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Determinants of Food Waste among Household in Rural and Urban Areas of Bogor Regency

Determinan Food Waste Rumah Tangga Wilayah Perkotaan dan Perdesaan Kabupaten Bogor

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ABSTRACT

Background: Food Waste remains a major concern both domestically and globally, with households being the largest contributors.

Objectives: This study aimed to determine the total generation of FW in households at risk of stunting and analyze its determinants in urban and rural areas.

Methods: A quantitative method with a cross-sectional study design was conducted from June-July 2023 in Ciampea and Sukajaya Subsitricts, Bogor Regency. This study involved 168 households, calculated using the SNI 19-3964-1994 method for sampling and measuring. The inclusion criterion was households with at least one stunting risk factor, according to the BKKBN. FW determinants included family characteristics and practices (planning, purchasing, storing, cooking, and consuming). The obtained data were then analyzed using chi-square and logistic regression.

Results: The total FW generated was 5.51 kg/cap/year (urban: 4.08 kg/cap/year; rural: 5.07 kg/cap/year). The most wasted food groups were vegetables and cereals/tubers. Urban households with high income were 4.3 times more likely to generate FW (OR=4.32, CI=1.72 – 10.77). Meanwhile, those with inadequate knowledge were 3.49 times more likely to generate FW (OR=3.49, CI=1.39 – 8.79), and those not planning purchases and processing according to preferences were 4.3 times more likely to generate FW (OR=4.32, CI=1.72 – 10.77). Rural households that did not store food properly were 3.81 times more likely to generate FW (OR=3.81, CI=1.22 – 12.03).

Conclusions: The total generation of FW in rural households was higher than in urban. The determinants of FW in urban areas were income, knowledge, and planning practices, whereas in rural areas, it was storage practices.

INTRODUCTION

Food Loss and Waste (FLW) remains a national and global issue that has yet to be resolved. Food Loss refers to the loss of food within the supply chain during food preparation. Food Waste (FW) is food intended for human consumption that is discarded or left to spoil at the consumer level (regardless of the cause)[1,2]. In 2021, the National Development Planning Agency (BAPPENAS) defined FW as a reduction in food quantity or waste generated during consumption at the household or consumer business level (such as restaurants or catering)[3]. In this study, the definition of FW used encompasses all types of food and beverages that are processed or brought into the home and intended for human consumption but are subsequently discarded. These include products that are spoiled, rotten, or expired. It does not include bones, skins, seeds, stems, eggshells, or food and beverage products discarded when dining out (such as in restaurants, cafés, cafeterias, and food courts). The average global FLW generation in 2021 has reached 121 kg per capita per year (931 million tons),

with 61% of households contributing[4]. A study of FLW in Indonesia over the past 20 years showed an average of 115–184 kg per capita per year, with the highest generation occurring during the consumption stage (5–19 million tons per year), and households were the largest contributors (80%). The high generation of FLW in Indonesia impacts the environment (producing an average of 7.29% of greenhouse gas emissions), economy (resulting in losses of 107–346 trillion rupiah per year), and social aspects (loss of nutritional content and food security)[3,5]. The increase in FLW generation contradicts high levels of hunger, food insecurity, and malnutrition. The presence of edible foods commonly found in FLW suggests a potential loss of nutritional content due to disposal. Over the past 20 years, Indonesia's FW generation has been estimated to meet the energy (29%-47%), protein (30%-50%), vitamin A (63%-166%), and iron (46%-72%) needs of the Indonesian population[3]. Meanwhile, Indonesia faces public health issues such as stunting, with a prevalence of 21.6% in 2022[6].

With a population of over 200 million, Indonesia has the potential to generate substantial FLW, which continues to increase each year. West Java is the most densely populated province on the island of Java, with nearly one-third (31.8%) of its population residing there. Bogor Regency, consisting of 87% urban and 13% rural areas, has a total population of over five million, making it the most densely populated area and the largest food consumer in West Java[7]. A dense population may lead to an increase in household FW generation. Numerous studies on household FW, particularly in urban areas, have been conducted in various countries including Australia[8], China[9] and the United States[10,11]. A study on FW in Indonesia in 2015, utilizing direct measurement through Waste Composition Analysis in urban East Java, found an FW generation of 77.3 kg per capita per year[12,13]. Literature reviews indicate that behaviors are determinants of FW, while socio-demographic and economic factors can influence FW generation[8,14,18]. Knowledge, attitudes, and other factors affecting purchasing behavior also contribute to FW[19,20] generation as well as the management of food waste[21–23].

Many studies on food waste (FW) have focused on high-income households in urban areas. To date, few studies have analyzed the determinants of FW in urban and rural households with low socioeconomic conditions. Therefore, this research aimed to analyze the determinants of FW in low-income households in both the urban and rural areas of Bogor Regency.

METHODS

This study employed a quantitative and cross-sectional approach. The study was conducted in Bogor Regency from June to July 2023. Bogor Regency was the most densely populated area in West Java in 2021, with a total population of 5,427,068. Approximately 13% of Bogor Regency falls into the rural category. The selection of sub-districts was purposive, referencing Central Statistics Agency (BPS) No. 120 of 2020 on the classification of urban and rural villages in Indonesia[24]. Ciampea sub-district represents urban characteristics, whereas the Sukajaya sub-district represents rural onesics. The population for this study comprised stunting-risk families in the Sukajaya and Ciampea sub-districts. The inclusion criteria for this study were families with at least one stunting risk factor according to the National Population and Family Planning Agency (BKKBN) 2021, which includes having children aged 0–23 or 24–59 months, adolescent girls, pregnant women, children aged 0–23 or 24–59 months, belonging to poor families (beneficiary families), or having low education levels for both husband and wife (elementary to junior high).

In this study, the selection of stunting-risk families was related to the utilization of family resources. Essentially, stunting-risk families can provide more food by minimizing food waste (FW) and ensuring that consumption levels are more adequate. All samples met the inclusion criteria for stunting-risk families, although in practice, it is still difficult to find families with socio-economic conditions categorized as poor (lower-middle) due to inaccurate income reporting and the unavailability of data on stunting-risk families. Therefore, this study used an approach based on the beneficiaries of the Social Services Department. Families classified as lower-middle in this study are Beneficiary Families (KPM), such as those in the Family Hope Program (PKH) and Non-Cash Food Assistance (BPNT). Additional inclusion criteria included families living with their children and those who care for their children themselves, who are willing to be sampled, and residing in Sukajaya and Ciampea sub-districts. The exclusion criterion for this study was that one family member was ill based on complaints.

The calculation of the minimum quantitative sample size refers to the Indonesian National Standard (SNI) 19-3964-1994 on the Methods of Sampling and Measuring Waste Generation and Composition in Urban Areas based on the physical condition of the house or the average income of the family head (National Standardization Agency 2019)[25]. A total of 168 households were sampled, with a minimum sample size of 103 households in urban areas and 65 households in rural areas. In this study, samples were drawn using simple random sampling. This study involved human participants and was approved by the Health Research Ethics Committee (KEPK) of the Faculty of Public Health, Universitas Airlangga (No. 2940-KEPK) July 31, 2023. The collected data included household characteristics refrigerator ownership; knowledge about FW; behaviors (planning, purchasing, storing, cooking, and consumption); and the amount, type, and category of FW generated. Data were collected through interviews using a pre-tested questionnaire. FW was measured through surveys using the Household Food Waste Questionnaire (HFWQ)[26] which has been tested and adapted to the population. Categories, weight (grams), and units used in the FW questionnaire for specific products, such as vegetables and fruits, as well as other food items, were adjusted based on findings from various literature sources, including PMK No. 41 of 2014 on Balanced Nutrition Guidelines[27], the Individual Food Consumption Survey 2014[28], food balance sheets[29], the Food Exchange List, and the Indonesian Food Composition Table.

Data were processed using Microsoft Excel 2019 for entry, editing, and cleaning. FW data extrapolation was performed to calculate the total and average FW generated by households in the urban and rural areas, expressed in kg/capita/year. Data analysis was performed using IBM SPSS 26, and univariate, bivariate, and multivariate analyses were performed. The first step involved univariate analysis of each characteristic of the research variables, followed by a normality test using the Kolmogorov-Smirnov test to determine the appropriate subsequent tests (bivariate). Correlation tests were chosen to analyze the relationships between independent variables and the dependent variable individually, using the Chi-squared test (χ^2) due to the categorical nature of the data. Multivariate analysis utilized logistic regression with a p-value<0.05 and a 95% Confidence Interval (CI) to indicate the strength of the influence of independent variables on the dependent variable.

RESULTS AND DISCUSSIONS

Household Characteristics

The household characteristics collected in this quantitative measurement include family size, husband's education, wife's education, husband's occupation, wife's occupation, family income, and knowledge about food waste (FW). Household characteristics are presented in Table 1. The households involved in this study consisted of small families with fewer than four members, typically newly married couples with mostly two toddlers. The education level of household heads in urban areas is predominantly high school or equivalent, whereas in rural areas, the highest education level is elementary school or equivalent.

In urban areas, the majority of husbands are employed as laborers (50%) because the research location is near blacksmiths or skilled workers who create iron tools. This labor occupation is undertaken by most household heads in urban areas, with uncertain working days and wages. This aligns with research conducted in the same sub-district in 2017[30] where a majority (55.7%) of household heads in Ciampea sub-district who married young people worked as laborers. In rural areas, the majority of household heads are self-employed (49%) and provide services such as motorcycle taxis and trading. The wives in both areas primarily worked as housewives (92%)[30]. After categorizing the family income based on the Regional Minimum Wage of IDR 4,520,212.25 according to the West Java Governor's Decree No. 561.7/Kep.77-Kesra/2022, 52.4% of urban areas are above Regional Minimum Wage, while 75.4% of rural areas are below the minimum wage.

Table 1. Frequency distribution of household characteristics in urban and rural areas of Bogor Regency

Household Characteristics Variables	Urban n=103 (%)	Rural n=65(%)	Total n=168 (%)
Family Size			
Small (<4 people)	65 (63)	38 (58)	103 (61)
Large (>6 people)	38 (37)	27 (42)	65 (39)
Husband's Education			
No formal education	3 (3)	2 (3)	5 (3)
Elementary School/Equivalent	35 (34)	39 (60)	74 (44)
Junior High School/Equivalent	24 (23)	15 (23)	39 (23)
Senior High School/Equivalent	38 (37)	8 (12)	46 (27)
College/University	3 (3)	1 (2)	4 (2)
Wife's Education			
No formal education	1 (1)	2 (3)	3 (2)
Elementary School/Equivalent	41 (40)	45 (69)	86 (51)
Junior High School/Equivalent	38 (37)	13 (20)	51 (30)
Senior High School/Equivalent	23 (22)	4 (6)	27 (16)
College/University	0 (0)	1 (2)	1 (1)
Husband's Occupation			
Private Employee	17 (17)	4 (6)	21 (13)
Laborer	51 (49)	22 (33)	73 (43)
Entrepreneur	17 (17)	32 (49)	49 (29)
Service worker	10 (10)	3 (5)	13 (8)
Casual worker	7 (6)	3 (5)	10 (6)
Other	1 (1)	1 (2)	2 (1)
Wife's Occupation			
Private Employee	1 (1)	0 (0)	1 (1)
Laborer	3 (3)	1 (2)	4 (2)
Entrepreneur	2 (2)	2 (3)	4 (2)
Service worker	1 (1)	0 (0)	1 (1)
Casual worker	2 (2)	0 (0)	2 (1)
Other	0 (0)	1 (2)	1 (1)
Housewife	94 (91)	61 (93)	155 (92)
Family Income			
Below the minimum regional wage[1]	49 (48)	49 (75)	98 (58)
Above the minimum regional wage	54 (52)	16 (25)	70 (42)
Knowledge			
Poor	63 (61)	55 (85)	118 (70)
Good	40 (39)	10 (15)	50 (30)

[1]The minimum wage for Bogor Regency in 2023 is IDR 4,579,541

Overall, household expenditures were divided into food and non-food expenditures. Monthly food expenditure was based on food groups adjusted to the Expected Food Pattern. Non-food expenditure was queried based on the results of a pre-test questionnaire, which found that the majority of routine monthly household expenses included purchasing fuel, cigarettes, and daily necessities. The detailed nhousehold food and non-food expenditures are presented in Table 2.

Table 2. Average expenditure (IDR/capita/month) and proportion (%) of food and non-food expenditures in urban and rural households, Bogor Regency

Expenditure	Urban=103 IDR/Capita/Month	%	Rural=65 IDR/Capita/Month	%	Total=168 IDR/Capita/Month	%
Food Expenditure						
Grains & tubers	79.039	25	69.737	24	75.440	25
Plant-based foods and legumes	24.031	8	22.793	8	23.552	8
Animal-based foods	68.826	22	64.084	22	66.991	22
Oils and fats	17.855	6	15.717	5	17.028	6
Vegetables and fruits	31.290	10	48.834	17	38.078	13
Sugar, salt and spices	20.827	7	23.685	8	21.932	7
Beverage ingredients	35.857	12	23.942	8	31.247	10
Others	32.887	11	22.471	8	28.857	10
Total Food Expenditure	310.61	49	291.262	48	303.125	46
Non-Food Expenditure						
Fuel	79.830	21	61.144	19	72.600	20
Cigarettes	93.782	25	111.312	35	100.564	28
Phone credits	32.422	8	15.712	5	25.957	7
Hygiene products	29.350	8	24.903	8	27.629	8
School expenses	69.919	18	48.647	15	61.688	17
Other (installments, etc)	76.834	20	58.414	18	69.708	19
Total non-food expenditure	382.137	61	320.132	52	358.147	54
Total Expenditure	692.749	100	611.395	100	661.273	100

Non-food expenditure was greater than food expenditure in the study households. Table 2 shows that cigarettes, fuel (gasoline, gas, electricity, etc.), and other costs (installments and savings groups) remained the largest non-food expenditures. The average expenditure on purchasing cigarettes ranged from IDR 90,000 to IDR 100,000. Tobacco expenditures impact the household budget as they reduce the consumption of other items, such as food (crowding-out effect). The population of households in this study consisted of households at risk of stunting, with one criterion being categorized as poor. Income significantly affects expenditure on purchasing cigarettes, as demand is inelastic among lower-middle households. As the income of poor households increases, the proportion of expenditure on cigarettes also rises; however, when cigarette prices spike, poor households tend to sacrifice the consumption of other commodities, such as food (carbohydrates, protein, fats, etc)[32].

The second-largest proportion of non-food expenditure is for purchasing fuel, such as gas, gasoline, and electricity. During the interviews, samples reported buying gas for IDR 23,000 and purchasing it about to 2-3 times a month. High gasoline expenditures were also acknowledged by rural residents, as many household heads worked as street vendors in Bogor and Depok, leading to significant gasoline expenses. Other expenditures, such as electricity tokens, start at IDR 20,000 – IDR 30,000 per month. Other expenses (installments and savings groups) become the third-largest non-food expenditure, with some samples reporting installment payments of approximately IDR

50,000 per month. The total expenditure for both areas is IDR 661,273 (urban: IDR 692,749; rural: IDR 661,273), which is not significantly different, although urban areas remain higher. These findings align with the National Socioeconomic Survey (SUSENAS) 2022, which indicates that the average total household expenditure in urban areas is higher than that in rural areas[33].

The average per capita monthly food expenditure in urban areas for all food groups was IDR 303,125 (urban: IDR 310,612; uural: IDR 291,262), with the largest proportion of food expenditure allocated to carbohydrate sources (25%). These findings indicate that rice remains the primary source of carbohydrate consumption for stunting-risk households, and the proportion of carbohydrate consumption is higher than that of protein (both animal and plant) and fat. This is consistent with Wijayanti et al (2019), who find that rice remains the largest expenditure for households in Indonesia, with an average weekly expenditure of IDR 58,545[34]. Food preferences are dynamic and change according to household characteristics (income and education). Income influences household preferences because an increase in income leads to a wider variety of carbohydrate sources, whereas lower-income households have limited choices because of restricted access to food[35,37]. This study found that the average subjects interviewed, who were mostly housewives, did not accurately know the size of their homes, resulting in an inaccurate reporting of house sizes (m²). Table 3 shows that the majority (57.1%) of homes in urban and rural areas were self-owned, while (37.5%) belonged to

parents. Based on interviews and field observations, families living in their parents' homes are typically young couples who married early and stayed with their parents because of financial constraints preventing them from purchasing land and achieving independence. This aligns with research on early marriages in Indonesia, where early marriages are often not financially stable, leading parents to retain their children, with many couples living with their in-laws after marriage[39].

Table 3. Household asset ownership in urban and rural areas

Type of Household Assets	Urban n=103 (%)	Rural n=65 (%)	Total n=168 (%)
Home ownership			
Owned	61 (59.2)	35 (53.8)	96 (57.1)
Contracted or rented	8 (7.8)	1 (1.5)	9 (5.4)
Owned by parents	34 (33)	29 (44.6)	63 (37.5)
Other	0 (0)	0 (0)	0 (0)
Refrigerator ownership			
No refrigerator	25 (24.3)	40 (61.5)	65 (38.6)
Has refrigerator	78 (75.7)	25 (38.5)	103 (61.3)

This study also inquired about refrigerator ownership as it relates to food storage, which is a determinant of FW. A total of 75.7% of urban households own refrigerators, while 61.5% of rural households do not, resulting in traditional food storage methods, such as keeping vegetables in open areas, which can lead to spoilage and contribute to FW. Having a refrigerator and storing food at appropriate temperatures can extend the shelf life of the food[40].

Calculation of Food Waste Using HFWQ

The measurement of household food waste in this study was conducted using a survey method. This method is a direct measurement of food waste (FW) aimed at assessing FW in terms of quantification and gathering factual information, allowing researchers to estimate FW (size, amount, frequency of waste generation, etc), as well as participants perceptions regarding the types and amounts of FW through recall or visual estimation. This study utilized the FW survey questionnaire validated by Van Herpen *et al* (2021)[26]. The study began with a pre-announcement to the subjects in accordance with previous research recommendations to create a potential effect on social desirability by prompting behavioral changes. The pre-announcement period was one week prior to conducting the interviews[26]. This study provided pre-announcements to community health workers (*kader posyandu*) in the research location to assist the research team in communicating with the subjects.

The second stage involved interviews using the introductory FW questionnaire to identify which food groups were wasted by the households. A total of 12 food groups were inquired about from the subjects, including vegetables, fruits, cereals and tubers, legumes (beans and their products), meat and its products, fish (seafood and its products), eggs, sauces or toppings, non-alcoholic beverages, flour and its products, salt (sugar, spices, etc), and other food groups. The reported unit of FW varies for each product category (spoons, pieces, slices, liters, etc),

necessitating conversion to a standard unit to obtain the total household FW size. The recommended unit is in grams[26]. To maintain consistency with previous studies, this study used standard units based on the assumptions of grams per unit and adjusted according to the Household Unit Size and Indonesian Exchange Units[26]. The unit of FW used is kilograms per capita per year, and the total FW is calculated by summing the estimated FW converted from URT to grams, then to kilograms, while categorizing FW disposal. The total FW generated by households was averaged to obtain the average household FW per week, which was then divided by the number of household members to obtain the per capita data. Table 4 summarizes the total FW generated by households in urban and rural areas, based on the 12 food groups[41,42].

The average FW produced by households in both areas is 5.07 kg per capita per year (rban: 4.8 kg per capita per year; rural: 5.51 kg per capita per year). The amount of FW in rural areas is higher than that in urban areas, which contrasts with studies conducted in the European Union and Lebanon, which found higher household FW in urban settings than in rural settings[41,42]. In this study, the high FW generation in rural areas was attributed to conventional storage practices that lead to short food shelf life, resulting in spoilage and disposal. The largest contributors to FW are vegetables (spinach, water spinach, chili, and tomato) due to storage issues (drying and rot), cereals and tubers (rice, potatoes, cassava) that spoil, and fruits (kweni, mangoes, bananas, oranges, watermelons, salak) that are discarded because of spoilage from improper storage and excessive quantities. This aligns with a study by Bappenas on food loss and waste in Indonesia, which indicated that the largest FW generation comes from the rice sector, totaling 12–21 million tons per year, and the least efficient food type is the horticulture sector, especially vegetables, with a total loss of 62.8%[3].

Table 4. Average (kg/capita/year) and proportion (%) of FW in urban and rural areas, Bogor Regency

Food Groups	Urban n=103 Average (%)	Rural n=65 Average (%)	Total n=168 Average (%)
Vegetables	1.92 (40)	1.53 (28)	1.77 (35)
Fresh fruits	0.76 (16)	1.34 (24)	0.98 (19)
Cereals and tubers	0.84 (18)	1.48 (27)	1.09 (21)
Legumes and their products	0.25 (5)	0.12 (2)	0.2 (4)
Meat and its products	0.09 (2)	0.02 (0)	0.07 (1)
Fish, seafood and their products	0.08 (2)	0.07 (1)	0.07 (1)
Eggs	0.02 (0)	0.05 (1)	0.03 (1)
Sauces and toppings	0.02 (0)	0 (0)	0.01 (0)
Non-alcoholic beverages	0.32 (7)	0.5 (9)	0.39 (8)
Flours and their products	0.09 (2)	0.08 (1)	0.09 (2)
Sugar, salt and spices	0.27 (6)	0.27 (5)	0.27 (5)
Fats, oils, etc	0.14 (3)	0.04 (1)	0.1 (2)
Total FW	4.8 (100)	5.51 (100)	5.07 (100)

The categories of food waste (FW) generation is divided into four categories: partially used, food leftovers, completely unused, and waste after storage. This study found that the reasons for higher FW generation in urban areas are related to consumption behavior, particularly the high amount of food left on plates per person after meals (64.6%). According to the interview results, children are the primary culprits for not finishing their food; another reason is boredom with the menu. In line with findings from food loss and waste (FLW) research in Indonesia, 51.13% of FW was due to leftovers on plates per person. Research in Pakistan has revealed that food sensory factors (taste, aroma, appearance) and improper menu planning and cooking methods can influence FW[46]. Nevertheless, high FW generation due to plate leftovers is a problem that can be fundamentally avoided[47]. The categories of FW generation in both areas are shown in Figure 1.
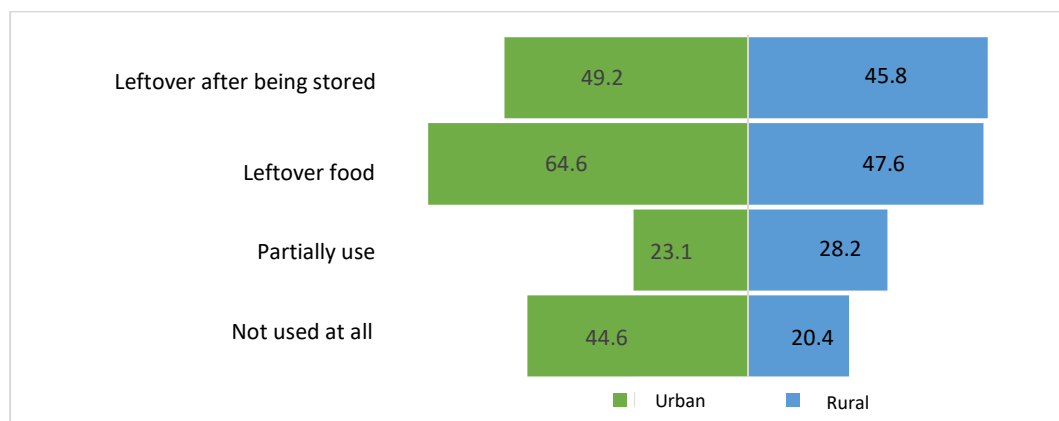
Figure 1. Household food waste generation by disposal category (%) in urban and rural areas

As many as 48.5% of rural households reported that their FW consisted of food leftovers that spoiled after storage (changes in color, smell, taste, and texture). A significant amount of food waste in rural areas is related to improper storage (61.5% of households do not have refrigerators). During the interviews, many indicated that food was often wasted because it was forgotten after being stored, either in the refrigerator or at room temperature. Commonly wasted foods after storage include vegetables and condiments, such as chili and onion, as well as other items already stored in the refrigerator. Households do not often give leftovers to livestock because of a lack of resources; typically, leftovers are repurposed into other meals. Refrigerator ownership significantly affects food storage practices in rural households. An intervention study in the U.S. demonstrated that providing education on refrigerator usage can reduce FW by 27.9%[48].

Determinants of Food Waste in Urban and Rural Households

Determinants of Food Waste in Urban and Rural Households Several studies have examined various factors responsible for FW generation at the household level, such as the number of household members, the gender of the household members responsible for food purchasing, and consumer habits, including planning, shopping, consumption, and the treatment of waste leftovers. These factors contribute to the generation of FW[17,58–60]. In this study, factors suspected to influence FW generation at the household level were tested using the Chi-squared test (χ2) and analyzed using logistic regression. Table 5 shows the results of tests examining the relationship between each determinant factor and total FW generation in urban households, indicating that

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there is no significant relationship between family size and refrigerator ownership and FW (p-value>0.05). Household income was significantly related to FW in urban areas (p-value=0.021), with the amount of FW generated increasing as income rose. Households with higher incomes tend to produce more FW. This aligns with studies conducted in Australia, China, and Lebanon, which have found that higher-income families generate more FW[16,42,44]. Research in Indonesia has also discovered that households with medium to high incomes tend to produce more FW[13,61].

Table 5. Relationship and proportion n(%) of household characteristics and knowledge based on food waste categories

Variabel	FW Rural			FW Urban		
	Below 4,8 kg/capita/year[1]	Above 4,8 kg/capita/year[1]	p-value[3]	Below 5,51 kg/capita/year[2]	Above 5,51 kg/capita/year[2]	p-value[3]
Family Size						
Small (<4 people)	29 (65.9)	36 (61)	0.611	18 (69.2)	20 (51.3)	0.150
Large (>6 people)	15 (34.1)	23 (39)		8 (30.8)	19 (48.7)	
Refigerator ownership						
No refrigerator	8 (18.2)	17 (28.8)	0.213	14 (53.8)	11 928.2)	0.037*
Has refrigerator	36 (81.8)	42 (71.2)		12 (46.2)	28 (71.8)	
Pendapatan total RT						
Below the minimum regional wage	28 (63.6)	24 (40.7)	0.021*	4 (15.4)	12 (30.8)	0.158
Above the minimum regional wage	16 (36.4)	35 (59.3)		22 (84.6)	27 (69.2)	
Pengetahuan FW						
Poor	21 (47.7)	42 (71.2)	0.016*	23 (88.5)	32 (82.1)	0.483
Good	23 (52.3)	17 (28.8)		3 (11.5)	7 (17.9)	

[1] Average food waste in urban areas
[2] Average food waste in rural areas
[3] Chi-Square test, *p-value significant <0.05
FW: Food Waste

This study found that knowledge of FW is significantly related to FW in urban households (p-value=0.016). Households with lower levels of knowledge tended to generate more FW. In rural households, refrigerator ownership was significantly associated with FW (p-value=0.037). Households without refrigerators tend to produce above-average FW. Owning a refrigerator, storing food under appropriate conditions and temperatures, and freezing food can extend the shelf life of food, and thus reduce FW[63,64]. Further analysis revealed no significant relationship between FW generation and expenditure on cereals and tubers in urban (p-value=0.622; r=-0.049) and rural areas (p-value= 0.537; r=-0.071). This indicates that the amount spent on cereals and tubers does not affect the quantity of discarded FW. A study in West Java showed that the cereal group, particularly rice, is a staple food that is price inelastic [65]. There was no significant relationship between FW generation and vegetable expenditure in rural areas (p-value=0.260; r=-0.142); however, a significant negative relationship was found between FW and vegetable expenditure in urban areas (p-value=0.000; r=-0.339). Purchasing vegetables may be related to FW generation as it involves consumer habits in urban areas, such as purchasing discounted food items in supermarkets (Yogyamart, Superindo, etc.). An additional analysis of household income categorized above and below the minimum regional wage (UMK) showed a connection with FW in urban households. Households with income above the UMK are more likely to purchase unplanned promotional items (discounted), which is significantly related to household purchasing behavior (p-value=0.010). Several studies have found that families with higher incomes and greater access to food tend to buy unplanned items, increasing their chances of FW[16,42,44].

Table 6. Relationship and proportion n(%) of behavior and food waste

Variabel Determinan FW	FW Rural			FW Urban		
	Below 4,8 kg/capita/year[1]	Above 4,8 kg/capita/year[1]	p-value[3]	Below 5,51 kg/capita/year[2]	Above 5,51 kg/capita/year[2]	p-value[3]
Planning Behavior						
Planning shopping and meals menus according to family preferences						
Often (0)	25 (56.8)	21 (35.6)	0.032*	11 (42.3)	26 (66.7)	0.052
Rarely (1)	19 (43.2)	38 (64.4)		15 (57.7)	13 (33.3)	
Purchasing Behavior						
Buying promotional or discounted items that are not planned						
Often (0)	12 (27.3)	31 (52.5)	0.010*	7 (26.9)	15 (38.5)	0.335
Rarely (1)	32 (72.7)	28 (47.5)		19 (73.1)	24 (61.5)	
Storage Behavior						
Storing food properly (in the refrigerator/closed containers)						

Variabel Determinan FW	FW Rural			FW Urban		
	Below 4,8 kg/capita/year[1]	Above 4,8 kg/capita/year[1]	p-value[3]	Below 5,51 kg/capita/year[2]	Above 5,51 kg/capita/year[2]	p-value[3]
Often (0)	23 (52.3)	35 (59.3)	0.476	20 (76.9)	18 (46.2)	0.014*
Rarely (1)	21 (47.7)	24 (40.7)		6 (23.1)	21 (53.8)	
Cooking Behavior						
Cooking only the amount needed for the family to avoid food waste						
Often (0)	19 (43.2)	30 (50.8)	0.441	18 (69.2)	22 (56.4)	0.298
Rarely (1)	25 (56.8)	29 (49.2)		8 (30.8)	17 (43.6)	
Perilaku konsumsi						
Consuming food outside the home						
Often (0)	33 (75)	37 (62.7)	0.186	22 (84.6)	30 (76.9)	0.448
Rarely (1)	11 (25)	22 (37.3)		4 (15.4)	9 (23.1)	

[1] Average food waste in urban areas
[2] Average food waste in rural areas
[3] Chi-Square test, *p-value significant <0.05
FW: Food Waste

Significant independent variables related to FW from correlation tests (p-value<0.05) were included in the multivariate analysis using logistic regression to identify determinants of FW (Table 6). The determinants of FW in Table 7 for urban households indicate that high income (above UMK) is associated with a 4.3 times greater risk of generating FW than low-income households (OR=4.32, CI=1.72 – 10.77). This aligns with studies in Indonesia that also found that medium-to-high-income households tend to generate more FW [13,61]. Households with low knowledge were at a 3.49 times higher risk of generating FW compared to those with good knowledge (OR=3.49, CI=1.39 – 8.79). A lack of knowledge regarding FW issues, proper storage methods, and practices contributes to higher levels of FW[62,68].

Table 7. Determinant food waste household in urban and rural area

Determinan FW	p-value[1]	OR (95% CI)
Urban		
Total household income (1 = above minimum wage)	0.002	4.32 (1.72 – 10.77)
Knowledge of food waste (1 = poor)	0.008	3.49 (1.39 – 8.79)
Planning shopping and meals menus according to family preferences (1 = rarely)	0.024	2.77 (1.14 – 6.73)
Rural		
Storing food properly (in the refrigerator/covered containers) (1 = rarely)	0.021	3.81 (1.22 – 12.03)

[1]Regresi Logistic *p-value significant <0.05
FW: Food Waste

Households that rarely plan their shopping and meal menus according to family preferences are at a 2.77 times higher risk of generating FW than those that frequently plan. Planning before shopping, such as checking food supplies and creating shopping lists based on needs, can significantly reduce FW at household level[69]. Subjects reported not making shopping lists because shopping was done daily, depending on their husband's income. The average daily shopping expenditure is IDR 30,000 used to buy rice, side dishes, and vegetables. The inability to plan shopping and meal menus was related to FW. This finding aligns with a study in Taiwan that found planning shopping to be the most effective strategy for preventing FW (33%)[22] due to its effectiveness in preventing the over-purchasing of food items[41]. Other factors that may influence FW disposal behavior include the absence of a shopping list, which can lead to excessive and unnecessary purchases, thereby increasing FW[17,20,67,70].

The determinants of FW in rural households are related to their storage behavior. Households that rarely store food properly (in refrigerator/closed containers) are at a 3.81 times higher risk of generating FW than households that practice proper storage. Some studies have found that food storage behavior, such as freezing food, can extend food shelf life[63,64] and the ability to store food properly can reduce household FW by 29%. A study conducted in Australia found that low temperatures can help maintain food freshness[22,71].

This study is the first in Indonesia to analyze the determinants of FW in both urban and rural areas simultaneously using a validated survey method. In its full study, this research also links FW with FCS and household food security. FW generation was measured using an interview method, and the reported FW results were based solely on respondents estimates and memory, which may have led to underreporting. The adapted and developed questionnaires did not extensively explore the types of discarded foods. Additionally, this study did not thoroughly investigate the social impact of FW, particularly the loss of nutritional content due to wasted food, highlighting the need for further research.

CONCLUSIONS

The average FW generated in both areas is 5.07 kg/capita/year (urban: 4.8 kg/capita/year; rural: 5.51

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kg/capita/year). The food groups most frequently wasted were vegetables (35%) and cereals and tubers (21%). FW generation in urban areas consists of leftovers after storage (64.6%), while in rural areas, it comprises food waste (48.5%). The determinants of FW in urban households are total household income, knowledge, and planning behavior, whereas the determinants in rural households are related to storage behavior.

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AUTHOR CONTRIBUTIONS

LL: data curation, formal analysis, funding acquisition, project administration, writing-original draft. YFB: conceptualization, methodology, writing-review and editing. IT: conceptualization, methodology, review.

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