that food vulnerability is a significant risk factor in the development of stunting in children under five in Indonesia. Furthermore, factors associated with vulnerability such as limited access to nutritious food and food variety could contribute to hindering child growth. These findings have important implications for the development of nutritional policies and interventions in Indonesia. Enhancing food resilience and access to quality nutrition emerged as key strategies in reducing the prevalence of stunting in children under five.

Keywords*: children under five, Indonesian Nutritional Status Survey, food vulnerability, stunting*

INTRODUCTION

Human health and national development are significantly impacted by nutrition. In developing countries, particularly, solving health issues related to nutrition is essential to reaching sustainable development objectives. Studies have suggested that malnutrition, one of the significant health burdens, still affects millions of people, especially small children and pregnant women (Müller & Krawinkel, 2005; Mutiara Tasyrifah, 2021). Thus, cross-disciplinary research, comprehensive and successful policies, and initiatives are needed to enhance nutrition and health in developing nations. It is often advocated that strategies to reduce maternal, neonatal, and infant mortality as well as enhance general public health and well-being should depend on addressing malnutrition (Semba & Bloem, 2008).

Stunting, as one of the malnutrition-related issues, undoubtedly plays a significant role in determining the health status and the success of a country's development (WHO, 2014). This condition, which is evident in children who are excessively small for their age because of malnutrition, is still a major public health concern in many developing countries, including Indonesia. Based on WHO's cut-off values for public health relevance for stunting, the prevalence of stunting in Indonesia is still between 30%-39% (Anastasia et al., 2023; Ayuningtyas et al., 2022). Furthermore, in contrast to the data of 2021, the 2022 Indonesian Nutritional Status Survey (INSS) data shows a

 Received 07-02-2024, Accepted 24-06-2024, Published online 30-09-2024.

declining trend in stunting and overweight, whereas trends in wasting and underweight have grown. (Kemenkes RI, 2021, 2022). The frequency of stunting in Indonesia, according to INSS statistics, is 21.6% nationwide on average, well behind the national target of 14% by 2024, despite the indications of improvement in 2022 (Kemenkes RI, 2022; TNP2K, 2018). The report also indicates that half of eastern Indonesia, including Sulawesi, still has a higher prevalence of stunting compared to the other regions in the country (Anastasia et al., 2023; Ayuningtyas et al., 2022).

Despite the relatively higher prevalence of stunting in North Sulawesi, the 2022 INSS statistics reported a downtrend in this region, falling from 21.6% in 2021 to 20.5% in 2022. However, one noteworthy finding from the data in 2022 is that East Bolaang Mongondow Regency was the only area with a substantial increase in stunting prevalence (>5%) (Kemenkes RI, 2021, 2022). This is an interesting trend that has not yet been studied, thus it is necessary to investigate the factors that contribute to stunting in Bolaang Mongondow in 2021.

As a complex health problem, stunting has multiple causes, according to UNICEF, which can be broadly divided into three categories, including immediate, underlying, and enabling determinants (Anastasia et al., 2023; Suratri et al., 2023; Thahir, Li, Holmes, & Gordon, 2023; Torlesse, Cronin, Sebayang, & Nandy, 2016; UNICEF, 2021). These factors highlight the importance of addressing stunting in Indonesian children through comprehensive policies and programs that focus on improving maternal and child nutrition, promoting healthy feeding practices, and enhancing access to clean water and sanitation. As an underlying factor of stunting, food security has a significant role in under-five health status. Numerous research studies have demonstrated a correlation between food insecurity and increasing stunting and anemia in children aged 6-23 months who live in rural areas of Indonesia (Muslihah, Wilujeng, & Kusuma, 2022; Sanggelorang, Farmawati, & Sudargo, 2017; Yuliantini, Sukiyono, Yuliarso, & Sulistyo, 2022). Stunted children and overweight/obese mothers are also predicted by household food insecurity in urban areas (Mahmudiono et al., 2018). Furthermore, according to UN food security report, nearly 70% of Indonesians, cannot afford nutritious food, which may be a factor in the high rate of stunting among children under the age of five (Widyawati, 2023).

The investigation of food vulnerability and stunting in children 0-59 months old in East Bolaang Mongondow is the main topic of this study. The focus of the research location is East Bolaang Mongondow due to the significant increase in stunting rates from 2021 to 2022 in this regency. It emphasizes the importance of undertaking research on the relationship between food insecurity and stunting, as well as the consequences for children's growth and development, particularly in terms of height. It also considers the distinct data patterns found in this area. This study can provide an important new understanding of the complex dynamics of nutritional well-being, which will be useful information for the planning and execution of focused interventions aimed at reducing stunting and improving population health in general.

METHODS

Design and Sample

This study used secondary data from the INSS, which had been carried out in 2021 by the Agency of Health Development Policy of the Ministry of Health of the Republic of Indonesia. It utilized an analytical observational research design with a cross-sectional method. The INSS population in the East Bolaang Mongondow Regency included all households with children under five in census block groups. The research sample consisted of 8893 households with children under five, as defined by data weighting. As part of the study, mothers or other family members who were at least 17 years old were interviewed to collect the data. A two-stage stratified sampling procedure was used to choose the research sample.

Measures

The dependent variable in this study was stunting, while the independent variables included parents' education and occupation and food vulnerability. The following are the operational definitions for every variable:

a. Parents' education (mother and father) was classified into 2 categories, namely high (if they

attained senior high school diploma or higher than that) and low (if their education attainment was below senior high level).
b. Parents' occupation was categorized into 2 groups: employed (if their occupation had any economic value) and unemployed (if their occupation did not have any economic value).
c. Food vulnerability was defined as a condition of a household that had experienced financial issues or other challenges to obtain sufficient and nutritious foods. Households were categorized as vulnerable to food security if they experienced any of the eight conditions mentioned in the questionnaire at least once, meaning they answered "yes" to at least one of the eight questions. Food secure was defined as a condition if a household never experienced the aforementioned condition. The Food Vulnerability Questionnaire was adopted and adapted from the Food Insecurity Experience Scale (FIES), which was developed to capture a comprehensive picture of food insecurity at the household level.

Enumerators with nutrition-related educational backgrounds, who had completed training in data collection for the survey, collected the INSS 2021 data. Every tool used in the study including an anthropometric measuring device ("multi-fungsi" to measure respondent's height/length) and questionnaires, had undergone validation. Enumerators were equipped with instruments that met the same criteria; while the data was gathered at respondents' households through door-to-door strategy.

Analytic Strategy

Since the dataset is not publicly available, a formal request for access to the raw dataset was proposed to the Ministry of Health's Agency of Health Development Policy before data analysis. After that, z-scores were computed to evaluate the toddlers' nutritional status using the WHO Anthro software. Before moving on to univariate and bivariate analyses, the dataset was first cleaned and coded. Aside from that, data weighting was also conducted prior to the univariate and bivariate analyses to guarantee the representativeness of the sample. This study used chi-square test computations in the context of bivariate analysis, using a significance level of $p<0.05$ to determine statistical significance. Computerized statistical software was used to perform the statistical analyses in this study.

Ethical Considerations

The Indonesian Nutritional Status Survey (INSS) was conducted with the authorization of the National Unity and Politics Agency in all provinces and regencies across Indonesia. The survey received support from the heads of health agencies throughout the country. During the research process, enumerators provided a comprehensive explanation of the study to potential respondents and obtained their informed consent for participation. Each respondent was presented with information regarding the research's nature, objectives, and potential benefits. It was emphasized that participation was voluntary. Respondents were assured that all data and information collected would remain confidential and exclusively used for research purposes. The findings from INSS were expected to contribute to the formulation of policies aimed at enhancing the implementation of health programs. Prior to utilizing the data in this study, official approval for its use was granted by the Indonesian Ministry of Health's Research and Development Agency, as indicated in the approval letter with reference number IR.03.01/H.I/5495/2023.

RESULTS AND DISCUSSIONS

Overview of the food vulnerability in households with toddler samples

The secondary data from the 2021 INSS in East Bolaang Mongondow comprised of 8893 children under five years old. The demographics of the respondents are summarized in Table 1, wherein the majority are female (51.8%), aged ≥24 months (58.1%), and living in rural areas (69%). Table 1 shows that more than half of the respondents had low educational backgrounds (57.2% of mothers and 52.9% of fathers). However, when comparing these proportions to the groups with higher educational levels revealed, no discernible differences were found. Furthermore, for parents' occupation, the majority fell into the employed category (95.5% for fathers and 57.2% for mothers).

Tabel 1. Characteristics of research sample

Sampe Characteristics		Frequency	Percent
Mother's education	Low	4912	55.2
	High	3682	41.4
Father's education	Low	4492	50.5
	High	3992	44.9
Mother's occupation	Unemployed	3679	41.4
	Employed	4915	55.3
Father's occupation	Unemployed	383	4.3
	Employed	8101	91.1

Table 2. Food vulnerability in households with toddler samples

Categories		Frequency	Percent
Food vulnerability	Vulnerable	3607	40.6
	Secure	5286	59.4
	Total	8893	100.0
Description of food vulnerability variables			
Concern about not having enough food	Yes	1020	11.5
	No	7873	88.5
Unable to consume healthy and nutritious meals	Yes	809	9.1
	No	8084	90.9
Consume only a limited variety of foods	Yes	1684	18.9
	No	7209	81.1
Skip one mealtime	Yes	2706	30.4
	No	6187	69.6
Consume fewer calories than recommended	Yes	1175	13.2
	No	7683	86.4
	Don't know	35	0.4
Run out of food	Yes	333	3.7
	No	8364	94.1
	Don't know	195	2.2
Feel hungry but do not eat	Yes	107	1.2
	No	8786	98.8
Skip meals throughout the whole day	Yes	188	2.1
	No	8668	97.5
	Don't know	37	0.4

Data in **Table 2** revealed that many families in the study were in food vulnerable status (40.6%). This data indicates that 4 out of 10 households had experienced at least one condition out of the 8 conditions queried in the food vulnerability. Moreover, data in Table 2 shows that, although the proportions are relatively small; there were households with toddlers who expressed concern about not having enough food (11.5%) and being unable to consume healthy and nutritious food (9.1%). The findings also reveal that there were households which consumed only a limited variety of foods (18.9%), some households with toddlers skipped one mealtime (30.4%), and there were even households that ate less than they should (13.2%). Other surprising findings, although in small numbers, were also worth noting that there were still households that ran out of food, felt hungry but did not eat, and even went without eating for an entire day, each at 3.7%, 1.2%, and 2.1%, respectively.

Understanding the prevalence of food vulnerability and insecurity—two serious public health concerns—requires access to the data displayed in **Table 2**. Though the percentage of households with food security was higher than those with vulnerable status, yet this percentage was still meaningful; nearly half of the total respondents (40.6%). The data indicates that a significant segment of the population experiences food vulnerability and insecurity, highlighting the necessity of focused approaches to enhance the availability of wholesome food and mitigate food adversity.

The result of this study can be addressed in a larger context, including the issue of food insecurity, its causes, and potential remedies. It also provides insights into the socioeconomic and demographic elements connected with food insecurity, as proven by the study conducted in Brazil's Northeast region. The study revealed that 68.4% of the population in the area experienced food insecurity and that the degree of insecurity was influenced by variables like income, education, and involvement in social programs (da Silva et al., 2022). In line with the results of the study conducted in the Northeast area of Brazil, Bolaang Mongondow Regency's INSS 2021 results in Table 1 also show that over half of the parents were poorly educated, which is likely to also contribute to the high percentage of household with vulnerable food status. Besides, the relatively high percentage of unemployed parents (50% of the mothers) in the present study also supports what was found in a previous study in Brazil. These

findings may clarify the substantial link between socioeconomic issues in the community with food insecurity and stunting.

Furthermore, the results presented in Table 2 can also be related to the effect of external forces on food insecurity, such as COVID-19 pandemic (as this research was conducted in 2021 during COVID-19 pandemic) and job loss. Though the present study did not examine the reasons underlying the unemployment status, it is likely that the pandemic could be associated with the job termination of the parents during the data collection, which eventually affected food insecurity. A previous study indicated that the COVID-19 pandemic has led to a rise in the likelihood of food insecurity for numerous households, highlighting the correlation between economic variables and food security (Milovanska-Farrington, 2021). Another study carried out in Bangladesh also found that food insecurity is one of the primary causes of vulnerability among the urban poor (Ara, 2022). Meanwhile, when linked to other health-related issues, a study in Brazil revealed that food insecurity was associated with unhealthy eating patterns and social vulnerability (da Silva et al., 2022). Inequalities in food security were linked to a lack of access to basic infrastructure, such as irrigation systems and agricultural supplies, according to a study conducted in Ethiopia that examined two nearby areas (Hidaru, Tolossa, & Tilahun, 2023).

In terms of the variables of food vulnerability, despite its relatively small proportion (11.5%), this study found that there were households that reported their concern about not having enough food to eat. A more alarming situation exists within this group, wherein families are unable to consume healthy and nutritious meals (9.1%), consume only a limited variety of foods (18.9%), skip one mealtime (30.4%), consume fewer calories than recommended (13.2%), and, notably, run out of food (3.7%). Consequently, some households find themselves compelled to feel hungry but do not eat (1.2%) and skip meals throughout the whole day (2.1%). Even though the percentage of families reporting each of these circumstances was relatively low, it is critical to take this issue seriously since multiple research findings indicate a link between food vulnerability and nutritional problems in children(Kusuma & Pangesti, 2023; Rokhmah, Farianingsih, Ma'rufi, & Khoiron, 2022; Suryana, Hartono, & Suryana, 2021). Therefore, due to its complexity, food vulnerability necessitates multisectoral intervention to reduce (Ara, 2022; da Silva et al., 2022; Hidaru et al., 2023; Milovanska-Farrington, 2021).

According to a report from the National Food Agency, the Indonesian government has reportedly taken several significant actions to tackle the issue concerning food vulnerability including the formulation of a food security and vulnerability map, food and nutrition alertness movement, which utilizes the tools of the Food and Nutrition Vulnerability Early Warning System. Additionally, various programs, such as carrying out food rescue activities, accelerating the provision of food aid to families whose children are stunted, diversifying food consumption, encouraging the supply and stabilization of food prices throughout Indonesia, facilitating the transfer of food from surplus to deficit regions, and the use of government food, have also been conducted by the government (Badan Pangan Nasional, 2023). These are to ensure that food security is achieved at individual, household, and community levels.

The relationship between food vulnerability and stunting

The results of the statistical analysis of the relationship between food vulnerability and stunting in children under five are detailed in **Table 3**.

The analysis results in **Table 3** indicate a significant association between food vulnerability and stunting in children under five years old (p-value < 0.05) with an odds ratio (OR) of 4.661. According to these statistics, children from food-vulnerable households were at a 4-time-higher risk of experiencing stunting compared to children

Table 3. The relationship between food vulnerability and stunting

Food vulnerability	Stunting				OR (95% CI)	p-value
	Yes		No			
	n	%	n	%		
Vulnerable	1418	68.7%	2189	32.0%	**4.661** (4.192-5.183)	**0.000**
Secure	645	31.3%	4641	68.0%		

from food-secure households. The proportion of food-vulnerable households was higher (68.7%) compared to food-secure households (31.3%) in the stunted group.

As discussed earlier, the negative impacts of food vulnerability extend beyond mere dietary concerns, manifesting as a serious health issue, particularly among children under five as a vulnerable group to nutritional challenges. Findings presented in **Table 3** indicate a significant association between food vulnerability and stunting. Children within the food-vulnerable group face a 4.661 times higher risk of experiencing stunting compared to their counterparts in the food-secure group. This finding is similar to a study conducted in West Sumatra, which found that food consumption as food security for toddlers is one of the determinants of stunting (Arlinda, Riviwanto, Muslim, Gusti, & Yanti, 2022). In Indonesia, food vulnerability can have a major impact on toddlers' nutritional health. The research findings shed light on the way children's nutritional condition is affected by food insecurity, particularly considering the COVID-19 pandemic. The pandemic's consequences on food security have worsened maternal and child malnutrition; the main concerns are the restricted availability and high cost of nutritious food ingredients. Reduced food quantities as a result of inadequate access to and availability of household food have a negative impact on the nutritional status of families, particularly mothers and children (Maryani & Putri, 2020).

Aside from the food vulnerability factor that affects stunting, as a complex health problem, stunting also can be caused by a number of child-related, mother-related, and environmental factors. Previous studies revealed that child-related factors including low birth weight, non-exclusive breastfeeding, frequency of infectious diseases, inadequate protein intake, poor parental feeding style, and lack of supplementary feeding variability are associated with stunting (Gustina, Sofiana, Ayu, Wardani, & Lasari, 2020; Ibrahim, Khomsan, & Riyadi, 2023; Marfianti, Wirawan, & Weta, 2017; Najahah, Adhi, & Pinatih, 2013). The literature also emphasizes the link between toddler growth and nutrient status, highlighting the vital role that nutrition plays in the development of children between the ages of three and four(Nurlela, Kridawati, & Ulfa, 2022). Additionally, a number of study findings have linked maternal variables to child stunting, including unsuitable gestational weight gain, irregular antenatal care (ANC) visits, low maternal education, unemployment, and low household income (Ayu, Sofiana, Wardani, & Haryanto, 2021; Gustina et al., 2020; Ibrahim et al., 2023; Najahah et al., 2013; Noviyanti, Sidiartha, Sawitri, & Adhi, 2019).

Environmental factors such as poor hygiene and sanitation, along with limited access to clean water, flooring type, and mycotoxin exposure have also been identified as leading factors predisposing children to stunting (Dwipayanti & Purnama, 2022; Marfianti et al., 2017; Widiyanto, Atmojo, & Darmayanti, 2019). Another study conducted in Palembang found that vulnerability perception is positively correlated with household food and water processing behavior, which can reduce the prevalence of stunting (Fadilah, Andrean, & Trinita, 2020).

Based on the findings of this study, food vulnerability emerges as a contributing factor to a significant increase (>5%) in the prevalence of stunting in the Bolaang Mongondow Regency, North Sulawesi; in accordance with the results of the INSS for the years 2021 and 2022 (Kemenkes RI, 2021, 2022). It is crucial to address food vulnerability and stunting issues due to their long-term effects which eventually may affect other issues including poor cognitive development. The domino effect of this issue may be linked to lower educational attainment and reduced cognitive function, weakened immune systems that make children more susceptible to infections and diseases, decreased productivity and general well-being as adults, and an increased risk of obesity in later life, especially if children are exposed to unhealthy feeding practices and a poor diet (Mutiara Tasyrifah, 2021; UNICEF, 2017, 2021; WHO & UNICEF, 2020).

It is important to highlight that this study exclusively concentrates on determinants pertaining to mothers and children while disregarding the examination of environmental factors, sanitation conditions, and access to clean water. Additionally, the scope of the study is limited to a specific regency within North Sulawesi.

Consequently, there is a pressing need for more-comprehensive research that encompasses a wider array of determinants and encompasses diverse socioeconomic backgrounds and geographical locations to gain a thorough understanding of the factors influencing stunting in Indonesia.

CONCLUSION

This study concludes that food vulnerability is a risk factor for stunting among under-five children in Bolaang Mongondow Regency, North Sulawesi, Indonesia. Efforts to address food vulnerability and improve food security can help reduce the prevalence of stunting in the affected populations. The intervention associated with enhancing household food security, such as community empowerment for backyard utilization and repurposing non-productive land for agriculture, may serve as an alternative avenue alongside promoting dietary diversity.

ACKNOWLEDGEMENT

This study was funded by the Center of Research and Community Services of Sam Ratulangi University under research contract number 317/UN12.13/LT/2023. The funding organization played no role in the research design, data collection, data analysis, or decisions regarding manuscript finalization and publication.

REFERENCES

Anastasia, H., Hadju, V., Hartono, R., Manjilala3, S., Sirajuddin, Salam, A., & Atmarita. (2023). Determinants of stunting in children under five years old in South Sulawesi and West Sulawesi Province: 2013 and 2018 Indonesian Basic Health Survey. *PLoS ONE*, *18*(5 May), 1–17. https://doi.org/10.1371/journal.pone.0281962

Ara, M. R. (2022). Assessment of Vulnerability and Sustainable Livelihood of the Urban Poor: a Study in Khulna City Corporation, Southwest Bangladesh. *Khulna University Studies*, *14*(December), 217–228. https://doi.org/10.53808/kus.2017.14.1and2.1702-s

Arlinda, S., Riviwanto, M., Muslim, B., Gusti, A., & Yanti, D. D. (2022). Determinant Factors of Stunting in West Pasaman District, West Sumatera Indonesia. *Jurnal Kesehatan Lingkungan*, *14*(1), 37–44. https://doi.org/10.20473/jkl.v14i1.2022.37-44

Ayu, S. M., Sofiana, L., Wardani, Y., & Haryanto, Y. (2021). Maternal social determinants of stunting events in Kulon Progo, Yogyakarta. *Public Health and Preventive Medicine Archive*, *9*(2), 116–119. https://doi.org/10.15562/phpma.v9i2.407

Ayuningtyas, D., Hapsari, D., Rachmalina, R., Amir, V., Rachmawati, R., & Kusuma, D. (2022). Geographic and Socioeconomic Disparity in Child Undernutrition across 514 Districts in Indonesia. *Nutrients*, *14*(4), 1–17. https://doi.org/10.3390/nu14040843

Badan Pangan Nasional. (2023). Badan Pangan Nasional Sinergikan Pengendalian Kerawanan Pangan dengan Daerah. Retrieved November 20, 2023, from https://badanpangan.go.id/blog/post/badan-pangan-nasional-sinergikan-pengendalian-kerawanan-pangan-dengan-daerah

da Silva, C. S., Lima, M. de C., Oliveira, J. S., Tavares, F. C. de L. P., Sá Leal, V., Valente, F. L. S., … Filho, M. B. (2022). Food insecurity in households in Pernambuco, Northeast region of Brazil: contributions to the discussion on the violation of the right to adequate food. *Saude e Sociedade*, *31*(4), 1–14. https://doi.org/10.1590/S0104-12902022210617en

Dwipayanti, N. M. U., & Purnama, S. G. (2022). Neglected Water, Sanitation and Hygiene Aspects in Preventing Childhood Stunting. *Public Health and Preventive ...*, *10*(2), 108–110. https://doi.org/10.53638/phpma.2022.v10.i2.p01

Fadilah, M., Andrean, A., & Trinita, M. (2020). Household Food And Water Processing Models To Reduce Stunting Prevalence In Toddlers In Indonesia. *Advances in Social Sciences Research Journal*, *7*(7), 918–926. https://doi.org/10.14738/assrj.77.8766

Gustina, E., Sofiana, L., Ayu, S. M., Wardani, Y., & Lasari, D. I. (2020). Good parental feeding style reduces the risk of stunting among under-five children in Yogyakarta, Indonesia. *Public Health and Preventive Medicine Archive*, *8*(2), 120–125. https://doi.org/10.15562/phpma.v8i2.306

Hidaru, A., Tolossa, D., & Tilahun, T. (2023). A comparative analysis of social vulnerability to household food security of Raya Kobo and Raya Alamata Weredas, Ethiopia. *Frontiers in Sustainable Food Systems*, *7*(June), 1–12. https://doi.org/10.3389/fsufs.2023.1050987

Ibrahim, N. I. F., Khomsan, A., & Riyadi, H. (2023). Stunting is influenced by toddler and maternal characteristics, history of infectious disease, IYCF practices, and protein intake: case control study in Nabire coastal areas, Indonesia. *International Journal Of Community Medicine And Public Health*, *10*(9), 3039–3046. https://doi.org/10.18203/2394-6040.ijcmph20232658

Kemenkes RI. (2021). *Studi Status Gizi Indonesia*. Jakarta.

Kemenkes RI. (2022). *Buku Saku Hasil Survei Status Gizi Indonesia (SSGI) 2022*. Kementerian Kesehatan Republik Indonesia. Retrieved from https://www.badankebijakan.kemkes.go.id/buku-saku-hasil-survei-status-gizi-indonesia-ssgi-tahun-2022/

Kusuma, I. R., & Pangesti, W. D. (2023). IMPLEMENTASI MODEL EDUKASI BIMBINGAN PADA IBU HAMIL UNTUK PENCEGAHAN RESIKO STUNTING DIKABUPATEN BANYUMAS : STUDI KUALITATIF Implementation Coaching Education Method For Pregnant Women To Prevent Stunting Risk In Banyumas : Qualitative Study Program Studi. *Jurnal Kesehatan Reproduksi*, *13*(2), 161–171.

Mahmudiono, T., Nindya, T. S., Andrias, D. R., Megatsari, H., Rachmah, Q., & Rosenkranz, R. R. (2018). Comparison of maternal nutrition literacy, dietary diversity, and food security among households with and without double burden of malnutrition in Surabaya, Indonesia. *Malaysian Journal of Nutrition*, *24*(3), 359–370.

Marfianti, I., Wirawan, I. M. A., & Weta, I. W. (2017). Association of supplementary feeding with stunting among children in Kintamani, Bangli, Bali Province. *Public Health and Preventive Medicine Archive*, *5*(2), 95–100. https://doi.org/10.15562/phpma.v5i2.21

Maryani, S., & Putri, N. R. (2020). COMMUNITY-BASED FOOD SECURITY EFFORTS IN THE FRAMEWORK OF NUTRITION FOLLOWING MOTHER AND CHILDREN IN THE PANDEMIC Period (COVID - 19): LITERATURE REVIEW. *Journal of Midwifery Science: Basic and Applied Research*, *2*(2), 43–47. https://doi.org/10.31983/jomisbar.v2i2.6508

Milovanska-Farrington, S. (2021). Job Loss and Food Insecurity During the COVID-19 Pandemic. *SSRN Electronic Journal*, (14273). https://doi.org/10.2139/ssrn.3823640

Müller, O., & Krawinkel, M. (2005). Malnutrition and health in developing countries. *CMAJ. Canadian Medical Association Journal*, *173*(3), 279–286. https://doi.org/10.1503/cmaj.050342

Muslihah, N., Wilujeng, C. S., & Kusuma, T. S. (2022). Household Food Insecurity, Inappropriate Complementary Feeding, and Associated with High Stunting and Anemia Among Children Aged 6–23 Months, in Madura Rural, Indonesia. *Current Developments in Nutrition*, *6*, 933. https://doi.org/10.1093/cdn/nzac067.053

Mutiara Tasyrifah, G. (2021). Literature Review: Causes of Stunting in Toddlers. *Muhammadiyah International Public Health and Medicine Proceeding*, *1*(1), 339–346. https://doi.org/10.53947/miphmp.v1i1.71

Najahah, I., Adhi, K. T., & Pinatih, G. I. (2013). Risk factors stunting for 12-36 month old children in Dasan Agung Community Health Centre, Mataram, West Nusa Tenggara Province. *University of Udayana*, *1*(2), 134–141. https://doi.org/10.53638/phpma.2013.v1.i2.p06

Noviyanti, N. P. A. W., Sidiartha, I. G. L., Sawitri, A. A. S., & Adhi, K. T. (2019). Gestational weight gain is a risk factor of stunting among children aged 6-23 months in Bangli District, Bali, Indonesia. *Public Health and Preventive Medicine Archive*, *7*(1), 14–19. https://doi.org/10.15562/phpma.v7i1.188

Nurlela, Kridawati, A., & Ulfa, L. (2022). Correlation Between The Nutrient Status And The Toddler Growth Of 3 And 4 Years Old In Rau Primary Health Center, Serang City In 2019. *Journal of Ageing And Family*, *2*(1), 30–37. https://doi.org/10.52643/joaf.v2i1.2169

Rokhmah, D., Farianingsih, Ma'rufi, I., & Khoiron. (2022). Study of Nutrition Food Access to Family With Stunting Toddlers in Stunting Countermeasures System in Lumajang Indonesia. *Amerta Nutrition*, *6*(1SP), 32–37. https://doi.org/10.20473/amnt.v6i1sp.2022.32-37

Sanggelorang, Y., Farmawati, A., & Sudargo, T. (2017). *Ketahanan Pangan Rumah Tangga Sebagai Faktor Risiko Kejadian Stunting Pada Anak Usia 3-5 Tahun Di Daerah Pesisir Kecamatan Siau Timur Kabupaten Sitaro* (Universitas Gadjah Mada). Universitas Gadjah Mada. Retrieved from http://libmed.ugm.ac.id/showDetail.php?col=kyi&id=19846

Semba, R. D., & Bloem, M. W. (2008). Nutrition and Health in Developing Countries (Second

Edition). In *Nutrition and Health Series* (Vol. 53). Humana Press. https://doi.org/https://doi.org/10.1007/978-1-59745-464-3

Suratri, M. A. L., Putro, G., Rachmat, B., Nurhayati, Ristrini, Pracoyo, N. E., … Raharni. (2023). Risk Factors for Stunting among Children under Five Years in the Province of East Nusa Tenggara (NTT), Indonesia. *International Journal of Environmental Research and Public Health*, *20*(2). https://doi.org/10.3390/ijerph20021640

Suryana, A., Hartono, M. D., & Suryana, M. R. (2021). Impacts of the COVID-19 pandemic on food and nutrition security in Indonesia. *IOP Conference Series: Earth and Environmental Science*, *892*(1). https://doi.org/10.1088/1755-1315/892/1/012033

Thahir, A. I. A., Li, M., Holmes, A., & Gordon, A. (2023). Exploring Factors Associated with Stunting in 6-Month-Old Children: A Population-Based Cohort Study in Sulawesi, Indonesia. *Nutrients*, *15*(15). https://doi.org/10.3390/nu15153420

TNP2K. (2018). Strategi Nasional Percepatan Pencegahan Stunting 2018-2024 (National Strategy for Accelerating Stunting Prevention 2018-2024). In *Tim Nasional Percepatan Penanggulangan Kemiskinan (TNP2K) Sekretariat Wakil Presiden Republik Indonesia*. Retrieved from http://tnp2k.go.id/filemanager/files/Rakornis 2018/Sesi 1_01_RakorStuntingTNP2K_Stranas_22Nov2018.pdf

Torlesse, H., Cronin, A. A., Sebayang, S. K., & Nandy, R. (2016). Determinants of stunting in Indonesian children: Evidence from a cross-sectional survey indicate a prominent role for the water, sanitation and hygiene sector in stunting reduction. *BMC Public Health*, *16*(1), 1–11. https://doi.org/10.1186/s12889-016-3339-8

UNICEF. (2017). *Malnutrition in Children*. Retrieved from https://data.unicef.org/topic / nutrition/%0Amalnutrition

UNICEF. (2021). Conceptual Framework on Maternal and Child Nutrition. *Nutrition and Child Development Section, Programme Group 3 United Nations Plaza New York, NY 10017, USA*, 2–3. Retrieved from www.unicef.org/nutrition

WHO. (2014). *Global Nutrition Targets 2025 Stunting Policy Brief*. Geneva. https://doi.org/10.7591/cornell/9781501758898.003.0006

WHO, & UNICEF. (2020). *Global Strategy for Infant and Young Child Feeding*. Geneva: World Health Organization.

Widiyanto, A., Atmojo, J. T., & Darmayanti, A. T. (2019). Pengaruh Faktor Kerawanan Pangan Dan Lingkungan Terhadap Stunting. *Interest : Jurnal Terpadu Ilmu Kesehatan*, *8*(1), 2016–2021. https://doi.org/10.37341/interest.v8i1.118

Widyawati, S. (2023). Advancing Indonesia's Food Systems Transformation: A Stocktaking Moment. Retrieved November 20, 2023, from United Nation in Indonesia website: https://indonesia.un.org/en/240200-advancing-indonesia's-food-systems-transformation-stocktaking-moment

Yuliantini, E., Sukiyono, K., Yuliarso, M. Z., & Sulistyo, B. (2022). Food Security and Stunting Incidences in the Coastal Areas of Indonesia. *Open Access Macedonian Journal of Medical Sciences*, *10*(F), 454–461. https://doi.org/10.3889/oamjms.2022.9335

THE EFFECT OF UNRIPE BERLIN BANANA FLOUR ON SUPEROXIDE DISMUTASE (SOD) IN DYSLIPIDEMIC RATS

(Pengaruh Tepung Pisang Berlin Mentah terhadap Kadar Superoxide Dismutase (SOD) Pada Tikus Dislipidemia)

Ratih Putri Damayati[1*], Ayu Febriyatna[1], Firda Agustin[1]
[1]Program Studi Gizi Klinik, Jurusan Kesehatan, Politeknik Negeri Jember, Jember, Indonesia
[*]E-mail: ratihputri@polije.ac.id

ABSTRACT

Dyslipidemia is the occurrence of conditions that have abnormal lipid profile levels in the blood. Consumption of food sources of flavonoids and resistant starch is expected to play a role in dyslipidemia. Unripe Berlin banana flour (UBF) is source of flavonoids and resistant starches that benefit in dyslipidemia. This study aimed to determine the effect of giving UBF on SOD levels in dyslipidemic rats. This research used true experimental method with Pretest-Posttest and Control Group Design. This study used 30 rats divided into 5 groups K-, K +, P1 (UBF 0.144g /rat/day), P2 (UBF 0.288g /rat/ day), and P3 (UBF 0.576g/rat/day). The data were analyzed with one-way Anova and paired T-test. The results of the study showed that the values of SOD levels pre and post-intervention were not significantly different between groups. The mean of SOD levels pre-intervention showed that the K+, P1 and P3 groups were lower than K- group, then post-intervention at P1, P2 and P3 had higher SOD levels than K+ group. Meanwhile, the SOD levels of each group pre and post-UBF intervention in the P1 group were significantly different ($p < 0.05$), while in the P2 and P3 groups were not significantly different. This study concluded that giving raw Berlin banana flour at a dose of 0.144 g / day could increase the SOD levels in dyslipidemic rats.

Keywords: *Dyslipidemia, superoxide dismutase (SOD), Unripe Berlin Banana Flour*

INTRODUCTION

Dyslipidemia is one of the causes of cardiovascular disease (Stahel et al., 2018). The prevalence of dyslipidemia in Indonesia's population over 15 years is 7.6% with high cholesterol levels, 24.3% with low High Density Lipoprotein (HDL) levels, 9% with high Low Density Lipoprotein (LDL) levels, and 3.4 % with very high LDL levels (Kemenkes, 2018). The condition of dyslipidemia is also related to oxidative stress, which is a fundamental process that contributes to cardiovascular pathogenesis (Rivera-Mancía et al., 2018).

A high-fat diet can cause dyslipidemia (Susetyowati et al., 2019). High fat intake can directly increase cholesterol, LDL, and triglyceride levels, while reducing HDL levels. This can indirectly worsen the lipid profile through insulin resistance (Maulana & Ridwan, 2021). A high-fat diet can lead to a decreased effect on the activity of antioxidant enzymes such as superoxide dismutase-1 (SOD1), as observed in the liver, heart, and plasma of rat (Bai et al., 2015). SOD, as an endogenous antioxidant, can combat free radicals as the first line of defense (Yin. et al., 2018).

Nutrients from food have the potential to naturally change the biological function of cells by increasing endogenous antioxidant mechanisms or altering the signaling status of oxidation reactions in cells. This is often associated with the composition of various antioxidant compounds found in different food ingredients. Antioxidants are beneficial in pathological conditions as they play a crucial role in combating oxidative stress (Csonka et al., 2016).

Unripe banana flour is a source of flavonoids and resistant starch that play a positive role in dyslipidemia (Agustin et al., 2019). The flavonoid content in unripe Berlin banana flour is 241 mg/100 g, and the resistant starch content is 40.01% (Febriyatna et al., 2019). In addition to

 Received 03-07-2023, Accepted 27-08-2024, Published online 30-09-2024.

their capacity as antioxidants, flavonoids also play a role in improving lipid profiles and have anti-inflammatory, antiplatelet, and antithrombotic effects (Csonka et al., 2016). Foods containing resistant starch can reduce fat accumulation, improve lipid profiles, and increase antioxidant enzyme activity (Zhang et al., 2015) (Chen et al., 2023). The aim of this study was to determine the effect of unripe Berlin banana flour on SOD levels in dyslipidemic rats.

METHODS

This research was conducted from August to November 2019 at the Biomedical Laboratory of the Faculty of Dentistry and the Biosciences Laboratory of the Dental and Oral Hospital, Jember University. The research was a true experimental study with a pre- and post-test design with a control group. The research used 30 male Wistar rats aged 2-3 months with a body weight of 150-200 grams. The minimum sample size was determined based on the Federer (1963) formula with an additional estimated drop out rate of 10% of the minimum sample size. The rats were divided into the negative control group (K-), positive control group (K+), P1 group with a dose of unripe Berlin banana flour (UBF) 0.144 g/day, P2 group with a dose of UBF 0.288 g/day, and P3 group with a dose of UBF 0.576 g/day. Dose of 0.144 g/day, based on research results from Agustin et al. (2019), showed that this dose can improve the lipid profile in dyslipidemic rats.

Rats were adapted for 7 days (Obernier & Baldwin, 2006). However, it was found that the rats' body weight did not meet the inclusion criteria, so an additional 13 days were required to reach the appropriate body weight. The adaptation period involved treating the rat with Rat Bio feed at a dosage of 30 g/rat/day. Additionally, the rat in the K- group continued to receive standard food, while the K+, P1, P2, and P3 groups were fed a high-fat diet (HFD) of 30 g/day for 8 weeks. The HFD was a mixture of standard Rat Bio brand feed, beef tallow, margarine, and coconut milk. Subsequently, blood samples were collected from the rat to analyze their lipid profile (total cholesterol, LDL, and HDL) using the CHOD-PAP method, as well as superoxide dismutase (SOD) as pretest data or before the intervention was administered.

After the rats were induced by HFD, rats in groups P1, P2, and P3 were intervened with the addition of UBF in the form of feed according to the dose for each group for 14 days. The intervention feed was prepared by mixing standard feed with UBF according to the dose, i.e., P1 0.144 g P2 0.288 g, and P3 0.576 g. Each rat was given 30 g/rat/day. Blood was collected from the rats to analyze lipid profiles as posttest data (cholesterol, LDL, and HDL), as well as for SOD analysis.

Data were analyzed with SPSS. Tests for differences between groups were performed using the One-Way ANOVA test. Meanwhile, the pre- and post-tests for each group utilized a paired t-test.

RESULT AND DISCUSSION

Lipid profile after HFD for 8 weeks (Table 1). Total cholesterol, LDL, and HDL showed no significant difference between groups.

High fat diet showed no significant effect on increasing cholesterol and LDL levels, and decreasing HDL. However, the total cholesterol and LDL levels in the K- group were lower than those in the K+ and P groups.

The high fat diet used fat sources from beef tallow, margarine, coconut milk which are high in saturated fat. The saturated fatty acid content of beef tallow is greater than that of pork and chicken tallow (Hermanto et al., 2008).

Saturated fatty acids can increase total cholesterol, LDL and increase HDL (Papotti et al, 2021). Margarine is an emulsion of vegetable oil and water containing at least 80% fat (Ulfa et al., 2017). The coconut milk used in this study is coconut milk powder with a fat content of 37% (Ariningsih et al., 2021). Coconut milk is also a source of saturated fat, but in the form of medium-

Table 1. Lipid Profile Analysis.

Groups	Total Cholesterol (mg/dl)	LDL (mg/dl)	HDL (mg/dl)
K-	85.3 ± 16.78	68.7 ± 18.23	35.1 ± 3.60
K+	108.5 ± 17.56	100.6 ± 33.44	46.5 ± 6.30
P1	93.8 ± 10.66	104.1 ± 13.88	40.7 ± 5.50
P2	89.7 ± 23.95	80.7 ± 29.47	38.7 ± 5.40
P3	96.1 ± 28.00	80.4 ± 19.59	38.7 ± 5.10

Note : (*) significant difference ($p<0.05$)

chain saturated fatty acids (MCFAs) (Raghavendra & Raghavarao, 2010). The increase in HDL levels in the study after feeding high-fat diets may be due to the effect of the medium-chain fatty acids (MCFA) contained in high-fat diets, which can increase HDL levels. MCFAs increase mRNA expression of ATP-binding cassette transporter A1 (ABCA1) in the liver, thereby increasing HDL particle biogenesis (Panth et al., 2018).

SOD Analysis

The results of the superoxide dismutase (SOD) analysis can be seen in Table 2, showing that the SOD levels between groups at pre- and post-intervention did not show a significant difference. The p-values for pre-intervention were p = 0.376 and for post-intervention were p = 0.476. The mean pre-intervention SOD levels in the K+, P1, and P3 groups were lower compared to the K- group. The mean SOD levels in the group of dyslipidemic rats that received UBF intervention (P1, P2, P3) were higher compared to the K+ group.

The SOD results for each pre-intervention and post-intervention group showed a significant difference in the P1 group, but not in the K-, K+, P2, and P3 groups. However, based on the statistical analysis of changes in SOD or delta levels in Table 2, it was found that there was no significant difference between groups.

Pre-intervention data were obtained after the rats were given a high-fat diet in the K+ and P groups, while the K- group was given standard food. SOD levels in the group given high-fat diet were lower than those in the K- group (Table 2). High fat diets contain saturated fats which affect mitochondrial metabolism and increase the accumulation of reactive oxygen species (ROS) (Leamy, A. K., Egnatchik, R. A., & Young, 2013).

SOD is the only enzyme that plays a role in preventing potential toxicity by controlling the level of presence of ROS molecules and reactive nitrogen species (RNS), as well as regulating signaling in cells (Yin. et al., 2018). Decreased SOD levels make cells susceptible to diseases associated with oxidative stress (Lobo et al., 2010). The body's most important form of compensation when there are high levels of free radicals in the body is by producing antioxidants. The body's first line of antioxidants to be produced are SOD, catalase, and glutathione peroxidase (GSH). However, hyperlipidemia can cause an increase in ROS levels, which makes it difficult for the body to compensate, resulting in a decrease in antioxidant activity, one of which is SOD (Ighodaro & Akinloye, 2018).

SOD levels increased significantly after intervention in the treatment group receiving a dose of UBF 0.144 g (Table 2). In contrast, the other groups did not show significant changes in SOD levels. The administration of UBF can improve the lipid profile in dyslipidemic rats, possibly due to the effects of resistant starch and flavonoid content in unripe Berlin banana flour (Agustin et al., 2019). The administration of flavonoid-rich fractions along with a high-fat diet led to a significant increase in SOD enzyme activity, indicating that flavonoid compounds protect tissues from lipid peroxidation through their antioxidant abilities, thereby reducing lipid peroxidation (Kaviarasan et al., 2008). This increase in SOD levels may also be attributed to the role of SOD as a first-line enzyme in cellular defense against oxidative injury, as they can be rapidly induced to decompose O_2 and H_2O_2 to prevent the formation of more reactive hydroxyl radicals (Xie et al., 2022).

In contrast to the group given UBF at 0.288g/rat/day (P2) and 0.576g/rat/day (P3), which did not have a significant effect on increasing SOD levels before and after the intervention. This could be caused by the higher dose of UBF, resulting in a higher resistant starch content in the feed. The meta-analysis results show that resistant starch (RS) has no significant effect on SOD levels (Wei et al., 2022).

Table 2. Superoxide Dismutase (SOD) Analysis

Groups	SOD Levels (mean±SD)			p-*value**
	Pre	*Post*	Delta (Δ)	
K-	0.77±0,18	0.92±0.18	0.10 ± 2.42	0.125
K+	0.59±0,10	0.76±0.19	0.27 ± 1.53	0.463
P1	0.68±0,05	1.05±0.24	2.80 ± 1.62	0.028*
P2	0.84±0,21	0.89±0.22	-0.28 ± 4.47	0.796
P3	0.65±0,34	0.77±0.15	3.60 ± 0.68	0.507
*p-value***	0.376	0.476	0.920	

Note: (*) Significant difference on pre and post intervention at paired t-test (p<0.05) (**) Significant difference at ANOVA test (p<0.05)

Flavonoids can inhibit the α-amylase enzyme when they interact with patients. Flavonoids can interact not only with α-amylase but also with other components in the food consumed, such as proteins, polysaccharides and lipids that form complexes with these compounds. Considering these interactions, it is thought to be difficult to maintain the high concentrations of free flavonoids required to inhibit α-amylase activity in the intestine (Takahama & Hirota 2018). In addition, the higher the carbohydrate component, especially fructose, which is contained in raw Berlin bananas, it can reduce SOD levels (Phillips et al., 2021) (Nagalievska et al. 2022).

CONCLUSION AND SUGGESTION

Unripe berlin banana flour dose 0,144 g/day on dyslipidemia rats can increase SOD levels Further analysis is required to determine the content of nutrients and bioactive compounds at a dose of 0,144 g/day of unripe banana flour.

REFERENCES

Agustin, F., Febriyatna, A., Damayati, R. P., Hermawan, H., Faiziah, N., Santoso, R. D., & Wulandari, R. D. (2019). Effect of Unripe Berlin Banana Flour on Lipid Profile of Dyslipidemia Rats. *Majalah Kedokteran Bandung*, *51*(2), 70–74. https://doi.org/10.15395/mkb.v51n2.1630

Ariningsih, S., Hasrini, R. F., & Khoiriyah, A. (2021). Analisis Produk Santan Untuk Pengembangan Standar Nasional Produk Santan Indonesia. *Pertemuan Dan Presentasi Ilmiah Standardisasi*, *2020*, 231–238. https://doi.org/10.31153/ppis.2020.86

Bai, J., Zheng, S., Jiang, D., Han, T., Li, Y., Zhang, Y., Liu, W., Cao, Y., & Hu, Y. (2015). Oxidative stress contributes to abnormal glucose metabolism and insulin sensitivity in two hyperlipidemia models. *International Journal of Clinical and Experimental Pathology*, *8*(10), 13193–13200.

Chen, X., Wang, Z., Wang, D., & Kan, J. (2023). Effects of resistant starch III on the serum lipid levels and gut microbiota of Kunming mice under high-fat diet. *Food Science and Human Wellness*, *12*(2), 575–583. https://doi.org/10.1016/j.fshw.2022.07.060

Csonka, C., Sárközy, M., Pipicz, M., Dux, L., & Csont, T. (2016). Modulation of hypercholesterolemia-induced oxidative/nitrative stress in the heart. *Oxidative Medicine and Cellular Longevity*, *2016*. https://doi.org/10.1155/2016/3863726

Febriyatna, A., Damayati, RP., Agustin, F. (2018). Analyze of Nutrition and Bioactive Compound in Unripe and Ripe Berlin Banana (Musa Acuminate) Flour. In Proceeding of the 1st International Conference on Food and Agriculture.

Hermanto, S., Anna, M., & Harahap, R. (2008). Profil dan Karakteristik Lemak Hewani (Ayam, Sapi dan Babi) Hasil Analisa FTIR dan GCMS Sandra. *Universitas Islam Negeri Syarif Hidayatullah Jakarta*, 102–109.

Ighodaro, O. M., & Akinloye, O. A. (2018). First line defence antioxidants-superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPX): Their fundamental role in the entire antioxidant defence grid. *Alexandria Journal of Medicine*, *54*(4), 287–293. https://doi.org/10.1016/j.ajme.2017.09.001

Kaviarasan, K., Kalaiarasi, P., & Pugalendi, V. (2008). Antioxidant efficacy of flavonoid-rich fraction from Spermacoce hispida in hyperlipidemic rats. *Journal of Applied Biomedicine*, *6*(4), 165–176. https://doi.org/10.32725/jab.2008.020

Kemenkes. (2018). *Laporan Nasional Riskesdas 2018*.

Leamy, A. K., Egnatchik, R. A., & Young, J. D. et al. (2013). Molecular Mechanisms and the Role of Saturated Fatty Acids in the Progression of Non-Alcoholic Fatty Liver Disease. *Prog Lipid Res*, *52*(1), 165–174. https://doi.org/10.1016/j.plipres.2012.10.004

Lobo, V., Patil, A., Phatak, A., & Chandra, N. (2010). Free radicals, antioxidants and functional foods: Impact on human health. *Pharmacognosy Reviews*, *4*(8), 118–126. https://doi.org/10.4103/0973-7847.70902

Maulana, H., & Ridwan, A. (2021). *High-Fat Diets-Induced Metabolic Disorders to Study Molecular Mechanism of Hyperlipidemia in Rats*. *3*(2), 92–105. https://doi.org/10.5614/3bio.2021.3.2.5

Nagalievska, M.R., Petryn, T.S. & Sybirna, N.O. Influence of High-Carbohydrate and High-Lipid Diet on the Enzymatic Link of Antioxidant Protection and the Level of Oxidatively Modified Proteins and Lipids in Rat Erythrocytes. Cytol. Genet. 56, 1–8 (2022). https://doi.org/10.3103/S009545272201008X. Diakses pada https://link.springer.com/article/10.3103/S009545272201008X

Obernier, J. A., & Baldwin, R. L. (2006). Establishing an appropriate period of acclimatization following transportation of laboratory animals. ILAR journal, 47(4), 364-369.

Panth, N., Abbott, K. A., Dias, C. B., Wynne, K., & Garg, M. L. (2018). Differential effects of medium- and long-chain saturated fatty acids on blood lipid profile: A systematic review and meta-analysis. *American Journal of Clinical Nutrition*, *108*(4), 675–687. https://doi.org/10.1093/ajcn/nqy167

Papotti, B., Escolà-Gil, J. C., Julve, J., Potì, F., & Zanotti, I. (2021). Impact of dietary lipids on the reverse cholesterol transport: What we learned from animal studies. *Nutrients*, *13*(8), 1–27. https://doi.org/10.3390/nu13082643

Phillips, K. M., McGinty, R. C., Couture, G., Pehrsson, P. R., McKillop, K., & Fukagawa, N. K. (2021). Dietary fiber, starch, and sugars in bananas at different stages of ripeness in the retail market. *PLoS ONE*, *16*(7 July), 1–21. https://doi.org/10.1371/journal.pone.0253366

Raghavendra, S. N., & Raghavarao, K. S. M. S. (2010). Effect of different treatments for the destabilization of coconut milk emulsion. *Journal of Food Engineering*, *97*(3), 341–347. https://doi.org/10.1016/j.jfoodeng.2009.10.027

Rivera-Mancía, S., Jiménez-Osorio, A. S., Medina-Campos, O. N., Colín-Ramírez, E., Vallejo, M., Alcántara-Gaspar, A., Cartas-Rosado, R., Vargas-Barrón, J., & Pedraza-Chaverri, J. (2018). Activity of antioxidant enzymes and their association with lipid profile in Mexican people without cardiovascular disease: An analysis of interactions. *International Journal of Environmental Research and Public Health*, *15*(12). https://doi.org/10.3390/ijerph15122687

Stahel, P., Xiao, C., Hegele, R. A., & Lewis, G. F. (2018). The Atherogenic Dyslipidemia Complex and Novel Approaches to Cardiovascular Disease Prevention in Diabetes. *Canadian Journal of Cardiology*, *34*(5), 595–604. https://doi.org/10.1016/j.cjca.2017.12.007

Susetyowati, S., Huriyati, E., Josephine Istiti Kandarina, B., & Faza, F. (2019). Association of Eating Pattern and Nutritional Status with Dyslipidemia Among Adults in Yogyakarta - Indonesia. *KnE Life Sciences*, *4*(11), 86. https://doi.org/10.18502/kls.v4i11.3855

Takahama, U., & Hirota, S. (2018). Interactions of flavonoids with α-amylase and starch slowing down its digestion. Food & Function, 9(2), 677-687.

Ulfa, A. M., Diah Astika Winahyu, & Jasuma, M. (2017). Penetapan Kadar Lemak Margarin Merk X Dengan Kemasan Dan Tanpa Kemasan Dengan Metode Sokletasi. *Jurnal Analis Farmasi*, *2*(4), 258–262.

Xie, D., Hu, J., Wu, T., Xu, W., Meng, Q., Cao, K., & Luo, X. (2022). Effects of Flavonoid Supplementation on Nanomaterial-Induced Toxicity: A Meta-Analysis of Preclinical Animal Studies. *Frontiers in Nutrition*, *9*(June). https://doi.org/10.3389/fnut.2022.929343

Yin., W., Robyn., B., Alycia., N., & Siegfired., H. (2018). Superoxide dismutases: Dual roles in controlling ROS damage and regulating ROS signaling. *Journal of Cell Biology*, *217*(6), 1915–1928. http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L622496320%0Ahttp://dx.doi.org/10.1083/jcb.201708007

Zhang, L., Li, H. T., Shen, L., Fang, Q. C., Qian, L. L., & Jia, W. P. (2015). Effect of dietary resistant starch on prevention and treatment of obesity-related diseases and its possible mechanisms. *Biomedical and Environmental Sciences*, *28*(4), 291–297. https://doi.org/10.3967/bes2015.040

RELATIONSHIP BETWEEN PICKY EATING BEHAVIOR AND LEVEL OF NUTRIENT ADEQUACY IN PRESCHOOL CHILDREN

Nur Aziseh[1]*, Muchammad Insan Kharisma Hakiki[2]
[1,2]Department of Nutrition, Faculty of Public Health, Universitas Airlangga, Surabaya
*Email: nuraz4825@gmail.com

ABSTRACT

Picky eating behavior or selective eating behavior in children poses a significant difficulty to parents during the preschool years of growth and development. This may have an impact on the range of foods that kids eat. Food variety restrictions will affect how much energy, protein, fat, and carbohydrates are consumed. This study was aimed to analyze the relationship between picky eating behavior and the level of nutrient adequacy in preschool children in Buduran District, Sidoarjo Regency. The method of this study was a cross-sectional study design involving 64 preschool children as respondents who were selected proportionally by random sampling method. Data were collected by completing the Child Eating Behavior Questionnaire (CEBQ) and Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Data analysis was performed using the Spearman Rank Correlation test. The study found a significant correlation between picky eating behavior and carbohydrate adequacy (p=0.014). Specifically, 51.6% of the subjects exhibited picky eating behavior, and among them, a significant proportion had a carbohydrate intake classified as deficient. The findings underscore the importance of targeted nutritional interventions for children with picky eating behaviors to ensure balanced nutrient intake.

Keywords*: nutrient adequacy, picky eater, preschool*

INTRODUCTION

Preschool children aged 3-6 years are a crucial period in the formation of healthy and adequate eating habits. During this period, children experience rapid physical, psychological and motor development, including the development of diet and nutrient intake (Kasenda *et al*., 2017; Lida, 2016). Given its long-term effects on children's growth, physical, cognitive, emotional development, an adequate and balanced diet is crucial. Children's growth and development at this time can serve as a baseline for assessing their nutritional and health status, indicating that parents must play an active part in giving their children the care they require (Mansur, 2019). However, parents frequently have to deal with children who exhibit "picky eater" behavior when it comes to food.

Picky eaters are kids who make specific dietary choices, as seen by their limited food options, reluctance to try new foods, avoidance of some meals, and preferences for certain foods, including the way food is presented (Yulianar, 2022). An eating problem called picky eating is also characterized by an individual's inability to consume particular food categories and their aversion to meals they have never tried before (Islami, 2022). Nowadays, preschool-aged youngsters are often prone to show picky eating behavior (Cahyani, 2019).

Globally, picky eating behavior among preschool children varies widely but remains a significant concern. For instance, in Taiwan, 72% of children aged 3-5 years exhibit such behaviors (Chao & Chang, 2017), while in the United States, eating difficulties in preschoolers are often linked to picky eating, with issues such as a lack of variety in food types (58.1%), rejection of vegetables, fruits, meat, and fish (55.8%), and a preference for specific cooking methods (51.2%) (Cerdasari *et al*., 2017). In Indonesia, the prevalence is similarly high, with around 60.3% of children under five displaying picky eating tendencies (Kusuma *et al*., 2016). Regional studies further highlight the concern, such as in Aceh, where 53.1% of preschoolers are picky eaters (Nadhirah *et al*., 2021), and in Balikpapan, where the figure reaches 82.2% (Puspita *et al*., 2023). In Sidoarjo, 52.2% of children were reported to exhibit picky

 Received 15-03-2024, Accepted 27-08-2024, Published online 30-09-2024.

eating behavior (Widati, *et al.,* 2024). Although the prevalence of picky eaters in Sidoarjo is lower than that reported in other parts of Indonesia and globally, it nonetheless highlights the importance of implementing targeted nutritional interventions for this specific population.

In certain countries, the prevalence of picky eating behavior is still known as a common occurrence. For example, in children aged 3-5 years in Taiwan, the incidence rate of picky eating behavior reached 72% (Chao & Chang, 2017). Research in the United States also shows that eating difficulties in preschool children are associated with picky eating behavior and involve a variety of factors, including lack of variety in food types (58.1%), rejection of vegetables, fruits, meat, and fish (55.8%), and a tendency to prefer certain cooking methods (51.2%) (Cerdasari *et al*., 2017). Conversely, among children under five in Indonesia, the percentage of finicky eaters is likewise rather high, at about 60.3% (Kusuma *et al*., 2016). A study conducted in Aceh revealed that more than half, 53.1% of preschool children experienced picky eating tendencies (Nadhirah *et al*., 2021), as well as a study conducted in Balikpapan in 2023 also mentioned that there are 82.2% of preschool children who show picky eating behavior (Puspita *et al*., 2023).

Picky eating in children can be influenced by a number of factors, including genetics, the effects of pregnancy, the introduction of food in the early postnatal period, the diet of the parents, and the family environment (Kamumu & Rakay, 2023). There are two types of influences that affect picky eaters: internal factors (kid behavior) and external factors (parental behavior). The mother's employment level, parenting styles, exclusive breastfeeding and supplemental feeding practices, eating habits of the parents, the number of children in the household, and food introduction delays are only a few examples of external factors. Conversely, internal influences include the child's sensory sensitivity, screen-time habits, and the existence of attention deficit hyperactivity disorder (ADHD) (Astuti *et al*., 2023).

Children who are picky eaters will tend to struggle with accepting meals due to the problems of this eating disorder. This may have an impact on the variety of food consumed. Limitations in food variety will have an impact on the consumption of protein, energy, meat and vegetables (Horst *et al*., 2016). If picky eating behavior is not addressed immediately, it can cause a decrease in nutritional intake and disrupt metabolic processes. This can form harmful habits, which in turn can lead to imbalances in nutrient intake and potentially compromise the adequate levels of energy, protein, fat and carbohydrate and lead to impaired nutritional status of the individual.

METHODS

This research is an observational analytical research using cross-sectional study design. The research was conducted in four Dharma Wanita Persatuan kindergartens located in Siwalanpanji Village, Sidomulyo Village, Banjarsari Village, and Damarsi Village in June 2023. The study population consisted of 198 children, who were all students in kindergarten A and kindergarten B classes in the four kindergartens. The sample size of 64 students was determined by Lemeshow's 1990 formula using the proportional stratified random sampling method. The total population of preschool children was divided into strata based on age and gender, ensuring that each subgroup was appropriately represented. The sample size was calculated with a 95% confidence level and a 5% margin of error to ensure that the selected sample accurately represented the entire population. Inclusion criteria included children aged 36-72 months whose mothers were willing to participate as respondents.

To measure picky eating behavior in children, the Child Eating Behaviour Questionnaire (CEBQ) instrument was filled out and interviewed, while to measure the level of nutrient adequacy using the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Data were analyzed using SPSS software version 27.0 by demonstrating the Spearman Rank Correlation test to evaluate the relationship between picky eating behavior and the level of nutrient intake in children. The significance level used was 95% ($\alpha = 0.05$). Where if the sig. <0.05, it can be concluded that there is a significant relationship between the variables being tested.

RESULTS

In this study, preschool children's characteristics such as age and gender were identified, along with mothers' characteristics such as age, education level, job status, and family income. The data from this identification is presented in table 1.

Table 1 shows that the majority of the study subjects were aged between 61-72 months (90.6%). The subjects had an average age of 67.03 ± 3.716 months, with the lowest age of 56 months and the highest age of 71 months. On the other hand, 32 subjects (50%) were female. The characteristics of the respondents obtained showed that 33 respondents (51.6%) had an age range between 31 to 40 years, with an average maternal age of about 34.19 ± 6.284 years. The youngest mother's age was 24 years, while the oldest reached the age of 54 years. The majority of respondents had a high school education, as many as 36 mothers (56.3%). Most of the respondent mothers, 41 mothers (64.1%), were not working, while 23 mothers (35.9%) were working. In addition, the characteristics of the respondents showed that a total of 22 respondents (34.4%) had family incomes located in the quintile 1 range, which ranged from Rp1,000,000 to Rp3,000,000, with an average family income of around Rp4,328,281.25 ± Rp1,970,497.121. The lowest recorded family income was Rp1,000,000, while the highest reached Rp11,000,000.

The data regarding picky eating behavior in the research subjects were collected through filling out the Child Eating Behavior Questionnaire (CEBQ) given to the respondents.

Table 1. Distribution of Subject and Respondent Characteristics in 4 Kindergartens of Dharma Wanita Persatuan, Buduran District

Variable	n	%	Mean±SD	Min	Max
Child's Age	-	-	67.03 ± 3.716	56	71
49-60 months	6	9.4	-	-	-
61-72 months	58	90.6	-	-	-
Child's Gender	-	-	-	-	-
Male	32	50.0	-	-	-
Female	32	50.0	-	-	-
Mother's Age	-	-	34.19 ± 6.284	24	54
21-30 years	21	32.8	-	-	-
31-40 years	33	51.6	-	-	-
41-50 years	9	14.0	-	-	-
51-60 years	1	1.6	-	-	-
Mother's Last Education	-	-	-	-	-
Completed elementary school	4	6.3	-	-	-
Completed junior high school	12	18.7	-	-	-
High school graduate	36	56.3	-	-	-
College graduate	12	18.7	-	-	-
Job Status	-	-	-	-	-
Work	23	35.9	-	-	-
Does not Work	41	64.1	-	-	-
Family income	-	-	4,328,281.25 ± 1,970,497.121	1,000,000	11,000,000
Quintile 1 (Rp1,000,000 – Rp3,000,000)	22	34.4	-	-	-
Quintile 2 (Rp3,001,000 – Rp3,400,000)	4	6.3	-	-	-
Quintile 3 (Rp3,401,000 – Rp4,200,000)	14	21.9	-	-	-
Quintile 4 (Rp4,201,000 – Rp5,500,000)	12	18.7	-	-	-
Quintile 5 (> Rp5,500,000)	12	18.7	-	-	-
Total	64	100.0	-	-	-

Table 2. Distribution of Picky Eating Behavior of Subjects in 4 Kindergartens of Dharma Wanita Persatuan, Buduran District

Variable	n	%
Picky Eating Behavior		
Not a picky eater	31	48.4
Picky eater	33	51.6
Total	64	100.0

Table 2 presents the findings of the investigation regarding the distribution of individuals' picky-eating behavior. As a result, 33 subjects (about 51.6%) showed picky eating behavior, while 31 subjects (about 48.4%) did not show picky eating behavior.

The Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ), which was distributed to the respondents, was used to collect information on the estimated nutritional intake of the subject.

Table 3 presents the findings of the investigation regarding the mean, minimum, and maximum values of the respondents' estimated nutrition intake amount. As a result, the mean value of the subject's estimated energy intake is about 1595.641 ± 630.5543 kcal. The average estimated protein intake of the subjects was about 74.595 ± 40.8644 grams. Meanwhile, the average estimated fat intake of the subjects was about 60.080 ± 29.0363 grams, and the average estimated carbohydrate intake of the subjects was about 190.580 ± 67.1806 grams.

Data regarding the level of nutrient adequacy of the subject was obtained by concerning the estimated nutrient intake of the subject with the Nutrient Adequacy Guidelines in accordance with the provisions listed in the Regulation of the Indonesian Minister of Health No. 28 of 2019 concerning Guidelines for Recommended Nutrient Adequacy for the Indonesian People. The subject's nutrient adequacy level is distributed shown in table 4.

Table 4 shows significant dietary imbalances among the subjects, with the majority showing excessive intake of energy (42.2%), protein (93.7%), and fat (50%). These findings suggest a dietary pattern high in these macronutrients, which may predispose children to overweight or other metabolic issues. Conversely, a substantial portion of the subjects (51.6%) had carbohydrate intakes that were classified as deficient, which could indicate an imbalance in the macronutrient distribution in their diets. This imbalance is critical to address, as it might reflect dietary habits that deviate from recommended guidelines, potentially impacting the overall nutritional status and health outcomes in this population.

Table 5 presents data collected from a cross-tabulation between picky eating behavior and the amount of energy, protein, fat, and carbohydrates that 4 Dharma Wanita Persatuan Kindergartens preschoolers aged 3-6 years consumed.

From the analysis of the relationship between picky eating behavior and the level of energy

Table 3. Distribution of Estimated Nutrient Intake Subjects in 4 Kindergartens of Dharma Wanita Persatuan, Buduran District

Nutrients	Average	Minimum	Maximum
Energy (kcal)	1595.641 ± 630.5543	356.7	2864.7
Protein (g)	74.595 ± 40.8644	10.6	191.1
Fat (g)	60.080 ± 29.0363	13.7	128.0
Carbohydrate (g)	190.580 ± 67.1806	47.0	348.1

Table 4. Distribution of Nutrient Adequacy Levels of Subjects in 4 Kindergartens of Dharma Wanita Persatuan, Buduran District

Nutrients Adequacy Level	Deficit		Adequate		Excess		Total	
	n	%	n	%	n	%	N	%
Energy (kcal)	13	20.3	24	37.5	27	42.2	64	100.0
Protein (g)	1	1.6	3	4.7	60	93.7	64	100.0
Fat (g)	17	26.6	15	23.4	32	50	64	100.0
Carbohydrate (g)	33	51.6	17	26.6	14	21.8	64	100.0

adequacy using the Spearman Rank correlation test, a p-value of 0.073 (p>0.05) was obtained. This result indicates that there is no significant relationship between picky eating behavior and the level of energy adequacy in preschool children.

As well as the result of the analysis conducted regarding the relationship between picky eating behavior and protein adequacy level using the Spearman Rank correlation test, a p-value of 0.333 (p>0.05) was obtained. This result indicates that there is no significant relationship between picky eating behavior and the level of protein adequacy in preschool children.

In addition, based on the results of the analysis of the relationship between picky eating behavior and the level of fat adequacy using the Spearman Rank correlation test, the p-value is 0.501 (p>0.05).

This indicates that there is no significant relationship between picky eating behavior and the level of fat adequacy in preschool children.

The results of the analysis of the relationship between picky eating behavior and the level of carbohydrate adequacy using the Spearman Rank correlation test obtained a p-value of 0.014 (p <0.05). This indicates a significant relationship between picky eating behavior and the level of carbohydrate adequacy in preschool children. The results of the r-calculated value of the analysis of the relationship between picky eater behavior and the level of carbohydrate adequacy showed a negative correlation value with a relatively low level of relationship strength of -0.306. This value indicates that the lower the child's picky eating behavior, the higher the level of carbohydrate adequacy obtained.

Table 5. Cross Tabulation of Picky Eating Behavior with Energy Adequacy Level

Picky Eating Behavior	Energy Adequacy Level						Total		p-value
	Deficit		Adequate		Excess				
	n	%	n	%	n	%	N	%	
Not a picky eater	5	16.1	9	29.0	17	54.9	31	100.0	0.073
Picky eater	8	24.2	15	45.5	10	30.3	33	100.0	

Table 6. Cross Tabulation of Picky Eating Behavior with Protein Adequacy Level

Picky Eating Behavior	Protein Adequacy Level						Total		p-value
	Deficit		Adequate		Excess				
	N	%	n	%	n	%	N	%	
Not a picky eater	0	0.0	1	3.2	30	96.8	31	100.0	0.333
Picky eater	1	3.0	2	6.1	30	90.9	33	100.0	

Table 7. Cross Tabulation of Picky Eating Behavior with Fat Adequacy Level

Picky Eating Behavior	Fat Adequacy Level						Total		p-value
	Deficit		Adequate		Excess				
	N	%	n	%	n	%	N	%	
Not a picky eater	9	29.0	4	12.9	18	58.1	31	100.0	0.501
Picky eater	8	24.2	11	33.3	14	42.5	33	100.0	

Table 8. Cross Tabulation of Picky Eating Behavior with Carbohydrate Adequacy Level

Picky Eating Behavior	Fat Adequacy Level						Total		p-value
	Deficit		Adequate		Excess				
	N	%	n	%	n	%	N	%	
Not a picky eater	12	38.7	8	25.8	11	35.5	31	100.0	0.014
Picky eater	21	63.6	9	27.3	13	9.1	33	100.0	

DISCUSSION

In this study, the number of subjects who were female and male was equal, 32 children each. The subjects were categorized as preschoolers and varied in age from 56 to 71 months. Children in the age range of 3 to 6 years old are referred to as preschoolers, and they typically enroll in kindergarten or preschool programs (Adiputra *et al*., 2021). This period is crucial, as during this time all aspects of motor development are growing rapidly (Kasenda *et al*., 2017).

The mothers of preschool-aged children who participated in this study were between the ages of 24 and 54, and the majority of them had completed senior high school. An individual's capacity to process information is significantly influenced by their level of education. As a result, those with greater education levels typically respond better to knowledge that helps them take better care of their kids on a daily basis (Lailatul & Ni'mah, 2015). Furthermore, the percentage of respondents who do not have a job is higher than that of respondents who do. Compared to moms who work outside the home, stay-at-home mothers have more opportunities to interact with their children and more time to acquire health-related education (Marfuah *et al*., 2022).

Based on the findings of this study, more than half or 51.6% of the subjects had picky eating behavior. The results of this study are in line with the results of a study in Surabaya which states that there are 57.8% of preschool children who have picky eating behavior (Putri & Muniroh, 2019). Children who tend to be picky eaters are generally not interested in trying new foods, tend to reject food without trying it, eat food slowly, and often do not enjoy food (Nisa *et al*., 2021).

In this study, it was found that the majority of subjects who did not exhibit picky eating behavior generally had good preferences and high interest in food, felt happy while eating, and often asked for food. On the other hand, the majority of subjects who exhibited picky eating behavior tended to have fast eating habits and refused to try new foods. Therefore, it can be concluded that children who do not exhibit picky eating behavior tend to be more open in accepting food and more active in requesting food compared to children who are picky eaters.

The selection of nutritious foods is crucial to guarantee that children get well nourished and prevent disruptions in their growth and development (Mayar & Astuti, 2021). Most of the subjects in the study had an excess intake of energy, protein and fat, but had a deficiency in carbohydrate intake. This may be due to the habitual consumption of fried foods and snacks. Snack foods make a significant contribution to nutrient intake at various age ranges, especially in children (Sari & Rachmawati, 2020). Snack foods can have a negative impact on health if they do not meet healthy food safety standards in the production process or when served (Rusmiati, 2020).

The findings of this study showed that there was no significant relationship between picky eating behavior and the adequacy of nutrients such as energy, protein, and fat. However, there was a significant relationship between picky eating behavior and carbohydrate intake. The high consumption of protein and fat sources in most preschool children indicates that picky eating behavior does not necessarily result in insufficient protein and fat intake in comparison to daily recommendations. This aligns with research conducted by Purnamasari & Adriani (2020), which indicated that there was no association between picky eating behavior and protein and fat intake levels in preschool-aged children. Another study also indicated that there was no significant association between energy, protein, and fat intake and picky eating behavior in preschool-aged children (Hardianti *et al*., 2018). In addition, the findings in this study also revealed that the majority of children who have picky eating behavior experience a deficit in carbohydrate intake as they often limit their consumption of carbohydrate-rich foods. On the other hand, children who do not have picky eating behavior tend to have a more diverse diet and often consume foods containing carbohydrates, so they meet their carbohydrate needs. Another study conducted by Purnamasari & Adriani (2020) stated that picky eating behavior has a strong relationship with carbohydrate and fiber intake in preschool children. Children with picky eating behavior tend to limit their intake of foods such as rice, vegetables, fruits, and fish. However, they more often consume wafers,

biscuits, milk, meatballs, chicken, nuggets and fried foods *(*Hardianti *et al*., 2018).

This study has several limitations. First, the reliance on self-reported data from questionnaires may introduce reporting biases, as parents may not accurately recall or report their child's eating behaviors. Second, although the sample size was determined proportionately, it may not fully capture the diversity of the population, potentially limiting the generalizability of the findings. Future research should consider larger and more diverse samples, as well as alternative methods of data collection to mitigate these biases.

CONCLUSION

In this study, there was no relationship between picky eating behavior and adequate levels of energy, protein and fat. However, there was an association between picky eating behavior and carbohydrate adequacy. Based on the findings of this study, it is recommended that early childhood educators and parents implement targeted nutritional interventions to address picky eating behaviors in preschool children. These interventions could include structured mealtime routines, exposure to a variety of healthy foods, and positive reinforcement strategies. Additionally, public health initiatives should focus on educating parents about the importance of balanced nutrition in early childhood development.

REFERENCES

Adiputra, I. M. S., Yustikarini, N. L. A., Hana Yundari, A. A. I. D., Trisnadewi, N. W., & Oktaviani, N. P. W. (2021). Persepsi Guru Paud tentang Attention Deficit Hyperactivity Disorder (ADHD) pada Anak Usia Prasekolah (3-6 Tahun). *Jurnal Akademika Baiturrahim Jambi*, *10*(1), 9-21. https://doi.org/10.36565/jab.v10i1.263

Astuti, Y., Magdalena, A., & Aisyaroh, N. (2023). Narrative Review: Faktor Faktor Yang Mempengaruhi Picky Eater Pada Anak Usia Prasekolah. *Jurnal Pendidikan Sejarah Dan Riset Sosial Humaniora*, *3*(3), 207–214. Accessed from https://ejournal.penerbitjurnal.com/index.php/humaniora/article/view/301

Cahyani, A. S. D. (2019). Hubungan Riwayat Pemberian Makanan Pendamping ASI (MP-ASI) dengan Persepsi Perilaku Picky Eater pada Anak Usia 12-36 Bulan (Studi di Wilayah Kerja Sidotopo Surabaya). *Amerta Nutrition*, *3*(3), 171-175. https://doi.org/10.20473/amnt.v3i3.2019.171-175

Cerdasari, C., Helmyati, S., & Julia, M. (2017). Tekanan untuk makan dengan kejadian picky eater pada anak usia 2-3 tahun. *Jurnal Gizi Klinik Indonesia*, *13*(4), 170-178. https://doi.org/10.22146/ijcn.24169

Chao, H. C., & Chang, H. L. (2017). Picky Eating Behaviors Linked to Inappropriate Caregiver–Child Interaction, Caregiver Intervention, and Impaired General Development in Children. *Pediatrics and Neonatology*, *58*(1), 22–28. https://doi.org/10.1016/j.pedneo.2015.11.008

Hardianti, R., Dieny, F. F., & Wijayanti, H. S. (2018). Picky eating dan status gizi pada anak prasekolah. *Jurnal Gizi Indonesia (The Indonesian Journal of Nutrition)*, *6*(2), 123–130. https://doi.org/10.14710/jgi.6.2.123-130

Horst, K. van der H., Deming, D. M., Lesniauskas, R., Carr, B. T., & Reidy, K. C. (2016). Picky eating: Associations with child eating characteristics and food intake. *Appetite*, *103*, 286–293. https://doi.org/10.1016/j.appet.2016.04.027

Islami, M. Nurul. (2022). Gambaran Picky Eater Pada Anak Usia Toddler (1-3 Tahun) di Kelurahan Bangetayu Kulon Kota Semarang. (Undergraduate thesis, Universitas Islam Sultan Agung Semarang). Accessed from https://repository.unissula.ac.id/29975/

Kamumu, F., & Rakay, I. (2023). Hubungan Picky Eating dengan Kejadian Stunting Pada Anak Usia Prasekolah di Kecamatan Lau Kabupaten Maros. (Undergraduate thesis, STIK Stella Maris Makassar). Accessed from http://repository.stikstellamarismks.ac.id/261/

Kasenda, M. G., Sarimin, S., & Onibala, F. (2017). Hubungan Status Gizi Dengan Perkembangan Motorik Halus Pada Anak Usia Prasekolah Di Tk Gmim Solafide Kelurahan Uner Kecamatan Kawangkoan Induk Kabupaten Minahasa. *Jurnal Keperawatan UNSRAT*, *3*(1), 1-8. https://doi.org/10.35790/jkp.v3i1.6744

Kusuma, H. S., Bintanah, S., & Handarsari, E. (2016). Tingkat Kecukupan Energi dan Protein pada Status Balita Pemilih Makan di Wilayah Kerja Puskesmas Kedungmundu Semarang. *The 3rd Universty Research Colloquium*, 557–564.

Accessed from https://publikasiilmiah.ums.ac.id/xmlui/handle/11617/6828

Lailatul, M., & Ni'mah., C. (2015). Hubungan Tingkat Pendidikan, Tingkat Pengetahuan dan Pola Asuh Ibu dengan Wasting dan Stunting pada Balita Keluarga Miskin. *Media Gizi Indonesia*, *10*(2015), 84–90. https://doi.org/10.20473/mgi.v10i1.84-90

Lida, K. S. (2016). Hubungan Pola Makan Dengan Status Gizi Anak Pra Sekolah Di Paud Tunas Mulia Claket Kecamatan Pacet Mojokerto. *Midwiferia*, *1*(2), 69-78. https://doi.org/10.21070/mid.v1i2.350

Mansur, A. R. (2019). Tumbuh Kembang Anak Usia Prasekolah. *Andalas University Pres* 1(1). Accessed from http://repository.uinjkt.ac.id/dspace/bitstream/123456789/33035/1/Istiqomah Aprilaz-FKIK.pdf

Marfuah, D., Kusudaryati, D. P. D., & Kurniawati, N. (2023, January). P*erbedaan Pendidikan Ibu, Pekerjaan Ibu dan Riwayat Pemberian MP ASI Pada Balita Stunting dan Non Stunting di Wilayah Puskesmas Trucuk II Klaten*. Proceeding of The 16th University Research Colloquium, 292–305. Accessed from http://repository.urecol.org/index.php/proceeding/article/view/2445.

Mayar, F., & Astuti, Y. (2021). Peran Gizi Terhadap Pertumbuhan dan Perkembangan Anak Usia Dini. *Jurnal Pendidikan Tambusai*, *5*(3), 9695–9704. Accessed from https://www.jptam.org/index.php/jptam/article/view/2545

Nadhirah, F., Taufiq, S., & Hernita. (2021). Hubungan Perilaku Picky Eater dengan Status Gizi pada Anak Usia Pra Sekolah di Taman Kanak-Kanak. *Darussalam Indonesian Journal of Nursing and Midwifery*, *1*(1), 30–38. Accessed from http://jurnal.sdl.ac.id/index.php/dij/

Nisa, N. J., Wiratmo, P. A., & Marianna, S. (2021). Perilaku Picky Eater dan Status Gizi Anak. *Inhrj*, *01*(02), 83–89. Accessed from https://lib.fikumj.ac.id/index.php?p=fstream-pdf&fid=24960&bid=6274

Purnamasari, A. R., & Adriani, M. (2020). Hubungan Perilaku Picky Eater Dengan Tingkat Kecukupan Protein dan Lemak pada Anak Prasekolah. *Media Gizi Indonesia*, *15*(1), 31-37. https://doi.org/10.20473/mgi.v15i1.31-37

Puspita, A. L., Sukamto, E., & Utami, R. P. (2023). Hubungan Perilaku Picky Eating dan Aktivitas Fisik Dengan Status Gizi Anak Prasekolah di KB Paud Imanul Wafa Balikpapan. *Jurnal Multidisiplin Indonesia*, *2*(8), 2178–2186. https://doi.org/10.58344/jmi.v2i8.429

Putri, A. N., & Muniroh, L. (2019). Hubungan Perilaku Picky eater dengan Tingkat Kecukupan Zat Gizi dan Status Gizi Anak Usia Prasekolah Di Gayungsari. *Amerta Nutrition*, *3*(4), 151-158. https://doi.org/10.20473/amnt.v3i4.2019.232-238

Rusmiati, D. (2020). Penyuluhan Kesehatan Dalam Memilih Jajanan Sehat Untuk Anak. *ARDIMAS: Jurnal Arsip Pengabdian Masyarakat*, *1*(1), 32–36. Accessed from https://ojs.fdk.ac.id/index.php/ESJ/article/view/2072

Sari, Y. D., & Rachmawati, R. (2020). Kontribusi Zat Gizi Makanan Jajanan Terhadap Asupan Energi Sehari Di Indonesia (Analisis Data Survey Konsumsi Makanan Individu 2014) [Food Away From Home (Fafh) Contribution of Nutrition To Daily Total Energy Intake in Indonesia]. *Penelitian Gizi Dan Makanan (The Journal of Nutrition and Food Research)*, *43*(1), 29–40. https://doi.org/10.22435/pgm.v43i1.2891

Widati, W., Nugraheni, P. A., Dikman, I. M., & Diarsvitri, W. (2024). Hubungan Pola Makan Ibu Saat Hamil Dengan Perilaku Picky Eater pada Anak Prasekolah di PG Dan RA Muslimat NU 60 Asy-Syuhada Pagerwojo Sidoarjo. *Surabaya Biomedical Journal,* 3(2), 81-88. Accessed from https://sub-biomed.org/index.php/sbj/article/view/77

Yulianar. (2022). Gambaran Perilaku Picky Eating (Pilih-Pilih Makanan) dan Status Gizi pada Anak Balita 3-5 Tahun di Wilayah Kerja Puskesmas Lambuya Kec. Lambuya. (Undergraduate thesis, Politeknik Kesehatan Kendari.). Accessed from http://repository.poltekkes-kdi.ac.id/3304/1/TUGAS AKHIR YULIANAR FIX.pdf.

RELATIONSHIP BETWEEN THE LEVEL OF MOTHER'S NUTRITIONAL KNOWLEDGE AND THE DIVERSITY OF ANIMAL PROTEIN INTAKE IN TODDLERS AT TERTEK VILLAGE

Eveline Gracela[1*], Auresa Caesarputriulya Wilmart[1], Lailatul Muniroh[1]
[1] Nutrition Department, Faculty of Health Sciences, Airlangga University, Surabaya
[*]E-mail: evelinegracela08@gmail.com

ABSTRACT

The importance of nutritional intake in the growth of toddlers has become a crucial matter, especially the intake of animal protein. Animal protein contains various essential amino acids with high bioavailability that contribute to supporting the growth and development processes of toddlers. One of the factors that can influence the diversity of animal protein consumption in toddlers is the level of mother's knowledge. This research was conducted to analyze the relationship between mother's nutritional knowledge level and the diversity of animal protein intake in toddlers aged 24-59 months at the Integrated Health Service Post (Posyandu) in Tertek Village, Pare District, Kediri Regency. The research design was cross-sectional with a total of 99 subjects selected through proportionate stratified random sampling. The data collection was carried out through interviews using questionnaires and Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) within the last one month. This research was conducted from January to June 2023 in Tertek Village, Pare District, Kediri Regency. Based on the research results, the majority of the mother's nutritional knowledge was categorized as low (39.4%). Meanwhile, the diversity of animal protein intake is still relatively low (60.6%). Statistical analysis results showed a significant relationship (p=0.027) with a low-level relationship (+0.260) between mother's nutritional knowledge and the diversity of animal protein intake in toddlers aged 24-59 months at the Integrated Health Service Post (Posyandu) in Tertek Village, Pare District, Kediri Regency. This indicates that the better the mother's nutritional knowledge, the higher the diversity of animal protein intake in toddlers.

Keywords**:** *Diversity of animal protein intake, Mother's level of nutritional knowledge, Toddlers*

INTRODUCTION

The issue of inadequate nutrition for children aged 24-59 months is still an ongoing problem until now. This influences the growth and development process in toddlerhood which has an impact on emotional development, intelligence, social awareness and creativity which are important foundations for further development (Candra, 2017). Protein Energy Deficiency (PEM) is one of the problems of nutritional insufficiency in toddlers. PEM is a condition of poor nutrition because energy and protein intake is less than daily requirements, making the Recommended Dietary Allowances (RDA) not met as recommended (Sinaga et al., 2021).

The trend of malnutrition problems in the form of stunting, underweight and wasting is increasing among toddlers aged 24-59 months in Indonesia (Sudikno et al., 2019). Toddlers aged 24-59 months are included in a group that is at risk of experiencing nutritional problems due to their relatively rapid growth and the changes in their eating patterns, which begin to follow the family's eating patterns (Azriful et al., 2018). Referring to data from the integration of the Study on the Nutritional Status of Toddlers in Indonesia (SSGBI) and the 2019 National Socio-Economic Survey (Susenas), the prevalence of underweight and stunted toddlers in the 24-59 month age group is higher than in the 0-59 month and 12-23 month age groups (Sudikno et al., 2019). In the 24-59 month age group there are 18.47% of toddlers classified as underweight, while in the 0-59 month age group there are 16.29% and in the 12-23 month age group there are 16.54% of toddlers classified as underweight (Sudikno et al., 2019). This also occurs in the TB/U index, namely that there are 32.8% of stunted toddlers in the 24-59 month age group and 27.7% of stunted toddlers in the 0-59 month age group (Sudikno et al., 2019). The

 Received 15-03-2024, Accepted 27-08-2024, Published online 30-09-2024.

prevalence of wasted toddlers based on the 2019 SSGBI and Susesnas integration data only includes data for the 24-59 month age group, namely 7.4% (Sudikno et al., 2019). Referring to SSGBI in 2022, the prevalence of toddlers affected by stunting (21.6%), wasting (7.7%), and underweight (17.1%) (Kementerian Kesehatan Republik Indonesia, 2023).

There are two main factors that influence nutritional problems, namely factors that have a direct and indirect impact. Indirect causal factors are parenting patterns, food security in the household, inadequate health care and environmental sanitation (Afrinis et al., 2021). Direct causes involve aspects such as infection and food intake (Afrinis et al., 2021). Judging from several factors that can influence nutritional problems, the nutritional intake of toddlers is a direct factor that influences the nutritional status of toddlers (Diniyyah & Nindya, 2017). One of the nutrients that affects the nutritional status of toddlers is protein.

Protein intake plays an important role in supporting toddler growth, especially in children under five years old because protein has the main function as a body building substance (Ernawati et al., 2016). Lack of protein intake in toddlers aged 0-60 months can increase the risk of stunting by 1,6 times and underweight by 1,8 times (Soumokil, 2017). Sources of protein can be obtained from animal and plant foods. Based on data from the Individual Food Consumption Survey (SKMI) in 2014, majority of protein intake still comes from vegetable protein with the average consumption of nuts reaching 56.7 grams per day, while animal protein only reaches 42.8 grams per day (Siswanto, 2014). Animal protein is a type of protein with better quality proportions and types of amino acids compared to protein from vegetable sources (Ernawati et al., 2016). Animal protein contains a variety of essential amino acids that have high bioavailability (Ernawati et al., 2016).

Nutritional problems in toddlers can cause a decline in cognitive abilities and health status which will have an impact on their quality of life (Singarimbun, 2020). There are several factors that can increase the risk of malnutrition in toddlers, including the mother's occupation, low level of mother's nutritional knowledge, and inadequate intake. Mother's employment status can have an impact on toddler care practices (Elba et al., 2023). Mothers who don't work have a lot of time at home so they can pay more attention to nutritional intake for toddlers (Elba et al., 2023). Apart from that, a low level of knowledge regarding the diversity of food types and ingredients can cause disruption to the growth and development process of toddlers (Nurma Yuneta et al., 2019). Therefore, parents, especially mothers, are expected to pay more attention to the fulfillment of adequate nutrition in toddlers.

Tertek Village is the only village in the Sidorejo Community Health Center area that has become a locus of stunting since 2019. Based on data from Sidorejo Health Center, there was an increase in the prevalence of wasting toddlers in Tertek Village, from 7.95% in 2022 to 8.06% in 2023. Based on this background, this research was conducted to analyze the relationship between the level of mother's nutritional knowledge and the diversity of animal protein intake in toddlers aged 24- 59 months at the Integrated Health Service Post (Posyandu) in Tertek Village.

METHODS

This research is quantitative research with analytical and design observation research types cross-sectional. The instruments used were mother and toddler characteristics questionnaires, nutritional knowledge questionnaire, and the Semi Quantitative Food Frequency Questionnaire (SQ-FFQ) form. The nutritional knowledge questionnaire contains eight questions that have been adapted to the research topic, this questionnaire has also been statistically testes for validity in the research population respondents. The use of the SQ-FFQ form instrument was carried out using the interview method to determine the diversity of animal protein intake in the past month.

The population that is the subject of this research is all toddlers aged 24-59 months who live in Tertek Village, Pare District, Kediri Regency in May 2023 which based on Sidorejo Health Center data were 523 toddlers. The sample in this study consisted of 99 toddlers, which met the minimum number of samples required. Inclusion

criteria in this study are : mothers who have toddler who have a Healthy Growth Monitoring Book (KMS), mother whose toddlers are not sick or under the care of a doctor or other health worker. Respondents in this study were mothers of toddlers who were sampled.

The research location was conducted in Tertek Village, Pare District, Kediri Regency which is included in the working area of the Sidorejo Health Center. The method used for sampling in this research is proportionate stratifies random sampling, there were 11 Integrated Health Service Post (Posyandu) that became the research location in Tertek Village. The research was conducted from January to June 2023, with data collection taking place in May 2023.

The analysis applied in this research is included in inferential statistics, which aims to draw conclusions based on the results of the analysis that have been linked to proving the hypothesis. The data that has been collected is then re-checked to ensure that the data obtained from respondents is complete and valid. Analysis to prove the existence of a relationship between the level of mother's nutritional knowledge and the diversity of toddlers' animal protein intake uses a non- parametric statistical test in the form of the chi-square test.

The research conducted has undergone ethical testing from the Health Research Ethics Commission (KEPK) Airlangga University with ethical certificate number 539/HRECC.FODM/V/2023.

RESULTS AND DISCUSSIONS

Distribution of Mother's Characteristics

In this research, identification was carried out on mother's characteristics such as age, education level and occupation. Data from this identification is presented in the following table.

Mother's age is grouped into three categories, namely 17-25 years which is the late adolescent age group, 26-35 years which is the early adulthood age group, 36-45 years which is the late adulthood age group (Depkes RI, 2009). The average age of mothers of toddlers was 33.82 ± 5.901 years. The youngest age of a toddler's mother is 22 years while the oldest age of a toddler's mother is 45 years.

Table 1. Distribution of Age, Education, and Occupation of Mothers of Toddlers in Tertek Village in 2023

Mother's Characteristics	n	%
Age		
17-25 years old	10	10.1
26-35 years old	50	50.5
36-45 years old	39	39.4
Total	**99**	**100**
Level of education		
Not educated	0	0
Finished elementary school	6	6.1
Finished middle school	36	36.4
Finished high school	47	47.4
Graduated from college	10	10.1
Total	**99**	**100**
Occupation		
Doesn't work	75	75.8
Farmers/fishermen	1	1
Laborer	1	1
Trader/entrepreneur	18	18.2
Private employees	1	1
Civil servants	2	2
TNI/Polri	0	0
Other	1	1
Total	**99**	**100**

The last level of education taken by the mother of a toddler reflects the mother's level of education. Table 1 shows that the majority of mothers of toddlers in Tertek Village, amounting to 47.5%, have finished high school or equivalent education. Table 1 also shows that the majority of mothers, 75.8%, do not work.

Distribution of Toddler Characteristics

In this research, identification was carried out on toddler characteristics such as age and gender. Data from this identification is presented in the following table.

The age of the toddler was obtained from the results of interviews using an instrument in the form of a questionnaire which was obtained by calculating the date of birth according to the KMS for toddlers with the appropriate age calculation data collection date is based on calculating the age of the full month. The average age of toddlers

Table 2. Age and Gender Distribution of Toddlers in Tertek Village in 2023

Toddler Characteristics	n	%
Age		
24-35 months	29	29.3
36-47 months	37	37.4
48-59 months	33	33.3
Gender		
Male	58	58.6
Female	41	41.4
Total	**99**	**100**

in the range of 24-59 months in Tertek Village is 41.88 ± 10.046 months. Based on Table 2, it can be observed that the majority of toddlers are aged 36-47 months, amounting to 37.4%. The male gender was 58.6%, while the female gender was 41.4%.

Mother's Nutritional Knowledge Level

The mother's level of knowledge was interpreted into three categories : less, medium, and good. The following is the distribution of knowledge levels of mothers of toddlers in Tertek Village.

Based on table 3, it was concluded that the majority of mothers of toddlers had a low level of knowledge of 39.4%. Only 25.3% of mothers had a high level of knowledge. The types of questions given to respondents include the frequency of toddler attendance at the Integrated Health Service Post (Posyandu), varied foods for toddlers, frequency of feeding for toddlers, high energy food sources, signs of good nutritional status in toddlers, the function of high protein foods for toddlers, the function of high zinc foods for toddlers, and the types of energy-forming nutrients. Most mothers of toddlers do not have nutritional knowledge regarding varied foods for toddlers and the function of high protein foods for toddlers.

Levels of Diversity in Animal Protein Intake

The level of diversity in animal protein intake is interpreted into two categories, which are low and high. The following are the results of the level of diversity in animal protein intake in Tertek Village.

The level of diversity in animal protein intake was analyzed using food consumption score calculations from the SQ-FFQ results, which is one of the research instruments. Food sources of animal protein have a score between 50-0 with criteria score 50 if intake ≥3 times/day, score 25 if intake 1-2 times/day, score 15 if intake 3-6 times/week, score 10 if intake 1-2 times/week, score 5 if intake 2-3 times/month, score 0 if never (Sirajuddin et al., 2018). The food consumption score is obtained by calculating the total score from the consumption column for each food item that has been consumed in the last month and then adding it up. The final score results are interpreted into two categories, namely intake diversity is classified as high if the score is more than the median value and intake diversity is classified as low if the score is equal to or less than the median value (Sari et al., 2022).

The level of diversity in animal protein intake of toddlers in Tertek Village shows that the majority of toddlers have a low level of diversity in animal protein intake (60.6%). Meanwhile, only a small percentage of toddlers have a high level of diversity in protein intake (39.4%). Chicken eggs are a food source high in animal protein that is most frequently consumed with daily consumption rate of 41.4% and weekly consumption rate of 54.4%. Additionally, cow's milk and powdered milk are also high protein animal foods consumed on a daily basis. Meanwhile, chicken meat,

Table 3. Distribution of Mother's Nutritional Knowledge Level in Tertek Village

Mother's Nutritional Knowledge Level	n	%
Low (score <60)	39	39.4
Moderate (score 60-80)	35	35.4
High (score >80)	25	25.2
Total	**99**	**100**

Table 4. Distribution of Variation Levels of Animal Protein Intake for Toddlers in Tertek Village in 2023

Levels of Variability in Toddlers' Animal Protein Intake	n	%
Low (≤median)	60	60.6
High (>median)	39	39.4
Total	**99**	**100**

sausages and meatballs are consumed on a weekly basis. Meanwhile, the three least consumed sources of animal protein are beef liver, mackerel and goat's milk. The average score for the diversity level of toddlers' animal protein intake is 135 with the lowest diversity level score being 65 and the highest diversity level being 330.

Relationship between Mother's Level of Nutritional Knowledge and Variability in Animal Protein Intake

Data compiled in the form of a cross tabulation between the level of mother's nutritional knowledge and the diversity of animal protein intake among toddlers aged 24-59 months in Tertek Village, is presented in the following table.

From the results of the analysis of the relationship between the mother's level of nutritional knowledge and the diversity of animal protein intake using the chi-square correlation test, a p value of 0.027 ($p<0.05$) was obtained. These results identify that there is a significant relationship between the level of mother's nutritional knowledge and the diversity of animal protein intake.

Protein has an important role in the formation of antibodies, building body structures, and growth. Animal protein is a more complete source of essential amino acids and micronutrients and has higher bioavailability than vegetable protein (Sari et al., 2022). Research that has been conducted shows that the majority of toddlers have a low level of diversity in animal protein intake (60.6%). Meanwhile, there is only a small percentage of toddlers who have a high level of diversity in protein intake (39.4%). Based on the results of research Sari et al (2022), the diversity of animal protein intake has a significant relationship with the incidence of stunting, if the diversity of animal protein intake is higher, the nutritional status of children under five will increase so that they will avoid stunting.

Table 5. Cross tabulation between mother's nutritional knowledge level and diversity of animal protein intake

Mother's Knowledge	Diversity of Animal Protein Intake						p-value
	Low		High		Total		
	n	%	n	%	N	%	
Low	24	61.5	15	38.5	39	100.0	0.027
Moderate	16	45.7	19	54.3	35	100.0	
High	20	80	5	20	25	100.0	

Consumption of various animal proteins is associated with increased growth in toddlers (Sari et al., 2022). This is because a lack of diversity in animal protein intake can result in the body lacking certain essential amino acids. The lack of diversity in animal protein intake can be influenced by the mother's level of knowledge. Knowledge is the result of human sensing of a specific object (Pramesthi et al., 2023). The results of the research that has been conducted show that many mothers of toddlers have a low level of knowledge (39.4%), while mothers of toddlers who have a high level of knowledge are only 25.3%. Based on previous research findings by Lailatul & Ni'mah (2015) regarding the relationship between the level of knowledge and wasting, it showed that most mothers of toddlers had a low level of knowledge (Lailatul & Ni'mah., 2015). This is also in line with research conducted by Nindyna Puspasari & Merryana Andriani (2017) who stated in their research results that mother's knowledge and food intake influence the nutritional status of toddlers. One of the fundamental factors that directly influences the nutritional status of toddlers is the mother's level of knowledge. This is because mother's nutritional knowledge can determine the mother's attitude or behavior in choosing food to be consumed by toddlers, as well as eating habits in terms of quantity, type and frequency (Auliany & Purnamawati, 2023). There are various factors that can influence a mother's level of knowledge, one of which is the level of education. Mother's education is basic for achieving good toddler nutrition (Rizcewaty et al., 2022). The mother's education level is related to the mother's ease in receiving information about nutrition and health from outside (Rizcewaty et al., 2022). The level of mother's nutritional knowledge is related to the diversity of animal protein intake in toddlers aged 24- 59 months ($p=0.27$) with a relatively low level of relationship (+0.260). Therefore, the level of mother's nutritional knowledge can influence the diversity of animal protein intake in children under five in Tertek Village. This means that if the

mother's level of nutritional knowledge is high, the toddler will have a high level of diversity in protein intake and conversely, if the mother's level of nutritional knowledge is low, the toddler's level of diversity in protein intake will likely be low.

Mothers' lack of understanding of nutritional knowledge can result in a decrease in the practice of processing and consuming nutritious food among toddlers, which can increase the risk of malnutrition (Doutel et al., 2019). Mothers with good nutritional knowledge can realize the importance of toddler health (Adelina et al., 2018). A mother who has good nutritional knowledge can often provide different types of animal protein foods. The nutritional needs of toddlers will be met if mothers apply their nutritional knowledge to make wise food choices and preparation (Doutel et al., 2019).

CONCLUSION

In this study, there was a significant relationship between the level of mother's nutritional knowledge and the level of diversity in animal protein intake for toddlers aged 24-59 months. The mother's role in providing a variety of animal protein intake to toddlers is very important. This is expected to be able to support children's growth and development optimally. With the results of this study, it is hoped that mothers of toddlers can increase the diversity of animal protein intake to support growth.

REFERENCES

Adelina, F. A., Widajanti, L., & Nugraheni, A. S. (2018). Hubungan Pengetahuan Gizi Ibu, Tingkat Konsumsi Gizi, Status Ketahanan Pangan Keluarga Balita Stunting (Studi pada Balita Usia 24-59 Bulan di Wilayah Kerja Puskesmas Duren Kabupaten Semarang). *Jurnal Kesehatan Masyarakat*, *6*(5), 361–369.

Afrinis, N., Verawati, B., & Hendarini, A. T. (2021). Analisis Faktor Yang Berhubungan Dengan Status Gizi Bayi Usia 6-12 Bulan Pada Masa Pandemi Covid-19. *PREPOTIF : Jurnal Kesehatan Masyarakat*, *5*(1), 304–310. https://doi.org/10.31004/prepotif.v5i1.1601

Auliany, D., & Purnamawati, D. (2023). *The Relationship Between Maternal Knowledge and Food Intake on the Nutritional Status of Children Participating in the Nutrition Post at Puskesmas Baja*. *III*(1), 181–186.

Azriful, A., Bujawati, E., Habibi, H., Aeni, S., & Yusdarif, Y. (2018). Determinan Kejadian Stunting Pada Balita Usia 24-59 Bulan di Kelurahan Rangas Kecamatan Banggae Kabupaten Majene. *Al-Sihah: The Public Health Science Journal*, *10*(2), 192–203. https://doi.org/10.24252/as.v10i2.6874

Candra, A. (2017). Suplementasi Mikronutrien dan Penanggulangan Malnutrisi pada Anak Usia di Bawah Lima Tahun (Balita) Aryu Candra Bagian Gizi, FakultasKedokteran, Universitas Diponegoro. *JNH(Journal of Nutrition and Health)*, *5*(3), 159–165.

Depkes RI. (2009). *Klarifikasi umur menurut kategori*. Ditjen Yankes.

Diniyyah, S. R., & Nindya, T. S. (2017). Asupan Energi, Protein dan Lemak dengan Kejadian Gizi Kurang pada Balita Usia 24-59 Bulan di Desa Suci, Gresik. *Amerta Nutrition*, *1*(4), 341. https://doi.org/10.20473/amnt.v1i4.7139

Doutel, E. J., Picauly, I., & Salmun, J. A. R. (2019). Determinan Status Gizi Balita pada Keluarga Petani di Wilayah Kerja Puskesmas Halilulik Kabupaten Belu Tahun 2019. *Lontar : Journal of Community Health*, *1*(3), 103–110. https://doi.org/10.35508/ljch.v1i3.2175

Elba, F., Hassan, H. C., Umar, N. S., & Hilmanto, D. (2023). Mother's knowledge of nutrition and protein intake in stunted children aged 12-36 months in Indonesia. *International Journal of Innovative Research and Scientific Studies*, *7*(1), 56–62. https://doi.org/10.53894/ijirss.v7i1.2418

Ernawati, F., Prihatini, M., & Yuriestia, A. (2016). Gambaran Konsumsi Protein Nabati Dan Hewani Pada Anak Balita Stunting Dan Gizi Kurang Di Indonesia. *The Journal of Nutrition and Food Research*, *39*(2), 95–102.

Kementerian Kesehatan Republik Indonesia. (2023). *Menteri Kesehatan Republik Indonesia Hasil Survei Status Gizi Indonesia (SSGI) 2022*. 1–7.

Lailatul, M., & Ni'mah., C. (2015). Hubungan Tingkat Pendidikan, Tingkat Pengetahuan dan Pola Asuh Ibu dengan Wasting dan Stunting pada Balita Keluarga Miskin. *Media Gizi Indonesia*, *10*(2015), 84–90. https://doi.org/Vol. 10, No. 1 Januari–Juni 2015: hlm. 84–90 terdiri

Nindyna Puspasari, & Merryana Andriani. (2017). Hubungan Pengetahuan Ibu tentang Gizi dan Asupan Makan Balita dengan Status Gizi Balita

(BB/U) Usia 12-24 Bulan. *Amerta Nutrition*, *1*(4), 369–378. https://doi.org/10.20473/amnt.v1.i4.2017.369-378

Nurma Yuneta, A. E., Hardiningsih, H., & Yunita, F. A. (2019). Hubungan Antara Tingkat Pengetahuan Ibu Dengan Status Gizi Balita Di Kelurahan Wonorejo Kabupaten Karanganyar. *PLACENTUM: Jurnal Ilmiah Kesehatan Dan Aplikasinya*, *7*(1), 8. https://doi.org/10.20961/placentum.v7i1.26390

Pramesthi, Z. L., Umijati, S., & Yulianti, E. (2023). Pengetahuan Ibu Berhubungan dengan Status Gizi Anak Berdasarkan Indeks BB/TB. *Jurnal Penelitian Perawat Profesional*, *5*(1), 77–82. https://doi.org/10.37287/JPPP.V5I1.1354

Rizcewaty, R., Rahman, E., & Suryanto, D. (2022). Hubungan Tingkat Pendidikan Dan Pengetahuan Tentang Status Gizi Dengan Kejadian Stunting Anak 12-59 Bulan Di Wilayah Kerja Puskesmas Pulau Kupang Kabupaten Kapuas Tahun 2021. *An-Nadaa Jurnal Kesehatan Masyarakat*, *9*(1), 39. https://doi.org/10.31602/ann.v9i1.7184

Sari, H. P., Natalia, I., Sulistyaning, A. R., & Farida, F. (2022). Hubungan Keragaman Asupan Protein Hewani, Pola Asuh Makan, Dan Higiene Sanitasi Rumah Dengan Kejadian Stunting. *Journal of Nutrition College*, *11*(1), 18–25. https://doi.org/10.14710/jnc.v11i1.31960

Sinaga, D., Sitepu, A. B., & Sianturi, M. (2021). Relationship Of Mother's Knowledge About Protein Energy Malnutrition With Nutritional Status Of Preschool Children In Kristina Clinic Perumnas Sidikalang In 2021. *Science Midwifery*, *10*(1), 151–155. https://midwifery.iocspublisher.org/index.php/midwifery/article/view/176

Singarimbun, R. J. (2020). Faktor-Faktor Yang Mempengaruhi Kecukupan Status Gizi Balita Di Kecamatan Medan Tuntungan Tahun 2019. *Dinamika Kesehatan: Jurnal Kebidanan Dan Keperawatan*, *11*(1), 281–289. https://doi.org/10.33859/dksm.v11i1.567

Sirajuddin, Surmita, & Astuti, T. (2018). *Survey Konsumsi Pangan*. Kementerian Kesehatan Republik Indonesia.

Siswanto. (2014). *Studi Diet Total : Survei Konsumsi Makanan Individu 2014*. Badan Penelitian dan Pengembangan Kesehatan.

Soumokil, O. (2017). Hubungan Asupan Energi Dan Protein Dengan Status Gizi Balita di Kecamatan Nusalaut Kabupaten Maluku Tengah. *Global Health Science*, *2*(3), 220–225.

Sudikno, Irawan, I. R., Setyawati, B., Sari, Y. D., Wiryawan, Y., Puspitasari, D. S., Widodo, Y., Ahmadi, F., Rachmawati, R., Amaliah, N., Arfines, P. P., Rosha, B. C., Pambudi, J., Aditianti, Julianti, E. D., & Safitri, A. (2019). *Laporan Akhir Penelitian Status Gizi Balita Tahun 2019*.

https://doi.org/10.20473/mgi.v19i3.311–321

LOW BIRTH WEIGHT AND INAPPROPRIATE FEEDING VARIATION CAUSED NUTRITIONAL DISORDERS BASED ON THE COMPOSITE INDEX OF ANTHROPOMETRIC FAILURE (CIAF)

Eka Safitri Yanti[1*], Endriyani Martina Yunus[2]
[1]Poltekkes Kemenkes Pangkal Pinang, Pangkal Pinang, Indonesia
[2]Jurusan Kebidanan, Poltekkes Kemenkes Pangkal Pinang, Pangkal Pinang, Indonesia
*E-mail: ekasafitriyanti89@gmail.com

ABSTRACT

Nutritional disorders in children apart from causing morbidity and death also cause diseases that can be inherited. Early detection by measuring a child's growth regularly is one way of prevention and early treatment. One way to detect growth failure is to use the Composite Index of Anthropometric Failure (CIAF) by specifying and combining various growth failures that occur so the risks are easier to predict. This research aims to find the determinants of nutritional disorders based on CIAF. This research is a descriptive-analytical study with a cross-sectional approach which was carried out for 10 months starting from January until October 2024 in Belitung Regency, Bangka Belitung Islands Province. The sample in this study consisted of 198 children aged 6 months to 5 years old. Samples were taken using a simple random sampling technique. Children will be examined to obtain weight and height data and then their nutritional status will be categorized based on the WHO 2006 graph. The questionnaires contain questions about parental characteristics, the child's birth weight, parents' height, family economics, family awareness about nutrition (regularly weighing children, exclusive breastfeeding, iodized salt, appropriate feeding variation, supplements during pregnancy and childhood), and clean and healthy living behavior (delivery assisted by health workers, exclusive breastfeeding, regularly weighing children, washing hand behavior, healthy latrines, eliminating mosquito larvae, appropriate feeding variation, physical activity, and smoking behavior). The results of the study showed that almost half of the respondents (40.4%) experienced growth failure. None of the characteristics of children and parents has a significant relationship with growth failure. Childbirth weight had a difference between children with growth failure and normal (p=0.048) as well as variations in the feeding menu had a significant relationship with stunting (p=0.009). Furthermore, other determinants tested such as mother's height (p=0.318), father's height (p=0.213), family income (p=1.000), and the indicators of family awareness about nutrition (p=0.438), and clean and healthy living behavior (p=1.000) were not proven to have a statistically significant relationship. Low birth weight is related to the incidence of growth failure in children and variation in feeding menu has a significant relationship with stunting.

Keywords*: CIAF, growth failure, inappropriate feeding variation, nutritional disorders, stunting*

INTRODUCTION

The issue of growth disorders in children is a form of malnutrition that is prevalent globally, particularly in impoverished and developing nations (Santosa et al., 2022). Worldwide, children under the age of 5 are considered to be at risk and prone to various issues, particularly in the area of nutrition. Generally, nutritional deficiencies and malnutrition have a greater impact on children compared to any other group (Amoah et al., 2024).

Nutritional deficiencies and malnutrition generally affect children (Amoah et al., 2024). Malnutrition especially stunting is often linked to chronic malnutrition, resulting in children being shorter than their expected height for their age. The consequences of stunting are detrimental not only for the affected children but also for the future of a nation. Children who have experienced stunting may undergo harmful effects, such as decreased physical and cognitive abilities, impaired neurodevelopment, and an increased risk of metabolic diseases into adulthood. Undoubtedly, these effects can place an economic strain on families and lead to a loss of skilled human capital for the country (Santosa et al., 2022).

Malnutrition in children under 5 is caused by a complex combination of factors related to the availability, accessibility, and utilization of

 Received 28-02-2024, Accepted 12-09-2024, Published online 30-09-2024.

food and healthcare services. Insufficient food consumption, inadequate caregiving and parenting, inappropriate food practices, and infectious comorbidities are specific nutritional factors. Food insecurity and limited economic resources at the individual, household, and community levels are examples of nutrition-sensitive factors. Other factors that negatively impact the nutritional status of children under 5 include limited or inadequate access to education, healthcare services, and infrastructure, as well as poor hygienic environments (Clark et al., 2020; Drammeh et al., 2019). Apart from that, parents' height was also found to have an influence on children's height and the risk of stunting (Wu et al., 2021).

Indonesia has a stunting prevalence of 21.5% in 2023. This figure is only reduced by 0.1% compared to the results of a survey conducted in 2022. This number is still slightly higher than the maximum limit for stunting prevalence set by WHO, which is 20%. Other malnutrition categories that were assessed were underweight (15.9%), wasting (8.5%), and overweight and obese (4.2%). Meanwhile, the number of malnutrition in Bangka Belitung respectively is stunting at 20.7%, underweight at 13.4%, wasting at 8%, and overweight and obese at 7.9%. Except for obesity, other figures are lower than the national figures. However, this number has not decreased significantly in the last few years (Badan Kebijakan Pembangunan Kesehatan, 2024). Belitung Regency has the second highest prevalence of stunting in Bangka Belitung in 2022 in Belitung, namely 7.1% (Ditjen Bina Pembangunan Daerah - Kementerian Dalam Negeri, 2022).

Belitung Regency has experienced a significant increase in stunting in the last two years. In 2020, only one village in Belitung Regency originally had a stunting prevalence of above 20 percent, increasing to eight villages in 2021. These villages are Kacang Butor Village (23.20%), Pulau Gersik Village (26, 76%), Air Selumar Village (21.76%), Sungai Padang Village (20.71%), Batu Itam Village (21.60%), Tanjung Binga Village (22.27%), Keciput Village (21.13 %), Tanjung Tinggi Village (25%) (Nurmalitasari, 2021).

Malnutrition causes morbidity and mortality. In malnourished children, these two risks are usually detected with conventional tools which generally only look at weight or height according to age. Over time, a categorization of malnutrition was discovered which was considered to better understand the phenomenon of nutritional disorders that occur in society, namely the composite index of anthropometric failure (CIAF). This method can specify and combine nutritional disorders that occur (Preedy, 2012). Although CIAF has not been officially validated as a method for assessing nutritional status in Indonesia, four main categories (stunting, underweight, wasting, and overweight) are surveyed every year. Several studies use the CIAF method as a way to see the picture of malnutrition that occurs in communities such as West Bangka, Bogor, Semarang and several other cities in Indonesia (Andini et al., 2020; Permatasari & Chadirin, 2022; Yanti et al., 2022).

CIAF is an anthropometric index that combines the three indicators of weight per age, height per age, and weight per height to determine the nutritional status of children. Nutritional status categories based on CIAF are divided into growth failure and normal. The CIAF category was originally recognized in 2000 by Svedberg and in the beginning divided into six categories: normal; stunting; wasting; underweight and stunting; underweight and wasting, underweight, stunting and wasting. In 2005, Sailen Nandy and the team added a seventh group, the Y category, or the underweight category only (Preedy, 2012; Svedberg, 2000). Over time, the emergence of a "double burden of malnutrition", a condition where the problem of undernutrition occurs simultaneously with overnutrition and obesity, makes the CIAF model with seven categories no longer sufficient. The model only detects children with weight and height below the population average based on WHO and the Centers for Disease Control and Prevention (CDC). This model does not show the condition of children with multiple nutritional problems where stunting and overweight can occur simultaneously. In fact, like wasting, underweight, and stunting, overweight children can suffer from many diseases. Therefore, two additional categories were proposed, namely overweight and overweight and stunting (Kuiti & Bose, 2018).

In this study, CIAF was divided into nine categories where growth failure was a combination

of eight categories namely normal; underweight; stunting; wasting; underweight and stunting; underweight and wasting, underweight, stunting and wasting; overweight; overweight and stunting. Underweight, stunting, and wasting are determined based on Z score < -2SD, while normal if Z score ≥ -2SD (Rahmadini et al., 2013). This model is used considering the increasing trend of obesity in Indonesia, especially in Bangka Belitung. Obesity is the only category of malnutrition that has increased in number compared to other categories which have experienced a decrease, although not significant (Badan Kebijakan Pembangunan Kesehatan, 2024).

Belitung Regency in particular and Bangka Belitung Islands Province in general have not classified malnutrition based on CIAF. Reviewing the annual survey data, the prevalence of malnutrition in Bangka Belitung has not decreased significantly, there are even categories of malnutrition that have increased. To see a more comprehensive picture of the incidence of malnutrition, the CIAF method is needed because it combines four main categories of malnutrition (stunting, underweight, wasting, and obesity). Apart from that, it is necessary to know the factors that underlie malnutrition to carried out specific treatment to reduce the rate of malnutrition appropriately and quickly. This research aims to determine the determinants of malnutrition based on the Composite Index of Anthropometric Failure (CIAF) in Belitung.

METHODS

This study is a descriptive-analytical study with a cross-sectional approach in Belitung Regency, Bangka Belitung Islands Province. This research was carried out for 10 months starting from obtaining permits from the health department and local government, exploring the research area, data collection to research evaluation. Another factor that caused the long duration of the research was the sample collection was adjusted to the Posyandu schedule in all Community Health Centers in Belitung Regency. The total time for collecting sample data was 2 months (July – September 2023).

All community health centers in Belitung Regency (a total of 9 community health centers) were used as research locations and one Posyandu was taken from each community health center using a simple random sampling technique. The population in this study were all families with toddlers aged 6 to 59 months in Belitung Regency. The sample consisted of 198 toddlers whose parents agreed to be respondents by signing informed consent. Respondents will be excluded if the toddler was born prematurely and has congenital abnormalities.

Respondents who meet the criteria to be sampled in this study will undergo an anthropometric examination to determine nutritional status. The child's age and the type of measuring instrument used will be taken into account in anthropometric measurements. A child's age is calculated in full months, in other words, age is considered one month old if it is full 30 days. The scales used can measure up to an accuracy of 100 grams and height measurement lying down (for children under two years old) or standing upright (for children over two years old).

Assessment of children's nutritional status using the 2006 WHO growth chart. Anthropometric results are then compared by looking at body weight based on age (weight for age), height based on age (height for age) and body weight based on height (weight for height). The results will be categorized into nine types: normal; underweight; stunting; wasting; underweight and stunting; underweight and wasting, underweight, stunting and wasting; overweight; overweight and stunting.

Furthermore, the child's parents will be asked using the questionnaire. The questionnaires contains questions about parental characteristics, child's birth weight, parents' height, family economics, family awareness about nutrition, and clean and healthy living behavior.

In detail, family awareness about nutrition contains questions about regularly weighing children for the last 4 months, exclusive breastfeeding, use of iodized salt, vegetables/ fruits and animal protein on the diet for the last three days, and government program supplements for children under five years of two doses of Vitamin A per year and 90 iron tablets for pregnant women.

Meanwhile, data on clean and healthy living behavior is assessed from mothers who give birth in health workers, exclusive breastfeeding, children being weighed regularly, washing hands with clean water and soap, using healthy latrines, eliminating mosquito larvae every week, eating fruit and vegetables every day, physical activity at least 30 minutes every day and family members do not smoke in the house.

The results obtained were then edited, coded, tabulated, and then analyzed using the statistic program. The Ethics Commission of Health Research of the Poltekkes Kemenkes Pangkal Pinang, acceded to this study (approval number 056/EC/KEPK-PKP/VI/2023). The Health Office of Belitung Regency and all community health centers in the study area also provided approval. Every participant in this research gave their written consent and signed the consent form after receiving full information about the study. Personal identifiers were excluded from the data collection form to ensure the confidentiality of the information provided by the participants. During data collection, priority was given to participant convenience, and their rights were respected.

RESULTS AND DISCUSSIONS

Based on Table 1, the prevalence of nutritional disorders based on CIAF with nine categories found that 40.4% or almost half of children experienced growth failure in Belitung. This data is similar to that obtained by research conducted in Ethiopia where the CIAF nutritional disorder rate was 48.5% (Endris et al., 2017). Growth failure is most common in the stunting category (11.6%) and least in the underweight category (1%). In Indonesia, malnutrition detection using CIAF has also been carried out in Bangka Barat Regency, another region in Bangka Belitung province, although using seven categories. The results obtained were that 48.4% of children experienced growth failure. This shows that in general, in Bangka Barat, almost half of the children experience nutritional disorders (Yanti & Permata, 2023).

Table 1. Prevalence of nutritional disorders based on CIAF in children under five in Belitung

	CIAF Category	Frequency (%)
I	Normal	118 (59.6)
II	*Underweight*	2 (1.0)
III	*Stunting*	23 (11.6)
IV	*Wasting*	8 (4.0)
V	*Underweight* dan *Stunting*	14 (7.1)
VI	*Underweight* dan *Wasting*	7 (3.5)
VII	*Underweight, Stunting,* and *Wasting*	4 (2.0)
VIII	*Overweight*	16 (8.1)
IX	*Overweight* dan *Stunting*	6 (3.0)
Total		198 (100)

Growth Failure (II + III + IV + V + VI + VII + VIII + IX) = 40.4%.

What is interesting is that overweight is the second highest category of nutritional disorders after stunting (8.1%) and there are 3% of children who are both overweight and stunted (double burden of malnutrition). This shows that children's nutritional disorders do not only occur due to lack of intake but can occur due to inappropriate feeding of children in terms of portions, variety, and nutrients. Furthermore, stunting occurs not only in children who experience a lack of food intake, but can also occur in children who are overweight, the cause of which may be due to inappropriate feeding methods or genetic factors (Prasetyo et al., 2023). Research finds that children with low socio-economic backgrounds have a double burden of malnutrition (especially stunting and obesity). However, in this study no correlation was found between parental education, parental occupation, or family income on the occurrence of malnutrition in children (Modjadji et al., 2022).

Malnutrition assessed using conventional methods only detects a small percentage of nutritional disorders compared to CIAF. (Dasgupta et al., 2014; Pei et al., 2014). The number of malnutrition based on the CIAF, growth category, will appear significantly higher when compared with the national level. This is because the malnutrition survey is classified separately, unlike the CIAF which sums up all combinations of malnutrition. When compared per category, the numbers obtained in this study are similar to the national survey and are even slightly lower, because there are children who experience malnutrition in more than one category (double-burden malnutrition) will be included in two categories of malnutrition at the national level.

Children with both stunting and overweight, for example, in CIAF will be included in category IX (table 1) but will be counted respectively in the stunting and overweight/ obese categories in the national survey.

Based on the research results obtained (table 2), more children in this study were female (52%) than male (48%). Statistical tests show there is no difference in nutritional status between the two genders, both boys and girls. This is contrary to research conducted in India and in sub-Saharan Africa where boys were found to have a higher risk of experiencing malnutrition although further research into this finding is needed. The possible cause is due to children's nutritional needs not being met as they get older (Porwal et al., 2021;

Table 2. Characteristics of Respondents and Their Relationship with Nutritional Status

Respondent Characteristics	Mean ± SD Frequency (%) n=198	p
Child's Gender		
Female	103 (52)	0.138[a]
Male	95 (48)	
Child's Age (months)	**28.03 ± 14.534**	0.117[a]
6 – 11	31 (15.7)	
12 – 23	55 (27.8)	
24 – 35	43 (21.7)	
36 – 47	47 (23.7)	
48 – 59	22 (11.1)	
Mother's age (years)	**29.42 ± 6.848**	0.561[b]
< 20	7 (3.5)	
20 – 35	156 (78.8)	
> 35	35 (17.7)	
Mother's Education		
High (university level)	17 (8.6)	0.223[b]
Advanced (senior high school)	102 (51.5)	
Basic (first nine years of schooling-elementary until junior high school)	78 (39.4)	
No Education	1 (0.5)	
Father's Education		
High (university level)	27 (13.6)	0.183[b]
Advanced (senior high school)	78 (39.4)	
Basic (first nine years of schooling-elementary until junior high school)	91 (46.0)	
No Education	2 (1.0)	
Mother's Occupation		
Government employees	8 (4.0)	0.773[b]
Laborer	2 (1.0)	
Self-employed	2 (1.0)	
Private employees	4 (2.0)	
Housewife	182 (91.9)	
Father's Occupation		
Government employees	11 (5.6)	0.440[b]
Laborer	104 (52.5)	
Self-employed	27 (13.6)	
Private employees	29 (14.6)	
Fisherman	24 (12.1)	
Farmer	3 (1.5)	

notes: [a]Chi-Square
[b]Mann-Whitney

Thurstans et al., 2020; Wamani et al., 2004). Boys are more susceptible to undernutrition starting from the fetal stage, even though they are larger at birth and during infancy. This vulnerability is more evident in severe cases of undernutrition and in socioeconomically disadvantaged settings. Their increased vulnerability to infectious diseases may be attributed to variations in their immune and endocrine systems (Thurstans et al., 2020).

The average age of the children in the study was 28.03 ± 14.534 months (table 1). The largest age categories for children are in the age range 12-23 months (27.8%) and 36-47 months (23.7%). No significant differences were found between the child's age and the child's nutritional status in this study (p=0.117). The results of this study contradict research conducted in Ethiopia and the Oromia region (Endris et al., 2017; Mengistu & Alemu, 2013; Rahman & Chowdhury, 2007; Wamani et al., 2004). The findings from these previous studies demonstrate a clear connection between age and malnutrition. Additionally, they indicate a strong correlation between age and gender. Furthermore, the influence of gender on nutritional status, which used to be significant, may alter with age (Garenne et al., 2021; Myatt et al., 2018).

In theory, maternal age plays a significant role in influencing a child's nutritional status because in the household the mother is the main actor in raising children. The average mother's age in this study was 29.42 ± 6.848 years. Statistical results show that there is no significant difference between maternal age and child nutritional status (table 2). Different results were found in Russia where the mother's age greatly influenced the baby's first year of life (Moiseeva Karina et al., 2020). Children with teenage mothers have three times the rate of child malnutrition than adult mothers in Ghana. For young mothers, ensuring their child's nutrition is adequate, access to clean water and ensuring that hygiene conditions are maintained are more difficult. Apart from that, this young mother was also considered psychologically unprepared for the process of raising children (Wemakor et al., 2018).

Parental education influences their child's growth. Mother's education was found more frequently at the advanced level, while father's education was found more at the elementary level (table 2). Statistical results show that there is no significant relationship between mothers' and fathers' education on the incidence of nutritional disorders in children. This is contrary to research analyzed from the Demographic and Health Surveys (DHS) which found that the level of parental education was related to the incidence of nutritional disorders in children, where the higher education of the father and mother resulted in a lower incidence of nutritional disorders in children (Vollmer et al., 2017).

Other study analyses also found the educational level of mothers has a clear and important impact on the nutritional status of children. Addressing this factor is crucial for preventing or improving childhood malnutrition (Iftikhar et al., 2017). Mothers' level of education significantly influences their knowledge and capability in managing healthcare, particularly in understanding maternal nutritional intake before, during, and after pregnancy. Educated women are more likely to have intelligent children, alleviate poverty, and better support their families, thereby reducing the risk of children being born stunted (Azizah et al., 2022).

Parental employment was not found to have a significant relationship with the incidence of nutritional disorders in children (p>0.05). The same results were also found in other research conducted in Indonesia. It is suspected that the knowledge on which parents base their care for their children can be influenced by various other factors, not only education, work, and income (Toyibah et al., 2023).

In this study, the characteristics of children and parents were not determinants that caused nutritional disorders. It can be concluded that in this study the respondents had similar or homogeneous background characteristics both in terms of mother's age, parents' education, and parents' occupation. Based on Table 3, it appears that there is no statistical relationship between nutritional status and the mother's height, father's height, household income, family awareness about nutrition, and clean and healthy living behavior. The only factor that had a significant relationship was birth weight (p<0.05). It can be seen in the table that the mean birth weight in the group with normal growth was higher (3010.25 ± 458.964) compared

Table 3. Analysis of Determinants of Nutritional Disorders Based on CIAF and Children's Nutritional Status

	Total n=198	Normal n=118 (59,5)	Growth Failure n=80 (40,4)	p
Birth Weight (gram)	2952.78 ± 528.835	3014.49 ± 456.515	2861.75 ± 612.099	0.048[a]
Mother's Height (cm)	154.50 ± 5.483	154.77 ± 5.120	154.10 ± 5.991	0.318[a]
Father's Height (cm)	164.34 ± 6.838	163.99 ± 6.793	164.85 ± 6.914	0.213[a]
Household Income				
Equal or more than the regional minimum wage	100 (50.5)	60 (60)	40 (40)	1.000[b]
Less than the regional minimum wage	98 (49.5)	58 (59.2)	40 (40.8)	
Family awareness about nutrition				
Yes	101 (51)	58 (63)	34 (37)	0.438[b]
No	97 (49)	60 (56.6)	46 (43.4)	
Clean and healthy living behavior				
Yes	54 (27)	32 (59.3)	22 (40.7)	1.000[b]
No	144 (73)	86 (59.7)	58 (40.3)	

notes: [a]Mann-Whitney
[b]Chi-Square

to the growth failure group (2880.50 ± 592.519). The same results were also found in research conducted in Gowa which found that children with a birth weight below 2,500 grams had a 5.96 times higher risk of experiencing stunting (Lukman et al., 2021).

One of the factors related to stunting in children is the parents' height. When compared with children born to short mothers and fathers, children born to tall mothers and fathers have a lower risk of stunting (Wu et al., 2021). Although other studies show that it is the mother's height that has a significant influence on stunting in children (Sindhughosa & Arimbawa, 2020). Parental height was not found to have a significant influence on respondents in this study (p>0.05). This may be due to other factors that influence the child's growth which makes him fail to grow as he gets older.

The economic situation of the household plays an important role in the nutritional status of children. This study found that more respondents had incomes equal to or above the Regional Minimum Wage for the Bangka Belitung Islands Province, even though there is no relationship between income and children's nutritional status statistically. These results are contrary to research obtained by research obtained in India where there was an increase in the incidence of stunting and malnutrition in children in less developed districts (S. Singh et al., 2019). This accumulation also occurs in poor communities as measured by income (S. K. Singh et al., 2020). However, the same results were also shown by research conducted in other regions of Indonesia, where income was found to have no significant relationship with parents' knowledge of children's feeding patterns (Toyibah et al., 2023).

Family awareness about nutrition and clean and healthy living behavior were assessed in this study. These two things show how aware the family is of being able to meet its nutritional needs and maintain the cleanliness and health of its family. Statistically, these two factors did not show a significant relationship with the occurrence of growth failure in children (p>0.05), although when analyzed further on the indicators assessed, variations in feeding were the only factor that had a relationship with the occurrence of stunting (table 4).

Based on Table 4, family behavior in implementing nutritional awareness and clean and healthy living habits is assessed. Several questions were asked to assess regularity in weighing children, history of breastfeeding children, use of iodized salt, variety of meals, consumption of supplements for pregnant women and children, eradication of mosquito larvae, physical activity of family member for 30 minutes per day, and appropriate smoking behavior. Apart from comparing nutritional disorders based on CIAF categories, researchers also compared the incidence

Table 4. Analysis of Family Awareness about Nutrition and Clean and Healthy Living Behavior with Child Nutritional Status (Based on CIAF and Stunting)

	CIAF Category			Stunting		
	Normal n=118 (59.5)	Growth Failure n=80 (40.4)	p	Normal n=153 (77.3)	Stunting n=45 (22.7)	p
Weight measurement						
Regularly	111 (60.0)	74 (40.0)	0.885[a]	143 (77.3)	42 (22.7)	0.601[b]
No	7 (53.8)	6 (46.2)		10 (76.9)	3 (23.10	
Breastfeeding						
Eksklusif	69 (61.1)	44 (38.9)	0.735[a]	84 (74.3)	29 (25.7)	0.334[a]
No	49 (57.6)	36 (42.4)		69 (81.2)	16 (18.8)	
Iodine salt						
Yes	112 (59.6)	76 (40.4)	0.625[b]	147 (78.2)	41 (21.8)	0.168[b]
No	6 (60.0)	4 (40.0)		6 (60.0)	4 (40.0)	
Feeding's Menu Variation						
Yes	106 (60.9)	68 (39.1)	0.424[a]	140 (80.5)	34 (19.5)	0.009[a]*
No	12 (50.0)	12 (50.0)		13 (54.2)	11 (45.8)	
Supplementation						
Yes	114 (60.0)	76 (40.0)	0.414[b]	148 (77.9)	42 (22.1)	0.263[b]
No.	4 (50.0)	4 (50.0)		5 (62.5)	3 (37.5)	
Eradicating mosquito larvae						
Yes	111 (59.4)	76 (40.6)	0.521[b]	145 (77.5)	42 (22.5)	0.475[b]
No	7 (63.6)	4 (36.4)		8 (72.7)	3 (27.3)	
Physical Activity						
Yes	99 (59.6)	67 (40.4)	1.000[a]	126 (75.9)	40 (24.1)	0.210[b]
No	19 (59.4)	13 (40.6)		27 (84.4)	5 (15.6)	
Smoking Behavior						
Appropriate	72 (58.1)	52 (41.9)	0.675[a]	95 (76.6)	29 (23.4)	0.911[a]
No	46 (62.2)	28 (37.8)		58 (78.4)	16 (21.6)	

notes: [a]Chi-Square
[b]Fisher's Exact
*Statistically significant

of stunting. Feeding variations are the only family indicator that influences the occurrence of stunting ($p<0.05$), although if measured using the CIAF category this indicator has no effect like the other indicators.

Contrary to the hypothesis in this study, family awareness about nutrition and clean and healthy living behavior did not influence the occurrence of malnutrition. However, when analyzed in more detail in the sectors assessed, eating variations have a significant correlation with the occurrence of stunting. Different results were obtained by other studies where family awareness about nutrition (the same sector was assessed) had a significant relationship with the incidence of stunting in toddlers (Rahmah et al., 2023). Different results were also obtained from research conducted in Samarinda where mothers' knowledge and behavior to live a clean and healthy life was related to the occurrence of stunting (Dhefiana et al., 2023).

This study found that appropriate feeding variation were related to stunting but not CIAF. On the other hand, the same findings were also found by Indahsari et al., (2023). regarding the influence of feeding variations on the occurrence of stunting. There was a significant relationship between dietary diversity and stunting but not food quantity (Indahsari et al., 2023). Children who were fed a variety of foods (four groups or more) were significantly associated with stunting and became a protective factor. Furthermore, consuming staple

food for children actually increases the risk factor for stunting (Mufida Wulan Sari et al., 2023).

CONCLUSION

Almost half of the respondents (40.4%) were children with growth failure based on CIAF with nine categories, where the highest cases were in the stunting (11.6%) and overweight (8.1%) categories. The variable that has a significant relationship to the occurrence of cases of growth failure is the child's birth weight while feeding variation is the factor that has a relationship to the occurrence of stunting.

This research has taken samples from all areas in the Belitung Regency. However, this research has several limitations. Anthropometric measurements have a risk of being inaccurate, including parental height data. Data may suffer bias in recalled information. The lack of detailed data regarding the type of food, amount of food, and how to feed children can be investigated further in future studies.

ACKNOWLEDGEMENT

The authors would like to thank the participants who made this study possible, including the Health Office of Belitung Regency, all health workers in community health centers, and health cadres as well as other parties whose names cannot be mentioned one by one.

REFERENCES

Amoah, W. W., Kobi, D., Tabong, P. T.-N., Kukeba, M. W., Alhassan, Y., Achaliwie, F., Amoah, A., & Adugbire, A. B. (2024). Factors Contributing to Malnutrition among Children Under 5 Years at St. Elizabeth Catholic Hospital, Ahafo Hwidiem. *Clinical Medicine Insights. Pediatrics*, *18*, 11795565231222716. https://doi.org/10.1177/11795565231222716

Andini, E. N., Udiyono, A., Sutiningsih, D., & Wuryanto, M. A. (2020). Faktor – Faktor yang Berhubungan dengan Status Gizi pada Anak Usia 0-23 Bulan Berdasarkan Composite Index of Anthropometric Failure (CIAF) di Wilayah Kerja Puskesmas Karangayu Kota Semarang. *Jurnal Epidemiologi Kesehatan Komunitas*, *5*(2), 104–112. https://doi.org/10.14710/jekk.v5i2.5898

Azizah, A. M., Nurmala, I., & Devy, S. R. (2022). The Effect of Mother's Educational Level and Stunting Incidence on Toddler: A Meta-analysis Meta Analisis: Pengaruh Tingkat Pendidikan Ibu terhadap Kejadian Stunting pada Anak Balita. *Print) Azizah, et Al | Amerta Nutrition*, *6*(4), 369–375. https://doi.org/10.20473/amnt.v6i4.2022.369-375

Badan Kebijakan Pembangunan Kesehatan. (2024). Survei Kesehatan Indonesia (SKI) 2023 Dalam Angka. In *Kota Kediri Dalam Angka*.

Clark, H., Coll-Seck, A. M., Banerjee, A., Peterson, S., Dalglish, S. L., Ameratunga, S., Balabanova, D., Bhan, M. K., Bhutta, Z. A., Borrazzo, J., Claeson, M., Doherty, T., El-Jardali, F., George, A. S., Gichaga, A., Gram, L., Hipgrave, D. B., Kwamie, A., Meng, Q., … Costello, A. (2020). A future for the world's children? A WHO-UNICEF-Lancet Commission. *Lancet (London, England)*, *395*(10224), 605–658. https://doi.org/10.1016/S0140-6736(19)32540-1

Dasgupta, A., Parthasarathi, R., Ram Prabhakar, V., Biswas, R., & Geethanjali, A. (2014). Assessment of under nutrition with composite index of anthropometric failure (CIAF) among under-five children in a rural area of west bengal. *Indian Journal of Community Health*, *26*(2), 132–138. https://doi.org/10.18203/2349-3291.ijcp20182583

Dhefiana, T., Reni Suhelmi, & Hansen. (2023). Hubungan Penerapan Perilaku Hidup Bersih Dan Sehat (PHBS) Orang Tua Dengan Kejadian Stunting Di Kelurahan Air Hitam Kota Samarinda. *Sanitasi: Jurnal Kesehatan Lingkungan*, *16*(1), 20–28. https://doi.org/10.29238/sanitasi.v16i1.1484

Ditjen Bina Pembangunan Daerah - Kementerian Dalam Negeri. (2022). *MONITORING PELAKSANAAN 8 AKSI KONVERGENSI INTERVENSI PENURUNAN STUNTING TERINTEGRASI*. https://aksi.bangda.kemendagri.go.id/emonev/DashPrev/index/4

Drammeh, W., Hamid, N. A., & Rohana, A. J. (2019). Determinants of household food insecurity and its association with child malnutrition in Sub-Saharan Africa: A review of the literature. *Current Research in Nutrition and Food Science*, *7*(3), 610–623. https://doi.org/10.12944/CRNFSJ.7.3.02

Endris, N., Asefa, H., & Dube, L. (2017). Prevalence of Malnutrition and Associated Factors among Children in Rural Ethiopia. *BioMed Research International*, *2017*, 6587853. https://doi.org/10.1155/2017/6587853

Garenne, M., Thurstans, S., Briend, A., Dolan, C., Khara, T., Myatt, M., Seal, A., & Wells, J. C. (2021). Changing sex differences in undernutrition of African children: findings from Demographic and Health Surveys. *Journal of Biosocial Science*, 1–11. https://doi.org/10.1017/S0021932021000468

Iftikhar, A., Bari, A., Bano, I., & Masood, Q. (2017). Impact of maternal education, employment and family size on nutritional status of children. *Pakistan Journal of Medical Sciences*, *33*(6), 1401–1405. https://doi.org/10.12669/pjms.336.13689

Indahsari, N. K., Herliani, O., & Masfufatun, M. (2023). The relationship between food quantity and diversity with stunting incidence in Indonesia. *Healthcare in Low-Resource Settings*.

Kuiti, B. K., & Bose, K. (2018). The Concept of Composite Index of Anthropometric Failure (CIAF): Revisited and Revised. *Anthropology - Open Journal*, *3*(1), 32–35. https://doi.org/10.17140/antpoj-3-118

Lukman, T. N. E., Anwar, F., Riyadi, H., Harjomidjojo, H., & Martianto, D. (2021). Birth Weight and Length Associated with Stunting among Children Under-Five in Indonesia. *J. Gizi Pangan*, *16*(1), 99–108.

Mengistu, K., & Alemu, K. (2013). Prevalence of Malnutrition and Associated Factors Among Children Aged 6-59 Months at Hidabu Abote District, North Shewa, Oromia Regional State. *Journal of Nutritional Disorders & Therapy*, *01*. https://doi.org/10.4172/2161-0509-3-T1-001

Modjadji, P., Masilela, L. N., Cele, L., Mathibe, M., & Mphekgwana, P. M. (2022). Evidence of Concurrent Stunting and Obesity among Children under 2 Years from Socio-Economically Disadvantaged Backgrounds in the Era of the Integrated Nutrition Programme in South Africa. *International Journal of Environmental Research and Public Health*, *19*(19). https://doi.org/10.3390/ijerph191912501

Moiseeva Karina, E., Ivanov Dimitry, O., Alekseeva Anna, V., Kharbediya Shalva, D., & Berezkina Elena, N. (2020). Influence of mother's age on infant child's nutrition. *Archivos Venezolanos de Farmacologia y Terapeutica*, *39*(2), 215–220.

Mufida Wulan Sari, N., Cahyaning Ayu, W., Mahmudiono, T., Mahmudah, M., & Soenarnatalina, R. (2023). Association between Stunting in Children Under Five and Types of Food Sources. *Indonesian Journal of Human Nutrition*, *10*(1), 12–19. https://doi.org/10.21776/ub.ijhn.2023.010.01.2

Myatt, M., Khara, T., Schoenbuchner, S., Pietzsch, S., Dolan, C., Lelijveld, N., & Briend, A. (2018). Children who are both wasted and stunted are also underweight and have a high risk of death: a descriptive epidemiology of multiple anthropometric deficits using data from 51 countries. *Archives of Public Health = Archives Belges de Sante Publique*, *76*, 28. https://doi.org/10.1186/s13690-018-0277-1

Nurmalitasari, A. (2021). Desa Stunting Belitung Bertambah, Pola Asuh Orang Tua Penentu Status Gizi Anak. *POSBELITUNG*. https://belitung.tribunnews.com/2021/07/21/desa-stunting-belitung-bertambah-pola-asuh-orang-tua-penentu-status-gizi-anak?page=all

Pei, L., Ren, L., & Yan, H. (2014). A survey of undernutrition in children under three years of age in rural Western China. *BMC Public Health*, *14*(1). https://doi.org/10.1186/1471-2458-14-121

Permatasari, T. A. E., & Chadirin, Y. (2022). Assessment of undernutrition using the composite index of anthropometric failure (CIAF) and its determinants: A cross-sectional study in the rural area of the Bogor District in Indonesia. *BMC Nutrition*, *8*(1), 1–20. https://doi.org/10.1186/s40795-022-00627-3

Prasetyo, A., Davidson, S. M., & Sanubari, T. P. E. (2023). Correlation between Individual Dietary Diversity and Children 2-5 Years Old Nutrition Status in Batur Village, Getasan Regency, Semarang District. *Amerta Nutrition*, *7*(3), 343–349. https://doi.org/10.20473/amnt.v7i3.2023.343-349

Preedy, V. R. (2012). Handbook of Anthropometry: Physical Measures of Human Form in Health and Disease. In *Handbook of Anthropometry: Physical Measures of Human Form in Health and Disease* (Issue July). London. https://doi.org/10.1007/978-1-4419-1788-1

Rahmadini, N., Sudiarti, T., & Utari, D. M. (2013). Status Gizi Balita Berdasarkan Composite Index of Anthropometric Failure. *Kesmas: National Public Health Journal*, *7*(12), 538. https://doi.org/10.21109/kesmas.v7i12.327

Rahmah, F., Rizyana, N. P., & Yulia, Y. (2023). The Relationship between Nutrition Aware Family Behavior and the Incidence of Stunting in Toddlers in the Ikur Koto Health Center Working Area in 2023. *Copyright © 2023 Fitri Rahmah, Nurul Prihastita Rizyana, Yulia.*

Published by STIKes Alifah Padang The 1st Alifah Padang Health College Symposium Proceeding, 82–85.

Rahman, A., & Chowdhury, S. (2007). Determinants of chronic malnutrition among preschool children in Bangladesh. *Journal of Biosocial Science*, *39*(2), 161–173. https://doi.org/10.1017/S0021932006001295

Santosa, A., Novanda Arif, E., & Abdul Ghoni, D. (2022). Effect of maternal and child factors on stunting: partial least squares structural equation modeling. *Clinical and Experimental Pediatrics*, *65*(2), 90–97. https://doi.org/10.3345/cep.2021.00094

Sindhughosa, W. U., & Arimbawa, I. M. (2020). Association between parentsâ€™ body height with stunting in children ages 1-5 years old in Nagi Primary Health Care Working Area Larantuka City, East Flores, Indonesia. *Intisari Sains Medis*, *11*(1), 315–319. https://doi.org/10.15562/ism.v11i1.567

Singh, S. K., Srivastava, S., & Chauhan, S. (2020). Inequality in child undernutrition among urban population in India: a decomposition analysis. *BMC Public Health*, *20*(1), 1–15. https://doi.org/10.1186/s12889-020-09864-2

Singh, S., Srivastava, S., & Upadhyay, A. K. (2019). Socio-economic inequality in malnutrition among children in India: An analysis of 640 districts from National Family Health Survey (2015-16). *International Journal for Equity in Health*, *18*(1), 1–9. https://doi.org/10.1186/s12939-019-1093-0

Svedberg, P. (2000). *Poverty and Undernutrition: Theory, Measurement an Policy*. Oxford University Press.

Thurstans, S., Opondo, C., Seal, A., Wells, J., Khara, T., Dolan, C., Briend, A., Myatt, M., Garenne, M., Sear, R., & Kerac, M. (2020). Boys are more likely to be undernourished than girls: a systematic review and meta-analysis of sex differences in undernutrition. *BMJ Global Health*, *5*(12). https://doi.org/10.1136/bmjgh-2020-004030

Toyibah, R. S., Purnama, D., Nurhakim, F., Rahayuwati, L., Yani, D. I., & Ramdhanie, G. (2023). Relationship between socio- economic with parent's knowledge of toddler feeding patterns. *Journal of Nursing Care*, *6*(2), 1–15.

Vollmer, S., Bommer, C., Krishna, A., Harttgen, K., & Subramanian, S. V. (2017). The association of parental education with childhood undernutrition in low- and middle-income countries: Comparing the role of paternal and maternal education. *International Journal of Epidemiology*, *46*(1), 312–323. https://doi.org/10.1093/ije/dyw133

Wamani, H., Tylleskär, T., Astrøm, A. N., Tumwine, J. K., & Peterson, S. (2004). Mothers' education but not fathers' education, household assets or land ownership is the best predictor of child health inequalities in rural Uganda. *International Journal for Equity in Health*, *3*(1), 9. https://doi.org/10.1186/1475-9276-3-9

Wemakor, A., Garti, H., Azongo, T., Garti, H., & Atosona, A. (2018). Young maternal age is a risk factor for child undernutrition in Tamale Metropolis, Ghana. *BMC Research Notes*, *11*(1), 1–5. https://doi.org/10.1186/s13104-018-3980-7

Wu, H., Ma, C., Yang, L., & Xi, B. (2021). Association of Parental Height With Offspring Stunting in 14 Low- and Middle-Income Countries. *Frontiers in Nutrition*, *8*(August). https://doi.org/10.3389/fnut.2021.650976

Yanti, E. S., & Permata, T. R. (2023). Prevalence of Undernutrition and Associated Factors: A Cross-sectional Study among Rural Toddlers in Bangka Belitung, Indonesia. *International Journal of Advanced Health Science and Technology*, *3*(1), 27–30. https://doi.org/10.35882/ijahst.v3i1.205

Yanti, E. S., Permata, T. R., & Karimah, R. (2022). Determinants Of Malnutrition Based On The Composite Index Of Anthropometric Failure (CIAF). *Jurnal Kebidanan Dan Kesehatan Tradisional*, *7*(2), 156–165. https://doi.org/https://doi.org/10.37341/jkkt.v0i0.389

THE EFFECT OF NUTRITIONAL EDUCATION ON PARENTAL KNOWLEDGE OF BALANCED NUTRITION IN CHILDREN AT YAYASAN AN - NUSYUR AENG PANAS, SUMENEP MADURA

Sasha Anggita Ramadhan[1], Soraya Tri Widayani[1], Trias Mahmudiono[1], Amanda Fharadita Olivia Rakhmad[1], Ernadila Diasmarani Hargiyanto[1], Fitiara Indah Permatasari[1], Callista Naurah Azzahra[1], Nur Sahila[1], Dominikus Raditya Atmaka[1]*, Eka Cahya Febrianto[1], Ratna Dwi Puji Astuti[1], Shinta Arta Mulia[1], Damai Arum Pratiwi[1], Siti Rahayu Nadhiroh[1], Tiara Tivany Simangunsong[1], Atika Anif Prameswari[1], Wan Ismahanisa Ismail[2], Mohamad Azhar bin Mohd Noor[2], Mohamad Halim bin Mohamad Shariff[2], Siti Salwa Binti Talib[2], Nurhidayah Binti Sabri[2], Nurul Ain Binti Abd Rahim[2], Rosnida Binti Tajuddin[3], Lee Siew Keah[4], Muhammad Firdaus Bin Mohd Fitri[5], Muhammad Syahmi Bin Rozlan[5], Rishan Rao al Morgan Rao[5], Azwa Binti Mat Yasin[6]

[1]Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia
[2]Faculty of Health Sciences, Universiti Teknologi Mara Pulau Pinang Kampus Bertam, Malaysia
[3]School of Biological Science, Universiti Sains Malaysia, Malaysia
[4]Faculty of Medicine and Health Science, Universiti Tunku Abdul Rahman Malaysia, Malaysia
[5]Faculty of Ocean Engineering Technology, Universiti Malaysia Trengganu, Malaysia
[6]Computer Science, Islamic International University Malaysia, Malaysia
*E-mail: dominikus.raditya@fkm.unair.ac.id

ABSTRACT

Parents play a crucial role in shaping their children's dietary habits from early childhood through adulthood. Parental behaviors and family habits significantly influence children's dietary habits, shaping their attitudes toward food and eating behaviors. Low parental health literacy and socio-economic status are associated with poorer child health behaviors, such as unhealthy nutrition and less exercise. Educating parents on balanced nutrition is crucial for promoting healthier eating habits. This study explores the impact of nutritional education on parental knowledge at Yayasan An-Nusyur Aeng Panas, aiming to improve childhood nutrition in resource-constrained setting by increasing their knowledge after receiving nutrition education on Community Services of Enhancing Coastal Health Through Ecological Approach (ECOHAP) program. This research used a quantitative pre-experimental design study (one group pre-test post-test). The intervention carried out in this research was a single time delivered nutritional education for 3 hours period regarding balanced nutrition for children given by nutritionist team from Indonesia and Malaysia. The primary data was a questionnaire filled by 27 parents of kindergarten students at Yayasan An—Nusyur Aeng Panas, Sumenep Madura in Febuary 2024. Data were analyzed using SPSS version 26, descriptive analysis techniques, and Wilcoxon Matched-Pairs Test. The result of this research showed that there were differences between pre-test and post-test scores. The pre-test score has an average (mean) of 84.444, and the post-test score has an average (mean) of 86.667. But, based on the Wilcoxon Matched-Pairs Test, it is known that the significance value for pre-test and post-test data is 0.439 (>0.05). There was an increase in participants' knowledge after receiving nutrition education on Community Services of Enhancing Coastal Health Through Ecological Approach (ECOHAP) program that was held, but there was not a significant difference between pre-test and post-test scores after parents received nutritional education.

Keywords: *Balance Nutrition, Children Health, Dietary Habit, Nutrition Education, Parental Influence, Pediatric Nutrition*

INTRODUCTION

Parents have a significant impact on the dietary choices of children throughout their developmental stages, spanning from early childhood to adulthood (Mahmood et al., 2021). Studies show a positive correlation between parental literacy and children's nutritional status. Results indicate that low parental health literacy and socio-economic status are associated with poorer child health behaviors, such as unhealthy nutrition and less exercise (De Buhr & Tannen, 2020). In recent years, childhood malnutrition, which includes undernutrition (wasting, stunting, and underweight), micronutrient deficiencies,

 Received 25-06-2024, Accepted 16-09-2024, Published online 30-09-2024.

and issues of overweight and obesity, presents a multifaceted health crisis (Vassilakou, 2021). Low- and middle-income countries, particularly in sub-Saharan Africa and Asia, face the highest levels of malnutrition, with children being especially at risk (Iwaret et al., 2021). Statistics from 2022, it was estimated that 149 million children under the age of 5 suffered from stunting (being too short for their age), 45 million were affected by wasting (being too thin for their height), and 37 million were either overweight or obese (World Health Organization, 2024, 2016). About 45% of deaths in children under the age of five are linked to undernutrition (WHO & UNICEF, 2017); this condition elevates their susceptibility to succumbing to common infections, intensifies the frequency and severity of these infections, and hampers the recovery process (UNICEF, 2015, 2020).

A study highlights that parental behaviors and family dynamics significantly influence children's dietary habits, shaping their attitudes towards food and eating behaviors (Aldridge et al., 2016; Cooke & Llewellyn, 2016). For instance, if parents do not prioritize healthy eating, they might overlook the importance of family meals, leading children to eat breakfast alone, particularly if other family members are occupied (Tenjin et al., 2020). Family meals are important for interaction and guidance, significantly shaping children's dietary habits (Kuche et al., 2020; Mitchodigni et al., 2017). Parents should avoid excessive pressure or strict restrictions to prevent negative food experiences and instead encourage healthy snacking and ensure breakfast through positive social modeling and moderate restriction (Rachmawati et al., 2019). By increasing parents' understanding of balanced nutrition, they can be empowered to make informed decisions regarding their children's diets, thereby improving overall health and well-being. Given the increase in malnutrition and diet-related health problems among children globally, educating parents about balanced nutrition is very important (Batool et al., 2015; Dipasquale et al., 2020; Grover & Ee, 2009).

Schools play a crucial role in promoting children's nutrition and fostering healthy eating habits for life. Research indicates that school-based nutrition programs positively impact children's health (Al-Jawaldeh et al., 2023). These programs encompass various initiatives aimed at improving nutrition, such as nutrition education, provision of healthy meals, and creating supportive environments for healthy food choices (Krebs-Smith et al., 2018). However, existing programs may fall short of addressing the specific needs of communities like Yayasan An-Nusyur Aeng Panas. Yayasan An-Nusyur Aeng Panas, located in Sumenep Madura, is one such community facing nutritional challenges among its children. Factors such as limited access to nutritious foods, cultural preferences, and economic disparities can contribute to malnutrition and pose difficulties to the effectiveness of existing initiatives (Santika et al., 2016). Additionally, the lack of interventions customized to specific needs of this community may perpetuate disparities in nutrition and health outcomes among children. Therefore, addressing the nutritional needs of communities like Yayasan An-Nusyur Aeng Panas requires comprehensive strategies that consider socio-economic, cultural, and environmental factors to ensure the success and sustainability of nutrition programs and ultimately improve the health and well-being of children.

Investigating the impact of nutritional education on parental knowledge of balanced nutrition in children holds significant relevance to several Sustainable Development Goals (SDGs). Firstly, it directly aligns with SDG 3: Good health and well-being, by addressing the crucial role of nutrition in promoting optimal health, particularly among children. Improving parental knowledge of balanced nutrition can contribute significantly to achieving this goal by ensuring children receive adequate nutrients for optimal growth and development (Hasan et al., 2019). Additionally, by enhancing parental understanding of balanced nutrition, this study contributes to SDG 4: Education Quality, as it empowers caregivers with essential knowledge and skills to make informed decisions about their children's diets, thereby promoting healthier lifestyles and overall well-being. Moreover, the focus on fostering nutritious diets indirectly supports SDG 2: Zero hunger by mitigating malnutrition and food insecurity among children through education on healthy eating habits. Enhancing parental understanding

of balanced nutrition indirectly supports efforts to eradicate hunger (Ammaniti et al., 2004; Ferdous et al., 2009; WHO, 2013). By promoting nutritious diets and food choices, nutritional education can contribute to reduce malnutrition and food insecurity among children, align with the goal of zero hunger.

Therefore, this research aims to investigate the effect of nutritional education on parental knowledge of balanced nutrition in children at Yayasan An-Nusyur Aeng Panas. By exploring the nuanced relationship between parental education, nutritional knowledge, and dietary practices, this study aims to inform future interventions and policies aimed at promoting childhood nutrition in resource-constrained settings. Through collaborative efforts between researchers, healthcare providers, and community stakeholders, sustainable solutions can be devised to ensure every child has access to the nutritious diet they need to thrive.

METHODS

This research used a quantitative pre-experimental design study (one group pre-test post-test). Although the pre-posttest method alone does not establish causality definitively, it can provide evidence that changes observed in the post-test are associated with the intervention. By using the pre-posttest method, researchers can identify which aspects of an intervention are most effective and which may need improvement. This can inform future program development and optimization. Compared to other more complex research designs, the pre-posttest method is relatively straightforward and cost-effective. It requires fewer resources and can be implemented more easily in various settings.

This research was held at the Yayasan An - Nusyur Aeng Panas, Sumenep Madura, on February 2024. The treatment in this research was conducted by providing nutrition education to 27 students' parents with lecture techniques and posters as a medium. The respondents were all the total population of students' parents in kindergarten of Yayasan An-Nusyur Aeng Panas, Sumenep, Madura. As the school is a submarginal underprivilege school, the total number of the students is far from ideal number of minimum sample for the study, but has been represented the general population of the below five children population in Aeng Panas District, Sumenep, Madura.

The intervention carried out in this research was a single time delivered nutritional education for 3 hours period regarding balanced nutrition for children given by nutritionist team from Indonesia and Malaysia. The independent variable in this research is nutrition education, while the dependent variable is student's parent knowledge. The intervention consisted of oral presentations and posters, designed to communicate key concepts of balanced nutrition. Oral presentations allowed for interactive learning, where participants could ask questions and engage in discussions, enhancing their understanding. Posters served as visual aids that reinforced the lecture content, providing a reference that participants could revisit.

Before and after receiving nutrition education, student's parent must take a pre and post-test of 5 questions to measure their knowledge. The pre-posttest were multiple choice questions adopted from the study by Nugraha et al., (2021) and has been validated and known for its reliability to be used by the population. The instrument used to measure parents' knowledge comprises a questionnaire developed by nutrition students. It contains five questions for both the pre-test and post-test stages. These questions are designed to align with the material presented by the educator and are in a multiple-choice type. This questionnaire is administered to parents both before (pre-test) and after (post-test) the educational session, with an expected completion time of 5-10 minutes for each topic and poster. Each correct response earns 20 points, with a perfect score being 100 points if all answers are correct. These questions focus on the principles of proper child nutrition, the "Isi Piringku" concept, and essential aspects of maintaining balanced nutrition for school-aged children. Parents are provided with the tests directly and are advised not to look up answers online or consult a committee.

Data were analyzed using SPSS version 26. The statistical significance of the observed difference was tested using the Wilcoxon Matched-Pairs Test, a non-parametric method suitable for small sample sizes and paired data.

https://doi.org/10.20473/mgi.v19i3.322–329

Image 1. Oral Presentation to Student's Parents

Image 2. Nutrition Education Posters

RESULTS AND DISCUSSION

Demographics and Participant Characteristics

Table 1 shows that the parents involved in this study are predominantly aged <30. The number of participants aged less than 30 years was 14 people or 51.9% of the total participants who took part in this nutrition education. Ten people, or 37.0%, have an age range between 30-40 years, while 3 people, or 11.1%, are more than 40 years old.

The age distribution of the participants reveals that the majority are relatively young parents, with 51.9% aged below 30 years. This demographic detail is significant as younger parents often represent a more dynamic and flexible group, potentially more open to adopting new practices and integrating nutritional knowledge into their daily routines. Their early stage in parenthood suggests they are still forming and solidifying their parenting styles and household norms,

Table 1. Characteristic of Respondents (n=27)

Age Group	n	%
<30	14	51.9%
30-40	10	37.0%
>40	3	11.1%

making them an ideal target for educational interventions aimed at establishing healthy habits early on. In contrast, 37.0% of the participants are in the 30-40 years age range. This group likely comprises more established parents who may already have ingrained dietary habits and practices. However, their participation indicates a willingness to enhance their knowledge and possibly make adjustments for the benefit of their children's health. This demographic is crucial as they might have more resources and experience in parenting, allowing them to implement and sustain nutritional improvements effectively. The smallest group, consisting of parents over 40 years old (11.1%), presents a different set of challenges and opportunities. These parents may have long-established routines and beliefs about nutrition, which could be more resistant to change. However, their involvement in the study highlights a universal concern for child health that transcends age. The challenge for this group lies in presenting the educational content in a way that respects their experience while providing compelling reasons to adapt their practices.

Table 2 shows descriptive statistics from the pre-test and post-test. Based on Table 1, the data shows that the pre-test score has an average (mean) of 84.444, and the post-test score has an average (mean) of 86.667. This indicates that there is a difference in the parents' average scores between the pre-test and post-test. Therefore, it can be said that there was an increase in parent's knowledge after being given nutrition education. This increase in the average score indicates that the nutrition education intervention had a positive impact on the parents' knowledge.

The improvement suggests that the educational program can enhance understanding of nutritional concepts. The mean score increase of 2.2 points reflects that the participants were able to absorb and retain the information provided during the educational sessions. The statistical test confirmed that the difference between pre-test and post-test scores is statistically significant. This statistical validation underscores the effectiveness of the educational intervention in enhancing parental knowledge about nutrition. The combination of oral presentation and posters likely contributed to the observed knowledge gain. Visual aids are known to enhance memory retention and understanding, especially when dealing with complex information. The interactive nature of lectures helps clarify doubts and ensures that the information is correctly interpreted. Together, these methods create a comprehensive learning experience that caters to different learning styles.

Table 3 shows that based on pretest and post-tests, it is known that data have 5 negative differences (negative ranks), which means that 5 parents experienced a decrease in their scores. 7 data have positive differences (positive ranks), which means that 7 parents experienced an increase

Table 3. Wilcoxon Signed Ranks Test

		n	Mean Rank	Ranks
PostTest-PreTest	Negative Ranks	5[a]	6.00	30.00
	Positive Ranks	7[b]	6.86	48.00
	Tiles	15[c]		
	Total	27		
Z				–775°
Asymp. Sig (2-tailed)				0.439

a. PostTest < PreTest
b. PostTest > PreTest
c. PostTest = PreTest
* Wilcoxon Signed Ranks Test Based on negative ranks.

Table 2. Descriptive Statistics of Pre-test and Post-test

Question (s)	Pre-Test		Post-Test		p-value
	Correct	False	Correct	False	
1. Which are the correct principles of children's food?	18	9	17	10	0.663
2. How many main meals a day are recommended for children?	18	9	23	4	0.057
3. What can be done to overcome picky eating?	24	2	24	3	1.000
4. Why is it important for children to eat fruits and vegetables?	27	0	26	1	0.327
5. What can parents do to teach children about mindful feeding?	27	0	27	0	0.327

in their scores. Besides that, 15 data points are the same between the pre-test and post-test.

Based on the data presented in Table 3, we observe several important patterns in the pre-test and post-test scores of parents. There are 5 negative ranks, indicating that 5 parents experienced a decrease in their scores from the pre-test to the post-test. This decrease could be due to various factors such as a lack of motivation or engagement during the post-test, difficulties in understanding the material, or external influences that negatively affected their performance. In contrast, there are 7 positive ranks, showing that 7 parents saw an improvement in their scores. This improvement suggests that parents may have benefited from the delivery of materials by educators, information from nutrition education posters, or other supportive measures provided during the interest period. Additionally, 15 data points remain unchanged, indicating that for these parents, there was no observable difference in scores between the pre-test and post-test. This lack of change could imply that the intervention had no measurable impact on these individuals or that their performance remained stable without significant improvement or decrease. The distribution of negative ranks, positive ranks, and ties provides valuable insights into the overall effectiveness of the program implemented. To address the varied outcomes, it may be necessary to investigate the specific reasons behind decreased scores, continue or enhance successful strategies for those who improved, and reassess the approach for those whose scores remained the same to ensure more impactful and personalized support.

Table 3 shows that based on the Wilcoxon matched pairs test, it is known that the data do not have a significance value (p-value) for pre-test and post-test data, which is 0.439 (>0.05). This shows that there is not a significant difference between the pre-test and post-test scores. Therefore, it can be said that there wasn't an increase in student's parent knowledge after receiving nutrition education.

Table 3 presents the results of the Wilcoxon matched pairs test applied to the pre-test and post-test data. The test yielded a p-value of 0.439, which is greater than the commonly accepted threshold for statistical significance of 0.05. A p-value above 0.05 indicates that the observed differences between the pre-test and post-test scores are not statistically significant, meaning that any changes in the scores are likely due to random chance rather than a meaningful effect of the intervention. In this context, the intervention in question is the nutrition education provided to the students' parents. The lack of statistical significance implies that there was no measurable increase in the parents' knowledge about nutrition as a result of the education program. Despite the intention to improve nutritional knowledge through this educational effort, the data do not support the effectiveness of the program in achieving this goal. It is important to consider various factors that could contribute to this outcome, such as the content and delivery of the education program, the engagement level of the participants, or other external influences that may have impacted the results. This study has several limitations, included the minimum number of subjects, the limited time to give intervention due to unproper place and time because the only time available is after school time which force students to stay in the school for another 3 hours. This makes students feel uncomfortable and the class room temperature raising which make students not cooperatives. This condition then makes the intervention not properly performed and impacting to the unsignificant progress in participants nutrition knowledge. Further analysis and potentially a revised approach to the nutrition education may be necessary to achieve the desired improvements in parental knowledge.

CONCLUSION

The result of this research shows that there is a difference between the pre-test and post-test scores. There was an increase in participants' knowledge after receiving nutrition education on Community Services of Enhancing Coastal Health Through Ecological Approach (ECOHAP) that was held. Still, there's not a significant difference between the pre-test and post-test scores after student's parent received nutritional education. Suggestions for further research include increasing the number of questions in the pre-test and post-test and increasing the weight of the questions given. This

aims to avoid bias in the research results caused by the questions being too few and easy, which cannot represent the participants' knowledge. Apart from that, it would be better to increase the number of research participants in future research.

Acknowledgement

The author would like to thank The Faculty of Public Health, Airlangga University, for allowing this research to be carried out. Thanks to Yayasan An - Nusyur Aeng Panas, Sumenep Madura for allowing the implementation of nutrition education to Community Services of Enhancing Coastal Health Through Ecological Approach (ECOHAP) 2024. Thanks also to all committees and participants from UNAIR, UiTM, UMT, USM, UIIA, and UTAR who have been involved in helping provide nutrition education to Yayasan An - Nusyur Aeng Panas parents of students so that this research can be held well.

Conflict of Interest and Funding Disclosure

The authors declare no conflict of interest.

REFERENCES

Aldridge, V. K., Dovey, T. M., Martin, C. I., & Meyer, C. (2016). Relative contributions of parent-perceived child characteristics to variation in child feeding behavior. *Infant Mental Health Journal*, *37*(1), 56–65. https://doi.org/10.1002/imhj.21544

Al-Jawaldeh, A., Matbouli, D., Diab, S., Taktouk, M., Hojeij, L., Naalbandian, S., & Nasreddine, L. (2023). School-Based Nutrition Programs in the Eastern Mediterranean Region: A Systematic Review. In *International Journal of Environmental Research and Public Health* (Vol. 20, Issue 22). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/ijerph20227047

Ammaniti, M., Lucarelli, L., Cimino, S., Ambruzzi, A. M., & D'Olimpio, F. (2004). Malnutrition and Dysfunctional Mother-Child Feeding Interactions: Clinical Assessment and Research Implications. *Journal of the American College of Nutrition*, *23*(3), 259–271. https://doi.org/10.1080/07315724.2004.10719369

Batool, R., Butt, M. S., Sultan, M. T., Saeed, F., & Naz, R. (2015). Protein-Energy Malnutrition: A Risk Factor for Various Ailments. *Critical Reviews in Food Science and Nutrition*, *55*(2), 242–253. https://doi.org/10.1080/10408398.2011.651543

Cooke, L., & Llewellyn, C. (2016). Nature and Nurture in Early Feeding Behavior. *Nestle Nutrition Institute Workshop Series*, *85*, 155–165. https://doi.org/10.1159/000439507

De Buhr, E., & Tannen, A. (2020). Parental health literacy and health knowledge, behaviours and outcomes in children: A cross-sectional survey. In *BMC Public Health* (Vol. 20, Issue 1). BioMed Central. https://doi.org/10.1186/s12889-020-08881-5

Dimas Nugraha, E., Bayu, A., & Nandiyanto, D. (2021). Introduction to Balanced Nutrition in Teaching for Elementary School Students. *Jurnal Abmas*, *21*(1), 99–102.

Dipasquale, V., Cucinotta, U., & Romano, C. (2020). Acute malnutrition in children: Pathophysiology, clinical effects and treatment. *Nutrients*, *12*(8), 1–9. https://doi.org/10.3390/nu12082413

Ferdous, T., Kabir, Z. N., Wahlin, Å., Streatfield, K., & Cederholm, T. (2009). The multidimensional background of malnutrition among rural older individuals in Bangladesh a challenge for the Millennium Development Goal. *Public Health Nutrition*, *12*(12), 2270–2278. https://doi.org/10.1017/S1368980009005096

Grover, Z., & Ee, L. C. (2009). Protein Energy Malnutrition. *Pediatric Clinics of North America*, *56*(5), 1055–1068. https://doi.org/10.1016/j.pcl.2009.07.001

Hasan, M., Islam, M. M., Mubarak, E., Haque, M. A., Choudhury, N., & Ahmed, T. (2019). Mother's dietary diversity and association with stunting among children <2 years old in a low socio-economic environment: A case–control study in an urban care setting in Dhaka, Bangladesh. *Maternal and Child Nutrition*, *15*(2), 1–8. https://doi.org/10.1111/mcn.12665

Iwaret, M., Stephen, O., & Allen, J. (2021). Severe acute malnutrition in low-and middle-income countries. *Paediatrics and Child Health*, *31*(8), 301–307.

Krebs-Smith, S. M., Pannucci, T. R. E., Subar, A. F., Kirkpatrick, S. I., Lerman, J. L., Tooze, J. A., Wilson, M. M., & Reedy, J. (2018). Update of the Healthy Eating Index: HEI-2015. *Journal of the Academy of Nutrition and Dietetics*, *118*(9). https://doi.org/10.1016/j.jand.2018.05.021

Kuche, D., Moss, C., Eshetu, S., Ayana, G., Salasibew, M., Dangour, A. D., & Allen, E. (2020). Factors associated with dietary

diversity and length-for-age z-score in rural Ethiopian children aged 6–23 months: A novel approach to the analysis of baseline data from the Sustainable Undernutrition Reduction in Ethiopia evaluation. *Maternal and Child Nutrition*, *16*(1), 1–11. https://doi.org/10.1111/mcn.12852

Mahmood, L., Flores-Barrantes, P., Moreno, L. A., Manios, Y., & Gonzalez-Gil, E. M. (2021). The influence of parental dietary behaviors and practices on children's eating habits. In *Nutrients* (Vol. 13, Issue 4). MDPI AG. https://doi.org/10.3390/nu13041138

Mitchodigni, I. M., Amoussa Hounkpatin, W., Ntandou-Bouzitou, G., Avohou, H., Termote, C., Kennedy, G., & Hounhouigan, D. J. (2017). Complementary feeding practices: determinants of dietary diversity and meal frequency among children aged 6–23 months in Southern Benin. *Food Security*, *9*(5), 1117–1130. https://doi.org/10.1007/s12571-017-0722-y

Rachmawati, Y., Anantanyu, S., & Kusnandar. (2019). Emotional eating, snacking behavior and nutritional status among adolescents. *International Journal of Public Health Science*, *8*(4), 413–418. https://doi.org/10.11591/ijphs.v8i4.20398

Santika, O., Februhartanty, J., & Ariawan, I. (2016). Feeding practices of young children aged 12-23 months in different socio-economic settings: A study from an urban area of Indonesia. *British Journal of Nutrition*, *116*(S1), S1–S7. https://doi.org/10.1017/S0007114515003438

Tenjin, K., Sekine, M., Yamada, M., & Tatsuse, T. (2020). Relationship between parental lifestyle and dietary habits of children: A cross-sectional study. *Journal of Epidemiology*, *30*(6), 253–259. https://doi.org/10.2188/jea.JE20190015

UNICEF. (2015). *UNICEF's Approach to Scaling Up Nutrition.* https://www.unicef.org/nutrition/files/unicef_nutrition_strategy.pdf

UNICEF. (2020). Nutrition, for every child UNICEF nutrition strategy 2020–2030. *UNICEF Publications*, 1–98. https://www.unicef.org/media/92031/file/UNICEF Nutrition Strategy 2020-2030.pdf

Vassilakou, T. (2021). Childhood malnutrition: Time for action. In *Children* (Vol. 8, Issue 2). MDPI. https://doi.org/10.3390/children8020103

WHO. (2013). Guideline: Updates on the Management of Severe Acute Malnutrition in Infants and Children. *WHO*.

WHO, & UNICEF. (2017). Global Nutrition monitoring framework. Operational guidance for tracking progress in meeting targets for 2025. In *World Health Organization*. http://apps.who.int/iris/bitstream/handle/10665/259904/9789241513609-eng.pdf;jsessionid=82B08433379C3E3E69B3F8D4F2690C34?sequence=1%0Awww.who.int/nutrition

World Health Organization. (n.d.). Global Nutrition Targets 2025 to improve maternal, infant and young child : Policy brief series. In *World Health Organization*. World Health Organization. https://www.who.int/publications/i/item/WHO-NMH-NHD-14.2

World Health Organization. (2016). The Double Burden of Malnutrition: Policy Brief. In *World Health Organisation*. World Health Organization. https://doi.org/10.1111/j.1745-6584.1983.tb00740.x

Media Gizi Indonesia

(National Nutrition Journal)

GUIDELINE FOR AUTHOR

Media Gizi Indonesia (MGI) / National Nutrition Journal

Last Updated: May 2024

I. GENERAL GUIDELINES

Papers submitted to the editorial are self-generated papers, scientific, contain contemporary issues and unpublished. To avoid duplication, the editor does not accept papers that are also sent to other journals at the same time for publication.

Each author should attach:

- A brief *Curriculum Vitae* (CV) of corresponding author on separate sheet, containing full name and title of author, address, home and institution phone number, formal education, publication and / or research of the last 5 years (optional)
- The original statement sheet (that the submitted article does not contain plagiarism)
- English proofread of the manuscript

II. FORMAT MANUSCRIPT WRITING

Manuscript should be typed using MS Word program, 1.5 space on A4 paper size with the left should be 4 cm length, while right, top, and bottom margin should be 3 cm length. The font used should be Times New Roman, sizing 16 pt for the title, 10 pt for author's name, 9 pt for author's identity, 11 pt for abstract and main content, and 9 pt for tables and figures. Specifically, for tables, single spaced should be used. The contents of the paper are made in two columns. The length of article should not below 10 pages and should not exceed 15 pages, send both in print-out and softcopy. Authors should also follow the manuscript preparation guidelines.

III. WRITING SYSTEM

Title in English

Author's Name (without degree)
Affiliation, City
Email:

Abstract in English (include keywords)
Introduction
Methods
Results and Discussion
Conclusion and Suggestion
References

Annotation

a. Title and Author's Identity

Title is written as clear, concise, informative, and understandable as possible. The maximum length of the title consists of 20 words. The author's name and identity (affiliation, city), are included

below the title. The name of corresponding author(s) is annotated by marking with numbers and (*) superscript. **For undergraduate thesis, the name of thesis advisor is written as second author.**

b. Abstract and Keywords

Abstracts are written in English in Bahasa Indonesia and in Times New Roman 11 pt, single-spaced. Abstracts consist of no more than 250 words length, written in 1 (one) paragraph. Keywords are written below the abstract, consist of 3-5 specific words that are consistently used in the manuscript. Avoid using quotations and the use of abbreviations in writing abstracts.

Abstracts contain brief information regarding the background of the study, objectives of the study, brief summary of the methods (research design, subject selection, methods of data analysis), results, and discussion (use the most specific data in answering the objectives of the study, along with the signification results of statistical test, if any), conclusion as well as the significance/urgency of obtained conclusion.

c. Manuscript

The core section of a manuscript consists of subtitles: introduction, methods, results and discussions, and conclusion and suggestions.

Introduction

The introduction part comprises the background of the study, research intention, research questions, previous studies and the objectives of the study.

Methods

The methods section consists of the steps completed by the author in doing the research, elaborated completely, yet concisely, begins from research design (including the sampling methods, if any), samples, materials, & tools used, working methods, techniques of data collection, and data analysis.

Methods also include agreement from ethical commission (research involving human subject and/ or animal experience).

Results and Discussions

Results of the study provide clear and concise results that are in line with the objectives of the study. The results can be complemented with tables and figures to help explaining the results.

- Number and title of a table are placed above the table and are written in bold. Table numbering is done in sequence. The lines used in table are only in table head and bottom (without column lines) with single space. Further explanations regarding the data on the table, the explanation can be written below the table.
- Number and label of figures are placed below figures and are written in bold. Figures numbering is done in sequence.
- Sources of reference are placed below tables/figures for tables and figures cited from other references (other than research results).

Discussions explains research results, concisely, and clearly. Using relevant arguments to the research topic and answering the research questions. Employ references (other research results or theories) to support the explanation of research. If there is abbreviation, use the standardized abbreviations. The use of abbreviations must be preceded by the extensions first. Foreign terms are written in *Italics*. Numbers written in the beginning of a sentence are written in a word.

Conclusion
Conclusion elucidates important matters discussed in the result and analysis briefly, concisely, clearly, and answers research questions. Conclusion can be completed with suggestions (if necessary).

Acknowledgement (if necessary)
Acknowledgement given to person/institution who have important roles in conducting a research (for example, funders) and/or writing scientific manuscripts and includes explanations whether the research is part of a series of research in thesis/dissertation.

Authors' Contribution
Details of each author's specific contribution to the research and the preparation of the paper. This section is important for transparency, accountability and proper attribution of credit.

References
Writing references refers to the APA Referencing Guide 6th edition. [*Publication Manual of the American Psychological Association*. (6th ed.). (2010). Washington, D.C.: American Psychological Association]. References are arranged systematically and sorted alphabetically according to author's name. Generally, writing references is as follows:

Author, A.A., Author, B.B, & Author, C.C. (year of publication). *Title of publication: sub title*. (Edition [if not the first edition]). City of publication: Publisher.

A minimum of 80% of the literature used comes from 'up to date' sources (published no more than 10 years before scientific papers submitted to MGI). Unpublished sources, such as manuscripts or personal communication cannot be used as references for the writing.

EXAMPLES OF CITATION IN MANUSCRIPT

a. 1 author
Smith (2017) or (Smith, 2017)
b. 2 authors
Smith and Jones (2017) or (Smith and Jones, 2017)
c. 3 or more authors
Smith, et al. (2017) or (Smith, et al., 2017)

EXAMPLES OF REFERENCES WRITING

a. **References from books**
- Contento, I.R. (2011). Nutrition Education (2nd ed.). Sadburry, Massachusetts: Jones and Bartlett Publishers.
- Mahan, L.K., & Raymond, J.L. (2017). *Krause's Food & The Nutrition Care Process*. Canada: Elsevier Health Sciences.

b. Books or reports composed by organizations, associations, or government agencies
Kementerian Kesehatan. (2013). *Hasil Riset Kesehatan Dasar 2013.* Jakarta: Badan Penelitian dan Pengembangan Kesehatan, Kementerian Kesehatan RI.

c. Book chapters on a book that has editors
Brown, J.E. (2011). Nutrition Through the Life Cycle (Fourth Edition). Janet Sugarman Isaacs, *Infant Nutrition* (pp. 223 – 225). Belmont, CA, USA: Wadsworth.

d. Conference manuscript – online

Bochner, S. (1996, November). *Mentoring in higher education: Issues to be addressed in developing a mentoring program.* Paper presented at the Australian Association for Research in Education Conference, Singapore. Diakses dari http://www.aare.edu.au/96pap/bochs96018.txt

e. Manuscripts from a journal

El-Gilany, A. H., & Elkhawaga, G. (2012). Socioeconomic determinants of eating pattern of adolescent students in Mansoura, Egypt. *The Pan African Medical Journal*, *13*, 22. https://doi.org/10.4314/pamj.v13i1.

McDonald, C. M., McLean, J., Kroeun, H., Talukder, A., Lynd, L. D., & Green, T. J. (2015). Correlates of household food insecurity and low dietary diversity in rural Cambodia. *Asia Pacific Journal of Clinical Nutrition*, 24(4), 720–730. https://doi.org/10.6133/apjcn.2015.24.4.14

Diana, R., Sumarmi, S., Nindya, T. S., Rifqi, M. A., Widya, S., & Rhitmayanti, E. (2017). *Household Income and Unbalanced Diet Among Urban Adolescent Girls. Proceedings ofthe 4th Annual Meeting ofthe Indonesian Health Economics Association (INAHEA 2017).*

f. Thesis/Dissertation – printed version

Hilgendorf, M. (2018). *Assessing Malnutrition In Liver Disease Patients Being Evaluated For Transplant Using The Nutrition Focused Physical Exam* (Unpublished master's thesis). University of Kentucky, Lexington, Kentucky.

Diana, R. (2014). *Pengaruh pemanfaatan pekarangan dan penyuluhan terhadap konsumsi sayur dan asupan gizi rumah tangga dan balita.* Institut Pertanian Bogor.

g. Thesis/Dissertation – web version

Hilgendorf, M. (2018). *Assessing Malnutrition In Liver Disease Patients Being Evaluated For Transplant Using The Nutrition Focused Physical Exam* (Master's thesis, University of Kentucky, Lexington, Kentucky). Diakses dari https://uknowledge.uky.edu/cgi/viewcontent.cgi?article=1065&context=foodsci_etds

h. Web page (if referenced are a few pages on the same web page, use the homepage page)

Statistic Bureau of East Java. (2018). Number and Percentage of Poor, P1, P2 and Poverty Line By Regency / Municipality, in 2017. Retrieved November 22, 2018, from https://jatim.bps.go.id/statictable/2018/01/15/733/jumlah-dan-persentase-penduduk-miskin-p1-p2-dan-garis-kemiskinan-menurut-kabupaten-kota-tahun-2017.html

Examples of tables:

Table 1. Characteristics of Patients in Malnutrition and Non-Malnutrition Groups

Karakteristik	Malnutrition (n=70)		Non-Malnutrition (n=233)		Total (n=303)	X^2	*p value*
	n	%	n	%			
Sex							
Male	38	54,3	117	52,5	155	0,070	0,790
Female	32	45,7	106	47,5	138		
Age							
<55 years old	48	68,6	151	67,7	199	0,890	0,180
≥55 years old	22	31,4	72	32,3	94		
Education							
Low	24	34,3	51	22,9	75	10,153	0,063
Middle	33	47,1	151	67,7	184		
High	13	18,6	21	9,4	33		

Table 2. Average of Nutrition Intake in Malnutrition and Non-Malnutrition Groups

Nutrition Intake	Malnutrition (Mean ± SD)	Non-Malnutrition (Mean ± SD)	t	*p value*
Calories	1328,1± 215,3	1482,9± 327,4	2,04	0,032
Protein	43,2±13,1	48,7±17,3	2,47	0,010

Example of a figure:

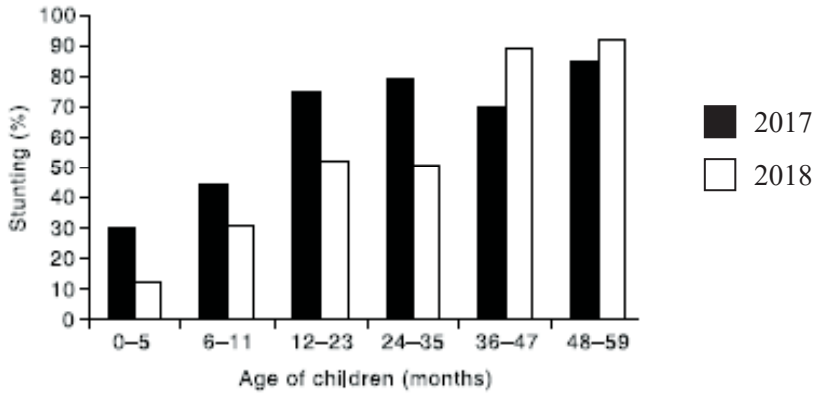


Figure 1. Changes in Stunting Prevalence (%) in Toddlers in Kalimantan

FORMULIR BERLANGGANAN

Jurnal Media Gizi Indonesia

Mohon dicatat sebagai pelanggan Jurnal Media Gizi Indonesia

Nama :

Alamat :

Telepon :

Email :

Bersama ini saya kirimkan uang langganan sebesar:

- Rp 600.000 (3 nomor), mulai nomor..... Tahun.....
- belum termasuk ongkos kirim (± 2kg untuk 3 nomor)

Uang tersebut telah saya kirim melalui:

- Bank Syariah Mandiri
  Cabang Kantor Kas Universitas Airlangga
  Rekening nomor 710-62-93297
  a.n. Jurnal Media Gizi Indonesia
- pos wesel dengan resi nomor..... tanggal.....
- lain-lain.....

(Foto copy bukti pembayaran terlampir)

.....,.....

(tanda tangan dan nama terang)