Media Gizi Indonesia
(National Nutrition Journal)

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.

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 provides both original research and literature review in the field of nutrition. To date, child and adolescent nutrition has become priority because a good nutritional status in that period will manifest a better quality of life during adulthood and elderly period. For that, this current edition of MGI presents several best research related to child and adolescent nutrition in relation to stunting, preschool children development, and dietary intervention. Besides presenting studies related to child and adolescent nutrition, the current edition of MGI also shows research in food product development to prevent degenerative diseases. More interestingly, this edition also publishes studies related to food waste and diet quality.

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

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MULTIDIMENSIONAL ANALYSIS OF CHANGING EATING HABITS: UNDERSTANDING THE COFFEE SHOP PHENOMENON IN INDONESIA

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ABSTRACT

Globalization and technological development have led to changes in lifestyles, including eating habits such as coffee consumption. The proliferation of cafes is evidence that coffee consumption has become a trend among adolescents and young adults who are exhibiting shift toward unhealthy eating patterns, such as consuming of high-sugar coffee. This study aims to analyse changes in eating habits in adults based on the theory of A Multidimensional Approach to the Study of Food Habits. This study used a systematic review using PRISMA method. Articles were sourced from two databases, Scopus and Google Scholar covering the past 8 years (2016-2024) with a total of 18 articles reviewed. The results showed that culture, ideology, food consumption, and preferences significantly influence coffee consumption habits. In Indonesia coffee culture not only about taste, but also involves social interaction, self-identity, and self-expression. Additionally, it was influenced by access, habits, needs, psychological factors, culture, and health. Coffee selection preferences were shaped by technological and socioeconomic factors including (promotions, discounts, employment, and income). This study provides insights into the factors influencing changes in eating habits, particularly coffee consumption, and can inform the development of effective interventions to promote healthy eating habits in this age group.

Keywords— *food habits, coffee consumption, café phenomenology, adult, coffee shop*

INTRODUCTION

The development of civilization necessitates globalization, which impacts all aspects of life. Indonesia is one of the countries affected by globalization. This process, often unintentional, breaks down barriers between nations, allowing foreign cultures to be more easily accepted in Indonesia, leading to cultural acculturation. This phenomenon is not limited to a single aspect but spans various areas, including language, art, fashion, music, and eating habits. Food from different regions is now easily accessible within local communities (Ayudya & Nurfaizah, 2022). This shift is driven by technological and economic advancements brought about by globalization (Wiradijaya et al., 2020).

Economic development is a goal pursued by every country, as it enhances the overall economy. This progress can be measured by increased production of goods and services. The trade sector is closely tied to this growth, with the culinary industry- particularly cafes and restaurants- being one of the most popular areas. The proliferation of cafes and restaurant businesses is further supported by government initiatives aimed at empowering Micro, Small, and Medium Enterprises (MSMEs) (Putra et al., 2020). Additionally, technological advancements have played a crucial role in enhancing business services. For instance, the rise of platforms that effectively disseminate information, especially regarding specific food trends has been instrumental (Br Jabat et al., 2022). As of now, with a consumer base of 3.97 million, MSMEs also leverage online platforms for marketing and distributing their products (Yuliani & Riadi, 2019).

Factors such as marketing and distribution activities, nutrition and health education, and support from cultural and natural environmental factors can influence change in eating habits. Peer-group dynamics also significantly contribute to evolving eating behaviours in this era. However, changes in eating habits that occur over a long period tend to become ingrained as long-term habits (Suhada et al., 2019).

Eating habits that are performed repeatedly become ingrained as habit, and these individual eating habits, influenced by several factors, can develop into established eating behaviour. According to Sanjur (1982) Theory of A Multidimensional Approach to the Study of Food Habits, there are four key aspects influencing eating habits: food consumption, preferences, ideology, and social culture. Food consumption refers to the type and composition of foods commonly consumed in daily life. Preferences are based on individual likes or dislikes regarding certain foods or eating practices. Ideology encompasses societal beliefs about food, such as taboo or beliefs regarding the health impacts of specific foods. Social culture includes factors that shape societal eating habits such as education, employment, and cultural practices (Suhaimi, 2019).

The late teenage to early adulthood period is a transitional phase where significant lifestyle and dietary changes often occur. During this period, eating patterns may shift towards unhealthy behaviours, such as consuming high-sugar coffee, which can lead to weight gain and other cardiometabolic risk factors. If these poor habits are not addressed and prevented, they may persist into adulthood, increasing the risk of non-communicable diseases later in life (Gherasim et al., 2020).

According to research by (Utami et al., 2023), coffee consumption is closely related to an individual's nutritional status. Excessive coffee consumption, particularly coffee with high sugar content, has negative effects and can contribute to increase the risk of central obesity, those consuming 3 cups per day have a 2.52 times higher risk of obesity. The wide variety of coffee drinks available, many of which are high in sugar and creamer, contributes to the rising prevalence of obesity (Lee et al., 2019).

While coffee consumption has some positive health associations -such as a reduced risk of Parkinson's disease and type-2 diabetes due to caffeine- it also has negative implications, including an increased risk of miscarriage. Additionally, coffee is linked to increased serum lipid levels, though these results are significantly influenced by study heterogeneity, and caffeine is associated with elevated blood pressure (Grosso et al., 2017),

However, common habits among late teenagers and early adults involve preferring high-calorie foods and high-sugar coffee, which increase the risk of obesity. Consequently, coffee consumption can be a negative factor for overall health, particularly by rising the risk of non-communicable diseases (Lee et al., 2019). Research by Putri (2022) indicates that teenagers with a preference for high-sugar coffee are more often found in the obese group. Excessive sugar consumption over a long period can lead to malnutrition, with many of these coffee drink contains 30-40 gram of sugar per cup.

In modern times, places for socializing, or ('nongkrong') have become more diverse and selective. The millennial generation, in particular, has specific preferences for the cafes they choose. Cafes have begun to appear in various locations, from city centers to rural (Hasibuan, 2023). Modern cafes offer attractive spaces with clean, well-maintained facilities, emphasizing customer satisfaction. They provide a variety of amenities, such as contemporary decor, free internet access, and excellent service. Drinking coffee or hanging out at cafes has become a necessary activity for teenagers (Sudarman, 2023). The modern cafe phenomenon reflects globalization and the spread of consumerism in both urban and rural areas. Cafes are often referred to as the "third place" after "home" and "work." According to Oldenburg, "third place" as a neutral public place where people can gather, interact, and enjoy their surroundings (Oldenburg in Lukito & Xenia, 2018).

The preference for cafes in hangout culture also reflects social class and function as form of social capital, which is an advantage gained from the cultural practices. The principle underlying social capital includes assets like the social structure of 'nongkrong' itself (Cooleman in Sudarman, 2023), along with the selection of preferences as another type of asset. Social spaces such as malls, junk food restaurants, game zones, or cafes are places where young people build new lifestyles, with their style. Within these spaces, they find their identity and assert their social class. Thus, the culture of hanging out will continue to be relevant in community life.

Coffee production offers the opportunity to make coffee not just a drink, but also a lifestyle. This makes the coffee business a promising

venture due to the high coffee consumption in Indonesia. According to MIX MarComm magazine (Judawinata, 2023) the number of cafes in Indonesia as of August 2019 exceeded 2,950 outlets, almost three times the number in 2016, which was only 1,000 outlets. This number has the potential to continue increasing because the census only covers major cities, excluding independent coffee shops, modern coffee shops, and traditional coffee shops areas.

With the rapid development of cafes, it is no wonder that drinking coffee has become part of the trend and culture in Indonesian society. National coffee consumption has increased significantly. In 2016, Indonesia coffee consumption reached 249.8 thousand tons, in 2019 it increased to 335.5 thousand tons, and it peaked in 2021 at 369.9 thousand tons. Coffee is not only a commodity but also part of the lifestyle. There is also the trend of third-wave coffee, from the first wave (instant coffee era), second wave (modern coffee era), to the third wave (specialty coffee era). The coffee business is also booming due to the high production of coffee farmers in Indonesia (Safitri & Anna, 2022). Based on the data and phenomena, this article will analyse changes in eating habits in adults based on aspects of the theory of A Multidimensional Approach to Study of Food Habits.

METHODS

The method used in this study is a systematic review using the PRISMA (Moher et al., 2009) for the theory of A Multidimensional Approach to the Study of Food Habits. This review includes comprehensive summary involving the analysis and synthesis of literature from journals, articles, books, and other relevant sources, with the inclusion criteria being journal literature from the past 8 years. Through desk research, literature will be collected and analysed using keywords such

as dietary behaviour, food habits, coffee shops, food consumption, preferences, social and cultural factors, ideology, changes in contemporary coffee consumption, cafe phenomenology, and cultural shift. The literature may include previous research findings, literature reviews, relevant theories, and expert opinions from related fields. The systematic steps in the preparation of this literature study can be described as follows:
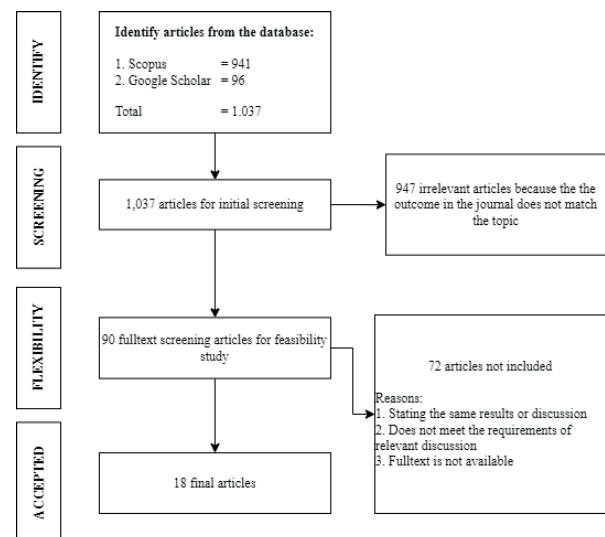
Figure 1. Literature Study Scheme.

Relevant journals were sorted and summarized before being tabulated. The journal summary results were analyzed for each journal before citing and drawing conclusions.

RESULTS AND DISCUSSIONS

Based on the screening results and journal reviews, a total of 18 relevant journals were identified that explain 4 aspects of the related theory. Additionally, bibliometric features indicate that there is one aspect most frequently discussed in the articles/journals, which is the aspect of food preference. Below is the Table summarizing the articles/journals.

Tabel 1. Literatur Review

No	Study references	Study design	Characteristic of subject	Location	Methods	Study purpose	Result
1	(Ridaryanthi et al., 2022)	Qualitative Study	Millennial Age 23 subjects	Indonesia	Qualitative (Focus Group Discussion)	Understanding How millennials, as coffee consumers, construct and share the significance of coffee consumption through their social interactions and communicative practices.	Culture plays a crucial role in determining how millennials consume coffee. For them, coffee consumption is not just a daily ritual but a social activity that fosters interaction, communication, and community building. Coffee also serves as a symbol of identity and self-expression for millennials.
2	(Allafi et al., 2020)	Cross-sectional Study	1483 participants aged between 18 and 35 years	Kuwait	Online Questionnaire	To examine how cultural factors and gender roles shape coffee consumption patterns in Kuwait capital.	This study reveals a high level of interest in coffee among young people. Coffee is often enjoyed socially with friends or family, reinforcing its role as a beverage that enhances social connections and coffee-drinking habits.
3	(Purnomo et al., 2021)	Qualitative Descriptive	Middle-class individuals	Indonesia	In-depth Interviews	To assess the impact of Starbucks presence on traditional Indonesian coffee practices, with a focus on middle-income consumers.	The coffee culture in Indonesia is evolving and adapting to global influences. It possesses unique characteristics distinct from Western coffee culture, often emphasizing social and community aspects. In Indonesia, coffee is frequently consumed in social setting with friends and family, serving as a medium for connection and interaction.
4	(Rachmawati et al., 2021)	Qualitative descriptive	Adolescents 10-24 years.	Malang	In-depth Interviews	Exploring how teenagers in Malang use coffee outings as a means to reduce and manage their stress levels.	An individual ideology can significantly impact their lifestyle, including consumption habits. Ideological factors related to coffee consumption often involve beliefs about its benefits, such as its stimulating effects that enhance alertness, focus, and energy. People who hold these beliefs are more likely to consume coffee regularly.
5	(Stachyshyn, et al., 2021)	Cross-sectional Study	317 tertiary students 16 years or older (≥16 years)	New Zealand	Online Questionnaire	To explore New Zealanders patterns of use and reasons for consuming various caffeine-containing substances, encompassing hot beverages, cocoa products, and alcohol.	Ideological, social, and cultural factors can influence coffee-drinking habits. Coffee is primary consume due to beliefs about its functional effects, such as increased awareness and energy. It is often enjoyed achieving specific goals, such as completing work or studying.
6	(Stachyshyn, et al., 2021)	Cross-sectional Study	317 tertiary students 16 years or older (≥16 years)	New Zealand	CaffCo Questionnaire	Examining caffeine intake patterns among university students in New Zealand.	The increase in the number and availability of caffeinated products makes it easier for students to access and consume coffee. Coffee is a primary source of caffeine for students, who regularly consume caffeinated products. Coffee consumption habits are influenced by the ideology or beliefs regarding the benefits of coffee.

No	Study references	Study design	Characteristic of subject	Location	Methods	Study purpose	Result
7	(Nicolopoulos et al., 2020)	Cohort	Total participants: 333,214	United kingdom	Interviews	Investigating the causal relationship between genetically-influenced coffee drinking habits and overall health outcomes.	Coffee is more commonly consumed by men than by women, with consumption patterns also influenced by various factors such as BMI, smoking, alcohol intake, tea consumption, physical activity, education, health status, and chronic diseases. There is a causal relationship between coffee consumption habits and an increased risk of osteoporosis, arthropathy, and obesity
8	(Zhou et al., 2022)	Cross-sectional study	Aged 18-35 years. Total participants: 49,648	China	Interviews	Assessing dietary variety and its influencing factors among young adults in central China.	About 78.3% of subjects reported a lack of dietary diversity, and 0.9% reported adequate dietary diversity. Preferences for snack consumption and regular eating, including coffee consumption, were more likely to be associated with sufficient dietary diversity.
9	(Shih et al., 2019)	Cross-sectional Study	Aged 13-19 years. Total participants: 2,513.	Taiwan	Secondary Data from the 1993-2011 Nutrition and Health Survey (NAHSIT).	To determine the relationship between energy intake from sugar-sweetened beverages (SSBs) and biomarkers as well as nutritional intake among adolescents.	Coffee consumption increased significantly over the 18 years of the study. More than 50% of adolescents consumed coffee or tea in 2010-2011. High intake of SSBs (Sugar-Sweetened Beverages), coffee, or tea was associated with high uric acid levels and poor diet quality.
10	(Khasanah & Safilah, 2023)	Cross-sectional	Total subjects 95 peoples	Indonesia	Interviews	To analyze the relationship of coffee consumption and sleep quality with nutritional status in adolescents in Jagakarsa urban village, South Jakarta.	The quantity of coffee consumption was 1-2 cups a day, 95%. Most of them are instant coffee types that contain about 15-20 gram of sugar, this type of coffee can lead to the possibility of obesity.
11	(Sawitri & Yuziani, 2021)	Cross-sectional	Total subjects 60 peoples	Indonesia	Interviews	Knowing the relationship between gender and coffee drinking habits in college students	57.1% of the students consumed coffee more than three times a week and most of them were male compared to 15.4% female. Young adult males are at risk for hypertension, CHD, gastritis, and insomnia due to their coffee-drinking habits.
12	(Widodo & Lontoh, 2023)	Observasional deskriptif	Young adult age. Coffee shop customers in East Jakarta	Indonesia	Interviews	To find out the description of the consumption of specialty coffee drinks for consumers in the young adult age category in coffee shops in the East Jakarta area.	A total of 63.3% of subjects had a preference for drinking coffee. The most popular type of coffee drink is milk coffee with a consumption frequency of 3-6 cups per week.

No	Study references	Study design	Characteristic of subject	Location	Methods	Study purpose	Result
13	(Utomo et al., 2023)	Pendekatan Kuantitatif	Total subjects 162 people aged 12-27 years	Indonesia (Malang)	Questionnaire	Exploring how technology, particularly digital marketing and service quality, shapes café preferences in Malang, Indonesia.	Technological factors, such as digital marketing, provision of tools, easy access to pay have a significant effect on customer preferences for hanging out in cafes with a significance level of 0.05. Similarly, the service quality variable has a positive effect on coffee shop consumer preferences with an ρ value of 0.000, namely the effect of service quality on consumer preferences is statistically significant.
14	(Grzegorz & Mokrysz, 2019)	Desk Research, deductive inference and comparative method	Euromonitor International research institute data top 10 global consumer trends 2019. Product trend data on 2018-2019 institutions.	Global	Secondary Data	Presents consumption trends, as well as factors that currently influence or will influence coffee consumer behavior in the next 2-5 years.	Digitalization, urbanization, and development are growing and will continue to grow. This makes the habit of consuming coffee in cafes grow rapidly due to certain trends that influence food preferences in consumers such as delicious coffee flavors, ease of access with features, branding, upgrades, coffee packaging served with ready-to-drink methods, and facilities.
15	(Sunarharum et al., 2021)		Coffee community consisting of coffee consumers, coffee farmers, baristas, Q-graders certified by CQI.	Indonesia	Online Survey	This study aims to determine Indonesian coffee consumers' perceptions of coffee, its quality and influence on consumption behavior.	There was a statistically significant difference (α = 0.05) between the two groups of consumers in terms of their motivations for coffee consumption. Both experienced and inexperienced consumers reported consuming coffee primarily due to its taste and sensation, as well as promotional activities, discounts, and social factors such as networking and peer interactions.
16	(Utami et al., 2023)	SOR theory and using the AISAS approach	Consumers who habitually drink coffee at least 1x/ week. Total sample size 420.	Indonesia	Online Questionnaire	Identifying current and future trends in coffee consumption behavior, with a focus on influential factors over the next 2-5 years.	Coffee consumption is significantly influenced by sensory appeal, lifestyle, and health motives. Sensory appeal positively affects attitudes and behaviors, while lifestyle positively impacts attitudes, information seeking, and behavior. Health motives positively influence attitudes. Lifestyle factors have the greatest influence.
17	(Yahya et al., 2022)	Cross-sectional	385 male and female respondents aged 18-40 years who consume coffee	Malaysia	Online Survey	Assessing Indonesian coffee drinkers perceptions of coffee, its quality, and how these views influence consumption habits.	Factors influencing coffee food preference in consumers are age with a p-value <0.05. In addition, the factor that has a fairly high Pearson Correlation value with a value of 0.747 is the socioeconomic status or type of work, as well as the income aspect with a value of 0.675.
18	(Michael & Abdul, 2022)	Descriptive Qualitative	10 representatives of visitors and cafe owners	Indonesia	Observational	Looking at consumers views and expressions of cafes as part of a lifestyle.	Peers, prestige, and overcoming boredom are the main reasons for having a habit of hanging out in cafes.

Culture of Coffee Consumption

Culture plays a significant role in determining how millennials consume coffee. The coffee consumption habits of the millennial community in Indonesia are built and shared through their interactions and communication with others, based on their individual experiences and social contexts. For millennials, coffee culture is both a personal and social construct. The personal meaning of drinking coffee is related to individual experiences and the desire for self-expression, while the social meaning is related to the values and norms adopted by the millennial community (Ridaryanthi et al., 2022).

The culture of coffee consumption in Indonesia continues to evolve and adapt to global influences. The local coffee culture in Indonesia may focus more on social and community aspects, with drinking coffee with friends and family as a way to connect and socialize. The Indonesian coffee culture has unique characteristics that differ from Western coffee cultures, such as Starbucks. Social culture plays a significant role in determining an individual coffee consumption habits. While the local Indonesian coffee culture has not been entirely replaced by Western influences, it has adopted certains elements, such as new coffee processing and presentation techniques. However, it still maintains its own values and traditions, particularly its emphasis on social and community aspects (Purnomo et al., 2021).

Western culture that brings coffee consumption habits is not only increasing in Indonesia. The rise of coffee consumption in Kuwait, as shown by research (Allafi et al., 2020) indicates that coffee can become a social beverage enjoyed with friends or family, thus forming a coffee culture that makes coffee a shared drink. Culture also shapes the image of coffee as part of modern or trendy lifestyle, but this habit can also have negative effects when individuals do not consider the nutritional content of each consumption.

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Ideology of Coffee Consumption

Ideology and belief can be significant factors in coffee consumption habits. Individuals who subscribe to an ideology that emphasizes hard work and productivity may be more inclined to consume coffee to enhance their performance. An individual ideology can influence their lifestyle, including their consumption habits. The ideological factor in coffee consumption is related to their belief in the benefits of coffee, such as its stimulating effects, based on their experiences when consuming. Therefore, those who adhere to this belief tend to consume coffee more frequently (Rachmawati et al., 2021). Ideological, social, and cultural factors can influence coffee consumption habits. Coffee consumption can become part of a culture and social tradition, for example, drinking coffee with friends can be a way to build relationships and strengthen a sense of community. According to research (Stachyshyn, et al., 2021) the primary reason for coffee consumption is its functional effects, such as increasing awareness and energy. This shows that coffee is often consumed to achieve specific goals, such as completing work or studying, alongside hedonic motivations like taste and comfort, which are also important factors in coffee consumption. Thus, ideology and beliefs

play a significant role in coffee consumption (Stachyshyn, et al., 2021).

The coffee consumption habits of university students in New Zealand are influenced by various factors, including the availability and accessibility of caffeinated products, personal habits and preferences, academic needs and demands, psychological and emotional factors, cultural and social factors, and health considerations. Regular coffee consumption is a strong determinant of coffee consumption habits, with 99.1% of tertiary students in New Zealand regularly consuming caffeinated products. Preferences for taste and desired effects of caffeine (such as alertness and cognitive benefits) also influence coffee consumption habits. Students often have busy schedules and high academic demands, which contribute to increased coffee consumption (Stachyshyn, et al., 2021).

Coffee Consumption

Based on the article review, two articles state that coffee is more commonly consumed by men than women. The long-term effects of coffee consumption habits can increase the risk of certain diseases. According to research by (Nicolopoulos et al., 2020) consuming more than 6 cups of coffee per day can increase the risk of osteoarthritis and arthropathy. Additionally, coffee consumption can be linked to obesity if there is a genetic predisposition. This is supported by research from (Khasanah & Safilah, 2023), which state that most coffee contains 15-20 gram of sugar, contributing to the risk of obesity.

Among university students, coffee is a trendsetter and has a unique appeal for them during their free time, whether they are working on assignments or engaging in discussion. Approximately 57.1% of students consume coffee more than three times a week, and most of them are male. Consequently, young adult men have a higher risk of developing hypertension, coronary heart disease, gastritis, and insomnia due to their coffee consumption habits (Sawitri & Yuziani, 2021).

Coffee consumption has significantly increased over the past 18 years. More than 50% of teenagers currently consume coffee or tea. High consumption of sugar-sweetened beverages (SSBs), including coffee and tea, has been linked to high uric acid levels and poor dietary quality. This also affects BMI (body mass index) and WC (waist circumference) and can reduce the quality of food intake. High consumption of simple carbohydrates like coffee or tea has been found to increase, while protein and phosphorus intake decreases (Shih et al., 2019).

Preference for Coffee Selection

Indonesia holds a strong position as one of the world leading coffee producers, with production increasing by 11% to 794,800 tons in 2022. It is estimated that the Indonesian population consumes at least 2.5 cups of coffee per person per day. This is not a sudden occurrence; there are specific reasons why people choose to consume coffee and make it a habit. These reasons are referred to as food preferences.

Based on the analysis using PRISMA, food preferences are the most frequently studied aspect among the four dimensions of the Multidimensional Approach. However, the results show that food preferences are more related to technology and socioeconomic aspects. According to (Choedon & Lee, 2020), caffeine from coffee can refresh a tired body and enhance physical performance, particularly for the brain. Additionally, socializing at cafes increases social relationships (Choedon & Lee, 2020). This has led to an increase in coffee demand at cafes, prompting cafe owners to consider plans to make their establishments more comfortable and increase their income.

According to Utomo et al. (2023), digital marketing and easy payment features through apps have significantly influenced coffee preferences among consumers. This provides convenience without limiting consumers to cash-only payments. Technology continues to evolve, and access to coffee is no longer limited to cafes; it can be ordered from anywhere. There are now specific apps for coffee brands, allowing customers to order without going through the cashier (Grzegorz & Mokrysz, 2019). Research by Sunarharum et al. (2021) examined the factors influencing coffee enthusiasts at cafes, including both experienced and new customers. The results showed that there are differences in coffee taste produced by cafes using specific coffee machines compared to those using standard machines.

It is not just technology; coffee preferences among consumers are also influenced by socioeconomic aspects. According to research by (Sunarharum et al., 2021) and (Utami et al., 2023) based on survey results, consumers choose to socialize and consume coffee at cafes due to promotional offers and social influences from friends or social environments, making them more frequent visitors to cafes. Additionally, the desire to expand social networks and the influence of friends or social environments have been significant factors.

Furthermore, work and income levels affect consumers purchasing intentions for any product or service. This aligns with descriptive statistical findings in research by (Yahya et al., 2022) which show that respondents agree that they seek high-quality coffee based on their work. Income levels are another factor that may influence consumption patterns in their study of variables affecting consumer behavior (Njigua, 2018).

Besides these factors, research by (Michael & Rahman, 2022) shows that social status and the desire not to be left behind by others in their environment are also significant. Other reasons include the availability of Wi-Fi, which makes the experience more comfortable, and the intention to show off their class or status to their surroundings (Michael & Rahman, 2022).

CONCLUSION

The phenomenon of changing consumption habits among Indonesian society, particularly among young people, is driven by globalization and related aspects such as food consumption, ideology, culture, and food preferences. Based on a review of various journals, it was found that these four aspects influence changes in food consumption habits, particularly coffee consumption in the current era. Changes in food preferences occur due to the development of technology, which makes accessing coffee easier, improved service and facilities at cafes, and other socioeconomic factors such as work, income, and social influences. The increase in coffee consumption is based on the ideology or belief that coffee provides certain pleasures or relaxation, such as increase focus, energy, and alertness, even though consumers are aware that long-term consumption can have negative effects. From a cultural perspective, coffee consumption can serve as a bonding experience among peers.

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PHYSICAL BEHAVIOURS IN ADOLESCENTS THAT CONTRIBUTE TO OVERWEIGHT/OBESITY

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ABSTRACT

Physical behaviours research in adolescents is still limiting in regard of overweight/obesity. Physical behaviour according to World Health Organization Global School Student Health Survey (WHO-GSHS) had four components namely physical activity, active transportation, physical education and sedentary behaviour showed inconsistent results investigating the obesity/overweight epidemic. The objective of this study is to examine the physical behaviour and metabolic components in overweight/obese adolescents. A cross-sectional study was conducted from September to October 2019 involving healthy obese adolescents with overweight/obesity in Sidoarjo and Surabaya. The statistical analysis was test of normality for interval/ratio variables, descriptive, bivariate correlation and binary logistic regression. All the analysis were conducted using SPSS ver. 21 (IBM, US). A total of 109 subjects were recruited in this study, consisting of male (50.46%) and female (49.54%) adolescents. The mean age of the subjects were 15.13 + 1.46 years old. Adolescents with sufficient physical activity, physical transport, physical class and recommended screen time was 93.58%, 23.85%, 14.68% and 36.70% respectively. The overweight subjects were 63 (57.80%) and obesity was 46 (42.20%), and prevalent in male than female (65.22% vs. 34.78%, p=0.012). The prevalent of MetS was 53.21%, no significant difference of MetS distribution among male and female (p=0.506). Subjects with physically transport behaviour had lower risk of abdominal obesity by 0.266-times than subjects with physically immobile. Thus, physical behaviour score did not correlate with anthropometric parameters indicating to overweight/ obesity and metabolic factors, but the component of physical behaviour, especially sedentary lifestyle correlated with anthropometric parameters and systolic blood pressure. Physical transport protected the adolescents to the present of abdominal obesity.

Keywords: *Adolescents, Overweight, Physical Behaviour, Metabolic Syndrome*

INTRODUCTION

Physical activity research in adolescents is still limiting in educational setting (Sluijs et al., 2022). Adolescents is a very important developmental stage in human life (Rahman, 2019), in which they experiences various changes physically and psychologically (Arruda et al., 2020), as it was a transitional stage from childhood to adulthood (Kanthi and Johnson, 2021). Adolescents are facing the health and health-related behaviour (Salam et al., 2016), such as unhealthy diet, smoking, and physical inactivity (Dang et al., 2022), sexual abuse and practices (Banvard-Fox et al., 2020), drugs and alcohol abuse (Shau and Zhou, 2022), mental health issue (Nebhinani and Jain, 2019), and many more, in which affecting their health in the future.

Adolescents also predicted to live under triple burden of health problems, including non-communicable disease (NCD) (Akseer et al., 2020), which was caused by the wrong food consumption and inactive physically (Biswas et al., 2022; Uddin et al., 2020a). Physical activity has been a health concern nowadays as more than 80% of adolescents had physical inactivity accompanied with longer screen time or sedentary life (Sluijs et al., 2022). Xu et al. (2020) using World Health Organization-Global School Student Health Survey (WHO-GSHS) describe physical behaviour as the four components namely physical activity, active transportation, physical education and sedentary behaviour, and only 6.6% of adolescents had combined those physical behaviour globally (Xu et al., 2020). It was stated that physical activity

and sedentary behaviour are the two important of physical behaviour components corelated with the later health outcome (Burahmah et al., 2023), and only 14.9% adolescents met the sufficient physical activity guideline, 16.5% attending sufficient physical education classes (Zhan et al., 2021), and screen time for more than 2 h/day was increased globally (Peltzer and Pengpid, 2016). A study conducted in high school adolescents noted the prevalent of unrecommended screen time was 79.5%, and higher in males than females (84.3% vs. 76.1%, p=0.000), and the prevalent was higher in the highest economic class (De Lucena et al., 2015).

Physical activity has been correlated to the rise prevalent of obesity globally (Koliaki et al., 2023; Raiman et al., 2023) and cardiometabolic event, but the evidence is limited (Sluijs et al., 2022). The rise of obesity prevalent leads to the increase of chronic NCD burden, and remain a challenge for public health (Özdemir, 2015), as NCD is one of the causes of premature death (Pham et al., 2022). Obesity during adolescents could be used as the best predictor for adult obesity (Simmonds et al., 2016), as this period is one of three critical period which is classified by Dietz and Gortmaker (2001): prenatal, adiposity rebound and adolescence period (Dietz and Gortmaker, 2001). Obesity is caused by the energy imbalance in which the increased calorie intake not accompanied by increased calorie expenditure (Grace et al., 2022), due to insufficient physical activity (Kaul et al., 2023) and longer screen time (Pitanga et al., 2019). Here we conduct a study to examine the physical behaviour and metabolic components in overweight/obese adolescents.

METHODS

A cross-sectional study was conducted during September to October 2019 involving healthy obese adolescents with overweight/obesity to access the effect of physical activity on anthropometric and metabolic parameters, including MetS. The population was adolescents whom study in Sidoarjo and Surabaya aged 12-18 years old. The school inviting this study was chosen using a simple random sampling according to the information we got from Education and Cultural Department. The inclusion criteria were: willing to take part in the study by signing inform consent (parents). The subjects were excluded when they: consumed corticosteroid during 6 months before the study were conducted, underwent dyslipidemia medication for 3 months before the study were conducted, had antibiotic medication or hormonal therapy, smoking, consume alcohol or drugs, had infectious or autoimmune diseases, or had endocrine disorders and chronic disease such as CVD.

Anthropometric measurements including body height (seca 213), weight (seca robusta 815), waist circumference (seca 201), and hip circumference (seca 201). The anthropometric measurements were conduct when the subjects wear light clothes with no accessories. Blood was collected after the subjects fasted for 10-12 hours and the blood was stored in EDTA tubes and processed within 2 hours after blood sampling or stored at -80 degrees and then transported to the selected laboratory responsible for epidemiological study. Blood pressure was assessed in a sitting position **using** a digital tensimeter (Omron HEM 7140T). Obesity assessment was based on BMI-for-age z-score as design by WHO using WHO Anthroplus (offline version, WHO), overweight was determined when BMI-for-age z-score $\geq$ + 2.00 to + 3.00 SD, and obesity was determined $\geq$ +3 SD.

MetS was determined using the International Diabetes Foundation (IDF) criteria, abdominal obesity (waist circumference $\geq$ 90th percentile) accompanied by at least two other signs, namely: hypertriglyceridemia (triglyceride levels $\geq$ 110 mg/dL for adolescents aged < 16 years old, and $\geq$ 150 mg/dL for adolescents < 16 years old), hyperglycaemia (fasting blood glucose or FBG levels $\geq$ 100 mg/dL for adolescents $\geq$ 16 years old and $\geq$ 110 mg/dL for adolescents $\geq$ 16 years old), hypertension (systolic blood pressure $\geq$ 130 mmHg or diastolic blood pressure $\geq$ 85 mmHg), and low level HDL-c (HDL-c levels < 40 mg/dL for adolescents < 16 years old and HDL-c < 50 mg/dL for adolescents $\geq$ 16 years old) (Magge et al., 2017; Zimmet et al., 2007).

According to the World Health Organization-Global School Student Health Survey (WHO-GSHS), physical behaviour comprised of 4 major categories, namely: physical activity, active

transportation, physical education and sedentary behaviour (Xu et al., 2020). Physical activity, the adolescents with the physical activity at least 1 h/day was categorised as physically active, weight as 1 (Pechtl et al., 2022). Active transport, the adolescents with at least 3 day of walking or bicycling to or from the school were categorised as active transport, weight as 1 (Liu et al., 2021; Xu et al., 2020). Physical education, the adolescents were categories as physical education when they attending the physical education class for 5 or more days, scores as 1 (Zhan et al., 2021). Sedentary behaviour was described as spending screen time for more than 3 h/day (Pechtl et al., 2022; Starks et al., 2023; Xu et al., 2020).

The study has been obtaining the ethical approval number 1360/KEPK/VII/2019, approved by the Health Research Ethics Committee of Dr. Soetomo Referral Hospital at July 31st, 2019. The statistical analysis was test of normality for interval/ ratio variables, descriptive analysis (presented as percentage and mean value), bivariate correlation and binary logistic regression. All the analysis were conducted using SPSS ver. 21 (IBM, US).

RESULTS AND DISCUSSION

A total of 104 adolescents were conclude this study. The prevalent of physical behaviour was summarized in **table 1**.

Adolescents with sufficient physical activity, physical transport, physical class and recommended screen time was 93.58%, 23.85%, 14.68% and 36.70% respectively. Those four aspects are the most often behaviour that contributing in preventing NCD, with the prevalent of physically active was 30.43% in other study. The prevalent of physically inactive in adolescents ranged from 2.3% to 93.5%, and more prevalent in girls. Sedentary behaviour, which marked with screen time activity, also had a high prevalent, with more than 50% (Filho et al., 2014). The prevalent of physical education ranged from 16.5% to 24.2% (Uddin et al., 2020b; Zhan et al., 2021), while physical transport ranged from 37.0% to 41.9% (Aguilar-Farias et al., 2018; Liu et al., 2021).

The adolescents perception on regard of physical behaviour was a sex-related (Aguilar-Farias et al., 2018) and age-related (Salvo et al.,

Table 1. Adolescent physical behaviour based on WHO GSHS

Variables	n	%
Physical activity for at least 60 min/day in a week		
None (0 day)	7	6.7
1 day	32	30.8
2 days	25	24.0
3 days	14	13.5
4 days	9	8.7
5 days	7	6.7
6 days	6	5.8
7 days	9	8.7
Physical transport (bicycle or walking) in a week		
None (0 day)	71	68.3
1 day	7	6.7
2 days	5	4.8
3 days	5	4.8
4 days	5	4.8
5 days	4	3.8
6 days	4	3.8
7 days	8	7.7
Physical education class in a week		
None (0 day)	8	7.7
1 day	65	62.5
2 days	7	6.7
3 days	8	7.7
4 days	5	48
More than 5 days	15	14.4
Screen time during a day		
Less than an h/day	11	10.6
1-2 h/day	29	27.9
3-4 h/day	39	37.5
5-6 h/day	18	17.3
7-8 h/day	6	5.8
More than 8 h/day	6	5.8

2020), especially in physical activity aspects (Aguilar-Farias et al., 2020). Other found that sedentary behaviour was related with age and gender specific, with being female as the risk factor of this behaviour (Aguilar-Farias et al., 2020). Adolescents are one of important stage of life which need to be concerned as their behaviour pattern and habituation may attribute to the next health issues such as NCD (type 2 diabetes, cardiovascular disease, cancer and obesity) (Akseer et al., 2020)

Table 2 summarized the subject characteristics. The overweight subjects were 63 (57.80%) and obesity was 46 (42.20%), and prevalent in male than female (65.22% vs. 34.78%, p=0.012), which mean that being male more likely to have

Table 2. Subject characteristics based on the physical activity categories

Subject characteristics	x ± SD	Min-max
Age, years-age	15.13 ± 1.46	12.00-18.00
Gender		
- Male	55	50.46%
- Female	54	49.54%
Body weight, kg	90.21 ± 14.99	54.80 - 130.70
Body height, cm	145.53 ± 25.16	94.30 - 179.00
BMI, kg/m^2	33.95 ± 4.68	26.80 - 56.90
BMI-for-age z-score	2.88 ± 0.53	2.00 – 4.26
Nutritional status		
- Overweight	63	60.6%
- Obesity	46	44.2 %
MetS	58	55.8%
Abdominal obesity	96	92.3%
Hyperglycemia	3	2.9%
Low HDL-c	51	49%
Hypertriglyceridemia	45	43.3%
Hypertension	72	69.2%
Waist circumference, cm	99.10 ± 11.64	74.00 - 139.00
Hip circumference, cm	111.34 ± 9.17	87.00 - 150.50
GDA, mg/dL	86.50 ± 6.47	66.00 -110.00
Total cholesterol, mg/dL	171.03 ± 33.27	92.00 - 271.00
HDL-c, mg/dL	43.37 ± 7.79	25.00 - 67.00
LDL-c, mg/dL	112.79 ± 28.33	40.00 - 188.00
TG, mg/dL	110.31 ± 55.63	28.00 - 267.00
Systolic blood pressure, mmHg	127.38 ± 12.88	100.00 - 163.00
Diastolic blood pressure, mmHg	82.24 ± 9.43	60.00 - 108.00
Physical behaviour score	8.86 ± 1.25	1.00 - 21.00
Physical activity score	2.71 ± 2.02	0.00 - 7.00
Physical transport score	1.27 ± 2.23	0.00 - 7.00
Physical education score	1.89 ± 1.61	0.00 - 5.00
Screen time score	3.03 ± 1.25	0.00 - 5.00

overweight/obesity by nature. The prevalent of MetS was 53.21%, no significant difference of MetS distribution among male and female (p=0.506). Obesity prevalent is greater in boys than girls among paediatric population (Shah et al., 2020), which was in line with this results. However, other found inconsistent outcomes regarding sex when it access using BMI, male : female ratio of obese adolescents was 1 : 1.5 (Iduoriyekemwen et al., 2023). The sex difference in obesity prevalent brought up several hypotheses such as societal idea in body weight, feeding practices and biological influences such as hormone and body composition (Shah et al., 2020). Also female adolescents had higher awareness in their physical image (Pawloski

et al., 2023). Other study found that MetS was more prevalent in male, ranged from 1.4 to 55.8%, and affecting them with overweight/obesity (Orsini et al., 2023). The risk for having MetS in boys was 6.57-folds, and combination with obesity increased the risk by 12.70-fold (Mehairi et al., 2013).

Table 3 summarized the correlation between physical behaviour, physical activity, physical transport, physical education and screen time with anthropometric and metabolic components in adolescents. It was showed that physical behaviour did not correlate with the anthropometric parameters and MetS components. Physical activity correlated positively with waist circumference (r=0.231, p=0.016), which was support by a

Table 3. The correlation between physical behaviour score and metabolic parameters

Anthropometric and Metabolic Variables	Physical behaviour		Physical activity		Physical transport		Physical education		Sedentary behaviour	
	r	p	r	p	r	p	r	p	r	P
BW, kg	-0.007	0.943[a]	0.218	0.023[a]	-0.144	0.238[a]	0.149	0.122[a]	0.387	0.000[a]
WC, cm	-0.021	0.832[a]	0.231	0.016[a]	-0.090	0.353[a]	0.130	0.177[a]	0.379	0.000[a]
BMI, kg/m^2	-0.119	0.216[a]	0.094	0.332[a]	-0.198	0.039[a]	0.107	0.266[a]	0.412	0.000[a]
BMI-for-age z-score	0.001	0.993[a]	-0.133	0.169[a]	-0.122	0.205[a]	0.224	0.019[a]	0.322	0.001[a]
GDA, mg/dL	0.048	0.617[b]	-0.067	0.490[b]	0.039	0.689[b]	-0.054	0.578[b]	-0.154	0.164[b]
TC, mg/dL	-0.004	0.967[a]	0.047	0.625[a]	-0.001	0.988[a]	0.003	0.973[a]	0.091	0.380[a]
HDL-c, mg/dL	-0.133	0.167[a]	0.067	0.487[a]	-0.059	0.542[a]	-0.128	0.184[a]	0.023	0.826[a]
LDL-c, mg/dL	-0.030	0.758[a]	0.034	0.725[a]	-0.056	0.566[a]	0.046	0.635[a]	0.109	0.826[a]
TG, mg/dL	0.140	0.145[b]	0.041	0.673[b]	0.129	0.181[b]	-0.078	0.423[b]	0.033	0.752[b]
SBP, mmHg	0.032	0.739[b]	0.108	0.262[b]	0.021	0.830[b]	0.090	0.355[b]	0.259	0.011[b]
DBP, mmHg	-0.088	0.362[b]	0.118	0.220[b]	-0.016	0.866[b]	0.073	0.452[b]	0.047	0.654[b]

[a]Pearson correlation; b Spearman Rho correlation

cohort study, the physically active subjects had lower waist circumference than physically inactive subjects (Gariballa et al., 2023). Other also supported this finding, in which stated obesity was correlated with high leisure time (Joshi et al., 2023), and that physically active was correlated with BMI (Malik and Chatterjee, 2023).

Physical transport correlated negatively with BMI (r=0.198, p=0.039), which was in line with other (Joshi et al., 2023). It was found that passive transport increase the risk of being obese by 5.6-folds (Mizwar et al., 2022). Also, children who walk or bicycle to school or go home had higher physical activity with better cardiovascular fitness than them with passive transport (de Jesus et al., 2021), even increase speed-agility among boys and muscle strength of lower body muscle in girls (Villa-González et al., 2015). The Latine countries design cut-off points for physical transport by walking to prevent overweight/obesity in adolescents as 7,304 and 5,162 of daily steps for girls and boys respectively (Ferrero-Hernández et al., 2022). In adults, active transport lowered men BMI by 0.97-1.10 points, and women 0.72-0.87 points (Flint et al., 2014).

A study found no correlation between physical transport with body weight reduction or BMI (Lee et al., 2008), but several study showed the effectiveness of physical transport promotion in enhancing physical activity levels during childhood in preventing NCD events in the future (Lam et al., 2023), as no significant results was found in regards of active transport. This inconsistency also marked by Andersen et al (2009), only 3 study found the association between active transport with body weight loss, while a study found that active transport was associated with higher BMI as the lack of evidence to support the findings (Andersen et al., 2009). The effect of physical transport on health may be a long-term event, so it can't be observe in a cross-sectional study, as shown in a study, that boys with active transport for 2-years had lower BMI and skinfold than those with the passive one, but this difference did not correlated with BMI or overweight status (Rosenberg et al., 2006).

Other also supported this findings (Bhargava et al., 2016). But physical education correlated positively with BMI-for-age z-score (r=0.224, p=0.019). In a qualitative study, physical education remains the only source of physical activity which was done by adolescents (Hills et al., 2015), and physical education can help obese student to get the better health and fitness via fitness approach and healthy lifestyle counselling (Syafruddin et al., 2023).

Sedentary behaviour was correlated with body weight (r=0.387, p=0.000), waist circumference (r=0.379, p=0.000), BMI (r=0.412, p=0.000), BMI-for-age (r=0.322, p=0.001), and systole blood pressure (r=0.259, p=0.011). A study showed that obesity was more prevalent to those who ate junk food while doing screen time (Jain et al., 2023). In the sedentary behaviour scoring system, we reverse

the score described by Xu et al. (2020) in order not to confuse us in reading the results.

A study based on GHSH questionnaire showed that screen time for > 3 h/day increased the risk of overweight and obesity by 1.42-fold (Arfines et al., 2020). The negative effect of screen time also seen in other result, in which the male subjects with screen time more than 6 h/day had abdominal obesity, but no correlation with BMI and hypertension (Singh et al., 2023). Body fat measurements (abdominal, triceps and subscapular fat mass) also found the significant correlation between screen time with body fat (Alamolhoda et al., 2020). A study also found that screen time was correlated with SBP and DBP (r=0.423, r=0.413, P<0.05), and each hour of screen time (in week) increases the hypertension risk by 1.18-fold (Stabouli, 2022).

CONCLUSION

Physical behaviour score did not correlate with anthropometric parameters indicating to overweight/obesity and metabolic factors, but the component of physical behaviour, especially sedentary lifestyle correlated with anthropometric parameters and systolic blood pressure. Physical transport protected the adolescents to the present of abdominal obesity.

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IRON INTAKE AND STRESS LEVEL WITH PRIMARY DYSMENORRHEA IN HIGH SCHOOL STUDENTS

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ABSTRACT

One of the signs of puberty experienced by young women is menstruation, some young women experience pain known as dysmenorrhea during menstruation. Iron is one of the essential nutrients for adolescent reproduction, and its deficiency can increase the risk of dysmenorrhea. Stress can also affect Dysmenorrhea, as stress can lead to hormonal imbalances and the secretion of prostaglandin hormones produced by stress. The purpose of this study was to analyze the relationship between iron intake and stress levels with the incidence of primary dysmenorrhea in adolescent girls at PB Soedirman Islamic High School Bekasi. This study uses an observational analytic method with a cross-sectional design, and data collection using consecutive sampling techniques with 100 respondents. Data were collected through semi-quantitative food frequency questionnaires (SQ-FFQ) and Perceived Stress Scale (PSS) and determining the incidence of dysmenorrhea using dysmenorrhea questionnaires. The results measured by Chi-square test, showed p-values for iron intake (0.010) and stress levels (0.002). This study found a significant correlation between stress levels and iron intake in adolescent girls in PB Soedirman Islamic High School Bekasi.

Keywords *— adolescent girls, iron intake, primary dysmenorrhea, stress level*

INTRODUCTION

According to the World Health Organization (WHO), adolescents are individuals aged between 10 and 19 years who experience rapid physical, mental, and reproductive organ growth. This stage of an individual's reproductive development is known as puberty. Menstruation is one of the signs experienced by adolescent girls when entering puberty (Nuzula dan Maulida, 2019).

During menstruation, many teenage girls experience pain caused by uterine muscle contractions that disrupt blood flow to the uterus, resulting in menstrual pain called dysmenorrhea. Severe pain or pain in the lower abdomen experienced by a woman during her menstrual cycle is also referred to as dysmenorrhea. This pain usually occurs from a few days before menstruation until menstruation itself (Ratnawati, 2018).

Primary dysmenorrhea is menstrual pain not caused by abnormalities in reproductive organs. This pain typically arises at the age of 20 or younger after a normal ovulatory cycle, and the highest incidence rates occur in late adolescence to early adulthood, between the ages of 15-25 (Tsamara et al., 2020). Primary dysmenorrhea is a condition related to increased uterine contractions due to heightened production of prostaglandins (Agustina, 2019).

Cramps, diarrhea, vomiting, nausea, and headache can all accompany menstrual pain (Sulaeman, 2019). According to Setyowati (2018), dysmenorrhea can affect daily life and have negative impacts such as decreased concentration in class, inability to exercise, decreased performance during school, disruption in social interactions, lower grades, and significant influence related to absenteeism. This is because individuals experiencing dysmenorrhea usually request permission to be absent from school, campus, or the workplace.

According to 2017 data from the World Health Organization (WHO), approximately 1,769,425 individuals, or around 90% of women, experience dysmenorrhea, with 10% to 15% experiencing severe dysmenorrhea. Worldwide, 90% of teenage girls face menstrual problems, and half of them suffer from primary dysmenorrhea (Idayanti

et al., 2018). In Indonesia, the prevalence of dysmenorrhea is 64.25%, of which 60-75% are adolescent girls with primary dysmenorrhea (Hamdiyah, 2020). According to Andriyani (2016), the prevalence of primary dysmenorrhea in West Java was 72.89% in 2015, while secondary dysmenorrhea was 27.11%.

Nutritional intake is a leading cause of dysmenorrhea. Iron deficiency, a vital nutrient for adolescent reproduction, increases the risk of dysmenorrhea (Bajalan et al., 2019). Dietary patterns significantly impact an individual's nutritional status as the amount and quality of consumed foods and beverages can affect nutrient intake, ultimately influencing one's overall health status (Sirajuddin, 2018). This is supported by research findings by Masruroh & Nur (2019) indicating a significant correlation between the prevalence of dysmenorrhea in adolescent females and iron intake (Fe) with a p-value of 0.014, determined by Spearman Rank test.

In addition, stress is a significant factor that can cause dysmenorrhea. Severe stress can potentially lead to disturbances. If not promptly addressed, excessive stress can endanger one's health. Moreover, stress can cause hormonal imbalances. The secretion of prostaglandin hormones, induced by stress, can cause dysmenorrhea (Fasha, 2017). This is further supported by another study by Sari et al. (2015) that found that participants with mild stress experienced mild dysmenorrhea in 54% of cases, while those with severe stress experienced dysmenorrhea most often (82%). This is consistent with the results of a cross-sectional study conducted by Ilmi et al. (2017), which found a p-value correlation of 0.037 indicating that stress or psychological factors may increase the likelihood of dysmenorrhea among female teenage students at Kanaan Christian High School in Banjarmasin.

Based on the information provided above, researchers are interested in conducting a study on the relationship between iron intake and stress levels with the incidence of primary dysmenorrhea in female adolescents at PB Soedirman Islamic High School Bekasi City. Researchers chose PB Soedirman Islamic High School as the research location because of its strategic location, close to places to eat, and diverse socio-economic backgrounds and lifestyles.

METHODS

The study utilized an analytical observational method with a cross-sectional design. The population for the study comprised female high school students at PB Soedirman Islamic High School Bekasi. The subjects were teenagers aged between 16-18 years, and the total number of respondents was 100. Data collection was conducted in March 2023, employing the Non-Probability Sampling technique using a consecutive sampling method. Abbreviations for technical terms will be clarified upon first use. Data collection was conducted in March 2023, employing the Non-Probability Sampling technique using a consecutive sampling method. This research study has received ethical clearance from the Ethics Committee for Health Research of Muhammadiyah University Prof. Dr. Hamka (KEPKK-UHAMKA) under the number: 03/23.03/02355.

Subjects were selected based on the inclusion criteria in the class so the total research subjects were 100 people. The inclusion criteria included female students who were currently enrolled in PB Soedirman Islamic High School, aged between 16 and 18 years, female students who were willing to participate, and had experienced menstruation. Exclusion criteria encompass students who were absent during the study and those with a history of reproductive disorders such as adenomyosis, uterine fibroids, endometriosis, cervical stenosis, pelvic inflammatory disease, or pelvic adhesions.

The independent variables in this study were iron intake and stress levels. The dependent variable was primary dysmenorrhea. This study was conducted through direct interaction with participants who gave their consent before completing the questionnaire and becoming research subjects. Iron intake data were collected using the Semi Quantity Food Frequency Questionnaire (SQ FFQ) which was conducted for reliability in schools that had similar characteristics to the research location. At the same time, stress levels were assessed through the Perceived Stress Scale-10 (PSS-10) questionnaire with a Cronbach's alpha of 0.669 (Kusumowati and Noerfitri, 2023). Primary dysmenorrhea data were obtained through a questionnaire tested for validity and reliability and produced a Cronbach alpha value of 0.761. Data was analyzed using univariate proportions

and bivariate statistical analysis utilizing the Chi-square test in the SPSS software program.

RESULTS AND DISCUSSION

Based on Table 1, the sample size consisted of 100 individuals. A normality test was performed on the age variable from all input data, where the test result showed a p-value > 0.05, indicating a non-normal distribution. Therefore, the age variable was analyzed using the median and interquartile range indicators. The median age for adolescents was 16 years, with an interquartile range variation of 1 from 16 to 17.

According to Table 2, out of 100 participants, data was collected from classes X and XI. Class X had more respondents with 54 students (54.0%). Moreover, 94 students (94.0%) had high allowance.

Based on Table 3 above, it is evident that out of the 100 female student respondents, 51 (51.0%) had insufficient iron intake. Furthermore, the distribution results show that 58 (58.0%) female students experienced high levels of stress in this study. Meanwhile, the distribution of primary dysmenorrhea incidence in this study revealed that more female students experienced dysmenorrhea complaints, a total of 54 individuals (54.0%).

Based on the Chi-Square statistical test result, a p-value of 0.010 was obtained, indicating a significant relationship between iron intake and the incidence of primary dysmenorrhea in female adolescents at PB Soedirman Islamic High School in Bekasi.

According to the Chi-Square statistical test results, with a p-value of 0.002, a significant relationship between stress levels and the incidence

Table 1. Age Overview of Adolescents

Variable	n	Median	IQR
Age	100	16.00	17-16

Table 2. Characteristic of Respondents

Characteristic of Respondents	n	%
Class		
Class X	54	54.0
Class XI	46	46.0
Allowance		
High ≥20.000	94	94.0
Low <20.000	6	6. 0
TOTAL	100	100,0

Table 3. Overview of Iron Intake, Stress Level, and Primary Dysmenorrhea

Variable	n	%
Intake of Iron		
Less	51	51.0
Simply	49	49.0
TOTAL	100	100.0
Stress Level		
Major Stress	58	58.0
Mild Stress	42	42.0
TOTAL	100	100.0
Primary Dysmenorrhea		
Dysmenorrhea	54	54.0
No Dysmenorrhea	46	46.0
TOTAL	100	100.0

Table 4. Relationship between Iron Intake and Primary Dysmenorrhea in Adolescent Girls.

Intake of Iron	Primary Dysmenorrhea				Total		p-value
	Dysmenorrhea		No Dysmenorrhea				
	n	%	n	%	n	%	
Less	34	66.7	17	33.3	51	100.0	0.010
Simply	20	40.8	29	59.2	49	100.0	

Table 5. Relationship between Stress Levels and Primary Dysmenorrhea in Adolescent Girls.

Stress Level	Primary Dysmenorrhea				Total		p-value
	Dysmenorrhea		No Dysmenorrhea				
	n	%	n	%	n	%	
Major Stress	39	67.2	19	32.8	58	100.0	0.002
Mild Stress	15	35.7	27	64.3	42	100.0	

of primary dysmenorrhea exists in adolescent girls at PB Soedirman Bekasi Islamic High School.

DISCUSSION

Iron is essential for the formation of hemoglobin (Hb), which can be found in the body in the form of hemoglobin, myoglobin, or chromium and plays a crucial role in the transport, storage, and utilization of oxygen. The majority of iron produced from the breakdown of red blood cells will be reused to produce hemoglobin, so iron deficiency must be supplemented with food (Adriani, 2016).

According to research findings, there is a correlation between iron intake and primary dysmenorrhea. Female students with low iron intake are more likely to experience menstrual pain. The lack of iron in female students could be attributed to poor eating habits, which may be assessed depending on the cafeteria's offerings such as instant noodles, seblak, burgers, kebabs, fried foods, meatballs, chicken noodles, chicken dishes, and fried rice. High-energy and high-fat snacks, such as nasi uduk and ketoprak, are deficient in vitamins and minerals. According to ELMoslemany (2019), malnutrition in teenage girls may result from poor eating habits and consumption of high-fat, high-sodium, and high-energy fast food with insufficient vitamins and minerals. Another contributing factor to nutrient deficiency is the common belief that one has met their recommended nutritional intake when feeling full. However, when someone feels full, it does not necessarily mean they have received all the necessary nutrients they need (Mokoginta et al., 2016).

Poor nutritional intake among teenagers could be due to their body image concerns. Additionally, most teenagers in modern times tend to control their food intake, and a fear of gaining weight is one of the reasons why young women may not have a proper diet. Sometimes changes can have negative consequences and can lead adolescents to behave inappropriately in pursuit of their ideal body shape, such as consuming imbalanced meals (Astini et al, 2021). Dieny (2014) suggests that irregular eating habits among adolescent girls may lead to low iron intake. Fear

of weight gain is one factor contributing to poor eating behavior in teenage girls. Irregular eating behaviors among teens, such as skipping meals, intentionally vomiting, excessive snacking, or following a special diet, can be linked to physical dissatisfaction among females.

If the hemoglobin level in the body is low, it can impede the oxygen flow throughout the body, including to the uterus. This constriction of blood vessels causes pain in reproductive organs. Hemoglobin deficiency may cause ischemia which can further result in the synthesis of phospholipids, arachidonic acid, prostaglandins, and vasopressin. This increase in prostaglandins and vasopressin results in arterial vasoconstriction and uterine ischemia, which can ultimately result in greater prostaglandin production, leading to menstrual pain (Kusumawardani and Cholifah, 2018).

Stress is a subjective experience that someone has in response to a situation that does not meet their expectations or is stressful. Demands can be influenced by internal or external factors (Shofiyah and Mutiah, 2022). The results showed that there was a correlation between stress level and the incidence of dysmenorrhea: the higher the level of stress experienced by female students, the more likely they were to experience menstrual pain. Different factors cause stress, which is divided into internal and external factors according to Gamayanti et al (2018), Stress arises from internal factors, including physical ailments, motivational influences, and distinct personality traits. A person's cognitive reaction and interpretation of events in life depend on cognitive appraisal, which discerns whether they deem these events as perilous or threatening. Conversely, external stressors emerge from an individual's surroundings, such as family, work, facilities, neighborhood, and school (Sutjiato & Tucunan, 2015). Stress levels experienced by respondents may vary depending on the cause of the stressor and the duration of exposure. The longer the respondents are exposed to the stressor, the more severe the stress they experience (Oken et al., 2015).

During a stress response, the neuroendocrine system, specifically corticotropin-releasing hormone (CRH) in the hypothalamus, stimulates the release of adrenocorticotropic hormone (ACTH) by the anterior pituitary, leading to

an increase in the release of glucocorticoids, mainly cortisol and adrenal, from the gland. Increased levels of glucocorticoids inhibit GnRH secretion in the hypothalamus and suppress the release of FSH and LH, causing disruptions in follicle development and leading to reduced progesterone release. This in turn increases the synthesis of prostaglandin F2a and prostaglandin E2. Excessive production of prostaglandins can cause uterine hypercontraction, reducing blood flow to the uterus and leading to ischemia. This heightened sensitivity of nerve fibers can result in dysmenorrhea. The formation of prostaglandins is additionally influenced by the adrenaline and cortisol hormones, which are associated with stress. This indicates that stress affects the levels of prostaglandins in the myometrium, both directly and indirectly (Whirledge and Cidlowski, 2010; Whirledge and Cidlowski, 2013).

CONCLUSIONS

There is a significant correlation between iron intake and the incidence of primary dysmenorrhea in female students of PB Soedirman Islamic High School. In addition, there is also a significant correlation between stress levels and the incidence of primary dysmenorrhea in female students of PB Soedirman Islamic High School. It is recommended for further researchers to consider additional factors, such as nutritional status, exercise habits, micro-nutrients (besides iron), and other variables related to the research variable while being supported by proper instruments. If researchers wish to use SQ-FFQ as an instrument, it is recommended that they conduct direct interviews with the participants to obtain optimal results.

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CORRELATION BETWEEN DIET QUALITY AND BODY COMPOSITION WITH WORK FATIGUE IN FEMALE WORKERS

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ABSTRACT

Introduction : *In 2020, labor force participation rate for women in East Java province was 70,0%, and in Lumajang district reached 66,19%. Women usually have a higher fat mass compared to men. Body composition dominated by fat mass can reduce oxygen distribution process, can cause anaerobic energy metabolism which produce lactic acid as final product and causes fatigue. Low diet quality is related with high energy and fat intake which will result in body fat mass elevation and work fatigue. This study aimed to determine the correlation between diet quality and body composition with work fatigue.* **Method:** *This study used cross sectional design with total respondents of 120 female workers in production division of wood factory. Collected data were means of anthropometric measurements (weight, height, upper arm circumference, and abdominal circumference), Semi Quantitative Food Frequency Questionnaire, and Subjective Self Rating Test. Correlation test used were Chi square test continued with Pearson correlation test.* **Result:** *Result showed a significant correlation between work fatigue and total sodium intake per day (p=0.040), total saturated fat intake (p=0.037), Body Mass Index (p<0.001), abdominal circumference (p<0.001), and upper arm circumference (p=0.002).* **Conclusion:** *Improving diet quality and decreasing body fat mass can reduce work fatigue.*

Keywords: work fatigue, diet quality, body composition, female worker, occupational health

INTRODUCTION

In 2021 the Labor Force Participation Rate for women in in East Java province was 70,0%, and in Lumajang district reached 66,19% (the Central Bureau of Statistics of Indonesia, 2020; the Central Bureau of Statistics of East Java, 2022). This high number often did not matched by the implementation of Health and Safety at Work and improvement of work environment. This condition causes worker to experience fatigue easily, and women tend to experience fatigue than men easily (Tseng et al., 2014; Arini, Martiana and Ardyanto, 2019). In general, women usually have higher fat mass than men (Lemieux et al., 1993; Srikanthan et al., 2021).

High body fat can cause a decrease in muscle contraction which then cause fatigue (Segura-Jiménez et al., 2016; de Lima et al., 2019). Fatigue is a feeling of tiredness felt by a person due to accumulation of various causative factors (Aaronson et al., 1999; Zwarts, Bleijenberg and van Engelen, 2008; Marino, 2019). In general, symptoms of fatigue include feeling of pain in the organs, feeling tired, dizziness, nausea, chaotic thought, and others (Zwarts, Bleijenberg and van Engelen, 2008; Klimas, Broderick and Fletcher, 2012; Wright and O'Connor, 2014; Borges et al., 2018).

Fatigue can be divided into two type, namely physical work fatigue and general work fatigue (Tarwaka, 2014). Physical work fatigue is related to muscle fatigue caused by muscle contractions that occur excessively and last a long time (Tarwaka, 2014). General work fatigue is related to psychological factors. Psychological factors perceived by workers can affect the activity of the inhibitory and mobilizing systems in the cerebral cortex reactions correlated with feelings onset of fatigue (Aaronson et al., 1999; Tarwaka, 2014; Lee and Giuliani, 2019).

Fatigue can be caused by various factors, both internal and external (Wright and O'Connor, 2014; Lestari, 2016). Internal factors are related to factors

that come from within the individual, for example health status, nutritional status, age, workload, work stress, and sleep duration. External factors are related to factors that come from outside the individual, for example the work climate, work environment (Wright and O'Connor, 2014; Lestari, 2016).

Female workers at wood factory in Indonesia is not common. Usually wood factory workers is men, because this kind of work needs higher power and strength. Since working in wood factory require physical ability, it also create higher fatigue and physical stress. Several ways can be done to decrease the fatigue and physical stress in female workers, one of which is by increasing their diet quality and maintaining body composition to their ideal body mass index. By these background, we aim to determine the relationship of diet quality and body composition with the level of fatigue in female workers.

METHODS

Study Population

This study was a cross sectional study design. Data was collected by interviewing respondents and observing the environment around respondents. Questionnaires that were used include SQFFQ (Semi Quantitative Food Frequency Questionnaire), and SRRT (Subjective Self Rating Test) issued by Industrial Fatigue Research Committee (IFRC). Primary data collected during May-June 2021. The study was conducted at "X" wood factory located in Pasirian District, Lumajang Regency-East Java.

Total samples was calculated using Lemeshow formula with two-proportion population hypothesis test in Putra (2018) and minimum sample required is 100 person. The selection of study respondents were following the inclusion criteria included female workers aged 15 to 64 years, working in production division, has been working for at least 3 months, has fixed salary each month, has no other job besides in the company, had no history of liver disease, and willing to follow the study by signed the informed consent. Respondents excluded if decided not to continue the study, pregnant or breastfed. This research has passed an ethical clearance by the Health Research Ethics Committee, Faculty of Public Health Airlangga University number 56/EA/KEPK/2022.

Dietary Assessment

The nutritional factors observed were food quality and body composition, especially body fat percentage. Diet quality was assessed using the Healthy Eating Index (HEI) method, which this method assess diet quality based on two criteria, adequacy and moderation (Krebs-Smith et al., 2018; Reedy et al., 2018). Body composition is a description or size of compartments in the body, which consists of two main compartments, namely fat mass and non-fat mass (Saltzman and Mogensen, 2013; Wang and Torriani, 2020). Fat mass is the weight of all fat in the body, while non-fat mass is the weight of bone, body fluids, and muscle. A simple body composition measurement done by measuring mid upper arm circumference (MUAC), abdominal circumference, waist circumference, and BMI (Santos et al., 2014; Reedy et al., 2018). Diet quality assessment aims to identify the quality of individual food intake and determine the balance of nutrient intake. A high value of diet quality indicates an individual's intake of adequate macronutrient needs, while a low diet quality indicates that an individual intake dominated by foods that high energy and fat, and low fiber and micronutrients (Cole and Fox, 2008; Krebs-Smith et al., 2018; Reedy et al., 2018).

Diet quality assessment was carried out by identifying eating habits of female workers through SQFFQ (Semi Quantitative Food Frequency Questionnaire) questionnaire from the last 6 months eating habits. SQFFQ contains all types of food ingredients which are grouped according to 7 food groups (including carbohydrate sources, animal proteins, plant proteins, vegetables, fruits, milk and beverages, snacks and packaged foods) consisted of 81 food items. The food ingredients in SQFFQ are foodstuffs that are commonly consumed and can be found by female workers in the study area (nearby or maximum in 1 km radius from the house and the workplace). The results of the SQFFQ were then used to analyze the quality of female workers diet using the HEI method.

HEI measurement using the guidelines of HEI-2015 where the scoring based on 13 components which divided into adequacy components (total

fruits, whole fruits, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafoods and plant proteins, fatty acids) and moderation components (refined grains, sodium, added sugars, saturated fats). The overall total score for HEI is 100. The higher the score, the better the diet quality. Based on the scoring, it can be divided into 3 groups, good diet if HEI score more than 80, needs improvement group if HEI score between 51-80, and poor diet if HEI score less than 51.

Anthropometric Measurement

Anthropometric measurements included measurements of weight, height, MUAC and abdominal circumference of the respondent. The measurement of weight uses Omron digital weight scale with level of accuracy of 0.1 kg, while the measurement of height using microtoise with the level of accuracy of 0.1 cm. Measurement of waist circumference and MUAC using a measurement tape with the smallest scale of 0 cm with the level of accuracy of 0.1 cm measured at the midline of the humerus bone measured from the acromion to olecranon of inactive hand based on anatomical position. The measurement repeated 3 times and 2 measurement with the closest value were taken as the result of measurement. Body mass index calculated by dividing body weight in kilogram with body height square in centimeter. Body mass index then classified into 4 categories based on WHO for Asia Pacific population, namely underweight (BMI $\leq$ 18.5), normal (BMI 18.5 – 23.0), overweight (BMI 23.0-25.0), and obese (BMI > 25.0).

Work Fatigue, Work Stress, and Workload Measurement

Work fatigue commonly defined as fatigue feeling felt by workers during working time. Measurement of work fatigue in this study using Subjective Self Rating Test (SRRT) questionnaire. This questionnaire contains three indicators for assessing work fatigue, namely indicators of weakening activities, weakening motivation, and weakening physical. Each indicator will contain ten questions related to worker conditions with four answer options. The answer choices given have different score values where the answer choices are very often worth 4, often worth 3, rarely worth 2, and never worth 1. Overall score then classified based on the level of fatigue. The level of work fatigue is mild if the total score is 30-52, moderate 53-75, high 76-98, and very high 99-120.

Statistical Analysis

Analysis of the correlation between dependent and independent variables using IBM SPSS 21 application. Normality test using Kolmogorov-Smirnov test. Because all data well normally distributed based on Kolmogorov-Smirnov test, then the test continued with normal inferential test.

Correlation test used Chi square test continued with Pearson correlation test for the respondent's characteristics which include age, workload, work stress, work fatigue, abdominal circumference, MUAC, BMI, total diet quality, components of diet quality and total intake of each nutrient in one day.

In this study, data analysis were using IBM SPSS version 21. Descriptive analysis perform to several types of data to see the distribution of the data. Assumption test including normality test, multicollinearity, and heteroscedasticity data performed as the requirement for multiple linear regression test. Multiple linear regression test used to see the relationship of independent variable on dependent variable. Multiple linear regression test is performed twice because there were intervening variable existed that needs further analysis. The results of the two regression tests are then compared to obtain a conclusion if there is an influence of the independent variable on the dependent variable through the intervening variable.

Work stress measured using HSE indicator tools 2003 with scoring divided into 4 group namely low stress (100-125), moderate stress (75-99), high stress (50-74), and very high stress (25-49). Workload in this study is focused to the mental workload, measured using NASA-TLX, classified into low (<50), moderate (50-80), and high (>80).

RESULT

Respondents Characteristics

"X" wood factory is one of the biggest factories in Lumajang, East Java which produce FJLB (Finger Joint Laminating Board), plywood, and bare code. Female worker in production division working in assembly and finishing part. Table 1 showed that most of the respondents belong to the early adult age group with percentage of 40% and the average value of mean age ± SD is 36.62 ± 9.22 years.

Based on anthropometric measurements, it was found that 61.67% of respondents had central obesity based on abdominal circumference measurements with an average abdominal circumference of 84.54 cm, based on measurements of MUAC 98.33% of respondents included in the normal category or not in chronic energy deficiency

condition. with an average MUAC of 29.58 cm, 53% of respondents had Body Mass Index (BMI) in the normal category (mean BMI 24.79 kg/m2), and 65% of respondents diet quality categorized in the Needs Improvement category with average value 72.87. The average value ± SD respectively for workload and work stress is 73.48 ± 13.78 and 74.96 ± 72.43.

Nutrient Intake

Table 2 shows that from all analysis of the correlation related to total intake of energy, protein, fat, carbohydrates, iron, and calcium, as well as the ratio between these nutrients and work fatigue, there are no significant relationship or significance value > 0.05. The average intake of energy (1708.66 kcal) and carbohydrates (307.22 g) was greater in the moderate work fatigue group.

Table 1. Characteristics of Age, Weight, Height, Abdominal Circumference, Upper Arm Circumference, BMI, Diet Quality of Respondents

Characteristics	n	%	Mean ± SD
Age			
Late adolescent (17-25 y.o.)	18	15.0	
Early adult (26-35 y.o,)	32	26.7	36.62 ± 9.22
Late adult (36-55 y.o.)	48	40.0	
Early elderly (56-65 y.o.)	22	18.3	
Work load	-	-	73.48 ± 13.78
Work stress	-	-	74.96 ± 72.43
Work fatigue	-	-	
Low (30-52)	72	60.0	50.23 ± 10.19
Moderate (53-75)	48	40.0	
Mid upper arm circumference			
Normal (>23.5 cm)	2	2.0	29.58± 3.53
Chronic energy deficiency (<23.5 cm)	118	98.0	
Abdominal circumference			
Central obesity (>= 0.8 m)	74	61.7	84.54 ± 10.54
Normal (< 0.8 m)	46	38.3	
BMI (Kg/m²)			
Underweight (<18.5)	8	7.0	
Normal (18.5-23)	64	53.0	24.79 ± 4.87
Overweight/obesity (>23)	48	40.0	
Diet quality			
Poor Diet (< 51)	8	7.0	
Needs Improvement (51-80)	78	65.0	72.87 ± 18.05
Good Diet (> 80)	32	28.0	

Table 2. Correlation of Energy, Protein, Fat, Carbohydrate, Iron, and Calcium Intake with Work Fatigue

| Nutrient Intake | Work Fatigue | | | | p-value |
| | Low | | Moderate | | |
	Mean	SD	Mean	SD	
Energy Intake (kcal)	1703.94	297.70	1708.66	312.47	0.20
Protein intake/day (g)	41.07	14.23	36.43	9.89	0.34
Fat intake/day (g)	31.55	17.66	27.81	6.37	0.28
Carbohydrate intake/day (g)	305.02	47.26	307.22	57.35	0.14
Iron intake/day (mg)	13.45	11.38	10.20	7.92	0.15
Calcium intake/day (mg)	338.65	267.47	272.35	167.64	0.89
Protein : energy ratio	0.10	0.03	0.09	0.02	0.10
Fat : energy ratio	0.17	0.08	0.15	0.02	0.17
Carbohydrate : energy ratio	0.72	0.08	0.72	0.06	0.72
Protein : carbohydrate ratio	0.14	0.05	0.12	0.03	0.14
Fat : carbohydrate ratio	0.11	0.06	0.09	0.02	0.11
Fat : protein ratio	0.76	0.28	0.79	0.18	0.76
Iron : protein ratio	0.32	0.26	0.28	0.17	0.32
Iron : energy ratio	0.01	0.01	0.01	0.00	0.10
Calcium : protein ratio	7.90	4.80	7.33	3.43	0.90
Calcium : energy ratio	0.19	0.12	0.16	0.10	0.19

The average intake of protein (41.07 g), fat (31.55 g), iron (13.5 mg), and calcium (338.65 mg) was greater in the low fatigue group. The comparison between intake of protein : energy ratio (0.10), fat : energy ratio (0.17), protein : carbohydrates ratio (0.14), fat : carbohydrates ratio (0.11), iron : protein ratio (0.32), calcium : protein ratio (7.90), calcium : energy ratio (0.19) was greater in the low fatigue group. Meanwhile, fat : protein ratio intake (0.79) was greater in the moderate work fatigue group, and the intake of carbohydrates : energy (0.72) and iron : energy (0.10) had the same value between the low work fatigue group and moderate.

Healthy Eating Index (HEI) Component

In Figure 1 it can be seen that 47% respondents consumed fruit in one day more than 0.8 cup equivalence per 1000 kcal, and 57% respondents consumed whole fruit in one day more than 0.4 cup equivalence per 1000 kcal. Respondents who consume vegetables in one day more than 1.1 cup equivalence per 1000 kcal is 68%. All respondents had consumption levels of green vegetables and nuts in one day more than 0.2 cup equivalence per 1000 kcal, seafood and vegetable protein in one day more than 0.8 oz. equivalence per 1000 kcal,

ratio of fat consumption (PUFAs+MUFAs)/SFAs in one day more than 2.5, and total consumption of saturated fat more than 8% of energy. Thirty three percent of respondents consumed whole grains in one day more than 1.5 oz. equivalent per 1000 kcal. Eight percent of respondents consume dairy products in one day more than 1.3 cup equivalence per 1000 kcal. Five percent respondents has a total consumption of protein in one day more than 2.5 oz. equivalence per 1000 kcal. Respondents with a total consumption of refined grains in one day more than 1.8 oz. equivalence per 1000 kcal is 15%. Respondents with a total consumption of sodium in one day less than 1.1 gram equivalent per 1000 kcal were 62%, and no respondents who consumed added sugar less than 6.5% of the total energy.

In Table 3, from overall components of diet quality assessment according to the HEI, only total intake of sodium and saturated fat in one day has significant correlation with level of work fatigue with p-values of 0.040 and 0.37, respectively, and with Correlation Coefficient values are -0.261 and -0.269, respectively. The Correlation Coefficient number is negative which indicates that the relationship between total sodium intake and work fatigue and total saturated fat intake with work

fatigue is opposite, which means that the lower the total sodium intake and saturated fat intake, the higher the level of perceived work fatigue.

Body Composition

In Table 4 it can be seen that the assessment of body composition which includes measurements of Body Mass Index (BMI), abdominal circumference, and MUAC has a significant correlation with work fatigue (p-value<0.05). Meanwhile p-values respectively for Body Mass Index (BMI), abdominal circumference, and MUAC are <0.001; <0.001; and 0.002, and the Correlation Coefficient value are 0.458; 0.507, and 0.398. The Correlation Coefficient number is positive which means the higher the BMI, abdominal circumference, and MUAC, the higher level of perceived work fatigue.

Table 3. Correlation of Diet Quality Components based on Work Fatigue Score

| HEI Component | Work Fatigue | | | | p-value | Correlation Coefficient |
| | Low | | Moderate | | | |
	Mean	SD	Mean	SD		
Adequacy						
Total fruits	93.61	158.24	60.76	77.36	0.272	-0.144
Whole fruits	45.97	53.43	29.23	46.37	0.258	-0.148
Total vegetables	112.69	61.23	108.60	32.77	0.993	0.001
Greens and beans	85.70	47.58	88.17	31.80	0.722	0.047
Whole grains	12.77	25.93	26.14	37.77	0.637	-0.062
Dairy	11.21	44.09	0.81	3.29	0.632	-0.063
Total protein foods	41.07	14.23	36.43	9.89	0.143	-0.192
Seafood and plant proteins	85.35	44.71	85.45	37.86	0.669	-0.056
Fatty acids (PUFAs+MUFAs)/SFAs	0.76	0.25	0.76	0.17	0.617	0.066
Moderation						
Refined grains	6.94	12.10	7.63	12.91	0.909	0.015
Sodium	268.97	299.87	179.48	184.36	0.044*	-0.261
Added sugar	20.79	8.07	19.33	7.78	0.425	-0.105
Saturated fat	12.34	2.46	11.56	1.97	0.037*	-0.269

Note: *) Values were significantly different from low and moderate work fatigue (p<0.05). P was obtained with X^2 test.

Table 4. Body Composition of Respondents based on Respondents Work Fatigue Score

| Body Composition | Work Fatigue | | | | p-value | Correlation Coefficient |
| | Low | | Moderate | | | |
	Mean	SD	Mean	SD		
Body Mass Index (kg/cm2)	22.28	3.25	27.30	4.96	<0.001**	0.458
Abdominal circumference (cm)	79.10	6.36	90.03	11.05	<0.001**	0.507
Mid upper arm circumference (cm)	28.13	2.47	31.03	3.85	0.002**	0.398

Note: **) Values were significantly different from low and moderate work fatigue (p<0.01). P was obtained with X^2 test.
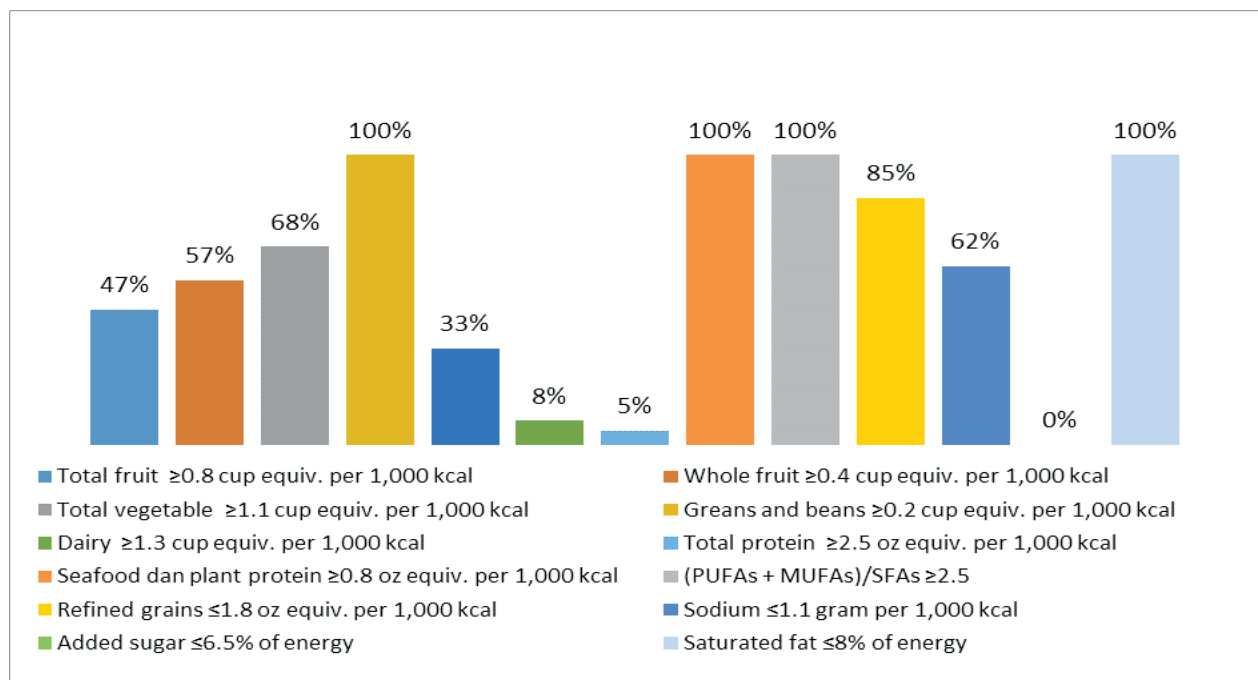
Figure 1. Distribution diagram of respondents consuming the component of diet quality based on the standards of HEI assessment.

DISCUSSION

The study result showed that the criteria for adequacy of each component of diet quality do not have significant relationship with the level of work fatigue, while on the moderating criteria there are two components of diet quality that have a significant correlation to work fatigue, namely total sodium intake and total saturated fat intake.

The correlation coefficient of the correlation between sodium intake and work fatigue is negative, which indicate the lower the respondent's sodium intake, the higher the perceived work fatigue. The average sodium intake of respondents is 0.22 grams with a lower limit of 0.014 grams and an upper limit of 1.3 grams. Most (62%) respondents had a total sodium intake of 1.1 grams in one day. The recommended daily limit for sodium intake is 1.1 grams-2 grams (Bellows and Moore, 2013; US. Food & Drug Administration, 2021).

Sodium is a micronutrient that functions to regulate fluid balance in the body (Hartanto, 2007; Bellows and Moore, 2013). If sodium and water intake is low while sodium expenditure (through sweat and urine) is high, it can cause dehydration with sodium deficiency (Hartanto,

2007; Santikatmaka, 2013). Lack of water and sodium in the blood plasma will be replaced by water and sodium from the interstitial fluid (the fluid that lies between cells). If the loss of water and sodium continues to occur, then water and sodium from the cells will continue to be removed, and if the volume of blood plasma cannot be maintained, circulation failure will occur (Hartanto, 2007; Hood and Scott, 2012; American Society of Health-System Pharmacists, 2020). This condition also causes a person to easily experience fatigue. Meanwhile, when sodium consumption is too high, the brain will stimulate the adrenal glands to secrete Endogenous Digital Like Factors (EDLF) (Blaustein et al., 2006). EDLF triggers sodium retention by increasing the expression of the sodium pump in the kidney. Retention of the sodium pump will inhibit the regulation of Na+/K+-ATPase in arteriolar and arteriolar blood vessel muscle cells, this causes the sodium concentration to increase while the potassium concentration decreases (Blaustein et al., 2006; Mckenna et al., 2006).

A decrement of potassium concentration causes a decrease in muscle function, so that the muscles will be more easily fatigue (Sjøgaard,

1996; Lindinger and Cairns, 2021). Fat is a macronutrient that plays a role in fulfilling body's energy. Fat in food is divided into several types including unsaturated fat and saturated fat. The differences between unsaturated and saturated fats located in the double bonds in carbon chain which only happened in the saturated fats. This difference in double bonds causes differences in physical and chemical properties (Sartika, 2008). Unsaturated fat itself is often correlated with the increased of HDL (High Density Lipoprotein) level (Gardner and Kraemer, 1995; Morton et al., 2019), while saturated fat is often correlated with the increment of LDL (Low Density Lipoprotein) level (Krebs-Smith et al., 2018; Tahuk, P.K., Dethan, A.A., Sio, 2018; Astrup et al., 2020).

Although saturated fat is often correlated with the risk of degenerative diseases, a few types of saturated fat are believed to lower blood cholesterol levels. Medium-chain saturated fats have the effect of lowering blood cholesterol levels, while long-chain saturated fats cause an increase in blood cholesterol levels (Bhavsar and St-Onge, 2016). The production of cholesterol in the blood vessels in the muscles can interfere with the process of muscle contraction, this causes people with higher cholesterol levels to experience fatigue more easily.

In this study, there is a significant correlation between saturated fat intake and the level of work fatigue with a negative correlation coefficient. The negative correlation coefficient means the higher the intake of saturated fat, the lower the work fatigue level. Respondent's saturated fat intake as a whole is below 8% of the total energy intake in one day, in addition, when compared to unsaturated fat intake, saturated fat consumption is much lower (Figure 1 all respondents have a comparison of unsaturated fat and saturated fat intake). The results of the comparison of unsaturated fat intake with saturated fat, which means that saturated fat intake 10% of total energy can reduce cholesterol buildup in blood vessels (Harland, 2012; Brouwer, 2020). Decreased cholesterol buildup in blood vessels can facilitate blood flow to circulate oxygen throughout the body. Fulfillment of sufficient oxygen consumption in the muscles can reduce the buildup of lactic acid, so that muscle contraction can occur optimally and work fatigue

can be reduced. But consumption of saturated fat reflected the amount of whole consumption of fat which is acted as energy sources. The lesser fat intake in human, may reflected the low energy consumption in total, which may resulted in work fatigue.

This study found significant correlation between the assessment of body composition and work fatigue. Assessment of body composition in this study was carried out by measuring body fat percentage by measuring BMI, abdominal circumference, and MUAC. Body Mass Index (BMI) is a scale that reflect the percentage of body fat based on body dimension (Nuttal, 2017). MUAC measures the thickness of subcutaneous fat and muscle tissue, while abdominal circumference measurements are used to identify central obesity to describe the condition of excess fat in the abdomen. Body fat percentage is related to VO2 max (Katch, McArdle and Katch, 2013; Mondal and Mishra, 2017; Vargas et al., 2018). VO2 max is the total oxygen used by the body for energy metabolism in muscles (Katch, McArdle and Katch, 2013; Mondal and Mishra, 2017). The high composition of fat in the body can reduce blood flow that carries oxygen to be circulated throughout the body, including muscles (Mondal and Mishra, 2017). The low level of oxygen in the muscles causes energy metabolism to occur anaerobically with a small amount of energy produced and lactic acid as the end product of the metabolic process. Lactic acid that accumulates in the muscles will reduce the power of muscle contraction which then causes fatigue (Proia et al., 2016; Fiorenza et al., 2019).

CONCLUSIONS

There are significant correlations between work fatigue and total sodium intake per day, total saturated fat intake, BMI, abdominal circumference, and MUAC. In assessing the quality of diet, the components of total sodium intake and total saturated fat intake have a significant correlationship with work fatigue. One of the efforts to reduce the level of work fatigue can be done by getting used to a healthy lifestyle, especially by improving diet quality both quantitatively and qualitatively.

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BODY MASS INDEX, WAIST-HIP RATIO, AND FASTING BLOOD GLUCOSE LEVEL IN PRE-ELDERLY AT TANJUNG RAMBANG HEALTH CENTER OPERATING REGION

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ABSTRACT

Elevated blood glucose when fasting is among the hazards associated with Diabetes Mellitus (DM). Obesity and diabetes mellitus are tightly associated. Body Mass Index (BMI) and Waist-Hip Ratio (WHR) measurements may be used to determine obesity. Prabumulih is known as city with a DM incidence of 2.02% in 2018, was placed second in South Sumatra. This research aims to investigate the relationship between BMI and WHR and older patient fasting blood glucose level in Tanjung Rambang Public Health Center operating region. Cross-sectional observational analysis is the method used in this study. The pre-elderly (45–59 years old) who resided in Tanjung RambangPublic Health Center working area made up as the population. Purposive sampling was used to choose 190 participants, meeting inclusion and exclusion criteria. This research use univariate and bivariate data analysis (using Chi Square test α=0.05). The majority of respondents (66.8%) are overweight; 53.2% of respondents had abnormal WHR; and 15.3% of respondents still had abnormal fasting blood glucose level. The analysis findings demonstrated no correlation (p=0.633) between BMI and fasting blood glucose level. The association between WHR and fasting blood glucose level is concluded to exist (p=0.001).

Keywords— *Body Mass Index, Diabetes Melitus, Fasting Blood Glucose, Obesity, Waist-Hip Ratio*

INTRODUCTION

Non-communicable diseases are currently the most common cause of death in Indonesia. Non-communicable diseases tend to increase over time. Diabetes Mellitus (DM) or the common people know diabetes is a non-communicable disease that occurs due to increased blood glucose level due to the pancreas not producing enough insulin or when the body cannot work effectively in usingthe insulin it produced (Santoso, etal., 2020). The International Diabetes Federation (IDF) (2021) notes that diabetes has caused 6.7 million deaths worldwide in 2021. This means that there is 1 death every 5 seconds. Indonesia is ranked sixth on this list. The number of deaths due to DM in Indonesia reached 236 thousand.

In 2018, 8.5% of people over the age of 15 had diabetes in Indonesia. DKI Jakarta has the greatest frequency of DM (3.4%). Meanwhile, the incidence of DM in South Sumatra reached 0.9% in 2013 and increased to 1.27% in 2018. With the highest prevalence of DM at the ages of 45-54 (2.75%), 55-64 years (4.50%), and 65-74 years

(3.81%) (Republic of Indonesia Ministry of Health Research and Development Agency, 2018). Health Profile Data for South Sumatra Province for 2020 the number of person living with DM is 172,044 people. This case has increased compared to 2019 which attacked 117,733 people.

Risk factors that can cause DM, namely factors that cannot be modified include a family history of DM, age ≥ 45 years, race/ethnicity, having a history of giving birth to a baby with a birth weight > 4000 grams, having a history of gestational DM, history of birth weight low (< 2.5 kg) and modifiable factors, namely obesity, lack of physical activity, hypertension, dyslipidemia, and diet (Widiasari et al., 2021).

Diabetes Mellitus is closely related to obesity, both general obesity and central obesity. Body Mass Index (BMI) generally indicates obesity, and Waist Hip Ratio (WHR) is one anthropometric measure that may be used to identify central obesity. While fasting blood glucose level may be used as indications of the presence of diabetes mellitus. Someone who has BMI that exceeds normal limits will cause an increase in insulin

resistance, so that blood glucose level increase. Likewise, the larger the WHR, the higher the fasting blood glucose level in person living with DM(Sapang et al., 2018).

Obesity will increase fat tissue in the body, and body tissue and muscles will be increasingly resistant to insulin action, especially if body fat is collected in the central part. Fat blocks insulin action so that glucose cannot be transported into cells and accumulates in the blood circulation. Not only has an impact on health, but obesity also causes a decrease in individual productivity which will then affect a decrease in the productivity of a country's economic wheels (Masrul, 2018). Obesity is caused by many factors, one of which is age. With increasing age, the body will experience various declines such as decreased organ function and physical changes due to the aging process. At the age of ≥ 45 years, the body's metabolism will slow down due to a decrease in muscle tissue mass, additional fat mass, and changes in fat distribution (Solikhah et al., 2020).

According to Luthansa and Pramono (2017) study, the chance of developing diabetes mellitus is 3.29 times greater in those with a BMI that is higher in nutrition. This is in line with study by Adnan etal. (2013), where discovered a connection between type 2 DM, BMI and fasting blood glucose level. As an individual BMI increases, so does their blood glucose level. This also applies to Dewi (2022), there was a robust, unidirectional association between WHR and fasting blood glucose level. The findings of this investigation are corroborated by Karimah (2018) research, which indicates a connection between fasting blood glucose level and WHR.

Based on Riskesdas data (2018) Prabumulih is the second highest city in South Sumatra which has a prevalence of DM in people aged ≥ 15 years with a prevalence of 2.02%. In 2019 the number of DM incidents in the city of Prabumulih reached 754 cases. There were 100 instances of DM patients in 2020, according to statistics from the Tanjung Rambang Public Health Center, andan additional 112 cases in 2021, according to the findings of a field study. There is a higher chance that the number of DM cases will rise given the high incidence of DM in the Tanjung Rambang Public Health Center operational region. Given the afore

mentioned circumstances, the researchers wanted to determine how the elderly in the Tanjung Rambang Public Health Center working area related to the measures of body mass index (BMI) and waist hip ratio (WHR) to fasting blood glucose level.

METHOD

This research has been approved by the Research Ethics Committee of the Faculty of Public Health, Sriwijaya University (440/UN9. FKM/TU.KKE/2022). This study employs a cross-sectional, observational analytical research methodology and is quantitative. Both primary and secondary data are used in data collecting. Univariate and bivariate analysis, together with statistical tests, will be used to analyze the acquired data. In this investigation, the Chi-Square test was used. Purposive sampling was used to choose the 190 participants for the sample. The following criteria were used to determine inclusion: the research subject had to have fasted for eight to twelve hours, been willing to participate in the study, signed an informed consent form, and havelived in the Tanjung Rambang PublicHealth Center working area foratleastthe previous year. Additionally, the subject could not have had a prior diagnosis of diabetes mellitus. In February 2023, this study was carried out in nine communities within the Tanjung Rambang Public Health Center operational area. Direct measurements of body weight, height, hip circumference, waist circumference, and fasting blood glucose were the key data gathered. While interviews were used to gather the respondent characteristics. Scales, microtoizes, metline, blood glucose test meters, and examination forms were among the instruments utilized in this investigation.

RESULT AND DISCUSSION

Univariate Analysis

Most of the respondents in this study were female, namely 85.5%. Based on the age of most respondents between 45-52 years, namely 56.3%. Respondents with low education were 65.3%, the rest had secondary education and higher education. There are 60.0% of respondents not working and 92.6% have low income.

Table1. Characteristics of Respondents

Characteristics	n	%
Gender		
Male	27	14.2
Female	163	85.8
Age		
45-52 year	107	56.3
53-60 year	83	43.7
Education		
Low (Not finished/Finished SD)	124	65.3
Medium (Finished SMP/SMA)	57	30.0
High (Bachelor)	9	4.7
Work		
Doesn't work	114	60.0
Work	76	40.0
Income		
Low (< Rp 3.165.519)	176	92.6
High (> Rp 3.165.519)	14	7.4
Total	**190**	**100**

Table2. Frequency Distribution of Respondents Based on Measurements of BMI, WHR and Fasting Blood Glucose

Measurement	n	%
BMI		
Overweight (>23 kg/m^2)	127	66.8
Normal (18.5-22.9 kg/m^2)	50	26.3
Malnutrition (<18.5 kg/m^2)	13	6.8
WHR		
Abnormal (M≥0.90/F≥0.85)	101	53.2
Normal (M<0.90/F<0.85)	89	46.8
Fasting Blood Glucose		
Abnormal (≥126 mg/dL)	29	15.3
Normal (<126 mg/dL)	161	84.7
Total	**190**	**100**

There were 66.8% who had more nutritional status, normal nutritional status as much as 26.3% and the rest had less nutritional status (6.8%). Based on the WHR, the respondents who were categorized as abnormal were 46.8% and normal (53.2%). As many as 15.3% of respondents had abnormal fastingbloodglucoseand 84.7% were normal.

Bivariate Analysis

Based on Table 3 above with the BMI variable, the results showed that 16.5% of respondents were overweight with abnormal fasting blood glucose and 12.7% had normal nutritional status with

Table 3. Bivariate Analysis

Variable	Fasting Blood Glucose				p-value
	Abnormal		Normal		
	n	%	n	%	0.633
BMI					
Overweight	21	16.5	106	83.5	
Normal	8	12.7	55	87.3	
WHR					0.001
Abnormal	24	23.8	77	76.2	
Normal	5	5.6	84	94.4	
Total	29	100	161	100	

abnormal fasting blood glucose. A p-value of 0.633 was found in the statistical analyses using the chi-square test, indicating no significant correlation between fasting blood glucose level and BMI.

Furthermore, 5.6% had normal WHR and abnormal fasting blood glucose, whereas 23.8% had abnormal WHR and abnormal fasting blood glucose level, according to Waist Hip Ratio (WHR) chart. The Chi-square test statistical findings show a substantial correlation between WHR and fasting blood glucose level, with a p-value of 0.001. The results of the Prevalence Ratio (PR) show that the elderly who have an abnormal WHR of 4.230 times will be at risk for increased blood glucose level (95% CI 1.684-10.618).

Respondent Characteristics

The majority of respondents were pre-elderly women (85.8%). The incidence of type 2 DM is often found in women, this is because physically women have the opportunity for a greater increase in BMI and women have a fairly high life expectancy, therefore more elderly women suffer from type 2 DM. Not only that, because progesterone and estrogen level are lowduring menopause, the insulin response will also be lower. The blood insulin response may be increased by the hormones progesterone and estrogen (Arania et al., 2021).56.3% of study participants were pre-elderly, meaning they were aged 45–52 years, while the remaining participants were aged 53–60 years. year. Increasing age can cause changes in the body's physiology, anatomy, and biochemistry, all of which can contribute to increased insulin resistance (Smeltzer, 2014)

Most of respondents (65.3%) had low education, 30% had secondary education and the rest had higher education. The level ofeducationisrelatedtothe individual ability to receive health information. Education level can increase individual knowledge about health. Education is an individual factor in understanding disease, disease management, self-care, and preventing complications through more appropriate treatment (Prawirasatra et al., 2017).

There are 60.0% of respondents not working and the rest are working. A person's work affects his physical activity, someone who does not work will have less physical activity and therefore can lead to the risk of obesity. The type of work can also determine the severity of the activity carried out so it can be said that a person's work affects his physical activity (Septyaningrum and Martini, 2014).

This study also shows that as much as 92.6% of respondents have low income. The level of family income is related to the ability to meet needs, the selection of types of food, and the amount of food, and influences the family's lifestyle (Rumagit et al., 2017).

Relationship Between Body Mass Index (BMI) and Fasting Blood Glucose Level

Based on 190 respondents' responses, data processing using the chi-square test revealed a p-value = 0.633 (p>0.05), indicating that there is no significant correlation between pre-elderly people's body mass index (BMI) and their fasting blood glucose level in the Tanjung Rambang Health Center's working area. With a 95% Confidence Interval (CI) of 0.611-2.774, the prevalence ratio (PR) is 1.302.The findings indicate that although individuals with higher nutritional status often have higher blood glucose level, those with average nutritional status will be less likely to have elevated blood glucose level. Elevated fasting blood glucose level may indicate the possibility of developing diabetes mellitus early on. According to the study's findings, body mass index (BMI) is unable to characterize the distribution or quantity of body fat, nor does it explain how well the body is metabolizing carbohydrates. There are two categories of risk factors for elevated blood glucose level, which are thefirst indication of

diabetes mellitus: those that are unchangeable and those that are modifiable. One modifiable component is the overnutrition status determined by BMI(Anri, 2022).

As many as 83.5% of respondents had BMI which was classified as overweight but normal fasting blood glucose. This may be because the respondents are people who live in rural areas, so they are not too exposed to a large amount of fast food as in big cities. Fast food generally contains high calories, fat, salt, and sugar and is low in vitamins, minerals, and fiber. The high salt content can increase saliva and enzyme secretion, thereby increasing the desire to continue eating. If this is allowed it will increase the risk of obesity. Fast food contains high carbohydrates, when the food enters the body, the body will immediately break down carbohydrates into glucose and put them into the body, this is what can cause the risk of developing diabetes.

This study supports study conducted by Wahyuni et al. (2022)which found no evidence of a significant correlation between fasting blood glucose level and BMI. BMI is a measure of obesity; it does not, however, clearly define how fat is distributed throughout the body. This is consistent with study by Karimah (2018) which found no evidence of a link between fasting blood glucose level and BMI. A person's blood glucose level may be influenced by a variety of things, such as hormones and food consumption. Consumption of carbohydrates is the primary factor influencing blood glucose level during fasting. The findingsofthisinvestigation conflict with those of Santoso et al. (2020) study, which found a substantial correlation between fasting blood glucose level and BMI. Variations in a person's BMI might provide information about changes in their nutritional state. There is a significant correlation between type 2 DM incidence and higher BMI.

Relationship BetweenWaist Hip Ratio (WHR) and Fasting Blood Glucose Level

Based on the results of the study using the chi-square test, showed a p-value = 0.001 (p <0.05), which means that there is a significant relationship between the Waist Hip Ratio (WHR) and fasting blood glucose level in the pre-elderly. Prevalence

Ratio (PR) 4.230 with 95% Confidence Interval (CI) 1.685-10.618. This means that WHR can be used as a sign or risk factor for increased blood glucose level.

WHR is an indicator that can better show the distribution of fat than the amount of total body fat. The results of this study indicate that individuals may experience two types of obesity simultaneously or only one, but individuals who are centrally obese will be at higher risk of experiencing insulin resistance and cardiovascular disease. This means that the higher the WHR, the higher the fasting blood glucose level.

WHR measurement can show the accumulation of fat in the visceral parts of the body. The greater the WHR indicates the presence of excess fat accumulation in the visceral parts of the body which in turn can increase fasting blood glucose level and increase the risk of Diabetes Mellitus and its complications. In people with central obesity, it will cause hypertrophy which has an impact on the development of insulin resistance caused by increased adipose mass resulting in pathological changes in the adipocyte hormone which plays a role in regulating insulin sensitivity(Surywan, 2014).

The findings of this investigation are consistent with the work of (Maria, Rante, and Woda (2020), who found a relationship between blood glucose level and central adiposity. One of the main causes of increased blood glucose levelis insulin resistance, which may be caused by increased body fat. According to research by Septyaningrum and Martini (2014), there is a noteworthy positive correlation between blood glucose and WHR. The research findings of Mulyani and Rita (2016) which found no relationship between WHR and fasting blood glucose level were not supported by this study. However, there is a tendency for people with high blood glucose level to also become fatter people.

CONCLUSION

The majority of respondents (66.8%) were overweight, 53.2% had abnormal WHR, and 15.3% still had abnormal fasting blood glucose levels. The analysis's findings demonstrated that there was no correlation (p=0.633) between BMI and fasting blood glucose level. The association between WHR and fasting blood glucose level is concluded to exist (p=0.001). 4230 PR (1.684-10.618). For seniors who have excess nutritional status and abnormal blood glucose level, maintain their diet by reducing their daily intake of sugar, salt and fat and always monitoring their body weight and blood glucose level to avoid degenerative diseases.

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POTASSIUM LEVELS, ANTIOXIDANT ACTIVITY, AND ACCEPTABILITY OF YELLOW VELVETLEAF (*LIMNOCHARIS FLAVA* (L.) BUCHENAU.) SNACK BAR

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ABSTRACT

Snack food consumption are high in fat and sodium, contributing to the risk of hypertension. One potential solution to this issue is to transform snacks into a more nutritionally superior form, such as snack bars. Previous studies did not thoroughly explore the potassium content of yellow velvetleaf as a potential product for addressing hypertension. This study aimed to investigate the differences in potassium content antioxidant activity and acceptability in snack bars with the addition of yellow velvetleaf flour. This research adopted a true experimental design. The gravimetric method was employed to determine potassium content, while the DPPH method was used to assess antioxidant activity. Statistical analysis of the average potassium content and antioxidant activity revealed significant differences among snack bars with 0%, 5%, 10%, and 15% added yellow velvetleaf flour. The highest average potassium content, 325.67 mg, was observed in the 15% treatment, while the maximum average antioxidant activity reached 21.7%. Considering the acceptability of the snack bars based on liking tests and statistical analysis, the treatment with 10% added yellow velvetleaf flour emerged as the most preferred in terms of taste and texture. The incorporation of yellow velvetleaf flour into snack bars not only increased potassium levels and antioxidant activity but also influenced overall acceptability. Conclusion of this research is the optimal formulation for the yellow velvetleaf snack bar is X2, because of containing a higher acceptance level and contains potassium which could serve as a viable solution to enhance potassium intake following current dietary habits.

Keywords—*antioxidant, hypertension, potassium, snack bars, yellow velvetleaf*

INTRODUCTION

Hypertension is a leading cause of high mortality and morbidity rates globally (Saputra et al., 2023). According to Basic Health Research (2018), the prevalence of hypertension in Indonesia is approximately 31.4%, with the age group of 25 to 34 years accounting for 20.1% of the total population. Hypertension increased risk of various cardiovascular-related diseases such as stroke, heart attack, coronary artery disease, myocardial infarction, accelerated atherosclerosis, congestive heart failure and also affects the risk of kidney failure. (Kaczmarski et al., 2019). Various factors influence hypertension, including lifestyle elements such as physical activity and diet (Elvira & Anggraini, 2019). Presently, the consumption patterns of the Indonesian population are shifting towards Western foods known for their appealing taste and quick processing, such as fast food with high levels of fat and sodium. This preference for practical and efficient options (Nurdiansyah, 2019) is contributing to the high prevalence of hypertension. Notably, the contents found in fast food are also present in snack foods widely available in the market. The demand for snacks is on the rise, particularly among young adults and adolescents (Crofton & Scannell, 2020).

Currently, there is inadequate awareness about the importance of vegetable consumption, particularly yellow velvetleaf (*Limnocharis flava*) known as genjer, an aquatic plant commonly found in shallow water areas like swamps or rice fields, and often regarded as a rice weed (Perkasa & Petropoulos, 2020). Despite being rich in potassium, antioxidants, fiber, and various other nutrients, the utilization of yellow velvetleaf remains suboptimal, limited mainly to dishes such as stir-fry. Additionally, the nutritional benefits of yellow velvetleaf are not widely known. As per the Indonesian Ministry of Health (2019), per

100 g yellow velvetleaf plants boast a potassium content of 905.8 mg. What sets yellow velvetleaf apart from other aquatic plants is its lack of anti-nutritional substances (Sianipar et al., 2022). Potassium, a key component found in yellow velvetleaf, acts as a diuretic, contributing to the reduction of blood pressure. Potassium consumed in large quantities can reduce blood pressure by increasing the concentration of intracellular fluid, thereby drawing fluid from the extracellular (Da Usfa et al., 2023). Body fluid balance and blood pressure that are disturbed due to excess sodium minerals in the body can be suppressed by high potassium content as well (Jacoeb and Abdullah, 2020). Furthermore, the antioxidants present in yellow velvetleaf can play a role in lowering cholesterol levels and supporting normal blood pressure (Saribu et al., 2021).

Better dietary pattern is encouraged to combat hypertension. Increasing potassium intake in the diet by 2-5 gram/day can effectively lower blood pressure in individuals with hypertension, as it aids in regulating sodium balance in the body (Nanda et al., 2021). A viable solution to enhance snack consumption patterns, considering current preferences, is to opt for highly nutritious snacks, such as snack bars enriched with yellow velvetleaf.

Various studies on yellow velvetleaf plants have explored their benefits. For example, Husni *et al.* (2020) focused on creating fiber-enhancing supplements by formulating instant granules from dried powder obtained from yellow velvetleaf stalks (*Limnocharis flava* (L.) Buchenau.). This study highlighted the development of functional foods, specifically with an emphasis on fiber. In another study by Jacoeb & Abdullah (2020) compared potassium and sodium levels in seaweed salt production using yellow velvetleaf, revealing a 0.59 reduction in sodium levels, particularly advantageous for individuals with hypertension. However, the exploration of functional food development from yellow velvetleaf, especially in the form of snacks to address hypertension, remains limited.

Previous research integrated yellow velvetleaf (genjer) formulations into meatball products at 5%, 10%, and 15%, while Silva et al. (2016) studied snack bars with 5%, 10%, 15%, and 20% formulations, indicating enhanced quality.

Inspired by these outcomes and driven by the need to address societal conditions and hypertension, researchers initiated this snack development study. It aims to analyze potassium content, antioxidant activity, and determine the optimal formulation for hypertensive patients based on nutritional content and acceptability.

METHODS

This research employed a true experimental design with a posttest-only control design. The experimental design followed a complete randomized design (RAL) and was conducted between January 2023 and March 2023. The target population for this study covered all individuals within the jurisdiction of the Sumbersari Health Center in Sumbersari District, Jember Regency. The sample size for this study consisted of 30 individuals selected from the general public of the Sumbersari Health Center working area, chosen through the systematic random sampling method. Inclusion criteria were selected based on the incidence of hypertension from basic health research data and data at the Jember district health office. Panelists were chosen based on inclusion criteria, specifically individuals aged 15–34 years residing in the Sumbersari Health Center area of Jember Regency. Exclusion criteria encompassed panelists with allergies to the ingredients used in the yellow velvetleaf leaf snack bar, those who liked or strongly liked yellow velvetleaf leaves and snack bars, individuals over 34 years old, pregnant individuals, and those in ill health. The research process involved multiple locations: the University of Jember RPHP laboratory for yellow velvetleaf flour production, the Jember State Polytechnic food analysis laboratory for potassium testing and antioxidant activity analysis, and the Sumbersari Health Center for acceptability testing.

The research began with producing yellow velvetleaf flour, followed by formulating snack bars added with this flour. Subsequently, laboratory tests were conducted to measure the potassium content and antioxidant activity of both the yellow velvetleaf flour and the resulting snack bars. This phase included a acceptability test to evaluate the overall liking of the snacks. The acceptability test for the yellow velvetleaf snack bars in this

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study used the hedonic scale test, assessing panelist acceptance of taste, aroma, texture, and color components. The test involved 30 untrained panelists. Statistical analyses of the potassium content, antioxidant activity, and the results of the hedonic test, and the calculation of the adequacy of the snack bar content adjusted to RDA.

The primary ingredients for producing yellow velvetleaf flour are yellow velvetleaf leaves and stems. The tools employed in this process include cutting boards, knives, baking sheets, and cabinet dryer ovens. The ingredients for yellow velvetleaf snack bars involve four treatment variations: the control group (0% yellow velvetleaf flour), the experimental groups with 5%, 10%, and 15% yellow velvetleaf flour additions. The components for these bars include wheat biscuits, instant oats, low-fat skim milk powder, rice flakes, honey, and raisins. Tools utilized in the making of yellow velvetleaf snack bars consist of a pot, stove, cutting board, knife, and aluminum foil.

The procedure for making genjer flour is adjusted to previous research in making vegetable flour that has similar characteristics to genjer (Priyanti et al., 2019), with modifications. Yellow velvetleaf flour is made by cutting fresh yellow velvetleaf stems and leaves into small, thin pieces to facilitate the drying process. The drying of yellow velvetleaf leaves is accomplished using a cabinet dryer set at a temperature of 60°C for approximately 7 hours. Subsequently, the dried yellow velvetleaf is sieved using a 40-mesh sieve.

The making of snack bars in this study used a recipe that referred to previous research conducted by (Silva et al., 2016) with modifications. Yellow velvetleaf snack bars involve four treatment levels: the control group (0% yellow velvetleaf flour), the experimental groups with 5%, 10%, and 15% yellow velvetleaf flour additions. The stages of making yellow velvetleaf snack bars include: 1) Weighing the ingredients; 2) Crushing biscuits; 3) Preparing the ratio of biscuits to yellow velvetleaf leaf flour for each formulation: 5% (380 g: 20 g), 10% (360 g: 40 g), 15% (340 g: 60 g); 4) Mixing dry ingredients in a stainless steel container; 5) Heating the binder syrup mixture (honey and raisins) to boiling; 6) Mixing the hot binder syrup into the dry ingredients while stirring until homogeneous; 7) Laminating the dough and letting it rest at room temperature for 4 hours; 8) Cutting

into 6×2 cm pieces weighing approximately 50 g; 9) Packing with aluminum foil.

The next stage is testing the content of potassium and antioxidant activity snack bars in the laboratory then hedonic testing to panelists. The most preferred or accepted snack bar from the hedonic test will be calculated the adequacy of the snack bar content adjusted to the RDA to determine the feasibility of snack bars as a light snack in terms of potassium content.

A One-Way ANOVA test was conducted to analyze the data on potassium content and antioxidant activity, followed by Duncan further test. Meanwhile, acceptability data were analyzed using Friedman analysis and the Wilcoxon signed-rank test. This research was conducted after obtaining ethical clearance from the Health Research Ethics Commission (KEPK) of the Faculty of Public Health, University of Jember, with the number 323/KEPK/FKM-UNEJ/II/2023.

RESULTS AND DISCUSSIONS

The average potassium content and antioxidant activity in yellow velvetleaf leaf snack bars varies depending on the treatment. The potassium content is known through analysis with the gravimetric method in the laboratory. While the DPPH method was used to assess antioxidant activity

Potassium Content Analysis of Snack Bars

This study examined four levels of snack bar treatment: without yellow velvetleaf flour, with 5% yellow velvetleaf flour, with 10% yellow velvetleaf flour, and with 15% yellow velvetleaf

Table 1. Average potassium content and antioxidant activity of yellow velvet leaf snack bars

Parameter	Average potassium content and antioxidant activity yellow velvetleaf snack bars			
	X0 (0%)	X1 (5%)	X2 (10%)	X3 (15%)
Potassium (mg)	21.33[a] ± 1.15	124.67[b] ± 2.52	221.0[c] ± 3.0	325.67[d] ± 3.05
Antioxidant Activity (%)	7.76[a] ± 0.05	14.6[b] ± 0.20	17.63[c] ± 0.30	21.7[d] ± 1.00

X0= 0% yellow velvetleaf flour addition; X1= 5%yellow velvetleaf flour addition; X2= 10%yellow velvetleaf flour addition; X3= 15% yellow velvetleaf flour addition. Description: Different subscript letters indicate significant differences using Duncan further test.

flour. The results showed that as the percentage of yellow velvetleaf flour in the snack bars increased, so did the potassium content. Statistical analysis using the One-Way ANOVA test indicated a significant difference between the treatments, with a p-value of <0.001, confirming that the potassium content varied depending on the yellow velvetleaf flour addition.

The highest average potassium level, 325.67 mg, was observed in treatment X3, representing a snack bar with a 15% addition of yellow velvetleaf flour. Conversely, the lowest average potassium level, 21.33 mg, was found in treatment X0, the control group with 0% yellow velvetleaf flour. The statistical analysis revealed significant differences among the four treatments.

The increase in potassium content with the addition of yellow velvetleaf flour is attributed to the fact that, in the form of flour, an ingredient tends to have better nutritional content compared to its fresh counterpart. According to data from the Indonesian Ministry of Health (2019), 100 gram of fresh yellow velvetleaf contains 905.8 mg of potassium. In this study, laboratory analysis revealed that yellow velvetleaf flour has a higher potassium content compared to fresh yellow velvetleaf, registering 1988 mg per 100 g of flour. Consequently, the addition of yellow velvetleaf flour led to an increase in the potassium content of yellow velvetleaf snack bars.

In line with this study, previous research by Puspaningrum et al. (2019) explored snack bars with the addition of vegetable-based ingredients, specifically moringa flour and soy flour. Their findings indicated that incorporating moringa flour increased the mineral content in snack bars. This increase is attributed to the processing of moringa leaves into flour, resulting in higher mineral content compared to fresh moringa leaves. Consequently, the addition of moringa leaf flour was shown to enhance the mineral content in snack bars. In a related study by Jacoeb & Abdullah (2020), it was noted that the addition of yellow velvetleaf increased the potassium content in seaweed salt. Seaweed salt without yellow velvetleaf had a potassium content of 56.21 mg, whereas seaweed salt with yellow velvetleaf had a potassium content of 115.87 mg.

Antioxidant Activity

The results of the antioxidant activity analysis indicated variations in the average values across different treatments of yellow velvetleaf snack bars without the addition of yellow velvetleaf (X0), with 5% yellow velvetleaf (X1), with 10% yellow velvetleaf (X2), and with 15% yellow velvetleaf (X3). Based on the average antioxidant activity analysis, it can be concluded that the higher the percentage of yellow velvetleaf flour added, the greater the antioxidant activity in the yellow velvetleaf snack bars.

The ANOVA test results indicated, a significant difference between treatments concerning the antioxidant activity of yellow velvetleaf snack bars. To identify specific group differences, Duncan further test was conducted, revealing that the antioxidant activity of X0 significantly differed from that of X1, X2, and X3.

The results in Table 1 show that the average antioxidant activity increases with the percentage of yellow velvetleaf flour added to the snack bar. The highest average antioxidant activity is observed in treatment X3, with the addition of 15% yellow velvetleaf, registering an average antioxidant activity value of 21.7%. Conversely, the lowest average antioxidant activity is in treatment X0, the control group, with an average value of antioxidant activity at 7.76%. The antioxidant activity in yellow velvetleaf snack bars is influenced by yellow velvetleaf flour. Laboratory analysis indicates that 100 gram of yellow velvetleaf flour used in this study has an antioxidant activity of 64.2%.

Similar research conducted by Hastuti & Afifah (2020) focused on sesame seed snack bars with the addition of antioxidants from pumpkin flour. The study revealed that with the incorporation of 5%, 10%, and 15% pumpkin flour, the antioxidant levels in the snack bars increased by 92.207%, 92.263%, and 93.43%, respectively. Another study by Azizaah et al. (2020) indicated that incorporating vegetable-based flour, such as moringa, into snack bars can enhance antioxidant activity. Specifically, the addition of 10 gram and 20 gram of moringa flour increased antioxidant activity by 80.76% and 94.56%, respectively.

Acceptability of Yellow velvetleaf Snack Bar

Taste

The analysis of panelist acceptance, based on the results of the hedonic scale test using the Friedman method for evaluating the taste aspect of yellow velvetleaf snack bars, indicates that the X2 experimental group—representing the yellow velvetleaf snack bar with a 10% addition of yellow velvetleaf—is the most preferred group among panelists. This group received a favorability score of 4.33 (like).

Yellow velvetleaf has a naturally fresh and slightly bitter-sweet flavor (Nion et al., 2018). Based on the results of the hedonic scale test and the Friedman method analysis evaluating the taste aspect of yellow velvetleaf snack bars, the X2 experimental group—representing the yellow velvetleaf snack bar with a 10% addition of yellow velvetleaf—is the most preferred among panelists, receiving a favorability score of 4.33 (like). On the other hand, the X3 experimental group is the least favored, with the lowest average favorability score of 3.43 (somewhat like).

Based on the taste descriptions provided in the comments on the acceptability test form for each treatment, treatment X0 is noted for having a taste that tends to be very sweet, treatment X1 retains a dominantly sweet taste, experimental group X2 offers a sweet and slightly bitter taste from yellow velvetleaf, and experimental group X3 imparts a bitter taste in the oral cavity. From these taste descriptions, it is evident that an increased addition of yellow velvetleaf is believed to contribute to a progressively bitter taste in the snack bar products.

This study aligns with several previous investigations by Nopianti et al. (2019) and Fahlia & Septiani (2020) concerning the addition of vegetable-based flour to snack bars, indicating that an increased addition of vegetable flour tends to intensify the bitterness of the snack bars. Nopianti et al. (2019) research on snack bars with the addition of vegetable-based flour, specifically spinach leaf flour, revealed that panelists did not particularly favor snack bars with a dominant spinach flavor. In contrast, in this study focusing on the addition of yellow velvetleaf flour, panelists demonstrated an acceptance of the taste of snack bars even with a higher percentage of vegetable flour, specifically with the addition of 10% yellow velvetleaf flour (X2).

Aroma

The analysis of panelist acceptance of the aroma of yellow velvetleaf snack bars, with proportions of 0%, 5%, 10%, and 15% in four treatment levels, using the Friedman test method revealed that the most preferred sample was X1—treatment with the addition of 5% yellow velvetleaf. The p-value of 0.002, which is <0.05, indicates a significant difference.

Based on the Friedman method analysis of the aroma acceptance test results for the yellow velvetleaf snack bar, the X1 experimental group, with a 5% addition of yellow velvetleaf, emerged as the most preferred treatment in terms of aroma, garnering a mean favorability value of 4.07 (like). In contrast, the X3 experimental group recorded the lowest mean favorability value of 3.50 (somewhat like). In a prior study by Fahlia & Septiani (2020) on the addition of vegetable plant flour, specifically moringa flour, it was observed that the higher the percentage of moringa flour
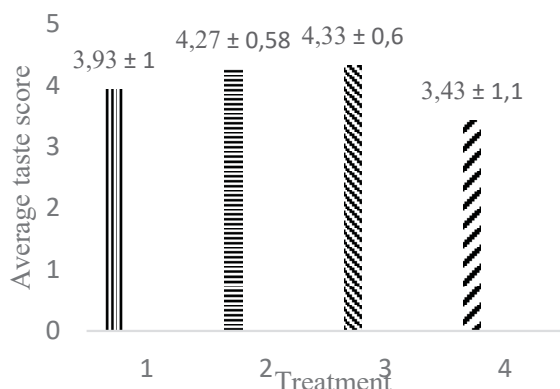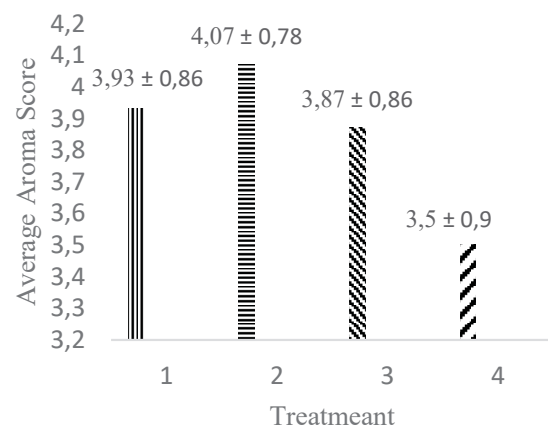

Figure 1 Average taste score

Figure 2 Average aroma score

added, the lower the favorability value of the snack bar product aroma, attributed to the intensified moringa aroma.

Texture

The analysis of panelist acceptance of the texture of yellow velvetleaf snack bars, featuring proportions of 0%, 5%, 10%, and 15% across four treatment levels, using the Friedman test method, revealed that the texture in X2—the formulation with a 10% addition of yellow velvetleaf—was ranked first, signifying the most preferred texture with a mean value of 3.83. The p-value of 0.027, being <0.05, indicates a significant difference.
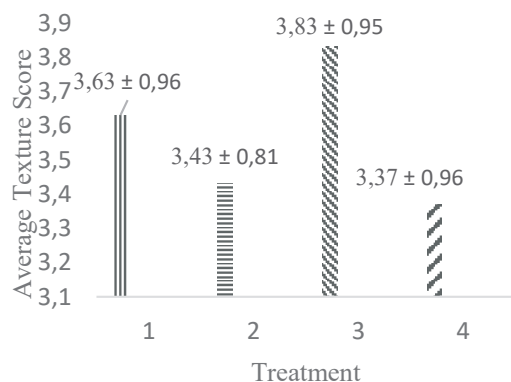

Figure 3 Average Texture Score

Based on the results of Friedman analysis, the texture of the yellow velvetleaf snack bar in the X2 experimental group with the addition of 10% yellow velvetleaf flour is panelist most favored treatment compared to other treatments with the highest mean value of 3.83 (somewhat like). Experimental group X3 had the lowest mean value of 3.37 (somewhat like). The variation in panelist liking for texture can be attributed to the X3 experimental group having the coarsest texture. Meanwhile, the X0 and X1 treatments exhibit a soft texture, and the X2 treatment, as the most preferred experimental group, features the right texture—neither too soft nor too rough.

The texture of the snack bar is influenced by the ingredients used; in X0 and X1, the texture is softer and sticky, while in X2, the texture is denser but not rough like the texture in X3 with the addition of the most yellow velvetleaf flour at 15%. The more yellow velvetleaf flour added, the denser, drier, and rougher the snack bar texture will be. This is suspected to be attributed to the

high fiber content in yellow velvetleaf. Fiber in food can impact the texture, affecting factors such as hardness or density (Henrique et al., 2020). In a different study by Na'imah & Putriningtyas (2021) on pumpkin and red bean snack bars, it was observed that fiber content influences the texture of snack bars; the higher the fiber content, the rougher and harder to swallow the texture becomes.

Color

The results of the analysis of panelists acceptance of the taste of yellow velvetleaf snack bars, with proportions of 0%, 5%, 10%, and 15% in four treatment levels using the Friedman test method, showed a p-value of 0.022, indicating a significant difference (<0.05). The X0 snack bar had the highest average liking value at 4.13 (like). Snack bars without the addition of yellow velvetleaf flour exhibited the lightest color compared to the other experimental groups—X1, X2, and X3—which had a darker color. The addition of yellow velvetleaf flour resulted in a darker and greener color for the snack bars. The green color is presumed to originate from the yellow velvetleaf flour used, as it comes from the stems and leaves, which have a slightly dark green hue.
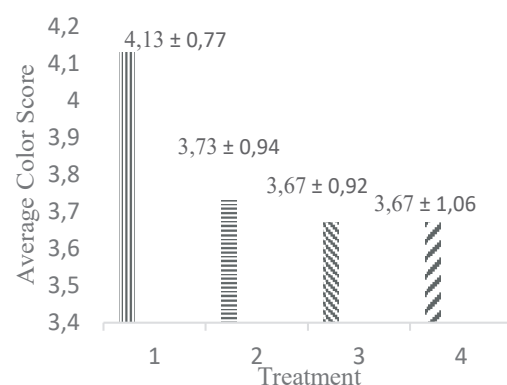
Figure 4 Average Color Score

Previous research on the quality of vegetable leather comparing yellow velvetleaf and pumpkin pulp, conducted by Limbong et al. (2017) with ratios of yellow velvetleaf to pumpkin at 80:20, 60:40, 40:60, and 20:80, indicated that the ratio of yellow velvetleaf to pumpkin significantly affects the color aspect. A higher quantity of yellow velvetleaf pulp results in a product with a higher color index. Another study on snack bars with a

Table 2. Contribution of Potassium Content of Yellow Velvetleaf Snack Bars to the RDA Requirement (% Sufficiency)

Age	Requirement 10% RDA (mg)		Potassium content(mg) per snack bar (50 g)	Recommendation (bar)
	Men	Woman		
16-18 years	530	500	110,5	4-5
19-49 years	470	470	110,5	4

leaf base from plants, specifically moringa leaves, demonstrated that the addition of more moringa leaf flour makes the snack bar green and darker. In that study, panelists preferred snack bars without the addition of moringa leaves (Fahlia & Septiani, 2020). This aligns with the findings of the current study, where the quantity of yellow velvetleaf flour added affects the snack bar color, making it darker, and panelists prefer the color of snack bars without yellow velvetleaf flour.

Potassium Adequacy of Yellow velvetleaf Snack Bars

The selection of yellow velvetleaf snack bars as a snack contributing to meeting Indonesia Recommended Dietary Allowances (RDA) was based on the most preferred treatment in the acceptability test, which was treatment X2, excelling in flavor and texture. According to the Regulation of the Minister of Health of the Republic of Indonesia No. 28 of 2019 concerning RDAs, the recommended potassium intake for Indonesian aged 16-18 years is 5300 mg/day for men and 5000 mg/day for women. For those aged 19-29 years and 30-49 years, the recommended potassium intake is 4700 mg/day for both men and women. The percentage of snacks from the total daily food intake is 10%.

According to The National Heart, Lung, and Blood Institute (NHLBI), the recommended potassium content in snacks (10% of the daily requirement) for adults with hypertension is 470 mg (Ariyanti et al., 2022). The calculation of potassium adequacy, according to the RDA, for the yellow velvetleaf snack bar X2 treatment per bar, as per the table, indicates a % sufficiency of 20.84% - 22.1% for individuals aged 16-18 years and 23.35% for those aged 19-49 years. The potassium content in the yellow velvetleaf snack bars in this research can contribute to meeting the RDA needs as a snack food by 20.84% - 23.35%. The recommended consumption of genjer snack bars in a day is 4-5 bars, the recommended number

of snack bars is not for one serving but can be divided into 2 snack times.

Potassium-containing yellow velvetleaf snack bars can be a solution to increase potassium intake in accordance with the current habits of people related to snack consumption habits, especially as a way to balance sodium intake and excess levels in the body. Yellow velvet leaf snack bars are recommended as a solution to the problem of lack of awareness of fruit and vegetable consumption and as a substitute for snacks because of the preferred of consuming snacks that are usually high in sodium. According to a study conducted by Filippini *et al*. (2020) additional potassium intake from foods such as snacks is better than supplementation because supplementation can cause resistance.

CONCLUSION

The addition of yellow velvetleaf flour to snack bars increased potassium levels and antioxidant activity. However, higher levels of yellow velvetleaf flour affected panelists acceptance in terms of taste, aroma, texture, and color, with the highest addition resulting in lower acceptance levels.

The best formulation for the yellow velvetleaf snack bar is X2, containing potassium, which could be a solution to increase potassium intake aligning with current public habits, particularly in balancing sodium intake. Further studies are needed to explore the potential impact of consuming yellow velvetleaf snack bars on lowering respondents blood pressure.

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DETERMINANT OF HOUSEHOLD FOOD WASTE : A DIRECT MEASUREMENT STUDY IN TANAH SAREAL SUB-DISTRICT OF BOGOR CITY

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ABSTRACT

The percentage of food waste generation has increased in Indonesia for 20 years, with 80% of food waste coming from households. This can cause various significant negative impacts on the environment, economy and social. Various factors affect the production of household food waste. This study aims to analyze household food waste based on its quantity, type, and determinants. This study uses some secondary data from primary research conducted by Swamilaksita (2024) with a cross-sectional design. The study sample of 110 households was selected using a stratified random sampling technique. Food waste data was obtained through direct measurement using the SNI 19-3964-1994 method. The entire data was analyzed descriptively, while multiple linear regression analysis was carried out to determine the determinants of household food waste. This study showed that the average amount of food waste was 318.4 g/HH/day and 76.7 g/cap/day. The cereal group was the most discarded food group, followed by vegetables and fruits group. Only three variables were proven to be statistically significant (p-value<0.1) affect the average amount of household food waste, namely the number of household members (p=0.000), mother work as civil servant/private employee (p=0.049), and purchasing and spending behavior (p=0.084). The conclusion was there is an average amount of food waste in units per household and per capita, with the dominant food group is the cereal group, as well as the determinants of household food waste, including number of household members, mother work as a civil servant/private employee, and purchasing and spending behavior.

Keywords*: amount, determinants, food waste, household type*

INTRODUCTION

Food waste is one of many critical matters against society because it represents the global condition of health, social, economic, and environmental problems. Food Waste Index Report reports an estimated average global food waste of 121 kg/capita/year with 61% of food waste coming from households weighted 74 kg/capita/year (UNEP, 2021). The percentage of food waste generation in Indonesia has increased over the past 20 years. There has been an increase from 39% in 2000 to 55% in 2019 with an average percentage of 44%. The highest number of food waste generation in 2000 – 2019 occurred at the consumption stage amounting to 25 – 73 kg/capita/year with 80% of food waste coming from households (Bappenas, 2021).

West Java Province is the province with the densest population in Java Island and also in Indonesia. Tanah Sareal is one of the sub-districts in Bogor City, West Java Province, which has 64,192 households with the second largest population growth rate (2.08%) in Bogor City (BPS Kota Bogor, 2020, 2021). An increase in population size has the potential increasing food waste generation in an area, particularly at the household level.

Food waste is more often thought to occur due to choices such as over-preparation of food or food negligence resulting in rotten, expired food, or excess food which are not eaten (CEC, 2019). Several categories of food waste are edible and inedible food waste, also referred to as avoidable and unavoidable food waste (van der Werf & Gilliland, 2017; Withanage et al., 2021). Food waste is able to cause various significant negative impacts on the environment, economy, and social sectors (Scalvedi & Rossi, 2021; Withanage et

al., 2021). Those impacts affect food security and become a matter of resource efficiency for healthy diets and sustainable food production (Foley et al., 2011; Willett et al., 2019).

The highest percentage of food waste occurs at the consumption stage in middle and high-income countries, especially at the household level with a value of around 6-20% in developing countries and 26-40% in developed countries. Many reasons underlying this thing, include attitude towards food shopping, storage management, personal preferences, beliefs, lifestyle, and awareness about waste and food preparation or consumption methods (Ghaziani et al., 2021), while other factors include demographic factors, psychographic factors, and socio-economic characteristics such as number of household members and household income that shown to be related to household food waste disposal behavior (Elimelech et al., 2018; Oberlin, 2013). In Indonesian context, the main factors of food waste are culture, poor storage, consumer preferences in selecting food, lack of education to the public, and consumer behavior toward consuming excessive portions of food (Kariyasa & Suryana, 2012).

Many studies related to household food waste with its determinants have been conducted in many developed countries such as UK (Grainger et al., 2018)food waste reduction requires an understanding of the socio-economic (contextual and behavioural, Finland (Koivupuro et al., 2012), and Taiwan (Teng et al., 2021). However, only a few studies related to household food waste and its determinants have been carried out in Indonesia, particularly in urban areas. From these considerations, it is necessary to carry out this research which aims to analyze household food waste based on the amount, type, and determinants of households in Tanah Sareal Sub-District of Bogor City. Knowing the amount and type of household food waste is one of important steps in reducing food waste. Meanwhile, exploring the determinants of household food waste is an effort to prevent the production of food waste by households.

METHODS

This research entirely uses some secondary data from the study "Food Management Behavior to Reduce Food Waste and Its Implications for Urban Household Food Security" by (Swamilaksita 2024) with a cross-sectional design as the research method. This study was held from December 2023 to February 2024 in Tanah Sareal Sub-District of Bogor City. The total sample in this study was 110 households. The sampling was carried out with stratified random sampling technique based on household income data in accordance with SNI guidelines. The inclusion criteria were housewives in age between 30 – 55 years old, willing to be involved in the research until its completion, in good health condition and able to answer the questions well, carry out conventional household management, have a refrigerator and categorized into medium income (S2) and low income (S3) households based on the UMK Bogor City 2024 towards total household income. The terms S2 and S3 are about waste sampling based on household income as stated in SNI 19-3964-1994.

The variable data of this study consisted of household characteristic (demography, education, occupation, and income), food management behavior (planning, purchasing and spending, storage, processing and consumption), and food waste (amount and type). Data on household characteristic and food management behavior were obtained by interviews using questionnaires, while food waste data was obtained by direct measurement using the collective buckets and digital kitchen scale set with an accuracy of 1 g under a capacity of 5 – 10 kg. The food waste collected is leftover food from household which still suitable for consumption (edible food waste) but thrown away in the trash for various reasons.

Demographic variable consisted of age and the number of household members; age consists of the age of father and mother which is categorized into < 40 years and ≥ 40 years while the number of household members consists of father, mother, children, and other members of the family, then categorized into small family (≤ 4 individuals), medium family (5–7 individuals), and large family (≥ 8 individuals). The education variable consisted of the education level of the father and mother seen from the length of completion time of their formal education then categorized into not attending school, not completing elementary school (SD)/equivalent, elementary school (SD)/

equivalent, junior high school (SMP)/equivalent, senior high school (SMA)/equivalent, and higher education level (D1, D2, D3 and S1/equivalent). The occupation variable consisted of the job of father and mother which is categorized into unemployed, laborer, entrepreneur, civil servant/private employee, and others for father occupation; housewife, domestic workers, entrepreneur, civil servant/private employee, and others for mother occupation. The income variable was obtained from the total income of all household members and then categorized based on city minimum wage (UMK) Bogor City 2024 and classified as low household income (<IDR.4,813,988) and medium household income (≥IDR.4,813,988). In this study, there were only two categories for household income because it refers to the inclusion criteria used and follows the setting of primary research conducted by Swamilaksita (2024).

The food management behavior variable is shown within a five-dimensional variable (planning, purchasing and spending, storage, processing and consumption). These behavioral dimensions were assessed by a Likert scale. The total score for each food management behavior is categorized according to the data distribution (a good category if the total score is above the average value and a poor category if the total score is below the average value). Food waste amount was obtained from weighing and direct measurement for 8 consecutive days by using SNI 19-3964-1994 guidelines to seek the average amount of the total food waste per capita (g/cap/day) and per household (g/HH/day) with the calculation formula to find the average amount of food waste per capita presented below (BSN, 1994):

$$\frac{Bs}{u} = \frac{\left(\frac{Bs1}{u} + \frac{Bs2}{u} + \dots + \frac{BsK}{u}\right)}{K} \text{ g/cap/day} = \quad (1)$$

Where :
Bs = weight of food waste measured (grams)
u = number of waste producing units (capita)
K = number of households (110 HHs)

Another equation for calculating the average amount of the total food waste per household is:

$$Bs = \frac{(Bs1 + Bs2 + \dots + BsK)}{K} \text{ g/HH/day} = \quad (2)$$

Where :
Bs = weight of food waste measured (grams)
K = number of households (110 HHs)

The type of food waste was obtained from food waste sorting based on the 12 food groups in Household Dietary Diversity Score (HDDS) and then weighed per each food group (Kennedy et al., 2013). After the weighing is complete, the amount of food waste data taken based on food groups will be processed into the calculation of the amount of food waste per food group in accordance with SNI guidelines with the following formula :

$$Kp = \left(\frac{Bklpangan1 + \dots + BklpanganK}{K}\right) \text{ g/HH/day} = \quad (3)$$

Where :
Kp = food group measured
Bklpangan = weight of food waste per food group measured (grams)
K = number of households (110 HHs)

All variables in this study were put into descriptive analysis by employing SPSS software version 25 for Windows to identify household characteristic, food management behavior, and food waste in the household, whereas the determinants of household food waste were analyzed by multiple linear regression analysis. There is a multiple linear regression equation based on 19 independent variables consisting of household characteristic (age of the father and mother, number of household members, education length of the mother and father, total household income, occupational data of the father: unemployed /laborer/entrepreneur/civil servant and or private employee, and mother: housewife/domestic worker/ entrepreneur/civil servant and or private employee) and food management behavior (planning, purchasing and spending, storage, processing and consumption). The multiple linear regression equation for this study is presented as follows:

$$Y = \beta_0 + \beta_1 X_1 + \dots + \beta_{19} X_{19} + \varepsilon \quad (4)$$

Where :
Y = average amount of total food waste for 8 days (g/cap/day)
β_0 = intercept
$\beta_1 - \beta_{19}$ = regression coefficients

$X_1 - X_{19}$ = independent variable
ε = error, where the error has a normal distribution with 0 mean value and quadratic sigma variety

Multiple linear regression analysis was applied by SPSS 25 for Windows with the stepwise method. Researcher also carried out classic assumption tests such as the normality, multicollinearity, and homoscedasticity test to fulfill several assumptions in using the multiple linear regression analysis. Although the household food waste data used in the multiple linear regression test was not normally distributed with positive skewness, errors around the mean value are considered normal based on the central limit theorem (CLT).

RESULTS AND DISCUSSIONS

Household Characteristic

The household characteristics observed in this study were demographic data (age of the parents and number of household members), education level of the parents, household income, and occupation of the parents.

Table 1. Household characteristic in Tanah Sareal Sub-District of Bogor City

Household Characteristic	n (%)
Father Age (years)	
0 year	8 (7.3)
<40 years	43 (39.1)
≥40 years	59 (53.6)
Mean ± SD	38.2 ± 12.9
Mother Age (years)	
<40 years	69 (62.7)
≥ 40 years	41 (37.3)
Mean ± SD	38.2 ± 6.7
Number of Household Members (individuals)	
Small family	63 (57.3)
Medium family	44 (40)
Large family	3 (2.7)
Mean ± SD	4.4 ± 1.2
Household Income (IDR/month)	
< IDR 4.813.988 (<UMK)	66 (60)
IDR 4.813.988 (UMK)	44 (40)
Mean ± SD	3.731.186 ± 1.211.076

Household Characteristic	n (%)
Father Education	
Not attending school	8 (7.3)
Not completing elementary school (SD)/ equivalent	1 (0.9)
Elementary school (SD)/equivalent	14 (12.7)
Junior high school (SMP)/equivalent	15 (13.6)
Senior high school (SMA)/equivalent	58 (52.7)
College/university	
D1	1 (0.9)
D2	0 (0)
D3	2 (1.8)
S1/equivalent	11 (10)
Mean ± SD	10.4 ± 4.0
Mother Education	
Not attending school	0 (0)
Not completing elementary school (SD)/ equivalent	2 (1.8)
Elementary school (SD)/ equivalent	11 (10)
Junior high school (SMP)/equivalent	28 (25.5)
Senior high school (SMA)/equivalent	51 (46.4)
College/university	
D1	0 (0)
D2	1 (0.9)
D3	6 (5.5)
S1/equivalent	11 (10)
Mean ± SD	10.9 ± 3.2
Father Occupation	
Unemployed	8 (7.3)
Laborer	38 (34.5)
Entrepreneur	13 (11.8)
Civil servant/private employee	34 (30.9)
Others	17 (15.5)
Mother Occupation	
Housewife	87 (79.1)
Domestic worker	4 (3.6)
Entrepreneur	11 (10)
Civil servant/private employee	6 (5.5)
Others	2 (1.8)

Table 1 shows the household sample of this study had an average age of parents between 30–40 years old with most fathers aged ≥40 years (53.6%) and most mothers aged <40 years (62.7%). In this table also shows a 0 year result in the father age (years) which is because there are 8 households that do not have a father or husband so there is no data regarding the father age.

Most of the households fell into category of small family which has less than four family members in one household (57.3%), and the average household income in this study was IDR.3.7 million with majority households fell into category of household income below UMK (60%). The education level of parents was mostly found

at senior high school (SMA)/equivalent level for the fathers (52.7%) and the mothers (46.4%) with an average years of formal education completion of 10 years for both. In parents occupation, most fathers work as laborers (34.5 %) and most mothers work as housewives (79.1%) in this study.

The Food Management Behavior in the Household

The food management behaviors observed in this study were behavioral data related to planning, purchasing and spending, storage, processing, and consumption behavior. Table 2 shows most of the food management behavior by household falls into the good category behavior as shown in the value of purchasing and spending behavior (55.5%), storage behavior (58.2 %), and processing behavior (54.5%). Only two food management behaviors tend to fall into the poor category behavior as shown in the value of planning behavior (52.7%) and consumption behavior (50.9%).

Table 2. The food management behavior in the household of Tanah Sareal Sub-District, Bogor City

Food Management Behavior	n (%)
Planning Behavior	
Poor	58 (52.7)
Good	52 (47.3)
Purchasing and Spending Behavior	
Poor	49 (44.5)
Good	61 (55.5)
Storage Behavior	
Poor	46 (41.8)
Good	64 (58.2)
Processing Behavior	
Poor	50 (45.5)
Good	60 (54.5)
Consumption Behavior	
Poor	56 (50.9)
Good	54 (49.1)

In terms of food planning behavior, most households were only occasionally planning food menus regularly as indicated by the habit of deciding on choosing a food menu when it is time to cook so this is done without planning in prior time. This finding is in line with a study conducted in Turkey that reported half of the households (56.7%) determine the type of food that will be cooked at the moment on the cooking day (Bozdağ & Çakiroğlu, 2021). Besides that, households also never making a shopping list as one of the planning behaviors. Households that do not make that list mostly were low income households. This is similar with study in Pakistan which show that most households with high income always make shopping list (19%) compared to low income households (12%) (Khalid et al., 2023).

An unplanned meal menu (without prior planning) and not making shopping list can have a negative impact on the production of household food waste. An absence of those behaviors can increase the exposure of excessive and unplanned shopping behavior from consumers (Bravi et al., 2020; Stancu et al., 2016). Purchasing so many varieties of ingredients or too much food will lead to too much cooking which will contribute to food waste (Bravi et al., 2019). Therefore, planning behaviors such as meal menu planning ahead of time and creating a shopping list can limit and decrease food waste (Principato, 2018).

Meanwhile, the consumption behavior classified as deficient is shown by several households that are unaware or do not know their household food portions which cause discrepancies in the food portion implementation within their households. The same finding is found from a study conducted on households in Croatia that stated the main reason for food waste in households was the family members did not eat according to their portions (Ilakovac et al., 2018).

There is a role, a good provider makes the parents especially the mother tend to act as a good mother who shows love for her family by her act in purchasing a variety of foods that are considered as healthy and nutritious food in excessive amounts leads to excessive food preparation, and parents cook more often and serve more food than necessities or appropriate consumption portions for their household members, especially for the children (Porpino et al., 2015). Too large portions served on a plate will make someone unfinished the food on their plate (plate waste). Although the leftover meal is still fit for consumption, eventually it will be thrown away as a result of too much food being cooked, prepared, and served rather than consumed (Katajajuuri et al., 2014; Torode et al., 2023).

The Amount and Type of Household Food Waste

Food waste is measured by the SNI 19-3964-1994 method. The average amount of total food waste in 110 households was weighed and calculated per household was 318.4 g/HH/day and per capita was 76.7 g/cap/day. The amount of food waste per household in this study is in line with the amount of household food waste in Cibinong sub-district of Bogor Regency (311.8 g/HH/day) (Diana, 2024) dan Norway (310 g/HH/day) (Hanssen et al., 2016). However, the amount of food waste found in this study was higher compared to a recent finding conducted in Canada (207.6 g/HH/day) (Everitt et al., 2022).

In terms of the amount of food waste per capita, the result of this study is similar to the household food waste amount in Southern Finland (around 63 – 77.8 g/cap/day) (Silvennoinen et al., 2022). Meanwhile, the amount of food waste per capita calculated in this study is found lower than the result of a recent food waste study conducted on households in the United Kingdom (191.8 g/cap/day) (Torode et al., 2023).

Not only calculating the overall amount of food waste, there is also the amount of food waste calculated based on the 12 food groups. Table 3 shows the cereal group (154.5 g/HH/day) is the type of food group which mostly thrown away by all households, followed by the vegetable (54.4 g/HH/day) and fruit group (17.9 g/HH/day).

Table 3. The average amount of food waste based on food group

Food Group	Mean ± SD (g/HH/day)
Cereals	154.5 ± 150.1
White tubers and roots	8.8 ± 18.2
Vegetables	54.4 ± 50.3
Fruits	17.9 ± 46.7
Meat	7.3 ± 11.5
Eggs	2.6 ± 7.9
Fish and other seafood	2.9 ± 5.0
Legumes, nuts, and seeds	17.0 ± 20.3
Milk and milk products	13.0 ± 24.7
Oils and fats	14.8 ± 36.0
Sweets	9.1 ± 17.5
Spices, condiments, and beverages	16.2 ± 47.3
Total	**318.4 ± 225.4**

These results are in line with a study of food waste in urban households showed that cereals are the food group most often thrown away by households (67.8 kg/HH/year) with the kind of cereals that most wasted is rice (Diana, 2024). Figure 1 shows the proportion of food waste based on food groups. Almost half of the food waste thrown away by households comes from the cereal group (48.5%). This group is the staple food of Indonesians, where it comes mostly from grain commodities and contributes the most to the amount of food waste in Indonesia (44.3%) (Bappenas, 2021). Apart from cereal, other food groups that are mostly thrown away or discarded are vegetables (17.1%) and fruits (5.6%).

A study from China also showed that the largest component of food waste came from cereal products (rice, pasta, and bread). The most wasted food group after cereal products are fruits and vegetables (Zhang et al., 2018). In support of this explanation, similar findings on the household food waste composition were also confirmed by previous research conducted in Israel which showed that vegetables and fruits were the most dominant food being discarded by the households (Elimelech et al., 2018).
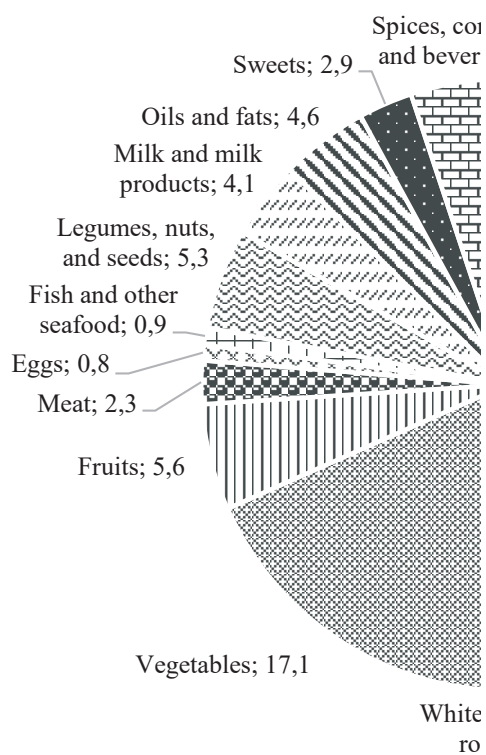

Figure 1. Proportion of the amount of food waste based on food groups (%)

Cereals, vegetables, and fruits are the food groups most consumed by the Indonesian people, including the people in Tanah Sareal District, Bogor City, West Java Province. This is indicated by the consumption of rice exceeding the recommendation (PPH score 58.9%), while the consumption of vegetables and fruits has reached the ideal composition in West Java Province (PPH score 6.1%) (Bapanas, 2024). Indonesian household consumption which is rich in carbohydrate staple foods (cereals) and the high consumption of vegetables and fruits by the community is in line with the large amount of food waste produced from these food groups (Bappenas, 2021).

Determinants of Household Food Waste

This research also analyzes determinants or influential factors to the average amount of total household food waste. There were 19 factors or independent variables analyzed in this study. Overall, of the 19 variables, only three variables were proven to have a significant influence on the overall average amount of household food waste as presented in Table 4.

Table 4 shows the R^2 value (coefficient of determination) of the model as stated to be 0.150, which indicates only 15% of the variability in household food waste is explained by the independent variables. The rest (85%) is unexplained. Table 4 also shows the p-value of each variable which is included in the final regression model. Three variables were proven to be statistically significant with p<0.1, listed as the number of household members (p=0.000), the mother occupation as a civil servant/private employee (p=0.049), and purchasing and spending behavior (p=0.084). Whereas the regression equation model based on household characteristic and food management behavior variables included in the final regression model is:

$$Y = 71.905 - 17.988X_3 - 47.322X_{14} + 1.494X_{16}$$

The regression equation shows a constant value of 71.905, meaning if there were no value in variables of the number of household members, mother occupation (civil servant/private employee), and purchasing and spending behavior,

the average amount of total household food waste will be 71.905 g/cap/day. The regression coefficient values for the number of household members (X_3) is 17.988, the mother occupation (civil servant/private employee) (X_{14}) is 47.322 and the purchasing and spending behavior (X_{16}) is 1.494 indicating that each additional value, the average amount of total household food waste will increase or decrease according to the coefficient values of these variables within the regression equation. The result of the regression equation showed the number of household members has a negative correlation to the average amount of total household food waste.

Table 4. Determinants of household food waste

Variable	B	SE	Sig.
Intercept	71,905	51,109	0.162
Number of household members (X_3)	-17,988	4,636	0.000**
Mother occupation (civil servant/private employee) (X_{14})	-47,322	23,714	0.049**
Purchasing and spending behavior (X_{16})	1,494	0,856	0.084*
R^2	0.150		

* Multiple linear regression test, statistically significant at the 10% level, **statistically significant at the 5% level

The more household members the less average amount of food waste produced by the household. This statement is in line with a study conducted by Giordano et al., which showed that households with one member (single household) throw away more food waste (713.7 g/cap/week) when compared to households consisting of four or more family members (424.5 g/cap/week) (Giordano et al., 2019). In general, the amount of food waste for households with a large number of members is less than a single household or a household of a couple without children while considering the amount per capita (Giordano et al., 2019; Koivupuro et al., 2012).

Mother occupation as a civil servant/private employee also has a negative correlation to the average amount of total household food waste. The more mothers who work as civil servants/ private employees, the less the average amount of food waste produced in the household. In line with results of a study conducted on UK households,

namely that 45% of high food wasters, one of whom was unemployed parents (Lyndhurst et al., 2007). Based on direct observations in the field, mothers who work in an office tend to cook less large portions of meals than mothers who do not work since they only have limited time and energy to process food due to excessive workload. Not excessive meal portions are the cause of less leftover food to be wasted as food waste.

Meanwhile, the purchasing and spending behavior variable has a positive correlation with the average amount of total household food waste. The more purchasing and spending behavior as indicated by higher score behavior, the greater the average amount of household food waste produced. Housewives spend much money on food and often buy healthy but perishable foodstuff (including meat and poultry, vegetables and fruits). High household expenditure on food tends to make many households throw away more food (Hermanussen et al., 2022; Visschers et al., 2016). The excessive purchases of food ingredients also the excessive supply of foodstuffs that are not durable and have a short shelf life will increase the risk of food waste because these foodstuffs will easily damage due to improper storage, prepared and served in too large quantities but eventually not consumed, and not been used correctly (Silvennoinen et al., 2014).

CONCLUSION

The average amount of total food waste from 110 households in unit per household and per capita was found to be 318.4 g/HH/day and 76.7 g/cap/day. The cereal group (154.5 g/HH/day) is the most food group thrown away by households. There are three factors or determinants of household food waste ($R^2 = 0.150$) : (a) number of household members, (b) mother occupation as a civil servant/private employee, and (c) purchasing and spending behavior.

It is necessary to execute education such as campaigns and direct assistance to households in improving the household knowledge regarding food waste and ways to reduce it, especially in the type of food groups that are most often thrown away. Apart from that, there is also a need to assist housewives such as assistance or guidance for making shopping lists and checking food supplies before shopping so they do not pursue excessive purchasing behavior and spending too much on food. This research does not include food waste in the form of liquid such as soup or gravy, so it requires further research to examine these aspects.

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RISK FACTOR FOR STUNTING IN TODDLERS AGED 24–59 MONTHS IN KERSANA PUBLIC HEALTH CENTER WORKING AREA

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ABSTRACT

According to the Indonesia Nutrition Status Survey 2022, Central Java highest stunting rate is in Brebes District. In Brebes Regency, the prevalence of stunting increased by 2.8% between 2021 and 2022. The goal of the study was to investigate the risk factors for stunting in toddlers in the Kersana Public Health Center area between the age of 24 and 59 months. This study employed a quantitative approach using a case-control design. Purposive sampling was used to create a sample set of 90. There are two variables in this study, namely the dependent variable (stunting) and the independent variables (family income, mother and father education, immunization, LBW, PBL, birth spacing, mother SEZ status during pregnancy, environmental sanitation, energy and protein intake, IMD, exclusive breastfeeding, complementary feeding, history of diarrhea and respiratory tract infections). The binary logistic regression test on multivariate analysis and the chi-square test were utilized in the bivariate analysis test. The study findings indicated that the following variables were linked to the incidence of stunting: immunization status (p-value=0.000), family income (p-value=0.000), environmental sanitation (p-value=0.000), history of diarrhea (p-value=0.030), early breastfeeding initiation history (p-value=0.006), history of exclusive breastfeeding (p-value=0.003), history of complementary feeding (p-value=0.000), energy intake (p-value=0.000), and protein intake (p-value= 0.001). According to the research, immunization status and energy intake are the two risk variables that have the most significant effects on stunting in children between the ages of 24 and 59 months.

Keywords: energy intake, environmental sanitation, immunization status, stunting

INTRODUCTION

In developing countries, stunting is one of the chronic nutritional issues that arise. WHO (World Health Organization) defines stunting as being of a low height compared to the age of the child. It is characterized by height for age z-score <-2SD, which is classified as stunted, and <-3SD, which is classified as severely stunted. Stunting arises from repeated infections and chronic starvation throughout the first 1000 days of life (Kementerian Desa Pembangunan Daerah Tertinggal dan Transmigrasi, 2017). The causes of stunting are related to poverty, poor maternal nutrition, frequent exposure to infectious diseases, and improper intake and care early in life.

Indonesia is the second country in the Southeast Asia region with the greatest incidence of stunting (United Nations Children's Fund (UNICEF), 2021). According to the Indonesian Nutrition Status Survey (SSGI) statistics from 2022, stunting was prevalent in 2021 (24.4%) decreased by 2.8% in 2022 (21.6%). RPJMN 2020-2024 states that stunting is a national priority issue, with a significant reduction target to 14% by 2024. Central Java has a stunting prevalence of 20.8% based on SSGI 2022. This figure does not indicate the achievement of the stunting prevalence target that has been set.

Brebes Regency in Central Java has the highest rate of stunting. The stunting prevalence in Brebes Regency in 2022 was 29.1%. Brebes Regency experienced an increase in the stunting prevalence rate of 2.8% from 2021 (26.3%) to 2022 (29.1%). Kersana sub-district is one of the sub-districts that is focused on reducing stunting rates in the Gotong Royong Prevent Stunting program in Brebes District in 2022. Kersana sub-district only has one public health center in its area. Based on the Kersana Public Health Center nutrition report, the villages with the highest

stunting rates are Ciampel Village, with 33 stunting children (20.37%), and Sutamaja Village, with 39 stunting children (19.2%). The village with the lowest stunting rate is Kersana Village, which has 16 (6.17%).

Stunting that occurs in children has long-term effects that can interfere with children's growth and development. Increased risk of infection and non-communicable illnesses, poor cognitive development, elevated risk of overweight or obesity, increased morbidity and mortality, and decreased work ability and productivity are some of the possible effects (Soliman et al., 2021). Cognitive development in stunted children decreases by 7% compared to normal children (Ekholuenetale et al., 2020)

Many interrelated factors influence stunting that occurs in children. Factors causing stunting consist of parental education, birth length, birth weight, birth spacing, the past of complementary feeding, the past of exclusive breastfeeding, the past of early breastfeeding initiation, the past of infectious illnesses, immunization status, family income, maternal chronic energy deficiency status during pregnancy, environmental sanitation, energy intake, and protein intake (Ariati, 2019; Sari et al., 2020).

Based on these problems, the researcher intends to research the causal risk factors of the incidence of stunting in three villages in the Kersana Public Health Center working area with the target of toddlers aged 24–59 months. This study aims to analyze correlation between each variable of the factors that cause stunting and the incidence of stunting in children under 24–59 months of age. This research needs to be done to add information and insight into the causes of stunting and the explanations obtained from respondents. Novelty related to child data that affects the indication of the main risk factors for stunting and the absence of research related to the risk of stunting in the area studied.

METHODS

A case-control design was employed in the analytical observational research type. The purpose of researchers using this research design is to study risk factors using a retrospective approach. Case samples were children aged 24–59 months

with height/age ≤-2 SD, and control samples were children aged 24–59 months with height/age >-2 SD in three villages in the Kersana Public Health Center working area.

In this study, the dependent variable is stunted children aged 24–59 months. The independent variable consists of two categories, namely indirect factors and direct factors. Indirect factors of stunting include socioeconomic factors (family income, mother education, father education), access to health services (immunization status), maternal health (birth weight, birth length, birth spacing, maternal SEZ status during pregnancy), and environmental factors (environmental sanitation). Direct factors of stunting include inadequate nutritional intake (energy intake and protein intake), inappropriate feeding practices (early breastfeeding initiation, exclusive breastfeeding, complementary feeding), and history of infection (diarrhea and respiratory tract infection).

The minimum sample calculation uses a two-proportion sampling technique with the Lameshow formula (1990). The sampling technique with a 95% confidence degree (1.96) and 80% test strength (0.84) with OR = 6.96 (Alfian S. Abas et al., 2021) resulted in a sample of 41 children with an additional 10% to anticipate dropouts so that the minimum sample was 45 children. The ratio of the number of cases and controls is 1:1, so the total number is 90 respondents. Respondents must match the age of 24–59 months, be residents of a village in the working area of the Kersana Public Health Center, and must have a regular attendance list at the integrated service post (Posyandu).

The Chi-square test was used in a bivariate analysis to ascertain the extent of risk factors influencing the prevalence of stunting in relation to the Odds Ratio. Fisher exact test analysis was used if the chi-square test did not meet the requirements. To determine the causative factors that most affect the incidence of stunting in the three villages, multivariate analysis employing the logistic regression test is used. The likelihood of stunting in children is calculated using probability depending on the outcomes of multivariate analysis. This study was approved by ethical clearance number 446 from the health research ethics committee (KEPK) of Semarang State University.

Probability Calculation

$$y = \text{constant} + a1x1 + a2x2$$
$$p = 1/(1 + \exp(-y))$$

RESULTS AND DISCUSSIONS

Table 1. Univariate Analysis (Indirect Factors)

Variable	n	%
SOCIOECONOMIC FACTORS		
Family Income		
Low (≤ Rp 2.018.836)	50	55.6
Sufficient (> Rp 2.018.836)	40	44.4
Mother Education		
High (≥ High School Graduate)	28	31.1
Low (< High School)	62	68.9
Father Education		
High (≥ High School Graduate)	32	35.6
Low (< High School)	58	64.4
ACCESS TO HEALTH SERVICES		
Immunization Status		
Complete	51	56.7
Incomplete	39	43.3
MATERNAL HEALTH		
Birth Length		
Normal (≥ 48 cm)	75	83.3
Stunted (< 48 cm)	15	16.7
Birth Weight		
LBW (< 2500 gram)	4	4.4
Normal (≥ 2500 gram)	86	95.6
Birth Spacing		
< 3 years	6	6.7
≥ 3 years	84	93.3
Maternal SEZ status during pregnancy		
SEZ	6	6.7
Normal	84	93.3
ENVIRONMENTAL		
Environmental sanitation		
Healthy (≥ 1068)	33	36.7
Unhealthy (< 1068)	57	63.3

Table 2. Univariate Analysis (Direct Factors)

Variable	n	%
Inadequate nutritional intake		
Energy intake		
Sufficient (≥ 100% AKG)	55	61.1
Low (< 100% AKG)	35	38.9
Protein Intake		
Sufficient (≥ 100% AKG)	65	72.2
Low (< 100% AKG)	25	27.8

Variable	n	%
INAPPROPRIATE FEEDING PRACTICES		
Early Breastfeeding Initiation		
Yes	82	91.1
No	8	8.9
Exclusive breastfeeding		
≥ 6 months	53	58.9
< 6 months	37	41.1
Complementary Foods		
On Time (6 months)	49	54.4
less or more than 6 months	41	45.6
HISTORY OF INFECTION		
History of Diarrhea		
Yes	78	86.7
No	12	13.3
History of respiratory infection		
Yes	7	7.8
No	83	92.2

Description of Univariate Analysis

Table 1 shows the frequency distribution of each variable studied. Babies born with normal length were 83.3%, and babies born short were 16.7%. There were more normal-weight babies (95.6%) than low-birth-weight babies (4.4%). Higher education in parents is less than low education. Fathers do higher education than mothers. High-education mothers (31.1%) and fathers (35.6%), low-education mothers (68.9%) and fathers (64.4%).

More mothers under five years old gave birth to children ≥ 3 years apart (93.3%) than mothers who gave birth to children < 3 years apart (6.7%). More children received early breastfeeding initiation (91.1%) than those who did not. Children who were exclusively breastfed were more likely (58.9%) than children who were not exclusively breastfed (41.1%). More children were given complementary foods on time (60%) than children who were not given complementary foods on time (40%).

There were more children with a history of diarrhea (86.7%) than children without a history of diarrhea (13.3%). Children with a history of respiratory infections were 7.8%, and children without a history of respiratory infections were 92.2%. Immunization status was declared incomplete if the toddler did not have consecutive immunizations until the age of 18 months, according to those in the mother and

child health book. Children who received complete immunization were 56.7%, and children who did not receive complete immunization were 43.3%. Mothers experienced chronic energy deficiency (CED) if the upper arm circumference (MUAC) was < 23.5 cm and standard if the MUAC was ≥ 23.5 cm. Mothers of toddlers showed the occurrence of SEZ by 6.7% and normal nutritional status by 93.3%.

The study of family income in the respondents showed that family income tended to be low, with a percentage of 55.6% and sufficient family income of 44.4%. Respondents who had a living environment with environmental sanitation were classified as healthy at 36.7%, and those classified as unhealthy were classified at 63.3%. Nutritional adequacy in toddlers is divided by age, namely age 1-3 years and age 4-6 years. Energy intake in the group of children aged 1-3 years was 1350 kcal, and in the group of toddlers aged 4-6 years was 1400 kcal. The energy intake of toddlers categorized as sufficient tends to be more (61.1%) compared to the energy intake of toddlers categorized as less (38.9%). The nutritional adequacy rate in toddlers is divided by age, namely age 1-3 years and age 4-6 years. Protein intake in the group of children aged 1-3 years was 20 grams, and in the group of children aged 4-6 years was 25 grams. Protein intake of toddlers categorized as sufficient tends to be more (72.2%) compared to energy intake of toddlers categorized as less (27.8%).

The Relationship Between Indirect Risk Factors and Stunting

Socioeconomic Factors

Mother education (p-value = 0.255) and father education (p-value = 1.000), indicating that there is no discernible link between the prevalence of stunting and the educational attainment of the mother and father. These results are similar to research conducted by Mustajab & Romdiyah (2023), It demonstrated that the frequency of stunting and mother education did not correlate (p=0.749). The study findings are consistent with studies conducted in three villages within the Sumberbaru Jember Public Health Center operational region, which found a p-value of 0.128 for the father education variable, which means that the father education does not have a meaningful correlation with the incidence of stunting (Rufaida et al., 2020).

The prevalence of stunting is correlated with family income (p-value = 0.000; OR 7.000; 95% CI = 2.742 - 17.867), indicating that toddlers from low-income homes are seven times more likely to be stunted than toddlers from high-income families. These findings concur with the study carried out by Akbar & Ramli (2022), It indicates that children are 2.6 times more likely to be stunted in families with low incomes. Aida (2019) suggests that the incidence of stunting decreases with increasing household income. This can occur because low family income makes it difficult to provide food that meets the nutritional needs of toddlers (R. M. Sari et al., 2020). A healthy income allows for the provision of delicious, high-quality food for every member of the family. The opposite can happen if sufficient income is not matched with sufficient nutritional knowledge. Families who do not consider adequate nutritional needs only choose food ingredients based on taste rather than nutritional aspects, even though the family income is sufficient.

Access to Health Service

Immunization status is associated with stunting (p-value = 0.000; OR = 35.875; 95% CI = 10.338-124.488), meaning that children who do not get complete immunization are 35.875 times at risk of stunting. This research was also carried out by Darmawan et al. (2022), who states that incomplete immunization has a 4.3 times risk of stunting. Immunization is given to increase immune system. In follow-up interviews conducted, there were several reasons why toddlers did not get complete immunizations. These reasons include children side effects, such as fever and the COVID-19 pandemic, as well as family influence. Toddlers who do not get complete immunizations tend to be easily infected with diseases, which results in decreased appetite in toddlers. Infections that occur repeatedly cause a rapid loss of energy (Theresia & Sudarma, 2022).

Maternal Health

Table 3 demonstrates that the occurrence of stunting is unrelated to birth length (p-value = 0.090). These results are similar to research

conducted by Dasantos & Dimiati (2020), It demonstrated that the frequency of stunting was unrelated to birth length.

Birth weight was not associated with the incidence of stunting (p-value = 0.616). These results are similar to research conducted by Trisiswati et al. (2021) which showed that there was no relationship between birth weight and the incidence of stunting, but toddlers born with low birth weight had a 1.65 times risk of stunting.

Birth spacing is not related with the incidence of stunting (p-value = 0.677). The study conclusions align with Trisyani et al. (2020), It revealed no association between the frequency of stunting and the spacing of births.

Stunting incidence was unrelated to pregnant women chronic energy deficient status (p-value = 0.677). Chronic energy deficit brought on by inadequate food intake in adolescence is characterized by a lack of energy reserves for a long time, which can be measured by upper arm circumference (Uswatun et al., 2021).

Environmental

Stunting prevalence is correlated with environmental sanitation (p-value = 0.000; OR = 9.75; 95% CI = 3.425-27.755), indicating that the likelihood of stunting in children living in unsanitary environments is 9.75 times higher. These results was also conducted by Wahdaniyah et al. (2022), It indicates that children who grow up in unsanitary environments are 2.949 times more likely to suffer from stunting. According to the interview results, unsanitary environmental conditions is caused by many things, such as the unavailability of trash bins, waste processing by burning, disposal of neighborhood garbage (near the river), room windows that are rarely opened, and disposal of baby feces not in the toilet. The state of environmental sanitation is also related to infectious diseases that occur in toddlers. An environment that does not meet health requirements allows children to get diseases such as diarrhea, worms, and ARI. Toddlers with poor water and sanitation conditions experience diarrhea more often (Lobo et al., 2019). Environmental sanitation is part of nutrition-sensitive interventions to support stunting reduction.

The Relationship Between Direct Risk Factors and Stunting

Inadequate Nutritional Intake

Energy intake is associated with stunting (p-value = 0.000; OR 11.781; 95% CI = 4.206-33.808), meaning that children who do not get enough energy intake are 11.781 times at risk of stunting. These results was also conducted by Aisyah and Yunianto (2021), This indicates that children who consume inadequate amounts of energy are 6.111 times more likely to have stunting. Toddler development and growth can be optimised when their dietary needs are met. The results of the study found that toddlers have a frequency of eating 2-3 times a day, drinking formula milk, proteins that are often consumed, eggs and chicken, and often consuming snacks. The nutritional rate of adequacy for toddlers aged 1-3 years is 1350 kcal/day, while toddlers 4-6 years are 1400 kcal/day. Research showing correlation between energy intake and nutritional status concluded that the better the energy intake in toddlers, the more regular the nutritional status (Azmy & Mundiastuti, 2018). Balanced food intake can determine the achievement of health, and the total adequacy of food consumed is a determinant of toddler growth.

Protein intake is associated with stunting (p-value = 0.001; OR = 6.4; 95% CI = 2.13-19.227), meaning that children who do not get enough protein intake are 6.4 times at risk of stunting. These results was also conducted by Fikawati et al. (2021), states that children whose protein intake is insufficient have four times the risk of stunting. Protein is essential for cell development in the body and maintaining human immunity. Children need protein for their growth period. In general, proteins are needed for growth, the synthesis of structural elements, and the production of antibodies (Azmy & Mundiastuti, 2018). The findings from the interviews with toddler mothers show that protein intake is less than the child nutritional adequacy rate can be caused by the amount of snack intake consumed by children (ice cream, donuts, chiki, biscuits), some children do not want to eat fish or chicken because of its texture, frequent consumption of instant noodles, and prefer to drink sweetened condensed milk rather than regular formula milk.

These findings concur with the study carried out by Tenriwati et al. (2019), children tend to consume instant food more often than protein, lack of drinking milk, and many children do not like fish.

Inappropriate Feeding Practice

Early Breastfeeding Initiation history is associated with the incidence of stunting (p-value = 0.006). The study findings are consistent with studies conducted by Lintang and Azkiya (2022), demonstrated a strong correlation between the occurrence of stunting and the history of early breastfeeding initiation (p-value = 0.019). The similar result was observed in another study, which linked the occurrence of stunting to the history of

early breastfeeding initiation (Punuh et al., 2021). Early breastfeeding initiation is a determinant of successful breastfeeding, as it ensures that children get the proper nutritional intake. Early breastfeeding initiation ensures that babies get colostrum, which can increase children immunity to infection (Muldiasman et al., 2018).

Exclusive breastfeeding history was correlated with stunting (p-value = 0.003; OR 4.230; 95% CI = 1.718-10.416), indicating that the risk of stunting was 4.23 times higher for children who were not breastfed exclusively. The study conclusions align with Samuel Rabung et al. (2021), It revealed that the incidence of stunting was 2.875 times higher for kids who were not fed only breast milk.

Table 3. Bivariate Analysis Results (Indirect Factors)

Variable	Stunting		Non Stunting		p-value	OR	95% CI	
	n	%	n	%			Lower	Upper
Socioeconomic Factor								
Family Income								
Low (< Rp 2.018.836)	35	77.8	15	33.3	0.000*	7.000	2.742	17.867
Sufficient (≥ Rp 2.018.836)	10	22.2	30	66.7				
Mother Education								
Low (<High school)	34	75.6	28	62.2	0.255			
High (≥ High School Graduate)	11	24.4	17	37.8				
Father Education								
Low (<High school)	29	64.4	29	64.4	1.000			
High (≥ High School Graduate)	16	35.6	16	35.6				
Access To Health Service								
Immunization Status								
Incomplete (< 18 months)	35	77.8	4	8.9	0.000*	35.875	10.338	124.488
Complete	10	22.2	41	91.1				
Maternal Health								
Birth Length								
Stunted (< 48 cm)	11	24.4	4	8.9	0.090			
Normal (≥ 48 cm)	34	75.6	41	91.1				
Birth Weight								
LBW (< 2500 gram)	3	6.7	1	2.2	0.616			
Normal (≥ 2500 gram)	42	93.3	44	97.8				
Birth Spacing								
< 3 years	4	8.9	2	4.4	0.677			
≥ 3 years	41	91.1	43	95.6				
Maternal SEZ status during pregnancy								
SEZ (< 23,5 cm)	4	8.9	2	4.4	0.677			
Normal (≥ 23,5 cm)	41	91.1	43	95.6				
Environmental								
Environmental Sanitation								
Unhealthy (< 1068)	39	86.7	18	40.0	0.000*	9.75	3.425	27.755
Healthy (≥ 1068)	6	13.3	27	60.0				

(*significant α = 0.05)

Table 4. Bivariate Analysis (Direct Factors)

Variable	Stunting		Non Stunting		p-value	OR	95% CI	
	n	%	n	%			Lower	Upper
Inadequate Nutrition Intake								
Energy Intake								
Low (< 100% AKG)	29	64.4	6	13.3	0.000*	11.781	4.206	33.808
Sufficient (≥ 100% AKG)	16	35.6	39	86.7				
Protein Intake								
Low (< 100% AKG)	20	44.4	5	11.1	0.001*	6.4	2.13	19.227
Sufficient (≥ 100% AKG)	25	55.6	40	88.9				
Inappropriate Feeding Practice								
Early Breastfeeding Initiation								
No	8	17.8	0	0.0	0.006*			
Yes	37	82.2	45	100.0				
Exclusive Breastfeeding								
< 6 months	26	57.8	11	24.4	0.003*	4.230	1.718	10.416
≥ 6 months	19	42.2	34	75.6				
Complementary Foods								
Less or more than 6 months	30	66.7	11	24.4	0.000*	6.182	2.464	15.512
On time 6 months	15	33.3	34	75.6				
History of Infection								
History of Diarrhea								
Yes	43	95.6	35	77.8	0.030*	6.143	1.262	29.895
No	2	4.4	10	22.2				
History of Respiratory Infection								
Yes	6	13.3	1	2.2	0.110			
No	39	86.7	44	97.8				

(*significant α = 0.05)

Children who consume exclusive breast milk may lower the likelihood of stunting because breast milk contains digestive enzymes that are easily digested and absorbed by babies (Azizah et al., 2022). Lactose is present in breast milk which functions to increase calcium absorption in the baby body. Lactose is essential for growth and health. This is because lactose provides about 40% of the baby energy needs (Heine et al., 2017) including the establishment of Bifidobacterium-rich fecal microbiota. In many populations, lactase levels decline after weaning (lactase non-persistence; LNP. Along with preventing dangerous food and water, breast milk contributes to the immune system that shields infants from infections, including diarrheal illnesses (Tello et al., 2022)feeding practices, and stunting in indigenous children. This study aimed to analyze the prevalence of breastfeeding and complementary feeding practices and explore their association with stunting in Ecuadorian indigenous children under two years of age. Methods: Cross-sectional study of secondary data analysis using the 2012 Ecuador National Health and Nutrition Study, in 625 children aged 0–23 months (48,069 expanded sample. Research conducted by Pramulya et al. (2021) demonstrates that infants who are fed formula milk have a lower height on the development curve than newborns who are breastfed exclusively. Locitasari (2015) stated that the growth of formula-fed infants had a 5.45 risk of experiencing poor growth than exclusively breastfed infants. The results of follow-up interviews related to exclusive breastfeeding found several reasons mothers did not give exclusive breastfeeding for their children. Mothers gave reasons for producing little breast milk: children often cry, so they are given food such as bananas; mothers think children want to eat because they cry; mothers want their children to get used to

eating food, and the influence of parents and mother-in-law in making decisions.

The occurrence of stunting is correlated with the history of complementary feeding. (p-value = 0.000; OR = 6.182; 95% CI = 2.464-15.512), meaning that children who do not get complementary food on time are 6.182 times at risk of stunting. These results are in line with research conducted by Virginia et al. (2020), which showed that children who were given complementary foods not on time had a 4.583 times risk of stunting. Complementary foods are given in a timely manner at the age of 6 months (Mayangsari et al., 2023). Short-term interview results revealed that the causes of mothers provide complementary foods at an early age were due to children who often cried, mothers who thought the children were hungry, and the influence of families who lived together (mother/father/parents). These findings are consistent with studies carried out by Virginia et al. (2020), which states that the reason mothers give complementary foods to children under six years of age is that children are fussy and mothers think children are hungry.

History of Infection

A history of diarrhea is associated with stunting (p-value = 0.030; OR 6.143; 95% CI = 1.262-29.895), meaning that children who have a history of diarrhea are 6.143 times at risk of stunting. These findings are consistent with studies carried out by Desyanti and Nindya (2017)whereas children in non stunting group had the diarrheal disease rarely (57.6%, It indicates that children with a history of diarrhoea are 3.619 times more likely to be stunted. Children who experience diarrhea will lose their appetite, so nutrient intake is reduced and cannot be adequately absorbed by the body. This condition can cause children weight to decrease slowly and be followed by stunted height growth (Firmansyah et al., 2023). Diarrhea can occur due to consumption of contaminated food or drinks and poor hygiene behavior. In follow-up interviews conducted, there are several reasons toddlers experience diarrhea. The mother gave the reason for the diarrhea: a neighbor gave the child snacks, the child likes to bite his toys and drink ice, the child nails are sometimes not cut, and the child often plays with sand or soil. These

poor hygiene practices can raise the chance of contracting infectious diseases characterized by disruption of appetite, nausea, vomiting, and diarrhea.

Stunting incidence is not correlated with a history of respiratory infections (p-value=0.110). The findings of this study are consistent with those of studies carried out by Al-firdausyah et al. (2021) in the Patimpeng Public Health Center working area, demonstrating that the incidence of stunting had no correlation with the history of respiratory illnesses (p=0.839).

Tabel 5. Multivariate Analysis Results

Variable	B	OR	95% CI	p-value
Immunization Status	-2.975	0.051	0.012-0.210	0.000
Energy Intake	-2.637	0.072	0.015-0.343	0.001
Constant	4.481			

Table 5 demonstrates that vaccination status is the factor that most affects the incidence of stunting in children between the ages of 24 and 59 months. There is a strong correlation between immunization status and the incidence of stunting (p-value=0.000, p<0.05), the results of the OR (Odds Ratio) statistical test are 0.051 (95% CI: 0.012-0.210), It demonstrates that toddlers with inadequate immunization status had a 5.1% higher likelihood of stunting than toddlers with complete immunization status. The following most influential variable is energy intake, with a p-value of 0.001 and an OR value of 0.072 (95% CI: 0.015-0.343); these results indicate that inadequate energy intake of toddlers has a 7.2% chance of being stunted compared to toddlers with adequate energy intake. OR < 1 suggests that both factors are classified as preventive factors, which, Stunting is less likely to occur in the child if it can be prevented. Based on the calculation of the results, the probability of children who have incomplete immunization and low energy intake experiencing stunting is 98.8%.

CONCLUSION

In the work area of the Kersana Public Health Center, factors linked to the prevalence of stunting in children between the ages of 24 and 59 months are the history of early breastfeeding initiation, history of exclusive breastfeeding,

history of complementary feeding, history of diarrhoea, immunization status, family income, environmental sanitation, energy intake, and protein intakeThe two main factors influencing the occurrence of stunting are energy intake and immunization status.

Researchers advise families, especially mothers, to pay attention to the food consumed by children to match the nutritional needs of children based on the established nutritional adequacy rate. Parents should provide complete immunization of children.

ACKNOWLEDGEMENT

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SOIL-TRANSMITTED HELMINTH INFECTION AND MACRONUTRIENT INTAKE AMONG STUNTED TODDLERS IN PANTI SUB-DISTRICT, JEMBER

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ABSTRACT

Soil-transmitted helminth (STH) infections are one of the most common infectious diseases in the developing world, with prevalence rates as high as 65%. STH infections generally affect the digestive system, which can reduce appetite and nutrient absorption. This study aimed to determine the association between STH infection and macronutrient intake in stunted toddlers aged 12-36 months in Panti Sub-district, Jember Regency. This study used observational analysis method with cross-sectional approach. The total number of subjects was 83 stunted toddlers. Data on STH infection were collected through fecal examination and 2x24 hour food recall questionnaire to assess their macronutrient intake. This study showed that the prevalence of STH was 4.8% with species identified in the examinations such as Ascaris lumbricoides (2.4%) and hookworm (2.4%). The majority of macronutrient intake was considered sufficient for protein (77.1%), deficit for carbohydrate (94%) and fat (77.1%). Bivariate analysis using the contingency coefficient correlation test showed that there was no significant correlation between STH infection and macronutrient intake. Macronutrient intake may be influenced by other factors such as the role of parents in preparing nutritious food, economic status, and mild degree of infection. However, the underlying mechanism remains unclear and should be further investigated.

Keywords*: macronutrient, soil-transmitted helminth, stunted, toddlers*

INTRODUCTION

Soil-transmitted helminth (STH) infections are one of the most common infectious diseases in the developing countries. STH infections belong to the group of diseases often neglected by the public. STH species that commonly cause infections in stunted toddlers include *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworms (*Necator americanus and Ancylostoma duodenale*) (Zeynudin et al., 2022). The prevalence of STH infection in Indonesia is still high, ranging from about 45 percent to 65 percent, and can even reach as high as 80 percent in areas with poor sanitation (Nasution et al., 2019). Meanwhile, other developing countries such as Ethiopia, Nigeria, and Gabon show lower prevalence of 67.4%, 54.8%, and 42%, respectively (Edoa et al., 2024; Geleto et al., 2022; Karshima, 2018). Data from Jember District Health Office in 2016 indicated

that there were 109 cases of STH infection in Jember (Baidowi et al., 2019).

Toddlers are a high risk group for infection with some factors may contribute the incidence of infections, including their medical history and stunting (Sunarpo et al., 2023). infected toddlers usually become malnourished and anemic due to the resulting nutritional deficiencies (Kabatende et al., 2020). Diagnosis of STH infection is established through microscopic fecal examination in the laboratory with a positive result when found one or more worm eggs (Khurana et al., 2021).

Stunting is characterized by the below the norm length or height of toddlers for their age based on the World Health Organization (WHO) growth curve (Elmighrabi et al., 2024). According to data from the Indonesian Nutrition Status Survey (SSGI) in 2022, the prevalence of stunting in East Java was found to be 19.2%, with Jember

district having the highest prevalence of 34.9% (Kemenkes, 2023). The prevalence of stunting in Panti sub-district is relatively high, reaching 56.2% (Ainy, 2020).

Previous studies shows that prevalence of stunted toddlers with STH infection (59,4%) is higher than those without STH infection. (Yoseph & Beyene, 2020). That was in line with study in Western Rwanda which showed significant associations between stunting and STH infection (Kabatende et al., 2020). However, specific research related to STH infection and macronutrient intake it still limited, therefore, this study aims to determine the correlation between STH infection and macronutrient intake in Jember due to stunting and STH infection still high.

METHODS

Observational analysis was used in this study with a cross-sectional approach. This study was conducted in Panti Sub-district, Jember Regency, East Java Province from May to December 2023. The study subjects were a total of 83 stunted toddlers aged 12-36 months, identified using purposive sampling method from the population of 451 stunted toddlers in Panti Sub-district. Sample size was defined using the Lameshow formula with a minimum of 62 samples. The source of population data for stunted toddlers was obtained from the Panti Subdistrict Health Center. Subjects were selected using the inclusion criteria of having a body length or height for age index (H/A) less than -2 standard deviations of the child growth curve. Toddlers who had taken deworming medication in the previous month were excluded. Researchers ensure that toddlers take deworming medication by asking for Integrated Service Post attendance in the last month and confirming it with parents and Integrated Service Post midwife cadres. Informed consent was obtained from parents. Consent forms were signed by parents after they were given sufficient information regarding this study.

Macronutrient intake data were collected from interviews with parents who completed the 2x24-hours food recall questionnaire. Interviews were conducted by asking what foods and beverages were consumed over the last 24 hours. The results from the questionnaire were converted into grams with reference to the Food Photo Book by the Individual Food Consumption Survey Team of the Indonesian Ministry of Health. The data were entered into Nutrisurvey software to determine the satisfactory level of macronutrient intake. The results were categorized into deficit and sufficient according to the recommendations of the Nutritional Adequacy Score (Permenkes, 2019). Parents were then given a stool pot to collect the toddler stool. Parents will informing by phone when the stool has been put in the stool pot, then the officer will take it to send to laboratory directly. Microscopic stool examination using direct smear and flotation methods were carried out to detect *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm eggs. The examination was conducted at the Parasitology Laboratory of the Faculty of Medicine, University of Jember. The equipment and materials used for the examination include a centrifuge, centrifuge tube, pipette, cover glass, object glass, microscope, distilled water, saturated $MgSO_4$ solution, and 1% Lugol solution. Examination results were matched with WHO guidelines for diagnosis of STH infection and confirmed by experts in parasitology.

Data were analyzed using IBM SPSS Statistic 26 and presented in tables of frequencies and percentages, while bivariate analysis was examined using the contingency coefficient correlation test. Ethical approval with number 4959/UN25.1.10.2/KE/2023 was obtained from the Ethics Committee of the Faculty of Medicine, University of Jember.

RESULTS AND DISCUSSIONS

Total subjects in this study were 83 stunted toddlers aged 12-36 months in Panti sub-district, Jember Regency. Table 1 provides the information regarding subject characteristics in this study including the characteristics of toddlers, mother of toddlers, and the family economics statuss. The characteristics of toddlers include gender and age group.

Previous research, shows that male toddlers have a higher risk of stunting compared to females (Elmighrabi et al., 2024). However, this study found that male toddlers were not significantly

different from female toddlers. The 12-24 month age group was also not significantly different from the 24-36 month age group. This group is considered crucial during the growth period of the toddler and vulnerable to stunting as found in previous studies (Elmighrabi et al., 2024). The majority of mothers of toddlers were between 20-39 years old and most of them had low to medium level of education. Mother method in educating toddlers is influenced by their educational level. Due to mother very limited knowledge and most of them followed the existing traditions in the society. Previous research shows that the risk of stunting is higher in mothers with low education (Elmighrabi et al., 2024).

Family economic status is also associated with stunting (Htet et al., 2023). This study found that most families of toddler had low incomes. This may affect the family ability to meet the nutritional needs of toddler, which increases the risk of stunting (Harvey et al., 2022). Families with lower incomes have higher rates of stunting at all ages, according to previous studies (Karlsson et al., 2023).

Table 1 also describes the results of fecal microscopic examination. Results of fecal examination using microscopy in the Laboratory of Parasitology, Medical Faculty, University of Jember found 4 positive samples infected with STH (4.8%). The STH eggs identified from the examination results showed *Ascaris lumbricoides* (2.4%) and hookworm (2.4%). Results of fecal examination can be seen on Figure 1. No *Trichuris trichiura* eggs were found in this study.

Stunted toddlers under five years of age are generally at high risk of infection due to their weak immune system (Agrawal et al., 2024). The prevalence of STH infection in this study showed lower prevalence than previous studies in Sikapas and Singkuang, North Sumatra, which found a prevalence of 76.8% and 87.2%, respectively (Nasution et al., 2019). Only a few eggs were found in the fecal examination results, indicating a mild degree of infection. The prevalence and mild level of infection may be due to routine worm infection prevention programs implemented in Panti subdistrict. Toddlers are dewormed every February and August. To reduce the incidence of worm infections, treatment is provided to
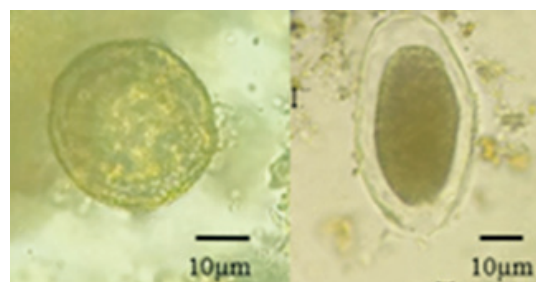
(a) *Ascaris lumbricoides* egg   (b) Hookworm egg

Figure 1. Microscopic Fecal Examination

reduce infection rates and improve health (Taylor-Robinson et al., 2019). In addition, to support this program, many of the mothers of toddlers in this study practiced good hygiene behaviors, which can reduce the risk of infection (Lebu et al., 2023).

Ascaris lumbricoides and hookworm eggs were found in this study. However, *Trichuris trichiura* was not found in this study. According to previous studies, *Ascaris lumbricoides* is the most infecting species among other species with a prevalence of 26%, while hookworm is less at 7.9% (Ganguly et al., 2022). Diarrhea is the most common presenting symptom of STH infection (Gitore et al., 2020). Diarrhea in toddlers in this study averaged more than 3 times per day. Infected toddlers had diarrhea symptoms within the previous month. However, a few were brought to health facilities for treatment of diarrhea. Accumulation of adult *Ascaris lumbricoides* and hookworm in the intestines of toddlers can cause inflammation of the intestinal wall, which can disrupt the process of food absorption and lead to a liquid stool consistency (Wei et al., 2017).

Ascaris lumbricoides trasmits via the oral fecal route by ingestion of eggs with food or drink. Therefore, hand and food hygiene, including cutlery, must be considered. The infective larvae of hookworm penetrate the skin. That's why wearing shoes when playing on the ground is important for toddlers (Hailu et al., 2019; Holland et al., 2022). Infected toddlers in this study liked to play on the ground, some rarely cut their nails, and did not use soap to wash their hands. These factors may increase the risk of transmission, as described in previous studies (Pasaribu et al., 2019).

Results of macronutrient intake data are presented in Table 2. These results derive from the 2 × 24-hour food recall interviews with

Table 1. Distribution of Subject Characteristics and STH Infection

Subject Characteristics	n	%
Toddler Gender		
Male	42	50.6
Female	41	49.4
Toddler Age (month)		
12-24	42	50.6
25-36	41	49.4
Mother Age (years)		
10-19	2	2.4
20-39	78	94.0
40-59	3	3.6
Mother's Educational Level		
Low	19	23.0
Moderate	39	71.0
High	5	6.0
Household Income		
Low	65	78.3
Moderate	18	21.7
STH Infection		
Positive	4	4.8
Negative	79	95.2
STH Species*		
Ascaris lumbricoides	2	2.4
Trichuris trichiura	0	0.0
Hookworm	2	2.4

Note: *= 4 out of 83 subjects were infected with STH

Table 2. Distribution of Macronutrient Intake Fulfillment Level

Macronutrient Intake	n	%
Protein		
Deficit	19	22.9
Sufficient	64	77.1
Carbohydrate		
Deficit	78	94.0
Sufficient	5	6.0
Fat		
Deficit	64	77.1
Sufficient	19	22.9

easy to cook and almost every toddler in this study loved fried egg.

Data from food recalls showed inadequate intake of carbohydrates and fats. Many of the toddlers consumed few sources of carbohydrates and fats in a day. Toddlers ate only a few spoonfuls of rice. Most mothers replaced it with snacks that did not contain enough nutrients.

Table 3 shows the distribution of infection status with macronutrient intake for each toddler. Table 3 also explains the results of statistical analysis of all variables. Statistical analysis showed all significance value >0.05 for correlation between STH infection and macronutrient intake. These results indicate that there is no significant correlation among all variables.

There was no significant association between STH infection and macronutrient intake of stunted toddlers in this study. This is different from previous research findings that mentioned STH infection as one of the factors causing poor nutritional intake in children under five years of age (Rahmi et al., 2021). STH infections in toddlers usually cause loss of appetite, leading to nutritional deficiencies (Oyeyemi & Okunlola, 2023). Reasons for this non-significant association may be due to several factors. The findings in this study may have been influenced by the mild degree and duration of infection. The toddlers infected with STH in this study did not show severe gastrointestinal symptoms. They only showed a history of diarrhea symptoms in the past month. Fecal analysis also found few STH eggs in the positive samples. This condition has less impact on toddlers nutrition than when they experience a more severe degree of infection and for a longer period of time.

mothers or caregivers of toddlers and completed questionnaires. Levels of macronutrient intake fulfillment are categorized into deficit and sufficient. The results showed that the majority of 64 toddlers (77.1%) were in the sufficient category for protein intake. While the majority of carbohydrate (94%) and fat (77.1%) intake was deficit.

The protein intake results showed that stunted toddlers aged 12-36 months tended to be quite good. Based on the results of the 2x24-hour food recall, toddlers had adequate protein intake from commonly consumed side dish sources such as eggs, fish, tofu, and tempeh. Protein sources were readily available in the Panti sub-district community. In addition, the prices of these side dishes were relatively low, which made them the preferred choices for daily family meals. Other protein sources such as meat and fresh cow milk were rarely found because the price was more expensive. Among these protein sources, chicken eggs were the most preferred because they were

Table 3. STH Infection and Macronutrient Intake

Variable	Macronutrient Intake					
	Protein		Carbohydrate		Fat	
	Deficit	Sufficient	Deficit	Sufficient	Deficit	Sufficient
STH Infection						
Positive	0	4	4	0	2	2
Negative	19	60	74	5	62	17
Significance	0.264		0.604		0.186	
Contingency Coefficient	0.122		0.057		0.144	

Mother contribution is one of the factors to ensure that toddlers receive adequate nutrition. Mother understanding influences the choice of foods consumed by toddlers (Duong et al., 2023). Most of the mothers of the subject in this study had low to moderate education. This may affect the nutritional status of toddlers. Mothers play an important role in providing good care for toddlers. Mothers were expected to be able to provide guidance to toddlers on good eating habits. For example, toddlers should be given orderly eating schedules, accustomed to eating nutritious foods, and advised to maintain cleanliness before and after eating. Implementation of good parenting by mothers can form good habits in toddlers when eating, with a hope that the nutritional needs of toddlers can be met (Mahmood et al., 2021).

The economic status indirectly influences toddler dietary intake. Low economic status affects limited access to food, which affects the ability to meet the family nutritional needs (Elmighrabi et al., 2024). Majority of the respondents in this study were found to have low income. This affected their daily diet. It can be seen from the results of food recall interviews that most of the respondent families tended to lack varied nutritional content. Therefore, some of the nutritional needs of toddlers were not adequtely provided. An interesting finding in this study was that infected toddlers were included in the sufficient category for protein intake. It may be due to the fact that the toddlers really liked protein sources such as eggs, tofu and fish. In addition, the price of protein foods was relatively cheap and was easily accessible by those families with toddlers.

This study used the 2x24-hour food recall interview method, which has limitations that it is highly dependent on the mother memory (Huang et al., 2022). Some mothers of toddlers in this study forgot the overal menu provided and only remembered parts of the food menu provided to their toddlers, which affected the completeness of the questionnaire. Food conversions to grams were also sometimes inaccurate because only the standardized food photo book measurements were used without direct wighing on the food scales. More accurate methods may be selected for further study. Our study has informed the community to pay more attention to the prevention of STH infection and nutritional fulfillment in children under five years of age. This includes efforts to maintain good hygiene and dietary habits.

CONCLUSION

Our results show that STH infection does not have a significant correlation with the intake of macronutrients in stunted toddlers between the ages of 12 and 36 months. This is probably because all infected toddlers had a mild degree of infection and were asymptomatic. Hence, it did not affect their digestive system. Deficits in macronutrient intake may also be caused by other factors such as mother contribution to parenting and diet. Economic status also plays a role in this regard. However, the underlying mechanism remains unclear and warrants further investigation.

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THE EFFECTIVENESS OF THE "LAYANAN KESEHATAN CUMA-CUMA DOMPET DHUAFA NUSA TENGGARA TIMUR" FROM "KAWASAN SEHAT" PROGRAM : EFFORTS TO REDUCE STUNTING PREVALENCE IN OEBELO VILLAGE

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ABSTRACT

Stunting is a failure of child growth characterized by a lack of height for age Z-score caused by chronic nutritional problems. Stunting has a negative impact on the quality of human resources in the future. Nusa Tenggara Timur (NTT) is the province with the highest stunting cases in Indonesia. LKC Dompet Dhuafa NTT help to accelerate stunting mitigation carried out in Kawasan Sehat Program. The study aimed to determine the effectiveness of stunting interventions through The Kawasan Sehat Program in Oebelo Village. This research is a qualitative and quantitative evaluative research with input-process-output approach. The selection of informants purposive sampling technique with seven informants. Primary data were collected by interviews and observations. Meanwhile, secondary data is carried out by reviewing documents. In the input component, there are still constraints in the adequacy of facilities, infrastructure, and cadre transportation. In the process component, necessary to enhance partnerships and strengthen the commitment of the target groups of the program. In the output component, there has been a decrease in stunting prevalence from 8% to 4%. There are several factors that affect the output such as economic factors, sanitation, and customs. Concluded that the stunting interventions in Kawasan Sehat Oebelo were effective and all components of inputs-processes-outputs were running well.

Keywords: *Children Nutrition, Health Services, Kawasan Sehat Program, Stunting*

INTRODUCTION

Stunting is a growth failure in children, as indicated by the lack of body height or length in comparison to children of the same age. Stunting is a multifactorial issue that stems from mother condition during adolescence, pregnancy, toddler diet, family economic status and environment, and access to healthcare (Kementerian Kesehatan RI, 2022). Indonesia is a developing country that focuses on reaching its target of eliminating stunting. The national target by 2024 is to reach a 14% stunting prevalence in order to achieve SDGs 2030 (PERPRES No. 72 Tahun 2021).

The prevalence of stunting in Indonesia will reach 21.6% in 2022 (Kementerian Kesehatan RI, 2023). According to the results of the Indonesian Nutritional Status Survey, Nusa Tenggara Timur (NTT) is the province with the most stunting cases in 2022, with a prevalence of 35.3% (Kementerian Kesehatan RI, 2023). The number of people living in poverty in NTT in 2022 amounted to 1131.62 thousand people or 20.05%, with an open unemployment rate of 3.54% (BPS, 2022).

The Ministry of Home Affairs annually designates priority villages for stunting as a form of evenly distributed program implementation throughout Indonesia (Kementerian Sekretariat Negara RI, 2021). The Oebelo village has became one of the stunting priority villages in NTT since 2020 with a stunting prevalence of 19%. Oebelo village is at risk of stunting, as there are still families without proper sanitation facilities and occurrences of anemia among pregnant women. The majority of the population works as vegetable farmers and laborers with a lower to middle economic status (Puskesmas Tarus, 2020).

Dealing with stunting cases is important because of the relationship between the potentially

low quality of human resources, which may decrease the economic productivity of a country in the future and negatively impact health status and child mortality (BKKBN, 2021). The ramifications of inadequate nutrition, such as a decrease in the workforce, rising healthcare costs, and reduced productivity, result in Pakistan losing approximately US$7.6 billion annually, which accounts for 3 percent of its GDP (Mahira A, 2017).

"Layanan Kesehatan Cuma-Cuma" (LKC) Dompet Dhuafa as a Non Governmental Organization (NGO) has contributed by executing several stunting interventions through the "Kawasan Sehat" program. The Kawasan Sehat program aims to develop a healthy lifestyle in a certain area with specific health indicators such as Maternal Health, Elimination Stunting, Non-Communicable Disease, Tuberculosis, Sanitation, Environmental Health, and Mental Health, with its main focus on the prevention of stunting or malnutrition through community empowerment, increasing the competence of human resources, management of local resources, and partnership.

Stunting in NTT is a priority because it has the highest number of cases of stunting nationally. Managing stunting in NTT requires synergy between specific institutions, one of which is LKC as a NGO that plays a role in reaching stunting elimination goals in NTT. LKC Dompet Dhuafa Pusat designed a study to understand the effectiveness of its stunting intervention program in the Kawasan Sehat of LKC Dompet Dhuafa NTT.

METHODS

This was qualitative and quantitative evaluative research with an input-process-output approach. This study was conducted in Kawasan Sehat Oebelo of the LKC Dompet Dhuafa NTT. The focus of this study was to examine the input, process, output, and effectiveness of the implemented stunting program. The input components were evaluated based on the availability of human resources, funds, methods, facilities, and infrastructure. The process components evaluated the planning, execution, and monitoring. The output components were evaluated on the basis of the prevalence of stunting. Finally, program effectiveness was evaluated based on the understanding of the program, accuracy, timeliness, achievement of objectives, and real changes (Hasanbasri, 2007).

Data were collected through in-depth interviews, document reviews, and observations. The informants were selected through purposive sampling. Interviews were conducted with seven informants, including the person in charge of the stunting intervention program, facilitators, and two cadres. Other supplementary informants included three mothers of toddlers who had received interventions from the beginning of their pregnancy until birth.

The respondent criteria consist of mothers of toddlers who have received intervention programs from pregnancy until their child's birth, the staff responsible for stunting intervention who have been involved in the program since 2020, stunting intervention facilitators who have been involved for one year, and cadres residing in Oebelo Village who are responsible for implementing the intervention program since 2020.

The instruments used in this study included interview, observation, and document review guidelines. Phone recorders were used to ensure that all informant answers were recorded. The interviews were conducted individually with each informant so that information given by one informant would not be influenced by others.

Qualitative data analysis was performed in three stages: data reduction, data presentation, and drawing conclusions. The data reduction stage involved the categorization and summarization of the data. After reduction, the data were presented in narrative form to be easily understood by the reader. The next step was to draw conclusions based on the data. The quantitative data are presented as descriptive statistics. This study was approved by the Ethics Committee of the Faculty of Health Sciences, UIN Syarif Hidayatullah Jakarta (letter number Un.01/F.10/KP.01.1/KE.SP/05.08.045/2).

RESULTS AND DISCUSSION

Input Components

Human Resources

The effectiveness of a program is valued not only by the amount of human resources, but also by their abilities and functional tasks (Sugianti, 2020). The LKC Dompet Dhuafa NTT has a limited number of nutritionists for executing stunting interventions.

'There is only one nutritionist, they're at the sub-health center. Uhh 2, 1 is at the community health center, the other is at the sub-health center. For LKC, I, as a midwife, am the program facilitator' (Program Facilitator).

Aside from the health workers from the LKC Dompet Dhuafa NTT, cadres play the role of ensuring the continuity of the stunting intervention program. The Kawasan Sehat Oebelo has seven integrated health posts (posyandu), each of which has five cadres, totaling 35 people. However, only two to three cadres per integrated health post were active in practice.

'Only some were involved, not all. At my place, there were only 3' (Cadre 1).

'For this one, there were only 2 people' (Cadre 2).

The utilization of voluntary health cadres is a useful approach to combat the limited number of health workers, especially in developing countries (Alam, Tasneem, & Oliveras, 2012). Sustainable cadre empowerment may increase cadre's motivation and act as a foundation for their awareness of responsibilities in integrated health post services (Mediani, Nurhidayah, & Lukman, 2020).

Funds

Based on the results, the funds of the stunting intervention program are sourced from RKAT (*Rencana Kerja dan Anggaran Tahunan* or Detailed Annual Activity Budget) of central funds, funds of zakat, infaq, and alms. The available funds are insufficient to cover the provision of supplementary food for all children under five, resulting in the provision of only children under two years of age. Fund allocation was used to purchase supplementary food ingredients and medical devices.

'The funds are from central RKAT funds, zakat, infaq, and shodaqoh funds. Since there are many stunting cases, especially in the Kawasan Sehat, we minimized it because if we included all children under 5, we'd be going over budget, so we only included children under 2' (Program person-in-charge).

The cadres complained about the distance of supplementary food distribution. Therefore, some cadres suggested adding an allocation for transportation allowance. A study by Wirapuspita (2013) found a significant relationship between the provision of transportation allowance and cadres' performance, where 76% of cadres who did not receive allowances lacked performance. Therefore, encouragement through incentives provided to cadres should be fulfilled.

Methods

The implementation of a stunting intervention by LKC Dompet Dhuafa is more focused on specific nutritional interventions. Specific nutritional interventions target the initial 1000 days of life and pregnant women. Sensitive nutrition interventions emphasize development beyond the healthcare realm through intersectoral collaboration. Sensitive nutrition interventions make up 70% of interventions, while specific nutrition interventions make up 30% (Kementerian Kesehatan RI, 2022).

Several specific nutritional interventions were performed by the LKC Dompet Dhuafa NTT to eliminate stunting, including the assistance of pregnant women, birthing process, breastfeeding, assistance of children with nutritional problems through home visits, distributing supplementary food, monitoring the growth and development of children, and parental counseling. A sensitive nutritional intervention is performed by providing aid for latrine construction.

'We monitor the mother since pregnancy, birthing, breastfeeding, and the child. If there are nutrition problems, we handle that by home assistance, home visits, integrated health post assistance, and PM' (Program person-in-charge).

'Yes, sometimes we also help through latrine construction. We give them to cement and toilets, and they will build them' (Facilitator Program).

Intervention methods for children under 2 years of age are more focused on the provision of supplementary food for a duration of 28 days. The 28-day intervention was based on a reference given by the community health center and nutritionist. The objective of the intervention was to change the mothers' child-feeding style through a positive deviance approach by adopting the behaviors of parents with low economic status but with healthy children.

Indicators for the implementation of all programs at Kawasan Sehat are available. The SOP is part of the input component. With an SOP, all program officers can perform their tasks based on existing guidelines (Sugianti, 2020).

Facilities and Infrastructure

Facilities used in stunting intervention programs include scales, microtoises, and measuring tapes for the upper arm circumference. The infrastructure for integrated health posts includes tables and chairs for registration, and a mattress for examining pregnant women. There are seven integrated health posts in Kawasan Sehat, where 5 are held in the homes of community members, and two in their designated buildings.

'There is only one supporting tool that we have, so we have to take turns on our designated schedule. The tools are measuring tapes and scales. We also have educational media that we use to support integrated health posts' (Program person-in-charge).

Readiness of facilities and infrastructure, optimization of utilization, and management may assist in the success of a program (Nur Wulandari et al., 2021). Based on these findings, facilities and infrastructure are available but insufficient, especially spaces for integrated health posts. However, these challenges do not threaten the continuation of the programme.

Process Component

Planning

Planning stunting intervention programs in Kawasan Sehat consisted of determining the areas of intervention and targets, conducting focus group discussions (FGD) and preparing resources for implementation. Targets were determined by stunting data and coordinated through sub-health and community health centers.

'In determining the area, Oebelo Village, we decided on it because of low sanitation. Since the beginning of the program, we started with sanitation and mother and infant mortality, because we knew that they had high rates'.

'To determine the targets, we did it through coordination with community health center nutritionists. They recommended we focus more on children under 2 years' (Program person-in-charge).

After the intervention targets were settled, the next step was FGD. The FGD was held to disseminate information regarding the provision of supplementary food. Preparing resources for program implementation was performed by training cadres. Training cadres can positively impact their capabilities to screen infants with nutritional deficiencies (Chomawati & Handayani, 2019). All planning activities for the stunting intervention program by the LKC Dompet Dhuafa NTT are based on integrated stunting suppression guidelines divided into three stages: situation analysis, preparation of activity plans, and stunting consultation.

Implementation

The interview results showed that the stunting intervention was conducted holistically. The assistance of pregnant women was provided through health checks and supplementary food for pregnant women with chronic energy deficiency. Pregnancy classes with exercise and educational sessions were also conducted. Breastfeeding women were educated on the importance of exclusive breastfeeding during their visits to integrated health posts.

LKC Dompet Dhuafa optimized the stunting intervention by providing supplementary food, which was divided into two categories: supplementary food for counseling and recovery. If there were no changes, the intervention was continued by providing raw ingredients containing animal protein.

For the three years that the stunting intervention program was implemented in the Kawasan Sehat Oebelo, the intervention deemed most effective in decreasing stunting cases was the provision of supplementary food for stunted children under two years of age. This was especially true for supplementary foods for recovery that were provided to overcome nutritional deficiencies in children (Nur & Annisa, 2022).

Supervision

Based on the results of the study, informants stated that supervision of the stunting intervention in the Kawasan Sehat Oebelo was performed by the program person-in-charge and cadres in their respective integrated health posts. Supervision was performed to monitor the provision of supplementary food by parents to their children.

Data recording and reporting were performed after the activities were completed and for new cases. The child growth and development reports were summarized monthly. Data recording and reporting were performed to understand the program achievements and for evaluation.

Monitoring and evaluation were performed upon completion of the program. If the monitoring results of child growth and development show that no changes have occurred since the intervention, the next step is to make efforts to find the root cause and its solution. The results of the problem and efforts to overcome are transformed into plans for the next period's program.

Output Component

Based on the output of the stunting intervention, the program was successful in decreasing stunting cases in the Kawasan Sehat, as proven by a decrease in stunting prevalence throughout 2021 – 2022 (Figure 1).

Based on the output component, the prevalence of stunting will decrease by 4% by 2022, which is less than the 8% decrease by 2021. The decrease in prevalence was supported by the program's assistance of pregnant women, breastfeeding mothers, provision of supplementary food for stunted toddlers, home visits, routine child growth and development monitoring, education, and supplementary food cooking demonstrations.
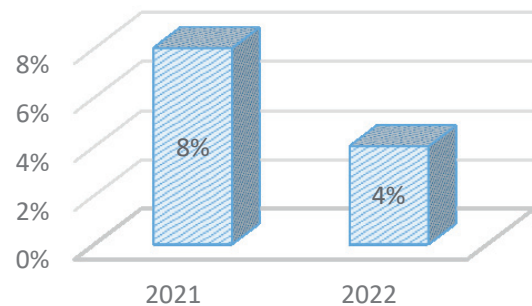

Figure 1. Prevalence of stunted children under 2 years old in Oebelo Villate in 2021 and 2022

The assistance of pregnant women contributed to the decrease in stunting cases; 48 pregnant women who were assisted in 2021 and 2022 did not have stunted children. In addition, 87% of breastfeeding mothers received assistance and exclusively breastfed their children in 2021, and 64% in 2022. These efforts played a role in eliminating the stunting.

Upon intervention, changes in the health status of stunted children under 2 years of age were observed. In 2021, 5 (45%) out of 11 stunted children under 2 years of age were given interventions that improved nutritional status, and 6 (55%) were still stunted. In 2022, the five stunted children under 2 years of age did not experience any changes in nutrition status, even after the intervention. Of the five children who did not experience a change in nutritional status, a continuous 28-day intervention was performed by providing supplementary food twice a day. After the 28-day supplementary food intervention, children who were still stunted received assistance through routine weighing at integrated health posts and nutritional counseling for the parents.

Program Effectivity

Program effectiveness is the correlation between the outputs and objectives. A program is deemed effective if its planned objectives are achieved (Aminah & Riduan, 2022). Effectivity was evaluated based on the understanding of the program, accuracy, timeliness, achievement of program objectives, and real changes.

The community understands that stunting intervention is implemented to improve child nutrition. With continuous socialization by health workers and cadres, the community has

become aware and willing to participate in routine integrated health posts to monitor their children's growth and development.

The accuracy of the targets in several activities was achieved. A large portion of the community felt helped by these intervention programs. People with low economic status and stunted children are helped by the supplementary food provided by LKC Dompet Dhuafa, whether through raw ingredients or cooked food.

The program's timeliness was punctual. Routine integrated health posts and the provision of supplementary food to stunted children were performed continuously until changes in the child's height were observed. The program objectives were achieved effectively, as shown by the decrease in the prevalence of stunting, although insignificant. However, this still shows that the program achieved its main objective of reducing prevalence of stunting.

Real changes in this stunting intervention program included stunted children who had a normal nutritional status after receiving the intervention. Mothers with troubled pregnancies were able to give birth to children with normal weight because of the assistance they received during pregnancy. A program is deemed effective if real changes take place that can impact and benefit the community (Aminah & Riduan, 2022). In this case, the intervention program by LKC Dompet Dhuafa was implemented effectively, as proven by the number of people who felt the changes and benefits of the stunting intervention program.

The limitation of this research is that the respondents, mothers of infants and toddlers, use the local language of NTT, thus requiring the researchers to recruit enumerators proficient in the NTT local language and to conduct language validation by the LKC Dompet Dhuafa NTT team and cadres.

CONCLUSION

It can be concluded that the stunting intervention in the Kawasan Sehat Oebelo is effective throughout all the input, process, and output components. Based on the input component, there remains a lack of nutritionists involved in stunting interventions. There is a need for a transportation allowance for active cadres and the addition of facilities in each integrated health post. The methods for specific nutritional interventions have run well. Based on the process component, planning has been done with the help of cadres, and the implementation has run well with holistic intervention activities. Based on the output component, the intervention has decreased stunting by 8% in 2021 and by 4% in 2022.

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