

Relationship Between Maternal Dietary Patterns and the Triple Burden of Malnutrition in Indonesian Families: A Complex Sample Cross-Sectional Study

¹Zulhadiman, ¹Dodik Briawan*, ¹Ikeu Ekayanti

Corresponding Author: *dbriawan@apps.ipb.ac.id

¹ Department of Community Nutrition, Faculty of Human Ecology IPB University, Bogor, Indonesia

ARTICLE INFO

Article history

Received 10 October 2025

Revised 05 November 2025

Accepted 10 November
2025

ABSTRACT

The triple burden of malnutrition (TBM), comprising undernutrition, overnutrition, and micronutrient deficiencies, remains a major nutritional challenge in Indonesia amid rapid economic growth and shifting dietary habits. This study aimed to analyze the prevalence of TBM and its association with maternal dietary patterns using data from 1,005 mother-child pairs in the 2023 Indonesian Health Survey. Complex sample logistic regression was applied to account for the multistage sampling design. The prevalence of TBM was 4.3%. In children, 16.6% were underweight, 21.3% stunted, and 21.7% anemic, while 51.4% of mothers were overweight or obese and 15.0% anemic. Maternal dietary patterns were significantly associated with TBM risk, whereby mothers who rarely or never consumed grilled or charred foods were more likely to belong to non-TBM families (AOR = 8.57; 95% CI: 1.43–51.29; $p = 0.018$), as were those with moderate consumption (AOR = 4.78; 95% CI: 1.09–20.98; $p = 0.038$). In contrast, rare consumption of meat, poultry, or fish products with preservatives (AOR = 0.13; 95% CI: 0.02–0.95; $p = 0.043$) and fruits or fruit-based products (AOR = 0.19; 95% CI: 0.06–0.61; $p = 0.005$) was associated with a higher likelihood of TBM. A non-linear association was observed for flavor enhancers, where moderate consumption was linked to lower odds of TBM (AOR = 0.33; 95% CI: 0.15–0.73; $p = 0.006$), whereas rare consumption increased the likelihood of belonging to non-TBM families (AOR = 2.79; 95% CI: 1.04–7.48; $p = 0.041$). Additionally, moderate consumption of fats and oils was positively associated with TBM risk (AOR = 2.94; 95% CI: 1.01–8.54; $p = 0.047$). In conclusion, maternal dietary

patterns significantly influence TBM risk among Indonesian families.

This is an open-access article under the [CC-BY-SA](#) license.



Keywords

Triple burden of
malnutrition
Dietary patterns
Mother and children
Nutritional status
Public health

Introduction

According to the United Nations (2023), malnutrition continues to be a pervasive global public health problem, impeding the realization of the Sustainable Development Goals (SDGs), particularly Goal 2: Zero Hunger [1]. Despite the global progress witnessed in the realm of food security, various forms of malnutrition persist, reflecting deep-rooted inequalities in diet quality, health access, and socioeconomic status [2].

Triple Burden of Malnutrition (TBM) refers to the coexistence of undernutrition (stunting, wasting, underweight), overnutrition (overweight and obesity), and micronutrient deficiencies (such as anemia) within the same population, household, or even family [3]. TBM has emerged as a hallmark of the ongoing nutrition transition in low- and middle-income countries (LMICs) [4]. A confluence of factors, including rapid urbanization, the globalization of food markets, and shifts in lifestyle patterns, has precipitated a transition in dietary habits from traditional, nutrient-rich foods to processed and energy-dense diets characterized by high levels of sugar, salt, and fat [5]. These shifts have contributed concurrently to the persistent undernutrition among vulnerable populations and the rising rates of overweight, obesity, and noncommunicable diseases (NCDs) in the broader population [6].

Although direct mortality data related to TBM are limited, this condition contributes to multiple adverse health outcomes, including impaired child growth, low birth weight, increased maternal complications, and higher long-term risks of noncommunicable diseases [6]. The coexistence of undernutrition, anemia, and obesity within the same household highlights the complexity of nutritional inequities in Indonesia and underscores the urgency of integrated public health responses [11].

The prevalence of the Triple Burden of Malnutrition (TBM) varies considerably among developing countries and is becoming a nutritional issue that is receiving increasing global attention. In India, approximately 5.7% of mother-child pairs experience TBM, with the main

risk factors including the mother's age and education, delivery method, and socioeconomic status [8]. In Nepal, the TBM rate reaches 7%, especially among short mothers and upper economic groups [9]. In contrast, in Sub-Saharan Africa, TBM is more commonly found in West Africa and is associated with male children, low birth weight, and low maternal education [10].

In Indonesia, finding from the Basic Health Research (RISKESDAS) surveys indicate a rising trend in the prevalence of triple burden of malnutrition among mother-child pairs [11]. Approximately 21.3% of households experienced TBM in 2013, increasing to 24.9% in 2018, suggesting a worsening integrational nutrition problem [11]. The data also reveal a higher risk among girls compared to boys [11]. These overlapping forms of malnutrition within the same household underscore the complex interplay between maternal and child nutrition, where maternal overnutrition or micronutrient deficiencies coexist with child undernutrition. Such interlinked patterns are often driven by dietary monotony, limited nutrition literacy, and socioeconomic disparities that restrict access to diverse and nutrient-rich foods [12].

Dietary behavior is among the most critical modifiable risk factors influencing the occurrence of malnutrition [13]. Frequent consumption of foods high in added sugars, fats, and refined carbohydrates has been demonstrated to increase the risk of overweight, obesity, and metabolic syndrome [14]. Conversely, inadequate intake of fruits, vegetables, and animal-source foods has been shown to contribute to micronutrient deficiencies and impaired child growth. In Indonesia, this imbalance in dietary patterns is further compounded by cultural preferences, limitations in the food environment, and the marketing of unhealthy foods [15]. However, despite the growing recognition of these issues, empirical evidence linking specific maternal food consumption patterns with the occurrence of TBM at the household level remains limited.

Addressing the issue of TBM necessitates a comprehensive understanding of how maternal dietary habits influence multiple forms of malnutrition simultaneously. As mothers occupy a central role in the determination of household food choices, their consumption patterns have the capacity to exert a direct influence on both their own nutritional status and that of their children [16]. The investigation of these relationships can yield critical insights into the mechanisms by which dietary transitions contribute to TBM, thereby facilitating the identification of leverage points for public health interventions [17].

Hence, this study aims to analyze the association between maternal dietary patterns and the Triple Burden of Malnutrition (TBM) among mother-child pairs in Indonesia, using nationally representative data from the 2023 Indonesian Health Survey (Survei Kesehatan Indonesia, SKI). The identification of key maternal dietary behaviors associated with TBM is expected to inform evidence-based nutrition policies and integrated interventions that

promote healthy, balanced diets. These insights may support the development of strategies to break the intergenerational cycle of malnutrition and accelerate progress toward achieving the SDGs in Indonesia.

Material and Methods

A. Study Design and Data Source

This study employed a cross-sectional design using secondary data from the 2023 Indonesia Health Survey (Survei Kesehatan Indonesia; SKI 2023) conducted by the Ministry of Health of the Republic of Indonesia. The SKI 2023 is a nationally representative survey designed to monitor population health indicators, nutritional status, and maternal health behaviors across Indonesian families.

B. Study Population and Sampling

The analytical sample consisted of mother–child pairs living in the same household. Inclusion criteria were: (1) availability of complete anthropometric and biochemical data for both mother and child; (2) mothers aged 15–49 years; (3) having a biological child aged 0–59 months. Exclusion criteria included pregnant mothers, incomplete records, and extreme or implausible anthropometric values. After data cleaning and weighting, a total of 1,005 families were included, representing an estimated 321,586 Indonesian families. Information on maternal or child morbidity was not included, as the analysis was confined to dietary pattern variables in relation to nutritional outcomes.

C. Dependent Variable

The nutritional status of children was analyzed using WHO Anthro (2006) and classified following the Regulation of the Minister of Health No. 2/2020: underweight (weight-for-age < -2 SD), stunted (height-for-age < -2 SD), wasted (weight-for-height < -2 SD), and overweight/obese (weight-for-height $> +2$ SD) [18]. Maternal nutritional status was determined by BMI (weight/height²) based on Regulation No. 41/2014: underweight (BMI < 18.5 kg/m²) and overweight/obese (BMI > 25 kg/m²) [19]. Hemoglobin concentration assessed anemia using WHO standards: <10.0 g/dL (children 6–23 months), <11.0 g/dL (24–59 months), and <12.0 g/dL (women 15–65 years) [20].

The inclusion of these specific indicators (WAZ, HAZ, WHZ, BMI, and hemoglobin level) was intended to capture the three core dimensions of malnutrition—undernutrition,

overnutrition, and micronutrient deficiency—as components of the Triple Burden of Malnutrition (TBM). Therefore, the classifications were selected not to describe all anthropometric categories separately, but to detect the coexistence of these conditions within the same mother–child pair. The Triple Burden of Malnutrition (TBM) was defined as the coexistence of undernutrition, overnutrition, and anemia within a mother–child pair. TBM criteria: (1) overweight/obese mother, undernourished child, and anemia in either/both; or (2) underweight mother, overweight/obese child, and anemia in either/both. Families not meeting these were classified as non-TBM.

D. Independent Variable

Maternal dietary patterns were assessed based on the food frequency questionnaire of the 2023 Indonesian Health Survey (SKI), which collected information on usual food consumption during the past month [38]. Two major food groupings were analyzed: risky food consumption patterns and overall dietary consumption patterns by food group.

The risky food consumption pattern included ten items representing energy-dense or nutrient-poor foods, namely sweet foods, sweetened beverages, salty foods, fatty or cholesterol-rich fried foods, grilled or charred foods, meat, poultry, or fish products with preservatives, flavor enhancers such as monosodium glutamate (MSG) or seasoning powder, soft drinks or other carbonated beverages, energy drinks, and instant noodles or other instant foods [38].

Meanwhile, the maternal dietary consumption pattern by food group comprised eleven categories representing nutrient-dense foods, including cereals and cereal-based products (e.g., rice, bread, noodles, biscuits, pasta), starchy tubers, legumes, nuts, tofu, tempeh, and related products, vegetables and vegetable-based dishes, fruits and fruit-based products, meat, poultry, or organ meats, fish, shellfish, shrimp, and their products, eggs (chicken, duck, etc.), milk and dairy products, fats and oils, and sugar, syrup, confectionery, and other sweetened products [38].

The original SKI questionnaire employed six frequency categories—(1) >1 time per day, (2) 1 time per day, (3) 3–6 times per week, (4) 1–2 times per week, (5) <3 times per month, and (6) never [38]. For analytical purposes, these were simplified into three categories: Rarely/Never (<3 times per month), Moderate (1–6 times per week), and Frequent (≥ 1 time per day), to minimize zero cells and ensure stable model estimation in the complex sample logistic regression.

E. Data Analysis

All analyses accounted for the complex sampling design using weighted estimations. Data was analyzed with Complex Sample Logistic Regression in IBM Statistic, incorporating strata, primary sampling units (PSU), and sample weights. Results were presented as Adjusted Odds Ratios (AORs) with 95% Confidence Intervals (CIs) and p-values. A significance level of $p < 0.05$ was considered statistically significant.

F. Ethical Considerations

Permission to use the 2023 Indonesian Health Survey data was obtained from the Center for Data and Information Technology (Pusdatin) of the Ministry of Health of the Republic of Indonesia with number FRM/SMKI-PUSDATIN/70/0692/2025. This study has also obtained ethical approval from the Research Ethics Committee of the Faculty of Dentistry, Universitas Airlangga with number 0785/HRECC.FODM/VII/2025 dated July 24, 2025.

Results and Discussions

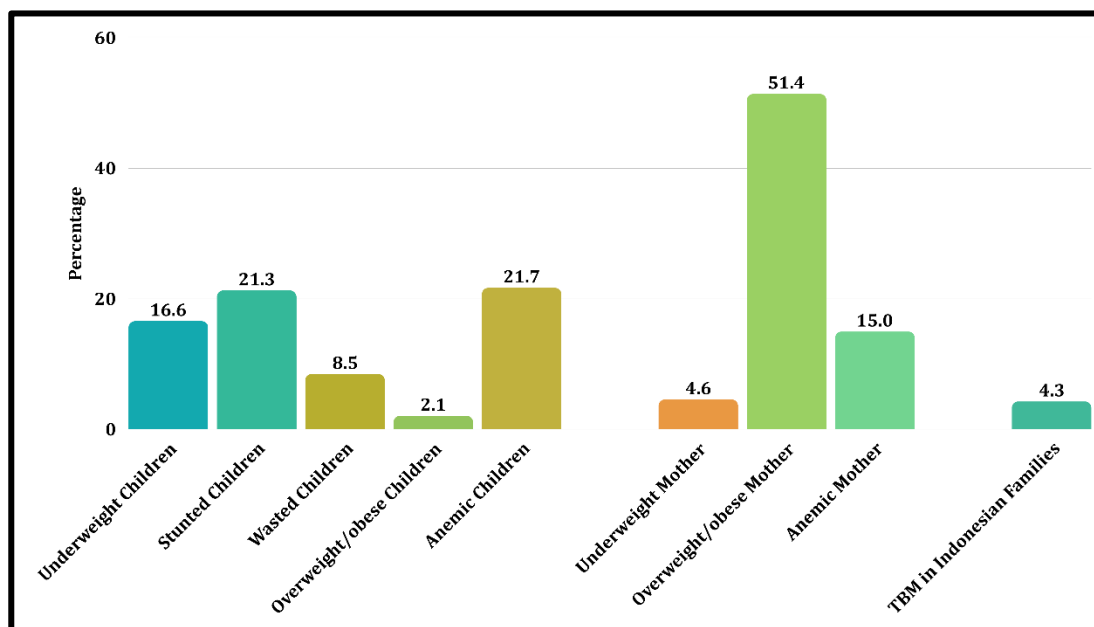
A. Nutritional Status of Mothers and Children and the TBM in Indonesian Families

The sample of 1,005 mother–child pairs was drawn from the 2023 Indonesian Health Survey (SKI), which used a multistage stratified sampling design representing all provinces of Indonesia. Weighted estimates ($n = 321,586$ families) were applied to ensure national representativeness.

In mothers, the prevalence of overweight and obesity was 51.4% and underweight 4.6%, indicating a continuing shift in nutritional patterns toward excess energy intake. This figure is slightly higher than the 47.9% prevalence of maternal overweight and obesity reported by Andriani et al. (2023), suggesting an ongoing nutritional transition from deficiency to overnutrition [11]. The coexistence of obesity and anaemia among mothers reflects a double burden of malnutrition, where excessive caloric intake occurs alongside micronutrient deficiencies. This condition may result from dietary transitions associated with urbanization and the growing consumption of ultra-processed foods that are energy-dense but poor in micronutrients [5].

The prevalence of anaemia among mothers was 15.0%, indicating a persistent public health issue related to iron deficiency. Although this figure is slightly lower than the 18.0% reported in the Indonesian Health Survey, it still highlights inadequate micronutrient intake

among women of reproductive age. The co-occurrence of obesity and anaemia is characterized as a form of double malnutrition in mothers that can adversely affect reproductive health and child nutrition [21].



Source: Authors' analysis of the 2023 Indonesian Health Survey (SKI) dataset

Fig. 1. Prevalence of maternal and child nutritional status and TBM in Indonesian families.

In children, nutritional outcomes exhibited a heterogeneous pattern across different indicators. Based on weight-for-age, 16.6% were classified as underweight. According to weight-for-height, 8.5% were wasted, while 2.1% were overweight or obese—indicating the early emergence of the double burden of malnutrition within this population. In terms of height-for-age, 21.3% of children were stunted, representing a notable decline from the 29.7% reported by Andriani et al. (2023) [11]. This reduction may indicate the partial effectiveness of national nutrition programs targeting the first 1,000 days of life (1,000 HPK). Nevertheless, the prevalence remains above the WHO threshold for a public health concern ($\geq 20\%$) [4].

Furthermore, the prevalence of childhood anaemia was 21.7%, a level categorized as serious according to WHO standards. The persistence of anaemia is likely attributable to insufficient intake of iron-rich animal-source foods, micronutrient deficiencies, and parasitic infections [22]. The consequences of anaemia during childhood are far-reaching, including impaired cognitive, motor, and immune development, which may perpetuate the cycle of intergenerational poverty [23].

The prevalence of the Triple Burden of Malnutrition (TBM) was found to be 4.3% among the surveyed families (95% CI: 3.2–5.7), which is equivalent to approximately 13,000 households in Indonesia. The term "TBM" is defined as the presence of mothers who are overweight, children who are undernourished, and anemia in one or both. This prevalence is considerably lower than the results of the 2013 (21.6%) and 2018 (28.4%) Riskesdas studies (Andriani et al., 2023), which may be influenced by changes in the analysis methodology, socio-economic dynamics, and the impact of the post-pandemic nutritional transition [11].

Despite a decline in the proportion, TBM persists as a significant challenge, reflecting an imbalance in nutritional consumption and distribution within households. A diet characterized by high energy but low micronutrient intake, in conjunction with inadequate nutritional literacy, has been demonstrated to elevate the probability of concurrent malnutrition [5], [24]. This condition underscores the significance of cross-sectoral interventions that focus on mothers and children as a unified family nutrition ecosystem [25].

B. Maternal Food Consumption Pattern

An analysis of maternal consumption patterns is presented in Tables 1 and 2. These patterns encompass the frequency of maternal consumption of risky foods and food group consumption. The tables offer a comprehensive overview of maternal dietary habits.

The majority of mothers exhibited a moderate consumption pattern of sweet foods (58.2%), followed by frequent consumption (31.9%) and rarely/never consumption (9.9%). A similar trend was observed in the consumption of sweet beverages, where the moderate category predominated (45.7%), followed by frequent consumption (39.2%) and rarely/never consumption (15.1%). The preponderance of mothers with moderate to frequent consumption of sweet foods and beverages signifies their high exposure to added sugar in their daily diet. A substantial body of research has demonstrated a positive correlation between excessive sugar intake and an increased risk of overweight, obesity, and type 2 diabetes mellitus [26]. In the context of the Triple Burden of Malnutrition (TBM), the high consumption of sweet foods and beverages by mothers not only exacerbates the risk of overnutrition in mothers but also affects children's taste preferences and eating behaviors, thereby reinforcing the cycle of intergenerational nutritional imbalance [27].

The consumption of foods high in fat, cholesterol, and fried foods was predominantly in the frequent category (46.9%), followed by the moderate category (43.9%) and the

rare/never category (9.2%). This pattern suggests a proclivity for dietary patterns characterized by elevated levels of saturated and trans fats. These dietary patterns have been linked to an augmented risk of adverse health outcomes, including elevated cholesterol levels, obesity, and cardiovascular disease [28]. In households at risk of TBM, a preference for high-fat foods can contribute to maternal overweight, while children are at risk of undernutrition due to the low quality of the family's diet [29].

Table 1. Pattern of Maternal Risky Food Consumption.

Variable	Rarely/Never (Weighted N)	(%)	Moderate (Weighted N)	(%)	Frequently (Weighted N)	(%)
Sweet foods	31,748	9.9	187,281	58.2	102,558	31.9
Sweetened beverages	48,587	15.1	146,869	45.7	126,130	39.2
Salty foods	50,737	15.8	155,986	48.5	114,864	35.7
Fatty/cholesterol-rich/fried foods	29,588	9.2	141,091	43.9	150,907	46.9
Grilled or charred foods	188,042	58.5	122,031	37.9	11,514	3.6
Meat/poultry/fish products with preservatives	133,655	41.6	163,886	51.0	24,046	7.5
Flavour enhancers (MSG or seasoning powder)	18,014	5.6	24,389	7.6	279,183	86.8
Soft drinks or carbonated beverages	294,514	91.6	23,644	7.4	3,428	1.1
Energy drink	311,322	96.8	8,415	2.6	1,850	0.6
Instant noodles or other instant foods	96,657	30.1	207,213	64.4	17,716	5.5

Source: Authors' analysis of the 2023 Indonesian Health Survey (SKI) dataset

* Rarely/never (<3 times per month), moderate (1–6 times per week), and frequently (≥1 time per day).

The consumption of grilled foods was found to be low, with the majority of mothers in the rarely/never category (58.5%), followed by moderate (37.9%) and frequent (3.6%). Concurrently, the consumption of meat, chicken, or fish that had undergone processing with preservatives was predominantly characterized by the moderate category (51.0%), with a significant proportion of respondents (41.6%) reporting rarely or non-consumption, and a smaller percentage (7.5%) indicating frequent consumption. Although the consumption of burnt foods is relatively rarely, the frequency of consumption of processed products with preservatives remains relatively high. Processed products with high sodium and nitrite content have been demonstrated to elevate the risk of developing hypertension and

metabolic disorders [30]. Prolonged exposure to processed foods has been demonstrated to influence intergenerational predilections for foods high in sodium [31]. This phenomenon serves to reinforce detrimental eating patterns, thereby perpetuating the cycle of TBM within households.

The consumption of flavor enhancers was predominantly in the frequent category (86.8%), with 7.6% in the moderate category and 5.6% in the rarely/never category. The high consumption of flavor enhancers indicates a strong preference for savory or umami flavors in the community's eating culture. The high sodium content in flavor enhancers has been identified as a significant risk factor for hypertension and non-communicable diseases [14]. The excessive use of flavor enhancers has the potential to influence children's early preferences, potentially leading to a heightened acceptance of foods high in sodium [32]. This, in turn, can adversely impact the overall quality of the family's diet.

The consumption of soft drinks and energy drinks is relatively low, with most mothers rarely or never consuming soft drinks (91.6%) or energy drinks (96.8%). However, the consumption of instant noodles or instant foods is notably high, with the majority of consumers falling within the moderate category (64.4%), followed by the rarely/never (30.1%) and often (5.5%) categories. While high-sugar beverage consumption remains at a low level, the substantial intake of instant foods signifies a shift towards a fast food diet that is deficient in nutritional value. Instant foods are characterized by elevated sodium and saturated fat content, and diminished fiber content [26]. Prolonged consumption of these foods has been associated with diminished diet quality and heightened risk of non-communicable diseases [26].

The consumption of instant noodles in Indonesia is frequently linked to lower socioeconomic status, as they are inexpensive and readily available [33]. This finding underscores the pivotal role that economic factors play in shaping the nutritional quality of a families diet [25]. The reliance on low-nutrient convenience foods has the potential to compromise the nutritional well-being of children, thereby elevating the susceptibility to the development of type 2 diabetes mellitus (T2DM) within their familial units [34]. The findings indicate that the majority of mothers have diets with high levels of sugar, fat, and sodium, and low levels of fresh, nutritious foods. This phenomenon mirrors the nutritional transition in Indonesia, where the coexistence of overnutrition among mothers and undernutrition and anaemia among children within the same household is a prevalent concern. This condition underscores the significance of family-based nutritional interventions in promoting behavioral changes, reducing exposure to ultra-processed foods, and fostering the development of healthy eating patterns across generations.

Table 2. Maternal Dietary Consumption Patterns by Food Group.

Variable	Rarely/Never (Weighted N)	(%)	Moderate (Weighted N)	(%)	Frequently (Weighted N)	(%)
Cereals and cereal-based products (rice, bread, noodles, biscuits, pasta, etc.)	3,402	1.1	25,414	7.9	292,772	91.0
Starchy tubers	130,369	40.5	177,220	55.1	13,998	4.4
Legumes, nuts, tofu, tempeh, and related products	34,303	10.7	167,623	52.1	119,661	37.2
Vegetables and vegetable-based dishes	6,497	2.0	114,365	35.6	200,725	62.4
Fruits and fruit-based products	31,348	9.7	216,726	67.4	73,512	22.9
Meat, poultry, or organ meats	62,349	19.4	230,283	71.6	28,954	9.0
Fish, shellfish, shrimp, and their products	78,596	24.4	208,172	64.7	34,819	10.8
Eggs (chicken, duck, etc.)	19,951	6.2	204,531	63.6	97,105	30.2
Milk and dairy products	218,731	68.0	78,705	24.5	24,150	7.5
Fats and oils	29,265	9.1	80,664	25.1	211,657	65.8
Sugar, syrup, confectionery, and sweetened products	80,357	25.0	96,068	29.9	145,162	45.1

Source: Authors' analysis of the 2023 Indonesian Health Survey (SKI) dataset

Rarely/never (<3 times per month), moderate (1–6 times per week), and frequently (≥1 time per day).

As illustrated in Table 2, the predominant proportion of mothers regularly ingest cereals and cereal products (91.0%). Conversely, the consumption of starchy tubers is predominantly moderate (55.1%). Notably, 40.5% of mothers rarely or never consume starchy tubers. A substantial proportion of mothers in Indonesia regularly consume cereals, which are the country's predominant staple food, particularly rice [35]. This finding is consistent with the predominant carbohydrate consumption pattern in Indonesia, which continues to place significant reliance on cereal-based sources. Concurrently, the consumption of starchy tubers remains comparatively low, despite its potential as a source of local food diversification [36].

The consumption of nuts, seeds, tempeh, tofu, and their processed products was highest in the moderate category (52.1%), followed by the frequent category (37.2%) and the rarely/never category (10.7%). Processed products, including tempeh and tofu, are

notable sources of plant-based protein and are rich in isoflavones and fiber [37]. This relatively substantial consumption contributes to diet quality; however, the portion must be increased to balance carbohydrate intake.

Vegetable consumption was predominantly frequent (62.4%), while fruit intake tended to be moderate (67.4%). This indicates that fruit availability and consumption remain suboptimal. These findings are consistent with the Indonesian Health Survey, which reported low compliance with the recommendation of consuming at least five servings of fruits and vegetables per day [38]. Insufficient intake may lead to deficiencies in fiber, vitamins, and essential minerals, contributing to stunting and anemia [39].

The majority of the subjects consumed meat and animal products in the moderate category (71.6%), fish and seafood in the moderate category (64.7%), and eggs in the moderate category (63.6%). The consumption of milk and dairy products was predominantly characterized by the "rarely/never" category, accounting for 68.0% of the sample. While the majority of mothers consumed meat, fish, and eggs in moderation, the consumption of milk and dairy products remained notably low (68.0% rarely/never). Milk constitutes a significant source of high-quality animal protein, calcium, and vitamin D, which have been demonstrated to play a crucial role in the prevention of micronutrient deficiencies [40]. The factors influencing low milk consumption include price, consumer preferences, and cultural dietary habits [41].

Concurrently, the consumption of fat and oil was predominantly observed in the frequent category (65.8%). The consumption of sugar and sweetened processed food items was found to be prevalent, with the frequent category constituting 45.1% of the sample. The high consumption of fats/oils (65.8% frequent) and sugar/sweet processed foods (45.1% frequent) indicates a tendency toward a high-energy diet with low nutritional quality [42]. Excessive consumption of these two food categories has been linked to an increased risk of obesity, metabolic syndrome, and non-communicable diseases [43]. Within the paradigm of the triple burden of malnutrition, this phenomenon contributes to an elevated risk of overnutrition among mothers, while children persist in their vulnerability to undernutrition or anemia due to inadequate intake of micronutrients.

C. Analysis of Maternal Dietary Patterns and the Triple Burden of Malnutrition

The complex sample logistic regression analysis of maternal dietary patterns revealed significant associations with the occurrence of Triple Burden of Malnutrition (TBM) within families (Table 3). The model accounted for sampling weights, strata, and primary sampling

units to ensure nationally representative estimates. The results indicated that several maternal dietary behaviors significantly influenced the likelihood of families experiencing concurrent forms of undernutrition, overnutrition, and micronutrient deficiencies.

Table 3. Complex Sample Logistic Regression of Maternal Dietary Patterns and TBM

Variable	Category	AOR	95% CI	p value
Grilled or charred foods	Rarely/Never	8.573	1.433 – 51.294	0.018*
	Moderate	4.777	1.088 – 20.978	0.038*
	Frequently	1.000	-	-
Meat/poultry/fish products with preservatives	Rarely/Never	0.132	0.019 – 0.945	0.043*
	Moderate	0.394	0.062 – 2.507	0.322
	Frequently	1.000	-	-
Flavor enhancers (MSG or seasoning powder)	Rarely/Never	2.788	1.038 – 7.482	0.041*
	Moderate	0.328	0.147 – 0.733	0.006*
	Frequently	1.000	-	-
Fruits and fruit-based products	Rarely/Never	0.191	0.061 – 0.605	0.005*
	Moderate	0.643	0.199 – 2.080	0.460
	Frequently	1.000	-	-
Fats and oils	Rarely/Never	1.657	0.364 – 7.543	0.513
	Moderate	2.938	1.011 – 8.538	0.047*
	Frequently	1.000	-	-

Source: Authors' analysis of the 2023 Indonesian Health Survey (SKI) dataset

Reference category = TBM; Estimates obtained using complex sample logistic regression.

*Significance at $p < 0.05$.

Mothers who rarely or never consumed grilled or charred foods had significantly higher odds of belonging to non-TBM families compared with those who frequently consumed them (AOR = 8.57; 95% CI: 1.43–51.29; $p = 0.018$). Similarly, those with moderate consumption also showed elevated odds (AOR = 4.78; 95% CI: 1.09–20.98; $p = 0.038$). This finding indicates that frequent consumption of grilled or charred foods is more closely associated with TBM, possibly due to exposure to toxic compounds generated during high-temperature cooking, such as polycyclic aromatic hydrocarbons (PAHs) and heterocyclic amines (HCAs). These compounds can interfere with nutrient metabolism, induce oxidative stress, and contribute to metabolic imbalances [44], which may manifest as both undernutrition and obesity within the same household—reflecting the nutritional duality characteristic of TBM.

A notable finding was that mothers who rarely or never consumed processed meat, poultry, or fish containing preservatives were less likely to belong to non-TBM families

(AOR = 0.13; 95% CI: 0.02–0.95; $p = 0.043$), suggesting that this group was more prevalent among TBM families. In many developing countries, these foods can serve as affordable and accessible protein options, contributing to better energy balance and micronutrient adequacy [45]. However, it is important to note that excessive consumption of preserved products can also pose health risks due to their high sodium content and the presence of additives [26]. Therefore, the adoption of a moderate approach appears to be imperative, as both deficiency and excess can exert a detrimental influence on the nutritional status of family members.

The utilization of flavor enhancers, such as monosodium glutamate (MSG) or seasoning powder, exhibited a non-linear association with TBM. Mothers who rarely or never used MSG or seasoning powder had significantly higher odds of belonging to non-TBM families (AOR = 2.79; 95% CI: 1.04–7.48; $p = 0.041$), whereas those with moderate consumption had a significantly lower likelihood (AOR = 0.33; 95% CI: 0.15–0.73; $p = 0.006$) compared with frequent users. These results may reflect broader dietary behaviors: households that strictly avoid these additives might prioritize natural, home-prepared foods, while moderate users may represent families with more diverse food choices [46]. Conversely, frequent use may indicate a reliance on ultra-processed meals, which are characterized by high sodium content and low levels of essential nutrients [14]. This dietary pattern can contribute to an energy imbalance and the development of micronutrient deficiencies that are hallmarks of TBM.

The analysis revealed that fruit consumption emerged as a significant protective factor. Mothers who rarely or never consumed fruits or fruit-based products were significantly less likely to belong to non-TBM families (AOR = 0.19; 95% CI: 0.06–0.61; $p = 0.005$), indicating that low fruit intake was associated with a higher probability of TBM occurrence. Fruits provide vital micronutrients, fiber, and antioxidants that support immune function and prevent both nutrient deficiency and excessive weight gain [47]. This result aligns with prior global findings, thereby reinforcing the role of dietary diversity and antioxidant-rich foods in maintaining balanced nutritional outcomes across all family members [48]. A paucity of fruit consumption may result in multiple nutritional imbalances, particularly deficiencies in vitamin C, folate, and potassium, which are commonly observed in households facing double or triple forms of malnutrition [47].

Furthermore, moderate consumption of fats and oils was positively associated with being in non-TBM families (AOR = 2.94; 95% CI: 1.01–8.54; $p = 0.047$), suggesting that adequate dietary fat intake may help maintain balanced nutritional outcomes within the family. Fats play essential roles in providing energy, supporting brain function, and aiding

the absorption of fat-soluble vitamins (A, D, E, and K) [49]. However, both deficiency and overconsumption can have deleterious effects. For instance, insufficient fat intake can result in energy inadequacy and impaired vitamin absorption, while excessive intake may lead to overweight or obesity [14]. Consequently, these findings underscore the significance of preserving sufficient, though not excessive, fat intake to maintain overall nutritional equilibrium.

The results of this study demonstrate that maternal food choices and preparation practices have a substantial influence on the nutritional outcomes of families. Mothers who adhere to a balanced diet, characterized by sufficient consumption of fruits, moderate intake of fats, and limited intake of grilled or processed foods, are more likely to prevent the co-existence of undernutrition, overnutrition, and micronutrient deficiencies within their households. These findings underscore the intricate interplay between diet quality, food processing, and cooking methods in shaping household nutrition.

Conclusion

The prevalence of TBM was 4.3%. Among the maternal population, 51.4% of mothers were classified as overweight or obese, and 15% were identified as anemic. Conversely, among the child population, 16.6% were categorized as underweight, 21.3% as stunted, and 21.7% as anemic.

Complex sample logistic regression revealed significant associations between maternal dietary patterns and TBM status. Specifically, mothers who rarely or never consumed grilled or charred foods were more likely to belong to non-TBM families (AOR = 8.57; 95% CI: 1.43–51.29; $p = 0.018$), as were those with moderate consumption (AOR = 4.78; 95% CI: 1.09–20.98; $p = 0.038$). In contrast, rare consumption of meat, poultry, or fish products with preservatives (AOR = 0.13; 95% CI: 0.02–0.95; $p = 0.043$) and fruits or fruit-based products (AOR = 0.19; 95% CI: 0.06–0.61; $p = 0.005$) was associated with a higher likelihood of TBM. A non-linear association was observed for flavor enhancers, where moderate consumption was linked to lower odds of TBM (AOR = 0.33; 95% CI: 0.15–0.73; $p = 0.006$), whereas rare consumption increased the likelihood of belonging to non-TBM families (AOR = 2.79; 95% CI: 1.04–7.48; $p = 0.041$). Additionally, moderate consumption of fats and oils was positively associated with TBM risk (AOR = 2.94; 95% CI: 1.01–8.54; $p = 0.047$).

The coexistence of undernutrition, micronutrient deficiencies, and overweight/obesity within one family reflects the broader nutrition transition occurring in Indonesia — a shift toward energy-dense, low-nutrient foods amidst rapid urbanization and changing lifestyles.

Consequently, interventions must extend beyond the scope of individual-level supplementation, encompassing determinants of the food environment, including affordability, accessibility, and the dissemination of knowledge concerning healthy food options.

Limitation

It is imperative to acknowledge the limitations inherent to this study. The cross-sectional design imposes limitations on the ability to make causal inferences regarding the relationship between diet and TBM. The dietary intake data were self-reported, which introduces the possibility of recall bias. Moreover, the analysis concentrated on maternal food patterns, excluding paternal and household-level economic variables. Notwithstanding these limitations, the employment of a substantial, nationally representative dataset and complex-sample logistic regression enhances the robustness and generalizability of the findings.

Future studies should employ longitudinal and mixed method approaches to better understand causal pathways between maternal diet and intergenerational malnutrition. The exploration of the role of household food insecurity, dietary diversity, and cultural food preferences could further inform tailored nutrition interventions. The incorporation of biomarkers indicative of micronutrient status and metabolic health would serve to fortify the extant evidence base linking dietary patterns with outcomes from the triple burden of malnutrition.

Acknowledgment

The author would like to thank the Ministry of Health of the Republic of Indonesia for providing the 2023 Indonesia Health Survey dataset. This research was supported by the Indonesia Endowment Fund for Education (Lembaga Pengelola Dana Pendidikan – LPDP), Ministry of Finance of the Republic of Indonesia.

Conflict of Interest

The authors declare no conflict of interest.

References

- [1] United Nation, "The Sustainable Development Goals Report Special edition," New York, 2023. [Online]. Available: <https://unstats.un.org/sdgs/report/2023/The-Sustainable-Development->

- Goals-Report-2023.pdf.
- [2] World Bank, "Addressing The DoubleBurden of Malnutrition in ASEAN," New York, 2019. [Online]. Available: <https://documents1.worldbank.org/curated/zh/804731578325978325/pdf/Addressing-the-Double-Burden-of-Malnutrition-in-ASEAN.pdf>.
 - [3] SUN, *Scaling Up Nutrition Movement - SUN Strategy 3.0 2021-2025*. St John's Lane, London, 2020.
 - [4] WHO, *Levels and Trends in Child Malnutrition: UNICEF/WHO/The World Bank Group Joint Child Malnutrition Estimates: Key Findings of the 2023 Edition*. Geneva, Switzerland, 2023.
 - [5] B. M. Popkin, C. Corvalan, and L. M. Grummer-Strawn, "Dynamics of the double burden of malnutrition and the changing nutrition reality," *Lancet*, vol. 395, no. 10217, pp. 65–74, Jan. 2020, doi: 10.1016/S0140-6736(19)32497-3.
 - [6] Global Health Advocacy Incubator, "Marketing of unhealthy ultra-processed foods and drinks: A key driver of corporate diets," no. 1, pp. 1–11, 2022, [Online]. Available: https://assets.advocacyincubator.org/uploads/2022/08/2022_08_alert.pdf.
 - [7] Jember University with IIED, *Indonesia's triple burden of malnutrition A call for urgent policy change*. Jember, Indonesia, 2019.
 - [8] P. Kumar, S. Chauhan, R. Patel, S. Srivastava, and D. W. Bansod, "Prevalence and factors associated with triple burden of malnutrition among mother-child pairs in India: a study based on National Family Health Survey 2015–16," *BMC Public Health*, vol. 21, no. 1, p. 391, Dec. 2021, doi: 10.1186/s12889-021-10411-w.
 - [9] D. R. Sunuwar, D. R. Singh, and P. M. S. Pradhan, "Prevalence and factors associated with double and triple burden of malnutrition among mothers and children in Nepal: evidence from 2016 Nepal demographic and health survey," *BMC Public Health*, vol. 20, no. 1, p. 405, Dec. 2020, doi: 10.1186/s12889-020-8356-y.
 - [10] B. O. Ahinkorah *et al.*, "Prevalence and Factors Associated with the Triple Burden of Malnutrition among Mother-Child Pairs in Sub-Saharan Africa," *Nutrients*, vol. 13, no. 6, p. 2050, Jun. 2021, doi: 10.3390/nu13062050.
 - [11] H. Andriani, E. Friska, M. Arsyi, A. E. Sutrisno, A. Waits, and N. D. Rahmawati, "A multilevel analysis of the triple burden of malnutrition in Indonesia: trends and determinants from repeated cross-sectional surveys," *BMC Public Health*, vol. 23, no. 1, p. 1836, Sep. 2023, doi: 10.1186/s12889-023-16728-y.
 - [12] A. Tahreem *et al.*, "Impact of maternal nutritional literacy and feeding practices on the growth outcomes of children (6–23 months) in Gujranwala: a cross-sectional study," *Front. Nutr.*, vol. 11, Jan. 2025, doi: 10.3389/fnut.2024.1460200.
 - [13] H. Lee, W. Oldewage-Theron, C. Lyford, and S. Shine, "Nutrition and health challenges among low-income families of young children in the post COVID-19 era: a qualitative study," *Nutr. Res. Pract.*, vol. 17, no. 6, pp. 1185–1200, Dec. 2023, doi: 10.4162/nrp.2023.17.6.1185.
 - [14] S. Thapsuwan *et al.*, "Relationship between consumption of high fat, sugar or sodium (HFSS) food and obesity and non-communicable diseases," *BMJ Nutr. Prev. Heal.*, vol. 7, no. 1, pp. 78–87, Jun. 2024, doi: 10.1136/bmjnp-2023-000794.
 - [15] S. K. Singh *et al.*, "Cultural and Contextual Drivers of Triple Burden of Malnutrition among Children in India," *Nutrients*, vol. 15, no. 15, p. 3478, Aug. 2023, doi: 10.3390/nu15153478.
 - [16] S. J. Hardcastle and N. Blake, "Influences underlying family food choices in mothers from an economically disadvantaged community," *Eat. Behav.*, vol. 20, pp. 1–8, Jan. 2016, doi: 10.1016/j.eatbeh.2015.11.001.
 - [17] J. Kueppers, K. F. Stein, S. Groth, and I. D. Fernandez, "Maternal and child dietary intake: The role of maternal healthy-eater self-schema," *Appetite*, vol. 125, pp. 527–536, Jun. 2018, doi: 10.1016/j.appet.2018.01.014.
 - [18] Ministry of Health, "Minister of Health Regulation No. 2 of 2020 on Standards of Anthropometry for Children," Jakarta, Indonesia, 2020. [Online]. Available: [https://peraturan.bpk.go.id/Download/144762/Permenkes Nomor 2 Tahun 2020.pdf?utm_source=chatgpt.com](https://peraturan.bpk.go.id/Download/144762/Permenkes%20Nomor%20Tahun%202020.pdf?utm_source=chatgpt.com).
 - [19] Ministry of Health, "Minister of Health Regulation No. 41 of 2014 on Guidelines for Balanced Nutrition," Jakarta, Indonesia, 2014. [Online]. Available: <https://peraturan.bpk.go.id/Home/Details/138632/permenkes-no-41-tahun-2014>.
 - [20] WHO, "Guideline on haemoglobin cutoffs to define anaemia in individuals and populations." Geneva, 2024, [Online]. Available: <https://iris.who.int/bitstream/handle/10665/376196/9789240088542-eng.pdf>.
 - [21] WHO, *Accelerating anaemia reduction: a comprehensive framework for action*. Geneva, 2023.

- [22] T. Aksu and S. Unal, "Iron Deficiency Anemia in Infancy, Childhood, and Adolescence," *Turkish Arch. Pediatr.*, pp. 358–362, Jun. 2023, doi: 10.5152/TurkArchPediatr.2023.23049.
- [23] G. A. Stevens *et al.*, "Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: a systematic analysis of population-representative data," *Lancet Glob. Heal.*, vol. 1, no. 1, pp. e16–e25, Jul. 2013, doi: 10.1016/S2214-109X(13)70001-9.
- [24] J. Fanzo *et al.*, "Sustainable food systems and nutrition in the 21st century: a report from the 22nd annual Harvard Nutrition Obesity Symposium," *Am. J. Clin. Nutr.*, vol. 115, no. 1, pp. 18–33, Jan. 2022, doi: 10.1093/ajcn/nqab315.
- [25] HLPE, "High Level Panel of Experts. 2017. Nutrition and food systems," *Comm. o World Food Secur.*, vol. 44, no. September, p. 150, 2017, [Online]. Available: <http://www.fao.org/3/a-i7846e.pdf>.
- [26] Y. Yang *et al.*, "The impact of ultra-processed foods and unprocessed or minimally processed foods on the quality of life among adolescents: a longitudinal study from China," *Front. Nutr.*, vol. 11, no. November, 2024, doi: 10.3389/fnut.2024.1489067.
- [27] W. Cheung, J. Davey, W. St John, C. Bydeveltdt, and S. Forsingdal, "Health literacy of mothers accessing child development services: a model of information use," *Aust. J. Prim. Health*, vol. 22, no. 6, p. 497, 2016, doi: 10.1071/PY15021.
- [28] A. Garduño-Alanís *et al.*, "Association between soft drink, fruit juice consumption and obesity in Eastern Europe: cross-sectional and longitudinal analysis of the HAPIEE study," *J. Hum. Nutr. Diet.*, vol. 33, no. 1, pp. 66–77, Feb. 2020, doi: 10.1111/jhn.12696.
- [29] A. Kumar, P. Khanna, and A. Kumar, "Socio-economic Demographics and Anthropometric Profiling for Assessment of Nutritional Status of Rural School Age Children of 7-9 Years of Rural Kanpur District of Uttar Pradesh, India," *Agric. Assoc. Text. Chem. Crit. Rev.*, vol. 13, no. 1, pp. 621–627, Mar. 2025, doi: 10.21276/AATCCReview.2025.13.01.620.
- [30] J. M. Poti, B. Braga, and B. Qin, "Ultra-processed Food Intake and Obesity: What Really Matters for Health—Processing or Nutrient Content?," *Curr. Obes. Rep.*, vol. 6, no. 4, pp. 420–431, Dec. 2017, doi: 10.1007/s13679-017-0285-4.
- [31] B. M. Popkin and S. W. Ng, "The nutrition transition to a stage of high obesity and noncommunicable disease prevalence dominated by ultra-processed foods is not inevitable," *Obes. Rev.*, vol. 23, no. 1, Jan. 2022, doi: 10.1111/obr.13366.
- [32] K. He *et al.*, "Association of monosodium glutamate intake with overweight in Chinese adults: the INTERMAP Study," *Obesity (Silver Spring)*, vol. 16, no. 8, pp. 1875–80, Aug. 2008, doi: 10.1038/oby.2008.274.
- [33] M. Sekiyama, K. Tsuchiya, K. Roosita, and H. Matsuda, "Socioecological and Dietary Change from 2001 to 2015 in Rural West Java, Indonesia," *Hum. Ecol.*, vol. 51, no. 6, pp. 1205–1216, Dec. 2023, doi: 10.1007/s10745-023-00469-y.
- [34] L. S. Pacheco *et al.*, "Sugar-sweetened beverage intake and cardiovascular disease risk in the california teachers study," *J. Am. Heart Assoc.*, vol. 9, no. 10, 2020, doi: 10.1161/JAHA.119.014883.
- [35] K. G. Dewey, "Reducing stunting by improving maternal, infant and young child nutrition in regions such as South Asia: evidence, challenges and opportunities," *Matern. Child Nutr.*, vol. 12 Suppl 1, no. Suppl 1, pp. 27–38, May 2016, doi: 10.1111/mcn.12282.
- [36] F. Fetriyuna, D. A. Nurunnisa, R. C. Purwestri, S. M. A. Letsoin, and H. Marta, "Nutritional Composition of Underutilized Local Food Resources for Rice Substitution and Gluten-Free Product," *Int. J. Adv. Sci. Eng. Inf. Technol.*, vol. 14, no. 4, pp. 1282–1290, Aug. 2024, doi: 10.18517/ijaseit.14.4.19822.
- [37] A. Shields, N. El-Abbadi, and G. Adamkiewicz, "Environmental Impact and Nutrient Quality Assessment of the Current Diet in Surabaya, Indonesia," *Curr. Dev. Nutr.*, vol. 4, p. nzaa042_012, Jun. 2020, doi: 10.1093/cdn/nzaa042_012.
- [38] Ministry of Health, *Indonesian Health Survey 2023 in Number*. Jakarta, 2023.
- [39] M. Lewis *et al.*, "Healthy Food Prices Increased More Than the Prices of Unhealthy Options during the COVID-19 Pandemic and Concurrent Challenges to the Food System," *Int. J. Environ. Res. Public Health*, vol. 20, no. 4, p. 3146, Feb. 2023, doi: 10.3390/ijerph20043146.
- [40] E. Gibson, N. Stacey, T. C. H. Sunderland, and D. S. Adhuri, "Dietary diversity and fish consumption of mothers and their children in fisher households in Komodo District, eastern Indonesia," *PLoS One*, vol. 15, no. 4, p. e0230777, 2020, doi: 10.1371/journal.pone.0230777.
- [41] A. T. Adesogan and G. E. Dahl, "MILK Symposium Introduction: Dairy production in developing countries," *J. Dairy Sci.*, vol. 103, no. 11, pp. 9677–9680, Nov. 2020, doi: 10.3168/jds.2020-18313.
- [42] M. Nurhasan *et al.*, "Dietary transitions in Indonesia: the case of urban, rural, and forested areas," *Food Secur.*, vol. 16, no. 6, pp. 1313–1331, Dec. 2024, doi: 10.1007/s12571-024-01488-3.

- [43] A. Szypowska, K. Zatońska, A. Szuba, and B. Regulska-Ilow, "Dietary Inflammatory Index (DII)® and Metabolic Syndrome in the Selected Population of Polish Adults: Results of the PURE Poland Sub-Study," *Int. J. Environ. Res. Public Health*, vol. 20, no. 2, p. 1056, Jan. 2023, doi: 10.3390/ijerph20021056.
- [44] N. I. Ab-Latif, R. Abdullah, S. Omar, and M. Sanny, "Risk Assessment of Polycyclic Aromatic Hydrocarbons and Heterocyclic Aromatic Amines in Processed Meat, Cooked Meat and Fish-Based Products Using the Margin of Exposure Approach," *Malays. J. Med. Sci.*, vol. 31, no. 2, pp. 130–141, Apr. 2024, doi: 10.21315/mjms2024.31.2.11.
- [45] D. Yang, C. Chen, D. Zhao, and C. Li, "Impact of ultra-processed meat products on human health: Review and outlook," *J. Food Sci.*, vol. 90, no. 2, Feb. 2025, doi: 10.1111/1750-3841.70040.
- [46] L. Trasande *et al.*, "Food Additives and Child Health," *Pediatrics*, vol. 142, no. 2, Aug. 2018, doi: 10.1542/peds.2018-1410.
- [47] B. Ghose and S. Yaya, "Fruit and vegetable consumption and anemia among adult non-pregnant women: Ghana Demographic and Health Survey," *PeerJ*, vol. 6, p. e4414, Feb. 2018, doi: 10.7717/peerj.4414.
- [48] G. Grosso, "Dietary Antioxidants and Prevention of Non-Communicable Diseases," *Antioxidants*, vol. 7, no. 7, p. 94, Jul. 2018, doi: 10.3390/antiox7070094.
- [49] A. Devrim-Lanpir, L. Hill, and B. Knechtel, "Efficacy of Popular Diets Applied by Endurance Athletes on Sports Performance: Beneficial or Detrimental? A Narrative Review," *Nutrients*, vol. 13, no. 2, p. 491, Feb. 2021, doi: 10.3390/nu13020491.

Authors



Zulhadiman    is a master's student in Nutrition at the Department of Community Nutrition, Faculty of Human Ecology, IPB University, Bogor, Indonesia. He graduated with a Diploma in Nutrition from Poltekkes Kemenkes Padang (2015) and a bachelor's degree in nutrition along with Dietitian Professional Certification from Universitas Brawijaya. He has professional experience working through the Nusantara Sehat Program (2015–2019) at Pulau Tello and Tanjung Makmur Health Centers. (email: nutrudazulhadiman@apps.ipb.ac.id).



Dodik Briawan    is a leading Indonesian nutrition expert and professor at the Department of Community Nutrition, Faculty of Human Ecology, IPB University, Indonesia. His research focuses on nutrition epidemiology, micronutrient deficiencies, anemia, stunting, and dietary patterns. He also serves as Vice Dean for Resources, Collaboration, and Development at Faculty of Human Ecology, IPB University. (email: dbriawan@apps.ipb.ac.id).



Ikeu Ekayanti    is a lecturer at the Department of Community Nutrition, Faculty of Human Ecology, IPB University, Bogor, Indonesia. Her expertise encompasses public nutrition and health, with a focus on nutrition assessment, nutritional epidemiology, and applied nutrition. Her work aims to address public health issues through evidence-based interventions and community-based nutrition strategies. (email: ikeuek@apps.ipb.ac.id).