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The effect of food waste behavior among Generation Z on sustainable food security

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Abstract

Generation Z, as the primary consumers in society, plays a crucial role in determining the sustainability of global food security. Despite being known as environmentally-conscious innovators, the gap between their attitudes and behaviors towards food wastage has adverse severe impacts. High levels of food waste are associated with a decrease in the amount of food available, increasing the risk of hunger and negatively impacting food security. This study analyzed 150 Generation Z participants to understand the diversity of socio-demographic characteristics and food consumption patterns. Through a holistic analysis, this study aims to identify factors such as attitudes, subjective norms, and behavioral control that underlie Generation Z's food wastage behavior, and explore their relationship with sustainable levels of food security. The research method used was a mixed method, which was analyzed using the theory of planned behavior (TPB). The results showed that food waste behavior among Generation Z, through attitudes, subjective norms, and behavioral control contributes 26% to food security, with attitudes having the most significant influence. These findings highlight the importance of increasing awareness and fostering positive attitudes towards sustainable food management as key factors in strengthening food security. Therefore, policies focusing on developing positive attitudes among Generation Z are essential to reducing food wastage and supporting sustainable food security.

1. Introduction

Food security is of global importance. It refers to when everyone has sufficient, safe and nutritious access to food to fulfill their nutritional needs and survive natural and artificial shocks (FAO, 2009; Peng and Berry, 2019). Phenomena such as climate change, increasing human population, urbanization and changing food consumption patterns pose significant challenges in achieving sustainable food security. These phenomena result in food supply instability, affecting social and political stability and leading to conflict and uncontrolled migration (Bulog, 2014; Brady *et al*., 2021). Various studies have been conducted to address the importance of food security. Besides a nutritional perspective, food security is also increasingly considering the environmental quality of diets (Righi *et al*., 2023). Excess food waste poses a challenge to achieving food security, making food rescue necessary as a strategy within existing policies (Ingram *et al*., 2013).

In Indonesia, various factors, such as food production, availability and accessibility, food utilization and stability, can affect the food security index (Hermawati *et al*., 2022). Indonesia scores 60.2 out of 100 on food security, ranking 63rd out of 113 countries worldwide (The Economist Group, 2022). This indicates that there are pressures on food security, both on a national and regional scale. Food security is also linked to behavioral issues resulting in food wastage as they impact adequate food availability and access. These behaviors include excessive purchasing, ineffective storage, poor cooking or food processing practices, and unnecessary food disposal (Leal *et al*., 2023). Food security should be viewed from a causal pathway from production to consumption and distribution to processing (Peng and Berry, 2019). From a food security

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perspective, food waste can exacerbate imbalances between production and consumption, resulting in economic losses and unequal access to food (Hall *et al*., 2009; Bartali *et al*., 2022). In line with this, Indonesia is one of the countries that produce a significant amount of food waste. It is even included in the list of 10 countries with the most food waste worldwide (FAO, 2019; Bappenas, 2021).

Between 2000-2019, 23-48 million tonnes of food waste was disposed of annually in Indonesia. At least around 115-184 kilograms of food waste is generated per person per year. Food waste has an economic impact, with a loss of IDR 213-551 trillion annually, or about 4-5% of Indonesia's GDP annually. Socially, this loss is equivalent to enough energy to feed 61-125 million people per year (Bappenas, 2021; Wiemers *et al*., 2021; Venessa and Aripradono, 2023). Food wastage is a phenomenon that deserves attention in the context of food consumption behavior, especially among Generation Z (Lemy *et al*., 2021; Tarczyńska *et al*., 2023). Generation Z consists of individuals born between 1997 and 2012 who have become a significant group in the food market. The younger generation may not have the cooking skills to tackle the problem of food waste at home, but they show great interest in learning it (Kubíčková *et al*., 2021; Kymäläinen *et al*., 2021). Young consumers' behavior is often portrayed as innovative and environmentally concerned. However, in real life, they are sometimes described as having a gap between attitude and behavior, which can be seen in a large amount of food waste they produce (Clement *et al*., 2023; Tarczyńska *et al*., 2023).

The behaviors that lead to food wastage in households can be analyzed using the theory of planned behavior (TPB) (Lourenco *et al*., 2022). The study states that a person's behavior is determined by their intention to perform the action, which is a function of attitude towards the behavior, perceived behavioral control, and subjective norms. The TPB can also be used to analyze a person's food safety knowledge, where the subjective norm variable is identified as the most influential variable (Lin and Roberts, 2020). While there have been studies that use the TPB to understand food waste behavior, no studies have directly used the TPB to determine the impact of food waste behavior among Generation Z on food security.

Generation Z has unique consumption behaviors, including a tendency to buy food in bulk and inappropriate food selection. These behaviors cause Generation Z to waste more food than previous generations (Visschers *et al*., 2016). Food wastage negatively impacts the sustainability of food security by affecting prices on an ongoing basis, influencing the composition of the diet, and being heavily influenced by income and price fluctuations (Santeramo, 2021). Examining the behavior of Generation Z and their food consumption patterns is necessary to develop policy alternatives to mitigate the negative impacts of such behavior. This study was conducted to identify the impact of food waste behavior among Generation Z on food security. Understanding the influence of food wastage behavior in Generation Z will enable the development of targeted strategies and policies to reduce food waste and strengthen sustainable food security.

2. Materials and methods

This research investigates the effect of food waste generation behavior among Generation Z on food security. The research method used in this study is mixed; primary data comes from quantitative data, and secondary data is obtained from in-depth interviews. A questionnaire was used as a quantitative data collection instrument, with 150 Generation Z people in Bantul Regency, DIY Province, Indonesia, as respondents. All respondents met the criteria, namely: (1) born in 1997 - 2012, (2) consumed rice as the primary source of carbohydrates, (3) lived in Bantul Regency, DIY, Indonesia. In addition, in-depth interviews were conducted with 6 Generation Z people to gain deeper insight into the factors that affect behavior in producing food waste. Exploratory and sequential qualitative and quantitative data collection techniques enable triangulation and evidence convergence, strengthening the research's validity and reliability (Suntornsan *et al*., 2022; Ostermann *et al*., 2024).

The questionnaire design was based on a literature review and modifications from previous research (Wulandari, 2020). The questionnaire consisted of 3 parts, namely the first part to explore the identity of respondents, the second part to identify food waste behavior as the independent variable (variable X), and the third part to determine food security as the dependent variable (variable Y). Generation Z's food waste behavior was analyzed using the Theory of Planned Behavior (TPB). Three TPB factors, namely attitude towards behavior, subjective norm, and behavioral control (Ajzen, 1991), became the independent variables (variables X1, X2, X3).

The number of questions for all X variables was 24 items. Variable X1 contains questions that reflect a person's positive or negative evaluation of the behavior. Variable X2 includes questions that reflect an individual's perception of the prevailing social norms related to the behavior, including social support or pressure (family, friends, and neighborhood). Variable X3 contains questions that reflect individuals' beliefs

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about the extent to which they have control over the behavior. While variable Y contains ten questions consisting of aspects of food availability, affordability and usefulness. A 5-level Likert scoring method was used in this study. Scores were calculated from 1 to 5 points for "strongly disagree" to "strongly agree". The higher the score, the more significantly the independent and dependent variables are correlated. Before further analysis, the data type was converted into an interval scale by applying the Successive Interval Method.

This research uses a simple random sampling technique to select samples from the population to ensure representativeness and generalisability. With the total population of Generation Z in Bantul Regency of 207,704 (BPS Kab. Bantul, 2020), the sample size was determined using the Slovin Formula. Although the minimum expected number was 100 respondents, the survey was conducted on 150 respondents as a precaution against possible errors. Data collected through questionnaires were analyzed descriptively, and inferential statistics were used to identify behavioral patterns and their relationship with food security. The next step is to conduct a multiple linear regression analysis using SPSS software to determine how much food waste production behavior among Generation Z can affect food security. Interviews were also conducted involving six informants from Generation Z. In-depth interviews were used to gain a more comprehensive understanding of the psychological, social and environmental factors that influence food waste generation behavior among Generation Z. Figure 1 shows the conceptual model used and applied in this study.

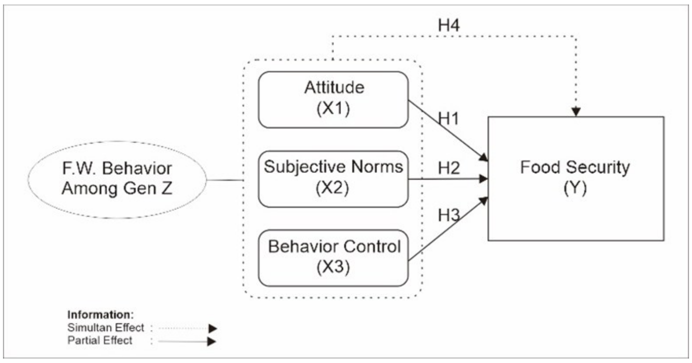

Figure 1. Conceptual model of the study.

3. Results and discussion

The results presented in this study described and analyzed the effect of behavior producing food waste among Generation Z on food security. This research examined a Generation Z sample of 150 people in Bantul Regency, DIY Province, Indonesia.

3.1 Characteristics respondent

The analysis of the characteristics of the 150 respondents involved in this research showed that the respondents consisted of various groups, which included multiple factors such as gender, age, area of residence, education level, employment status, food expenditure per day, and the frequency of eating rice per day. From the analysis results, we found that 31% of respondents were men and 69% were women. The average age of respondents was 17 years, aged between 12 and 26 years. As many as 70% of respondents live in rural and urban areas, another 17% live in the mountains, and the remaining 13% live on the coast. The education level of respondents was divided into undergraduate (50%), postgraduate (2%), high school equivalent (41%), and middle school (7%). Respondents' employment status showed that 30% work full time, 61% are students, and 9% are unemployed. Most respondents answered that daily food expenditure was IDR 15,000.00 - IDR 30,000.00. As many as 65% of respondents consumed rice three times a day, 31% concurred it two times a day, and another 4% consumed rice only once daily. A comprehensive description of the respondents' characteristics is shown in Table 1.

Table 1. Characteristics of respondent.

Characteristics	Criteria	N	(%)
Gender	Man	46	31%
	Woman	104	69%
Age	12 - 17 years old	25	17%
	18 - 22 years old	55	37%
	23 - 27 years old	70	47%
Residential Area	Rural/urban area	105	70%
	Mountains	26	17%
	Coast	19	13%
Level of Education	Undergraduate (D1/D2/D3/D4/S1)	75	50%
	Postgraduate (S2/S3)	3	2%
	Senior High School	61	41%
	Junior High School	11	7%
Job Status	Employed	45	30%
	Student	92	61%
	Unemployed	13	9%
Food Expenses per day	Less than Rp 15,000	36	24%
	More than Rp 45,000	5	3%
	Rp 15,000 - Rp 30,000	94	63%
	Rp 30,000 - Rp 45,000	15	10%
Frequency of Eating rice per day	One time	6	4%
	Two times	47	31%
	Three times	97	65%

3.2 Classic assumption test in multiple linear regression analysis

This research evaluates the effect of food waste generation behavior among Generation Z on food

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security through multiple linear regression analysis. Data was collected through attitude scales, subjective norms, behavioral control, and food security scales. Validity and reliability tests using SPSS confirmed the reliability of the instruments, with 34 questionnaire items deemed valid (r calculated > r table, significance <5%). The reliability test showed an alpha coefficient of 0.904, indicating a high level of reliability (Budiastuti and Bandur, 2018). In the context of statistical analysis, data from Likert scale questionnaires are ordinal, meaning they can be ranked but lack consistent value intervals. Since regression analysis requires interval or ratio data for accurate calculations, ordinal data must be transformed using the successive intervals (MSI) method to align with the standard normal distribution (Ningsih and Dukalang, 2019).

After converting ordinal data into interval data and confirming its validity and reliability, a classical assumption test was conducted to ensure that the linear regression model met the assumptions of residual normality, homoscedasticity, and multicollinearity. The normality test, using the Kolmogorov-Smirnov method, showed a significance value of 0.2, indicating that the data was normally distributed (Mishra *et al*., 2019). The heteroscedasticity test using the Glejser method showed that the significance values of the three independent variables were greater than 0.05, indicating no heteroscedasticity in the regression model. The multicollinearity test, conducted using the tolerance and variance inflation factor (VIF) methods, revealed that the tolerance values were greater than 0.10 and the VIF values were less than 10.00, confirming the absence of multicollinearity. Thus, the regression model meets the classical assumptions and can proceed with hypothesis testing to analyze the effect of independent variables on the dependent variable.

3.3 Research hypothesis test

There are four hypothesis formulations in this research:

H1: There is a relationship between positive attitudes (X1), positive subjective norms (X2), and positive Behavioral control (X3) simultaneously with food security (Y).

H2: A significant relationship exists between attitudes (X1) and food security (Y).

H3: A significant relationship exists between subjective norms (X2) and food security (Y).

H4: There is a significant relationship between Behavioral control (X3) and food security (Y).

The results of multiple linear regression analysis (F-test) showed that there was a significant effect between the independent variables (attitude, subjective norms, behavioral control) together or simultaneously with the dependent variable (food security). The F-test is carried out by calculating the F-statistic value with SPSS software.

With a sample of 150, three independent variables, and a significance level of 0.05, the critical F-table value was 0.267, while the F-statistic was 17.108, indicating a significant effect of the independent variables (attitude, subjective norms, and behavioral control) on food security ($p<0.05$). The SPSS R-Square test result of 0.260 suggests that X1, X2, and X3 collectively influence Y by 26%, while the remaining 74% is affected by other factors outside this study. Next, the t-test results show that attitude (X1) ($p = 0.010$), subjective norms (X2) ($p = 0.022$), and behavioral control (X3) ($p = 0.007$) have a significant impact on food security. These results produce a regression equation that describes the relationship between the independent and dependent variables: $Y = 12.761 + 0.445\ X1 + 0.386\ X2 + 0.196\ X3$.

The constant 12.761 represents the food security value (Y) when all independent variables (X1, X2, X3) are zero. The regression coefficients, 0.445 for attitude (X1), 0.386 for subjective norms (X2), and 0.196 for behavioral control (X3), indicate the expected increase in food security (Y) when each independent variable increases by one unit while keeping the others constant. Thus, an increase of one unit in X1 raises Y by 0.445, X2 by 0.386, and X3 by 0.196. The t-test results highlight the contribution of each independent variable to food security. The complete linear regression analysis results are presented in Table 2.

Table 2. Results of multiple linear regression analysis.

Variable	Unstandardised coefficients
	B
(Constant)	12.761
Attitude (X1)	0.445
Subjective norms (X2)	0.386
Behavioral control (X3)	0.196

4. Discussion

Respondents come from diverse backgrounds with variations in gender, age, place of residence, and rice consumption patterns, which influence household food security (Mazenda *et al*., 2022). The data indicate that males and females have similar rice consumption patterns, averaging 2-3 times per day, consistent with previous research (Choi and Seo, 2023). 61% of males and 66% of females consume rice three times a day, with a nearly identical distribution of consumption frequency

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across both groups. The frequency of rice consumption is associated with respondents' age and place of residence. The 12–17-year-old group consumes rice three times a day more frequently than the 18–22 and 23–27-year-old groups. These findings align with previous research, which highlights differences in consumption habits based on age and growth phases (Ogundijo *et al.*, 2022).

Geographical factors also influence eating patterns (Kvalsvik *et al.*, 2021). 65% of respondents in mountainous areas consume rice three times a day, while in coastal areas, the percentage is higher at 89%. In urban and rural areas, consumption patterns are relatively similar, with 60% of respondents eating rice three times daily. This trend reflects food accessibility and local dietary habits, which should be considered in food security policies. The relationship between gender, age, and place of residence in daily consumption patterns is illustrated in Figure 2.

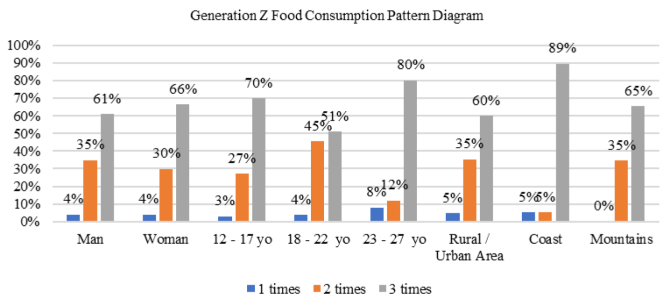

Figure 2. The relationship of gender, age, and residential area on daily rice consumption patterns.

The research findings indicate that the independent variables (attitude, subjective norms, and behavioral control) significantly influence food security, with a coefficient of determination of 26%, while the remaining 74% is affected by external factors such as inflation, unemployment, low income, geographical conditions, and natural disasters (Islam, 2024). Hypothesis testing confirms that 26% of consumption behavior impacts food security, emphasizing the importance of production and consumption habits, particularly in reducing food waste. Generation Z plays a crucial role in shaping societal consumption trends; therefore, enhancing food security requires government support, institutional involvement, and active participation from young generations in developing innovative and sustainable solutions (Munirah and Hanoon, 2022).

The t-test results indicate that attitude, subjective norms, and behavioral control partially have a positive effect on food security. The interaction of these three variables within Generation Z forms the psychological and social foundation that shapes individual responses to food security issues (Stancu *et al.*, 2016). Strategies that integrate education, normative changes, and the strengthening of individual control have the potential to enhance participation in maintaining food security. Furthermore, the regression equation results show that a one-unit increase in attitude improves food security by 0.445, subjective norms by 0.386, and behavioral control by 0.196, assuming other variables remain constant. These findings confirm the hypothesis that food waste behavior among Generation Z has a positive and significant impact on food security through the three aspects of the Theory of Planned Behavior: attitude, subjective norms, and behavioral control.

Individual attitudes play a crucial role in food security through food consumption, resource management, and participation in the food sector. Research findings indicate that a positive attitude toward responsible food consumption, such as reducing food waste, can enhance food security. Observations and interviews reveal that Generation Z's attitudes toward food waste vary. Some exhibit high environmental awareness and actively reduce waste by making mindful purchases, properly storing food, and creatively repurposing leftovers. However, others show less concern or awareness of its impact. Therefore, education and awareness about food waste management are essential in fostering more sustainable attitudes.

The study also shows that subjective norms significantly influence food security, with a correlation of 0.386. If Generation Z accepts and applies subjective norms related to sustainable food management, food security can improve. Consistent with research (Aydin and Yildirim, 2021), individuals who perceive food waste as morally or ethically wrong tend to be more committed to sustainable food management. By raising awareness and reinforcing subjective norms regarding food appreciation and sustainable practices, Generation Z is more likely to adopt behaviors that support food security.

In the theory of planned behavior, behavioral control refers to individuals' perceptions of the extent to which they can carry out desired behavior (Ajzen, 1991). The research findings indicate that behavioral control has a significant impact on food security, with a correlation of 0.196, although its effect is smaller compared to attitudes and subjective norms. Factors influencing Generation Z's behavioral control over food security include a lack of knowledge about sustainable food management, limited access to resources for efficient food management, and low awareness of the negative impact of food waste. Informant data support this: "The challenge of reducing food waste for me is because I am hampered by education. There is still a lack of knowledge about food

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waste management, and it also feels like it has become normal to throw away food" (Personal Interview, October 1, 2023).

Prevention, reuse, recycling, recovery, and disposal are the primary priorities in food waste management (Amato *et al*., 2021). A positive attitude, such as avoiding food waste, significantly contributes to food security by increasing food availability. Reducing food waste can enhance food availability, lower the risk of hunger, and strengthen food security. A positive attitude encourages Generation Z to distribute edible food and raise environmental awareness. Waste reduction also decreases greenhouse gas emissions from food decomposition (Raimi *et al*., 2020). A responsible attitude reflects individual awareness and drives concrete actions to support food security.

Food waste behavior among Generation Z significantly impacts the achievement of SDG 2 (Zero Hunger) and SDG 12 (Responsible Consumption and Production) and is closely linked to food security. Excessive food waste leads to the depletion of valuable food resources, reduces food availability, and exacerbates pressure on the global food system. Therefore, Generation Z must take serious action to minimize food waste, enhance food availability, reduce hunger, and support the zero-hunger goal. Reducing food waste is also crucial in establishing sustainable consumption patterns. By minimizing waste, individuals and communities can reduce environmental impact, support sustainable agriculture, and adopt more eco-friendly consumption practices, contributing to the achievement of responsible consumption and production.

The impact of food waste on food security is evident in several aspects. In terms of food availability, food waste decreases the amount of food accessible for consumption, worsens distribution imbalances, and increases the risk of food shortages. From a public health perspective, food waste not only contributes to food insecurity but also results in the loss of essential nutrients, potentially leading to malnutrition and health issues. Regarding sustainability, food waste behavior reflects unsustainable consumption patterns. The production of wasted food contributes to greenhouse gas emissions, worsening climate change and posing greater challenges in managing natural resources.

Wise food management practices help reduce food insecurity, increase accessibility of healthy food, and strengthen community food security. By optimizing the use of food resources, both in terms of production and consumption, communities can strengthen their food security against external fluctuations and possible food crises. Thus, reducing food waste behavior among Generation Z not only contributes positively to the achievement of zero hunger and responsible production consumption but also plays a crucial role in improving food security, ensuring access to sufficient, safe and nutritious food for all, and building sustainable and adaptive food systems.

Policy interventions can be formulated by understanding the influence of food waste behavior among Generation Z. The detailed strategy to achieve this goal includes several essential steps, such as: 1) developing educational outreach campaigns that can reach the wider community, thereby increasing awareness about the importance of sustainable practices in consuming and disposing of food. 2) Through food management skills training. Through this training, generation Z individuals gain practical knowledge about managing food wisely, from purchasing the right thing to storing it correctly to reduce food waste. 3) Policies that encourage collective responsibility to reduce food waste and increase food security are needed through incentives for sustainable practices and regulations that regulate certain aspects of the food supply chain. By implementing awareness-raising strategies, skills training, and solid policy support, the hope is that it will help individuals, communities, and governments collectively reduce food waste, increase efficiency in food resource management, and ultimately strengthen food security holistically.

This research enriches our understanding of the factors that influence food security, which is associated with Generation Z's food consumption behavior. This study can improve social theories on food consumption behavior, waste, and sustainability. The practical impact of this research is that information can be used to develop interventions and policies to reduce food waste and increase food security. This research has limitations, such as the relatively small sample size. Samples were taken from the Bantul Regency area, which reportedly has the lowest food security status among other regions in the DIY province. Of course, researching a more extensive sample can provide better insight into food waste behavior among Generation Z.

5. Conclusion

This study investigates the influence of food waste generation behavior among Generation Z on food security. Food waste behavior has severe implications for food security at the global level. The adverse impacts can be seen in three crucial aspects, namely food availability, public health, and sustainability issues. Therefore, it is crucial to effectively address this food-wasting behavior to strengthen overall food security.

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The results showed that the three independent variables (attitude, subjective norms and behavioral control) have a significant effect on food security, with a total effect of 26%. However, 74% of other factors not examined in this study also affect food security. Further analysis using the t-test shows that attitudes, subjective norms and behavioral control partially affect food security. In partial hypothesis analysis, it is known that the attitude variable has the most important influence on food security compared to the other two variables, followed by the subjective norm variable, and finally, the behavioral control variable which has the least impact.

As the attitude variable contributes most significantly to food security, policies focusing on attitude development among Generation Z are needed, namely through education, active participation and cross-sector collaboration. First, it is necessary to integrate education on environmental issues and food waste management into the school curriculum to increase the understanding and awareness of Generation Z from an early age. Second, the government and non-governmental organizations can launch effective public campaigns using social media, advertisements and community events to educate Generation Z about food waste reduction and its impact on food security. Third, generation Z needs training and mentorship programs to develop skills in cooking, food management and waste reduction practices. Fourth, the government and private sector can encourage restaurants, food stores and the food industry to adopt food waste reduction practices, such as smaller portions and donating unconsumed food. Lastly, there is a need for increased cross-sectoral collaboration between government, society and industry to create policies and initiatives that support food waste reduction, including rewards and incentives for individuals or groups that make positive contributions. By implementing these policies, it is expected that Generation Z will have a high awareness of environmental issues, actively reduce food waste, and collectively support the realization of sustainable food security.

Conflict of interest

The authors declare no conflict of interest.

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