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Estimation of Food Waste and Nutrient Loss in The Free Nutritious Meal Program for Students in East Aceh, Indonesia

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ABSTRACT

Food waste remains a major challenge in school meal programs, as it not only causes economic losses but also leads to resource inefficiency, and reduced nutritional benefits. This study aims to analyze differences in food waste amounts across free nutritious meal programs at the elementary, middle, and high school levels, estimate nutrient loss, and identify related factors of food waste among students in East Aceh Regency. A cross-sectional design was employed involving 106 students purposively selected from three schools participating in the free nutritious meal programs. Data were collected using a weighing method over a 10-day menu cycle, anthropometric measurements, structured interviews on student characteristics, and food preferences. Data were analyzed using the Kruskal-Wallis test, Pearson and Spearman correlations, and linear regression. The results showed that the average food waste was 24,3% of the served portion, with the highest amount in middle school (29,8%) and the lowest in high school (16,5%). The largest proportion of waste came from staple foods, vegetables, and plant-based side dishes. Nutrient loss due to food waste was equivalent to 12 complete lunch portions for a child per year. Factors significantly associated with food waste were age, gender, BMI-for-age, pocket money, and menu variety ($p<0,05$). Older students, males, who perceived the menu as more varied, tended to waste less food. These findings highlight the importance of portion adjustment, appropriate serving times, diversified menus, and nutrition education to reduce food waste and optimize the benefits of the Free Nutritious Meal program

Key Messages:

- The Free Nutritious Meal program exhibits an average food waste rate of 24.3%, resulting in a significant annual nutrient loss equivalent to 12 complete lunch portions per student, which underscores the urgent requirement for age-appropriate portion management and menu diversification to enhance the program's nutritional and economic efficiency

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GRAPHICAL ABSTRACT

INTRODUCTION

Sustainable healthy diets play an important role in the global food system. In 2012, the United Nation Secretary-General launched the Zero Hunger Challenge, which aims to end hunger, prevent stunting, promote sustainable food systems, boost productivity, and reduce food waste. Globally, food waste remains a major concern. In 2022, approximately 1.05 billion tons of food was wasted in the retail, food service, and household sectors combined. This is equivalent to 132 kilograms per capita per year (1). Indonesia is also claimed to be the second largest producer of food loss and waste in the world, estimated at 300 kg per capita per year (2). Food waste not only causes economic losses but also has a negative impact on the environment by contributing to approximately 4.4 Gt CO2-eq of global greenhouse gas emissions (3).

This situation is ironic considering that hunger and malnutrition remain high, with around 783 million people still suffering from hunger each year, and 150 million children under the age of five experiencing growth and development disorders due to malnutrition (1). The problem of nutrition in Indonesia, especially among children and adolescents, is indeed very concerning. Based on data from the Indonesian Health Survey (2023), 21.5% of children under five years of age are stunted, 15.9% are underweight, and 8.5% are wasted (4). This condition can interfere with their concentration and even affect their learning performance at school. It is important to ensure that all children and adolescents have adequate access to nutritious food and health education.

The government, through Presidential Regulation of the Republic of Indonesia No. 83 of 2024, is currently implementing the Free Nutritious Meal Program or 'Makan Bergizi Gratis (MBG)' for school children as an effort to meet nutritional needs and improve nutritional status to support optimal growth and development (5). However, various studies show that school meal programs often face the problem of high food waste. The amount of food waste in Spain ranges from 60 to 100 grams per student per day (6). In Italy, the rate of school food waste ranges from 20–29% of the food prepared (7, 8). East Aceh Regency, one of the areas that has received this program for five months, has a high prevalence of stunting 29.7%, underweight 28.1%, and wasting 14.7% in 2023 (4). Food waste not only reflects inefficiency in food distribution and consumption, but also contributes to inadequate nutritional intake, especially for vulnerable groups such as pregnant women and children. In fact, discarded food should be utilized to meet the nutritional needs of people in need, thereby helping to reduce stunting and other nutritional problems. In this context, food waste in this program not only has the potential to cause economic losses but also

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leads to a waste of resources and a reduction in the nutritional benefits that children, as a vulnerable group, should receive.

Research on food waste in schools generally focuses on the amount and factors causing it. However, there is still limited research that specifically analyzes the loss of nutrients due to food waste in Free Nutritious Meal (MBG) Program. Therefore, this study aims to analyze the differences in the amount of food waste in school meal programs at the primary, middle, and high school levels in East Aceh Regency, estimate the resulting loss of nutrients, and identify factors related to food waste.

METHODS

This study used an analytical observational design with a cross-sectional approach to analyze nutrient loss in food waste in free nutritious meal programs targeting primary, middle, and high school students in East Aceh Regency. The study was conducted in May-June 2025 at three schools in East Aceh that had received the Free Nutritious Meal Program. These schools were selected purposively because, at the time of data collection, they were the only ones where the program had been implemented in East Aceh.

The research population consisted of all students who received the Free Nutritious Meal Program in East Aceh. The sample was selected using purposive sampling, coordinated with the school, and consisted of 5th-grade primary school students, 7th-grade and 8th-grade middle school students, and 11th-grade high school students. The sample size was determined using the Slovin formula with a minimum result of 96 subjects, plus 10% to anticipate dropouts, bringing the total to 106 students. The inclusion criteria for this study were children who were registered as students at the primary, middle, and high school levels in East Aceh Regency, were present and participated in the free nutritious meal program on the day of data collection, were in good health and able to answer questions well, and were willing to participate in the study with informed consent and informed assent from their parents or guardians.

$$n = \frac{N}{1+N\,e^2}$$
$$= \frac{1936}{1+(1936 \text{ x } 0{,}1^2)}$$
$$= \frac{1936}{20{,}36} = 95{,}08 \sim 96$$

Description:
n : minimum sample size required
N : total program recipients 1936 students
e : *margin of error* (10% or 0,1)

The type of data collected in this study was primary data covering student characteristics (age, gender, education level, BMI for age, pocket money, parent's occupation, parent's income), food preferences (taste, texture, appearance, and menu variety), and data on nutrient loss as seen from the amount of waste and types of food in food waste. Data were collected through measurements and interviews using questionnaires. Measurements and recording of food waste during one menu cycle (10 days) were carried out using the food weighing method at the individual level. Anthropometric measurements were taken directly using calibrated digital scales and stadiometers.

Data processing and analysis were performed using WHO AnthroPlus, Microsoft Excel 2019, and IBM SPSS Version 25.0. Descriptive analysis was used to describe the distribution of student characteristics and food preferences. Data processing and analysis of nutrient loss estimates were performed using the wasted daily diets (WDD) calculation method. WDD is determined based on the lowest value of the wasted nutrient days (WND) for the analyzed nutrients. WDD represents the amount of nutrients lost due to food waste that could meet the daily nutritional needs of a certain number of people. WND is calculated by dividing the annual nutrient loss from food waste by the recommended dietary intake for each nutrient (energy and other nutrients). The nutrients in each food item were calculated using the Indonesian Food Composition Table or Tabel Komposisi Pangan Indonesia (TKPI). The nutrients analyzed were energy, protein, fat, carbohydrates, fiber, iron, vitamin C, vitamin A, and calcium. The Kruskal-Wallis Test was performed to analyze differences in food waste at the primary, middle, and high school levels in East Aceh Regency. Bivariate analysis used Pearson and Spearman Rank correlation analysis with a significance value

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of <0.05. Meanwhile, multivariate data analysis used linear regression analysis.

CODE OF HEALTH ETHICS

This study has been approved by the Research Ethics Committee of the Bogor Agricultural University No. 1750/IT3.KEPMSM-IPB/SK/2025.

RESULTS

Student characteristics consisted of age, gender, education level, BMI for Age, allowance, parents' education, parents' occupation, and parents' income. Overall characteristics are presented in Table 1.

Table 1 Characteristics of students

Characteristics	n = 106	%
Age		
10-12 years	44	41.5
13-15 years	31	29.2
16-18 years	31	29.2
Median (min; max)	13 (10;17)	
Gender		
Male	42	39.6
Female	63	60.4
Level of education		
Primary school	33	31.3
Middle school	42	39.6
High school	31	29.2
BMI fo Age		
Underweight	10	9.4
Normal	83	78.3
Overweight	8	7.5
Obesity	5	4.7
Median (min; max)	18.3 (12.8; 33.5)	
Pocket Money		
Insufficient	27	25.5
Sufficient	79	74.5
Median (min; max)	10,000 (5,000; 25,000)	
Father's occupation		
Not working/deceased	11	10.4
Farmer/Fisherman	22	20.8
Laborer	15	14
Self-employed	45	42.5
Civil servant/state-owned enterprise employee	13	12.3
Mother's occupation		
Not working/deceased	63	59.4
Housemaid	7	6.6
Laborer	2	1.9
Self-employed	10	9.4
Civil servant/state-owned enterprise employee	24	22.6
Family income		
Low (<Rp3.413.666)	70	66
Sufficient (≥Rp3.413.666)	36	34
Median	2,500,000 (2,000,000; 17,000,000)	

The characteristic data showed that most of the respondents were aged 10–12 years, accounting for 44 individuals (41.5%), followed by those aged 13–15 years and 16–18 years, each comprising 31 students (29.2%). In terms of gender, female students predominated, totaling 63 individuals (60.4%), while male students accounted for 42 individuals (39.6%). Regarding educational level, the majority of respondents were in middle school (39.6%), followed by primary school students (31.3%), and high school students (29.2%). Based on BMI-for-age classification, most students had a normal nutritional status (78.3%), while 9.4% were underweight, 7.5% overweight, and 4.7% obese. In terms of pocket money, the majority of students (74.5%) reported having sufficient daily allowance, while 25.5% stated it was insufficient.

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With respect to father's occupation, the largest proportion were self-employed (42.5%), followed by farmers or fishermen (20.8%), laborers (13.2%), civil servants or employees of state-owned enterprises (12.3%), and 10.4% were not working or deceased. In contrast, most mothers were not working (59.4%), while 22.6% were civil servants or state-owned enterprise employees, 9.4% were self-employed, 6.6% worked as housemaids, and 1.9% as laborers. Finally, in terms of family income, the majority of respondents came from families with low income (<Rp3,413,666), totaling 70 households (66%), while 36 households (34%) had sufficient income (≥Rp3,413,666).

The distribution of food preferences in terms of taste, variety, texture, and appearance is presented in Table 2. The majority of respondents rated the food served as having a neutral taste, accounting for 93 individuals (87.7%), while only 7 students (6.6%) stated that they liked the taste, and 6 students (5.7%) reported disliking it. Regarding texture, the majority of respondents (56.6%) rated it as neutral, followed by 39.6% who liked it, and 3.8% who disliked it. This implies that the food texture was generally acceptable for most students. In terms of appearance, most respondents (84%) rated the food as neutral, while 9.4% liked it and 6.6% disliked it. In terms of menu variety, more than half of the respondents (55.7%) perceived the meals as lacking variety, while 39.6% expressed neutral opinions, and only 4.7% considered the food varied.

Table 2 Distribution of taste. variety. texture. and the appearance of food preferences

Aspect	n = 106	%
Taste		
Dislike	6	5.7
Neutral	93	87.7
Like	7	6.6
Variation		
Dislike	59	55.7
Neutral	42	39.6
Like	5	4.7
Texture		
Dislike	4	3.8
Neutral	60	56.6
Like	42	39.6
Appearance		
Dislike	7	6.6
Neutral	89	84.0
Like	10	9.4

The overall average amount of food waste per student during one menu cycle (10 days) showed in Table 3. The average amount of food waste was 104.2 g/day (24.3%) of the initial amount of food provided. The highest percentage of food waste by food group compared to the amount provided was vegetables (43.4%), followed by plant-based side dishes (37.1%), staple foods (26.1%), animal-based side dishes (16.9%), and fruit (6.8%).

Table 3 Average percentage of food waste by school level

	Percentage					
School level	**Staple Food**	**Animal-based Side Dish**	**Plant-based Side Dish**	**Vegetables**	**Fruit**	**Total**
Primary	22.3[a]	23.7[a]	39[a]	49.6[a]	9.7[a]	24.9[a]
Middle	36.9[b]	18[a]	42.2[b]	49.6[b]	5.5[b]	29.8[b]
High	16.3[a]	8.8[b]	28.8[a]	30.5[c]	5.7[b]	16.5[c]
Avarage	26.2	16.9	37.1	43.4	6.8	24.3
p value	<0.001*	<0.001*	<0.001*	<0.001*	0.013*	<0.001*

Note: Different superscript letters in the same column indicate significant differences based on the Kruskal Wallis test ($p<0.05$)

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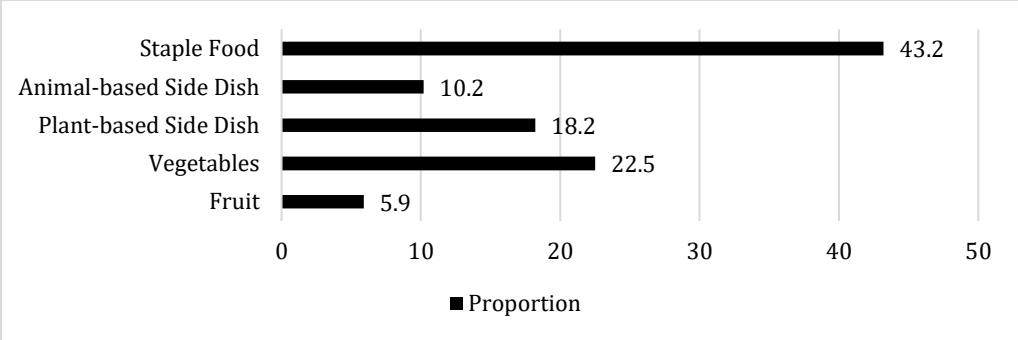

Figure 1 Proportion of food waste based on food group type

Figure 1 shows the proportions of food waste by food group. The largest proportion of waste was observed in the stapple foods (43.2%), vegetable group (22.5%), followed by plant-based (18.2%), animal-based foods (10.2%). The fruits (5.9%) contributed the smallest proportion of food waste.

Table 4 Nutrient loss based on wasted daily diet (WDD)

Nutrient	Avarage nutrient loss (kap)	Total *nutrient loss* (kap/year)	RDA	WND	WDD
	a	b	C	d	E
Energy (Cal)	176.2	35240	633.3	55.6	
Protein (g)	6.5	1,300	18.3	71.3	
Fat (g)	7.3	1460	21.7	67.3	
Carbohydrate (g)	21.4	4280	93.3	45.8	11.5=12
Fiber (g)	0.9	180	9.0	20.8	
Iron (mg)	1.5	300	2.7	111.3	
Vitamin A (mcg)	11.5	2300	200.0	11.5	
Vitamin C (mg)	3.0	600	16.7	36.1	
Calcium (mg)	65.2	13040	400.0	32.6	

Notes: a=average nutrient content (units/cap/day); b= a x 200 (active school days per year); c= RDA for girls aged 10-12 years based on 2019 RDA; d= b/c x 100; e= lowest WND value

Table 4 presents the estimated nutrient loss based on wasted daily diet (WDD). The average daily nutrient loss per capita was 176.2 kcal for energy, 6.5 g for protein, 7.3 g for fat, and 21.4 g for carbohydrates. The total annual nutrient loss per capita reached 35,240 kcal for energy, 1,300 g for protein, 1,460 g for fat, and 4,280 g for carbohydrates. In addition, the average loss of dietary fiber was 0.9 g/day, while the loss of micronutrients included 1.5 mg of iron, 11.5 mcg of vitamin A, 3.0 mg of vitamin C, and 65.2 mg of calcium per day. Compared with the Recommended Dietary Allowance (RDA) for girls aged 10–12 years, the proportion of nutrient loss ranged from 11.5% to 111.3%, with iron showing the highest relative loss.

Table 5 Correlation between school children's characteristics and total food waste

Variable	Correlation coefficient	Sig.
Age[1]	-0.330	<0.001*
Gender[1]	0.354	<0.001*
BMI for Age[2]	-0.328	<0.001*
Pocket Money[1]	-0.196	0.044*
Father's education[1]	-0.132	0.178
Mother's education[1]	0.05	0.614
Father's occupation[1]	-0.098	0.062
Mother's occupation[1]	-0.043	0.662
Parental income[1]	-0.122	0.214
Taste[1]	-0.008	0.937
Variation[1]	-0.236	0.015*
Texture[1]	-0.145	0.137
Appearance[1]	-0.014	0.888

Note: 1) Spearman Correlation Test; 2) Pearson Correlation Test; *significant at (p<0.05)

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The relationship between student characteristic data and total food waste produced shows that age (r= -0.330; p<0.001), gender (r= 0.354; p<0.001), BMI/U (r= -0.328; p<0.001), and pocket money (r = -0.196; p= 0.044) have a significant relationship. Meanwhile, the relationship between food waste and food preference data shows that of the four aspects analyzed, only food variety (r = -0.236; p = 0.015) has a significant relationship (Table 5).

DISCUSSION

The results indicate that organoleptic factors, such as taste, texture, and appearance, are not significant barriers to student's acceptance of food (Table 2). However, the results also show that menu variety remains a major weakness, with more than half of respondents rating the food served as lacking in variety. It is also important to note the preferences of students who only rated the food as "neutral" or "well enough." Although the majority of respondents did not rate the food as bad, a "neutral" level of acceptance may indicate that their satisfaction is not optimal. In a crossover study involving children aged 8–11 years in Denmark, an inverse correlation was found between the level of liking for school meals and the amount of food leftovers; the higher the level of liking, the less food was left over shows that children who really like fruit or vegetables ("love") produce the least food waste, while those who do not try the food at all produce the most food waste (9). These findings reinforce the assumption that a level of satisfaction that is only "well enough" is not effective enough to reduce food waste.

Based on Table 3, the overall average amount of food waste per student during one menu cycle (10 days) was 104.2 g/day or 24.3% of the initial amount of food provided. The highest percentage of food waste by food group compared to the amount provided was vegetables (43.4%), followed by plant-based side dishes (37.1%), staple foods (26.1%), animal-based side dishes (16.9%), and fruit (6.8%). These results are similar to research in Thailand, which shows that a menu of rice with side dishes produces quite high levels of food waste. At the primary school level, the food waste produced was 38.4 g per serving or 10.3% of the food served, where vegetables were the food group with the highest leftovers (16.5 g or 35.4%), followed by rice (14.5 g or 7.0%) and fruit (2.8 g or 16.3%). Animal protein shows better acceptance with relatively low waste (meat 5.2 g and eggs 2.0 g) (10). Other studies report that the average food waste in schools in the United States, South Africa, and China is 133 g, 107 g, and 87 g per capita per meal (11). This is not much different from the study conducted by Liu et al. in 2016 six schools in Beijing, which reported that the average food waste produced by students was 130 g/capita (21%), with staple foods (43%) and vegetables (42%) being the dominant proportions (12).

Table 3 shows that the average amount of food waste among students at three different school levels was significantly different (p<0.001). The highest average was found in middle school, which was 129.9 g/day (29.8%), while the lowest was in high school, which was 74.6 g/day (16.5%). Middle school students tended to have higher food waste in almost all types of food, especially staple foods, vegetable side dishes, and vegetables. The high amount of food waste among middle school students was influenced by the time of food serving. Food was provided by the Nutrition Fulfillment Service Unit at around 9:00 a.m. but middle school students consumed their meals at around 12:00 p.m. just before dismissal time (1:00 p.m.). Meanwhile, primary and high school students consume food during their break time (10:00 a.m.). This difference in meal times plays an important role in determining consumption levels and food waste (13). The high amount of leftover staple foods and vegetables is influenced by low acceptance of the taste, aroma, and texture of vegetables, as well as excessive portions of staple foods (14). The amount of leftover vegetable side dishes is also quite high due to local cultural habits. Based on interviews with teachers and students, the Acehnese is generally not accustomed to making tofu and tempeh the main side dishes in their daily meals and more often recognize them as snacks or light meals. In addition, the fact that they are always fried makes students feel bored. Simple and less varied processed foods tend to be less popular with students, thereby increasing food waste (15).

Fruit waste is higher among primary school students than middle and high school students. Previous study found that fruits and vegetables are the food group with the highest waste rate among primary school students (16). This is closely related to the low preference of children aged 7–10 years for fruits and vegetables, as well as the tendency of food neophobia, which makes children more likely to reject

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new or disliked foods. These findings explain why fruit waste is higher among primary school students than middle and high school students, as acceptance of fruits and vegetables tends to increase with age. These results are in line with findings from a study in East Aceh, which showed that primary school students still leave more fruit waste than students at higher levels of education.

Estimating the nutrients lost from food waste is important to determine the types and amounts of nutrients that are wasted and to raise public awareness about reducing food waste. The average loss per capita per day is 176.2 kcal of energy, 6.5 g of protein, 7.3 g of fat, 21.4 g of carbohydrates, 0.9 g of fiber, 1.5 mg of iron, 11.5 mcg of vitamin A, 3.0 mg of vitamin C, and 65.2 mg of calcium. The research on school lunch programs in Thailand shows that every 100 grams of food waste contains approximately 106-118 kcal of energy. with carbohydrates (13-20 g) as the largest component, followed by protein (4.5-5 g) and fat (2.2-3.8 g) (10). This loss has the potential to reduce daily nutritional intake if it continues. Lost micronutrients such as iron and vitamin A are important for preventing anemia and maintaining the immune system, while calcium plays an important role in children's bone development (17, 18).

This study also analyzed the amount of nutrients wasted from food waste that could meet the healthy diet according to the 2019 RDA for girls aged 10-12 years as a representation of the majority of the research subjects. The WDD calculation results were obtained based on the lowest WND value (the result of calculating the amount of nutrients from food waste per capita per year divided by the nutrient adequacy). This calculation method refers to previous studies (19, 20, 21) converted into wasted daily diets (WDD). The accumulated loss of nutrients due to food waste generated by one school child in East Aceh in a year is equivalent to meeting the energy and nutrient requirements of 12 lunch portions or 4 days of complete meals for each 10-12-year-old girl (Table 4).

The results in Table 5 show that age is negatively correlated with food waste. The older child, the less food is wasted. This finding is consistent with the previous research which states that younger primary school students tend to waste more food than older students (22). This can be explained by the development of children's preferences and eating habits. At a younger age, children tend to be more selective about food, especially fruits and vegetables, resulting in higher levels of food waste. Food preferences, especially for fruits and vegetables, are closely related to the amount of food left on children's plates (9). As children get older, their food preferences become more diverse, and their ability to finish their food also increases, so food waste tends to decrease.

Gender has also been shown to have a significant effect on food waste, with girls tending to produce more food waste than boys. This finding is in line with the research by Nguyen et al. in 2023 which also found that boys throw away less food than girls (23). The similarity of these results indicates that differences in consumption behavior based on gender are an important factor affecting the level of food waste among primary school children.

The negative relationship between BMI for age and food waste indicates that children with better nutrition tend not to waste food excessively. This is in line with research by Wang et al. in 2024, which states that higher BMI tends to result in less food waste compared to those with lower BMI (24). Lower BMI actually tends to result in more food waste compared to those with higher BMI (25). The similarity of these results indicates that nutritional status plays an important role in determining children's consumption behavior, where children with better nutrition tend to be more responsible in finishing their food. This may be due to lower energy requirements and the normative perception that "being thin is ideal" so some children deliberately throw away food even though they don't want to.

Children's pocket money is negatively associated with food waste, although the effect is weak. This suggests that children with more pocket money tend not to waste food excessively. This finding differs from a study in China which found that students with better economic conditions (high pocket money) were more wasteful in their consumption and contributed to higher food waste (25). The difference in the direction of the relationship is difficult to explain directly because most previous literature has found that greater purchasing power increases consumptive tendencies and the potential for higher food waste. One possibility is that there are differences in the context of the food supply system, consumption culture, and the role of pocket money in the daily lives of students in Indonesia compared to China. Further research is

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needed to examine the mechanism of the relationship between pocket money and food waste in order to explore student's perspectives on decisions to consume or leave food.

The analysis shows that food variety is significantly related to food waste, meaning that the better the menu variety, the less food is wasted. Meanwhile, taste, texture, and appearance do not have a significant effect even though they are rated quite good by children. Previous study shows that the type of food and menu variety greatly affect the amount of food waste, with certain vegetables and side dishes being wasted more than other foods (26). Overall, the menu patterns presented show a repetitive tendency, both in terms of food ingredients and processing techniques. The staple food is almost always white rice in large portions, with very limited variety, so its contribution to food waste is relatively consistent. Animal side dishes are dominated by fried chicken in various seasonings, as well as omelets or scrambled eggs, while vegetable side dishes are almost always fried tempeh and fried tofu. Vegetables are also not much different from day to day, consisting of simple stir-fries made with cabbage, green beans, carrots, or caisin.

The tendency toward preparation methods, such as frying for side dishes and stir-frying for vegetables, further narrows the variety of dishes available to children. The lack of exploration of other local foods, such as tubers, fish, nuts, and vegetables of different colors and textures, contributes to the low diversification of the menu. This low variety of ingredients and cooking techniques has an impact student's interest in consuming their food, which ultimately increases the potential for food waste. Previous research states that a combination of interventions such as increasing menu variety, improving taste quality, and adjusting to children's preferences, along with nutrition education and changes to the eating environment, has been proven to be more effective in increasing children's food consumption at school while reducing food waste (27). Adjusting portions and increasing menu variety can significantly reduce food waste, even by 20-30% compared to the initial conditions (28). Thus, portion management and menu variety strategies are practical keys to reducing food waste while ensuring adequate nutrition for students.

Meanwhile, parental characteristics, such as education, occupation, and income, did not show a significant relationship with children's food waste. These findings indicate that children's individual behavior is more dominant in determining the amount of food wasted than their parent's socioeconomic factors. This finding is in line with the research by Ang WZ et al. in 2021, which emphasizes that food waste behavior is determined more by individual awareness and responsibility in consuming food than by external factors (29). This means that although the socio-economic can influence consumption patterns, ultimately children's decisions to finish or leave food are greatly influenced by their own attitudes and behaviors towards responsible consumption. In other words, efforts to reduce food waste in schools should focus more on instilling habits and educating children about proper and responsible food consumption. This study has several limitations. It was conducted in only three schools located in East Aceh Regency, so the findings cannot be generalized to all schools in Indonesia. In addition, this study did not include a comparison between rural and urban areas, which limits the generalization of the results to different school contexts and characteristics.

CONCLUSION

This study shows that the average percentage of food waste is 24.3% per student, with the highest amount at the middle school level and the lowest at the senior high school level. Most food waste comes from staple foods and vegetables. Student's acceptance of food in terms of taste, texture, and appearance is relatively good, with intake reaching 75.7%. The avarage of nutrient loss due to food waste per day reached 176.2 kcal of energy, 6.5 g of protein, 7.3 g of fat, 21.4 g of carbohydrates, 0.9 g of fiber, 1.5 mg of iron, 11.5 mcg of vitamin A, 3.0 mg of vitamin C, and 65.2 mg of calcium, equivalent to 12 servings of a complete lunch for children aged 10–12 years. Factors that influence food waste include age, gender, BMI for age, pocket money, and preferences for food variety. In an effort to reduce food waste, schools should adjust meal times and portions, increase menu variety and presentation, and instill a culture of wise eating through nutrition education.

At the policy level, food waste needs to be an indicator for evaluating the Free Nutritious Meals Program, with strategies for utilizing surplus food and regular monitoring of menus and presentation methods. Further research in various regions and educational levels, as well as comparisons between rural

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and urban areas, are needed to provide a more comprehensive picture of food waste and nutrient loss.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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