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Decisional Factors Driving Household Food Waste Prevention: Evidence from Taiwanese Families

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Abstract: Although previous studies have discussed food waste at the household level and the antecedents of food disposal in western countries, very few studies have investigated food waste practices in Asian countries at the household or individual levels. As the food waste issue has drawn considerable concerns, the aim of this study was to examine how moral norms, perceived behavioral control, and food choices affect household food waste under the mediating role of household storing and cooking routines, as well as the moderating role of unplanned events. A questionnaire survey of Taiwanese families eventually obtained 954 valid questionnaires for analysis. Overall model fit and the study hypotheses were tested by structural equation modeling method (SEM). The SEM results showed that household storing and cooking routines significantly mediate the effects of moral norms and food choices on household food waste. Moreover, the moderating effect of unplanned events is statistically significant, indicating that under a higher degree of unplanned events, families are less likely to reduce food waste through household storage practices and cooking routines. Several implications and suggestions are also discussed for the reduction of household food waste.

Keywords: moral norm; perceived behavioral control; food choices; storing and cooking routines; household food waste; unplanned events

1. Introduction

Household food waste can be defined as all drink and food that, at some point before being thrown away, was edible [1–3]. To predict and explain key factors that drive household food waste, several studies have applied the theory of planned behavior (TPB) by Ajzen [4]. So far, studies applying TPB on studying household food waste have had two problems: (1) the problem of the intention–behavior gap [5], whereby individual intentions to avoid food waste may not lead to actual food waste prevention behaviors; (2) the relatively small behavioral variances accounted for by the TPB model [6]. These studies imply that individual intention to avoid food waste should not be considered as the core and only predictor of food waste prevention. In fact, household food storage and cooking practices have been identified in some qualitative research for their decisive roles in potential household food waste prevention [7,8]. In Richter and Bokelmann [9], the household diary method revealed that food storage and food waste are significantly correlated. Later, Khalid et al. [10] confirmed that major reasons of household food waste include poor planning of meals, improper cooking, and cooking too much food. Based on these recent qualitative findings, food storing and cooking routines should not be neglected in household food waste prevention. Therefore, the current study aimed to investigate whether household storing and cooking routines significantly reduce household food waste.

The most intensively studied factor in household food storing and cooking routines is moral norms [1,2,11–13], because individual moral intention is naturally linked to proenvironmental intentions. Chen [12] found that moral obligation is an important positive driver to intention to engage in carbon reduction behaviors and energy savings in Taiwan. Individuals who have high moral norms tend to feel guilty or bad when wasting food or causing environmental problems [2], which increases their intention to prevent food waste [3]. In contrast, those with weak moral norms often find their own reasons to justify food waste as a proper and reasonable action [13]. On the other hand, people have stronger intention to perform proenvironmental behaviors when they recognize that such behaviors are easy to achieve [14], revealing behavioral control as another key factor driving household food storing and cooking routines. When people who prepare food for their families recognize the importance of controlling family food waste, they can potentially influence their real actions on reducing household food waste [6] as well as how they manage household food [3]. In addition to moral norm and behavioral control, recent studies have indicated that the food choices of individuals affect their meal planning routines [11] and food waste actions [1]. Health-conscious consumers tend to check food labeling during food purchase [13] and find proper ways for food preservation and cooking [15], which results in less food waste than the general public [16].

In addition, recent research findings [8,17] have shown that unplanned events may ruin the plans that family members make to prevent household food waste. Through in-depth interviews with Taiwanese families, Teng and Chih [17] found that several interviewees complained about the difficulty of effectively preventing food waste due to unexpected changes in the dining schedule (e.g., not eating at home without prior notice). Porpino et al. [8] also indicated that the main reason why families overprepare food is that family members always unexpectedly dine out. Therefore, even when families follow proper food preservation methods and cooking routines, the unplanned events still bring unwanted household food waste [18,19].

This study had three objectives: (1) to investigate the relationships among household moral norm, perceived behavioral control, food choices, household storing and cooking routines, and food waste; (2) to examine the mediating effect of household storing and cooking routines on the relationships among moral norm, perceived behavioral control, food choices, and food waste; and (3) to examine how unplanned events moderates the relationship of household storing and cooking routines to food waste.

2. Literature Review

2.1. Moral Norms and Household Storing and Cooking Routines

In the setting of household food waste, moral norms refer to an individual's feelings of guilt and bad conscience (mostly toward the poor or/and natural environment) when they waste food [2]. According to the literature, a sense of guilt causes individuals to cherish food resources, especially among organic-minded consumers because they normally have more awareness toward proenvironmental and humanity issues [20]. Stefan et al. [3] found that people who have strong moral norms have a strong intention to prevent food waste. Quested et al. [16] pointed out that most people dislike wasting food and explained that the sense of guilt generated through food waste motivates people to prevent household food waste. While interviewing families in Brazil, Porpino et al. [8] found that interviewees often exhibited embarrassment or shame when admitting their own food waste actions. To prevent such negative feelings, families interviewed in Porpino et al. [8] reported that they prevent food waste by using the food to feed animals or by reducing the amount of food they cook for family meals. Parizeau et al. [13] further found that individuals with low moral norms are likely to make excuses for waste made during their food preservation and cooking and are not concerned about the social and economic outcomes of food waste. Based on the above, moral norm can potentially motivate individuals to change their household food storing and cooking routines [13,21]. Therefore, we proposed the following hypothesis:

Hypothesis 1 (H1). *Moral norms positively affect household storing and cooking routines.*

2.2. Perceived Behavioral Control and Household Storing and Cooking Routines

Perceived behavioral control refers to perceptions regarding their own personal capability to achieve a certain level of behavioral performance. According to TPB, whether consumers perceive that their behaviors can prevent food waste can affect their related intentions and actions [4]. Graham-Rowe et al. [6] found that, when people have high perceived behavioral control, they have high confidence in their capability to reduce food waste, which leads to their strong intention to reduce household food waste. Perceived behavioral control could also influence the food-related behaviors of consumers, especially food planning routines (e.g., making a food shopping list and checking food inventories) and shopping routines (e.g., buying too much food and impulsive food shopping) [3]. Therefore, based on Stefan et al. [3], we proposed that when individuals perceive that they can control their food planning and shopping behaviors, their actual practices on household food planning and shopping routines have a tendency to reduce food waste. According to TPB, when preparing food for a whole family, individuals' perceived behavioral control could be transferred into related practices, such as household food storing and cooking routines, for preventing food waste. Hence, we proposed Hypothesis 2:

Hypothesis 2 (H2). *Perceived behavioral control positively affects household storing and cooking routines.*

2.3. Food Choices and Household Storing and Cooking Routines

Food choices in this study refers to the extent that individual considerations about health and safety issues (e.g., nutrition and hazardous ingredients) affect food choices [1]. Foodborne disease is a common illness caused by food through means such as inappropriate cooking or preservation [15]. When household food ingredients are not preserved and cooked under appropriate temperatures, family members are very likely to get foodborne disease [15]. Therefore, we proposed that individuals with high awareness of food choices are likely to have good household food storing and cooking practices. McCarthy and Liu [20] also pointed out that organic-minded consumers are likely to be aware of resources and pollutions consumed during growing, processing, packaging, and transporting food, and are therefore more likely to gain negative feelings when wasting food than others. Other studies have found that consumers who have a healthy diet tend to minimize the amount of food that their household throws away [16] and are more likely to read nutrition labels during food shopping and produce less organic waste (e.g., food waste, pet waste, and soiled paper) [13]. Therefore, we proposed the following hypothesis:

Hypothesis 3 (H3). *Food choices have a positive influence on household storing and cooking routines.*

2.4. Household Storing and Cooking Routines and Food Waste

Common food management errors that cause food waste include wrong (or too long) storage, lack of planning food provisioning, overstock of meals and food, misplanning of meals, improper cooking, and cooking too much [10,22]. All of these errors are related to household food storing and cooking routines. Proper household food storing not only maintains the quality of food items, it also helps family members find places for their desired food items, prevent overpurchasing of food, and understand expiration dates of stored food [7]. Therefore, systematically categorizing and storing food products can prevent food waste [13,23]. Accurately estimating the amount of food that should be prepared by a household can also prevent food waste [8,21,24]. Hence, it is important to understand the food amount needed for a family during food shopping and when planning meals for a family [16]. In contrast, inappropriate cooking skills can also cause food waste. Porpino et al. [8] found that inappropriate cooking skills (e.g., overcooked meat or vegetables) make meals unappealing to family members, resulting in waste of food. Other causes of household food waste reported in another study by Ponis et al. [25] include errors in food management (e.g., improper storage, poor cooking skills,

bad expiration date monitoring) and food portioning (food not served but discarded, food was scraped from plate). Based on the above, proper household food storing and cooking routines may reduce household food waste. Thus, we proposed Hypothesis 4:

Hypothesis 4 (H4). *Good household storing and cooking routines reduce food waste.*

2.5. The Mediating Effects of Household Storing and Cooking Routines

This study proposed that household storing and cooking routines have mediating effects on foods waste for three reasons. First, former literature has indicated that moral attitude influences consumer behaviors such as purchasing, preserving, and preparing food [13,21]. For people who want to avoid the guild caused by food waste, increasing people's general moral awareness of food waste is a practical approach to reducing household food waste [16]. Porpino et al. [8] and Parizeau et al. [13] both noted that moral norms can affect food storage and cooking behaviors. People with low moral norms are less concerned about social and environmental impacts from food waste when they practice food storage and cooking and are less likely to make efforts to prevent food waste [8,13]. Second, from TPB perspective [4], individuals have more motivation to perform a certain behavior when they have better control of the specific behavior. Therefore, when people have high confidence that they can control the quality of their food and healthy cooking, they make efforts on proper food storage and cooking, resulting in the decrease of household food waste. Third, health-conscious consumers may make efforts to reduce food waste due to their high proenvironmental awareness [13,16,20]. Besides, health-conscious consumers may be highly concerned about household food storage and cooking routines because they want to ensure food safety and prevent the risk of foodborne disease [15]. For these reasons, actions made by health-conscious consumers in household food storage and cooking routines could significantly reduce food waste at home. Based on the above, the following three hypotheses were proposed:

Hypothesis 5a (H5a). *Household storing and cooking routines mediate the relationship between moral norm and food waste.*

Hypothesis 5b (H5b). *Household storing and cooking routines mediate the relationship between perceived behavioral control and food waste.*

Hypothesis 5c (H5c). *Household storing and cooking routines mediate the relationship between food choices and food waste.*

2.6. The Moderating Effect of Unplanned Events

Farr-Wharton et al. [7] pointed out that households often experience "spur-of-the-moment" situations that leads to a cancellation of formerly planned consumption of household food. The authors referred to this "spur-of-the-moment" situation as unplanned events. Studies have also indicated that, because it is convenient or because it saves time, family members sometimes make unplanned decisions to dine out or cancel family cooking plans, causing the waste of purchased food and/or leftovers to spoil [13,26]. These frequent unplanned events can reduce the time available for consumption of purchased household food before their expiration dates [13,26]. Studies also found that families living with children always have difficulty predicting whether children will dine at home or not, causing frequent "cook too much" problems [8,27], as well as increasing the amount of food waste [19]. That is, although practicing household storing and cooking routines could reduce food waste, frequent unplanned events in a household may limit efforts to prevent food waste. Therefore, this study postulated that unplanned events would have a moderating effect on the relationship between household storing and cooking routines and food waste. Consequently, the following hypothesis was proposed:

Hypothesis 6 (H6). *Unplanned events moderate the effects of household storing and cooking routines on food waste.*

Figure 1 depicts the hypothesized model based on the above discussion.

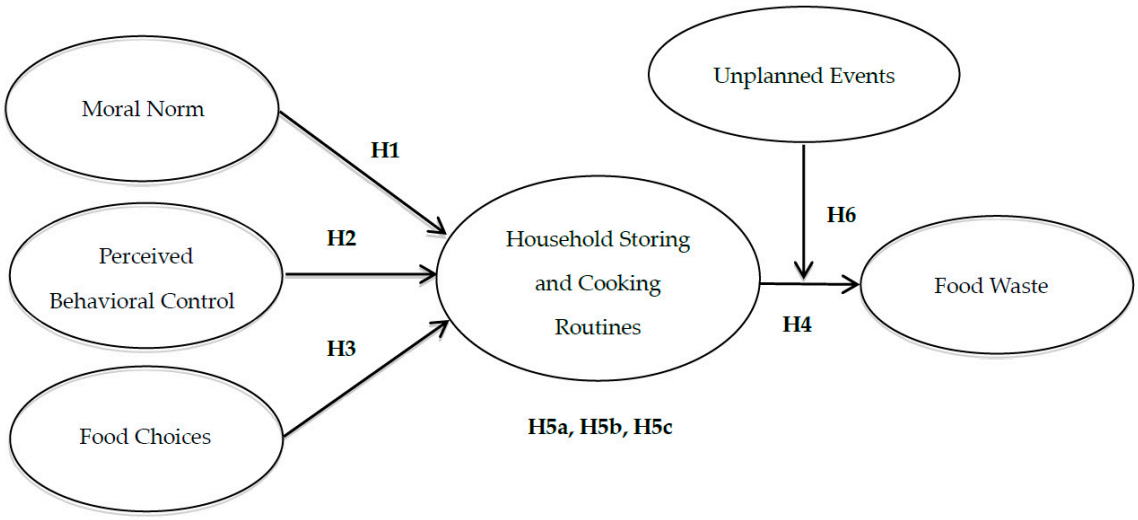

Figure 1. The hypothesized model.

3. Methodology

3.1. Data Collection

With the assistance of a marketing survey corporation, this study performed an online survey of a stratified random sample of Taiwanese citizens living in different regions of the country. To ensure that all participants were familiar with their own family food management and had practical experience in preparing food for their own family, the inclusion criteria were (1) family size of two or more, and (2) the participant is the person who prepares or purchases most food for their family. These two selection criteria were added as filter questions in the beginning of our online survey. Those who did not match these selection criteria were not allowed to take the whole survey. Data were collected from May to June in 2018. Out of 1022 survey responses collected, 954 were usable samples, resulting in usable response rate of 93.3%. Among the 954 participants, 619 were female, and 335 were male. Most participants were aged 31–50 (31–40: 44.4%; 41–50: 24.9%), had higher education (67.8% had a college/university degree), were married (67.3%), and family members were parents with children (56.3%). In terms of the number of family members who typically dined together, 49.7% usually dined with 4–6 family members and 47.6% usually dined with 1–3 family members. Besides, 53.5% of participants made family food purchases two or more times per week and 43.9% cooked lunch or dinner at home 4–6 times per week. In monthly household income (1 USD is around 30 NTD), 48.4% were between NTD30,001–90,000 and 20.9% were between NTD90,001–120,000. Table 1 shows the profiles of the participants. Samples collected in this study are representative of Taiwan because the participants' profile presented in Table 1 is similar to former empirical study sampling a representative group of Taiwanese consumers, such as the one by Teng and Lu [28].

Table 1. Demographic profiles of the sample (n = 954).

	n	%		*n*	%
1. Gender			7. Monthly household income (1 USD = 30 NTD)		
Male	335	35.1	NTD30,000 or less	40	4.2
Female	619	64.9	NTD30,001–60,000	209	21.9
2. Age			NTD60,001–90,000	253	26.5
21–30	150	15.7	NTD90,001–120,000	199	20.9
31–40	424	44.4	NTD120,001–150,000	118	12.4
41–50	238	24.9	NTD150,001–180,000	66	6.9
51–60	106	11.1	More than NTD180,001	69	7.3
Above 61	36	3.7	8. Location		
3. Education			Northern Taiwan	547	57.3
Under junior high school	24	2.5	Central Taiwan	172	18.0
High school	139	14.6	Southern Taiwan	224	23.5
College or university	647	67.8	Eastern Taiwan	10	1.0
Above graduate	144	15.1	Kinmen and Matsu	1	0.1
4. Marriage			9. Amount of family members to dine together		
Married	642	67.3	1–3	454	47.6
Unmarried	312	32.7	4–6	474	49.7
5. Occupation			Above 7	26	2.7
Government agencies	101	10.6	10. Family members		
Manufacture	260	27.3	A couple	111	11.6
Service	336	35.2	Parents with children	537	56.3
Freelance	95	10.0	Single parent with children	32	3.4
Homemaker	90	9.4	Grandparent, parents, and children	175	18.3
Retired	19	2.0	Grandparents and grandchildren	2	0.2
Others	53	5.6	Grandparents, parents, children, and grandchildren	42	4.4
6. Frequency of family food purchase			Others	55	5.8
Twice or more per week	510	53.5	11. Frequency of cooking lunch or dinner at home		
Once per week	368	38.6	1–3 times per week	318	33.3
Once per two weeks	57	6.0	4–6 times per week	419	43.9
Once per three weeks or less	19	2.0	Above 7 per week	217	22.7

3.2. Measures

Most of the used multi-item scales were adopted from former literature [1,2,7,8,16,21]. Some scales were self-developed under reviewing related former literature. Scale items that were originally developed in English were back-translated by two native speakers to confirm consistency between the original content and the translated content. Except for food waste, all scale items were rated using seven-point Likert scales ranging from strongly disagree (1) to strongly agree (7). Used scales are shown as the followings:

(1) Moral norm: The three-item scale established by Stancu et al. [2] was used to assess moral norms regarding food waste. Examples of items included, "Wasting food would make me feel guilty about people who do not have enough food" and "Wasting food would make me feel guilty about the environment".

(2) Perceived behavioral control: The three-item scale developed by Stancu et al. [2] was used for a self-evaluation of the capability to reduce food waste. Example items included, "In my opinion wasting food is unavoidable" and "In my opinion loading the environment with my household's food waste is unavoidable".

(3) Food choices: A modification of the 4-item scale developed by Abdelradi [1] was used to measure choices of safe and healthy food. Example items include: "It is important that the consumed food is rich in vitamins and proteins" and "For me, it is important that the food we consume contains no hazardous ingredients as dioxins, pesticides".

(4) Household storing and cooking routines: Scale items for this construct were developed through extracting items from Farr-Wharton et al. [7], Graham-Row et al. [21], Porpino et al. [8], and Quested et al. [16], Four items were used to assess storing routines and five items were used to assess cooking routines. Higher values indicate that participants had good household

storing and cooking practices. Example items include: "I understand proper methods to preserve different food", "I can plan food storage and know places of all the stored food", "I can use proper containers to store and preserve food", and "I know the difference between expiration date and best before date".

(5) Unplanned events: Three items derived from Farr-Wharton et al. [7] were used to assess the extent to change family cooking plans due to unexpected events. A high value indicates a high frequency of changes in family cooking plans because of unplanned events. Example items include: "Due to unexpected dining out, I always change my family cooking plan" and "Due to unexpected parties, I always have to change my family cooking plan".

(6) Food waste: The four-item scale of Abdelradi [1] was used to evaluate respondents' food waste at home. Food types measured in this measurement included leftovers, stored food and not used consumed eventually, excessive preparation of food, as well as opened canned and not consumed. Items of food waste were rated using a seven-point scale from "never waste" (1) to "a lot of waste" (7). A high value of the scale items indicates high extent of food waste.

3.3. Data Analysis

The proposed hypotheses in our model were examined using structural equation modeling (SEM). A statistical software, AMOS 21.0, was applied to run SEM. The analytical procedure of SEM includes two phases [29], including a measurement model and a structural model. According to Anderson and Gerbing [29], during the phase of running a measurement model, confirmatory factor analysis (CFA) was conducted to ensure fit between the measurement model and collected data. Then, at the phase of running a structural model, path analysis was conducted to examine the proposed relationships among constructs.

4. Results

4.1. Measurement Model

Table 2 shows the CFA results. All factor loadings ranged from 0.65 to 0.92 ($p < 0.001$), average variance extracted (AVE) values of all constructs ranged from 0.57 to 0.82, and composite reliability (CR) values of these constructs ranged from 0.84 to 0.93. Based on threshold values suggested by former literature [29–31], the CFA results showed good convergent validity and good internal consistency of our measures. Table 3 shows the correlation table and square roots of each construct's AVE. Each construct's correlations with other constructs were lower than its square root of AVE, demonstrating good discriminant validity [32]. Meanwhile, Cronbach's α of all constructs ranged from 0.84 to 0.93, demonstrating good reliability [32]. Moreover, Harman's single factor test was conducted to ensure the issue of common method bias. We found that the single-factor model accounted for 29.90% of the total variance, showing common method bias as not a critical threat in this study.

Table 2. Results of confirmatory factor analysis (n = 954).

Factors and Items	Unstd. Estimates	S.E.	t-Value	Std. Loading	SMC	Cronbach's α	CR	AVE
Moral Norm						0.933	0.933	0.823
1. Wasting food would make me feel guilty about people who do not have enough food	1.000			0.916	0.839			
2. Wasting food would make me feel guilty about the environment	0.992	0.023	43.281 ***	0.903	0.815			
3. Wasting food would give me a bad conscience	0.963	0.022	43.217 ***	0.902	0.814			
Perceived Behavioral Control						0.878	0.883	0.717
1. In my opinion wasting food is unavoidable (R)	1.000			0.935	0.874			
2. In my opinion loading the environment with my household's food waste is unavoidable (R)	0.905	0.027	32.938 ***	0.841	0.707			
3. Not to throw food away would be difficult (R)	0.827	0.029	28.162 ***	0.754	0.569			
Food Choices						0.850	0.854	0.663
1. It is important that the consumed food is rich in vitamins and proteins	1.000			0.734	0.539			
2. For me it is important that food consumption is low in fat (D)	—	—	—	—	—			
3. For me it is important that the food we consume contains no hazardous ingredients, such as dioxins and pesticides	1.177	0.049	23.927 ***	0.820	0.672			
4. I am concerned about food safety	1.214	0.049	24.842 ***	0.882	0.778			
Storing Routines						0.852	0.857	0.602
1. I understand proper methods to preserve different food	1.000			0.785	0.616			
2. I can plan food storage and know places of all the stored food	1.044	0.039	26.822 ***	0.832	0.692			
3. I can use proper containers to store and preserve food	1.026	0.039	26.459 ***	0.821	0.674			
4. I know the difference between "expiration date" and "best before date"	0.832	0.041	20.258 ***	0.651	0.424			
Cooking Routines						0.838	0.843	0.573
1. I can control portion size needed for my family	1.000			0.705	0.497			
2. I try to add variety on cooking for my family	1.041	0.050	20.943 ***	0.746	0.557			
3. I can control proper skills to cook food	1.075	0.047	22.813 ***	0.824	0.679			
4. I try to utilize food ingredients and don't waste them (e.g., I make bone broth)	1.053	0.050	20.990 ***	0.748	0.560			
5. I eat leftovers (D)	—	—	—	—	—			
Unplanned Events						0.872	0.874	0.699
1. Due to unexpected dining out, I always have to change my family cooking plan	1.000			0.825	0.681			
2. Due to unexpected parties, I always have to change my family cooking plan	1.136	0.039	29.045 ***	0.896	0.803			
3. Due to unexpected reasons from my family members, I always have to change my family cooking plan (e.g., someone cannot dine at home without prior notice)	0.918	0.035	26.408 ***	0.782	0.612			
Food Waste						0.893	0.894	0.678
1. Food leftover on a plate after a meal	1.000			0.798	0.637			
2. Cooked food over your needs	1.070	0.038	28.196 ***	0.838	0.702			
3. Saved food and eventually not used	1.118	0.040	27.816 ***	0.829	0.687			
4. Opened products (cans, sauces, etc.) and haven't been used	1.111	0.040	27.786 ***	0.828	0.686			

[1] *** $p < 0.001$; n = 954. [2] χ^2 = 916.794; df = 231; χ^2/df = 3.969; AGFI = 0.899; CFI = 0.952; SRMR = 0.037; RMSEA = 0.056. [3] SMC = square multiple correlation or R2; CR = composite reliability; AVE = average variance extracted.

Table 3. Correlations of variables.

Variables	Mean	SD	1	2	3	4	5	6	7
1. Moral Norm	5.35	1.11	0.907						
2. Perceived Behavioral Control	4.34	1.36	0.239 **	0.846					
3. Food Choices	5.82	0.87	0.357 **	0.133 **	0.814				
4. Storing Routines	5.13	0.89	0.321 **	0.156 **	0.486 **	0.775			
5. Cooking Routines	5.14	0.86	0.377 **	0.169 **	.0505 **	0.686 **	0.756		
6. Unplanned Events	4.14	1.23	0.110 **	−0.23 **	−0.001	0.023	−0.016	0.836	
7. Food Waste	2.85	1.09	−0.223 **	−0.457 **	−0.279 **	−0.251 **	−0.277 **	0.226 **	0.823

[1] * $p < 0.05$, ** $p < 0.01$ (two-tailed); $n = 954$. [2] The square roots of AVE for discriminant validity are italicized along the diagonal.

4.2. Hypothesis Testing

Relationships between variables were tested by SEM. Based on Hu and Bentler [33], the maximum likelihood estimation results indicated an adequate data fit (Comparative Fit Index, CFI = 0.952, Root Mean Square Error of Approximation, RMSEA = 0.056). Figure 2 also shows that hypothesis testing results demonstrated that moral norm was positively related to household storing and cooking routines, with a standardized coefficient of 0.22 *** ($p < 0.001$), which supported H1. Perceived behavioral control was not positively related to household storing and cooking routines, with a standardized coefficient of 0.05 ($p = 0.097$), which rejected H2. Food choices was also positively related to household storing and cooking routines, with a standardized coefficient of 0.54 *** ($p < 0.001$), which supported H3. The hypothesis testing results further demonstrated that household storing and cooking routines has a negative effect on food waste, with a standardized coefficient of −0.12 * ($p < 0.05$), supporting H4. In summary, H1, H3, and H4 were supported.

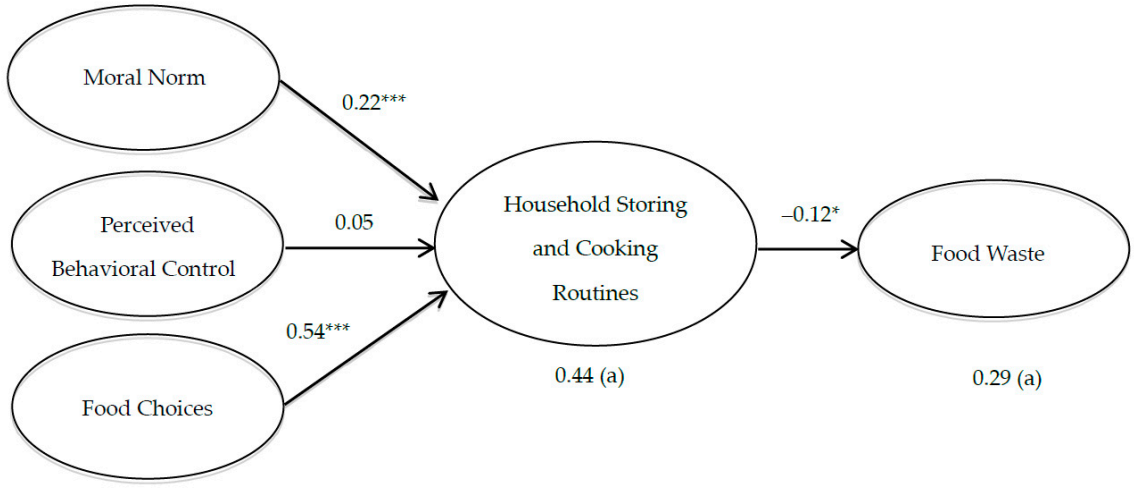

Figure 2. Structural equation modeling (SEM) results. (**a**) * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; $n = 954$; (**b**) $\chi^2 = 292.963$; $df = 81$; $\chi^2/df = 3.617$; CFI = 0.977; RMSEA = 0.052; (**c**) R squares are beside latent variable (**a**).

To examine mediating effects, following Taylor et al. [34], this study used percentile bootstrapping and bias corrected percentile bootstrapping under a 99% confidence interval and 10,000 bootstrap samples. To test the indirect effects, this study calculated the confidence interval of the lower and upper bounds [35]. Table 4 shows that, according to the bootstrap test results, the indirect effect (standardized indirect effect = −0.026 *, $p < 0.05$) of moral norms on food waste was significant and the direct effect (standardized direct effect = 0.000, $p = 0.968$) was not significant, indicating that household storing and cooking routines serve a full mediating role for the relationships between moral norms and food waste (H5a). Additionally, the total effect (standardized total effect = −0.271 **, $p < 0.01$), indirect effect (standardized indirect effect = −0.065 *, $p < 0.05$), and direct effect (standardized direct effect = −0.206 **, $p < 0.01$) of food choices on food waste were all significant, which indicated that household storing

and cooking routines plays partial mediation for the relationships between food choices on food waste (H5c). Thus, both H5a and H5c were supported. However, the indirect effect (standardized indirect effect = −0.006, $p = 0.065$) of perceived behavioral control on food waste was insignificant. That is, household storing and cooking routines have no mediating effect on the relationship between perceived behavioral control and food waste. Therefore, H5b was rejected.

Table 4. Standardized total effects, indirect effects, and direct effects of the model.

	Point Estimate	Product of Coefficients		Bootstrapping					
				Bias-Corrected Percentile 95% CI			Percentile 95% CI		
		S.E.	Z	Lower	Upper	Two-Tailed Significance	Lower	Upper	Two-Tailed Significance
Total effect									
Moral Norm → Food Waste	−0.026	0.040	−0.650	−0.104	0.053	0.533	−0.104	0.052	0.519
Perceived Behavioral Control → Food Waste	−0.451	0.034	−13.264	−0.516	−0.381	0.001 **	−0.517	−0.381	0.001 **
Food Choices → Food Waste	−0.271	0.037	−7.324	−0.345	−0.199	0.001 **	−0.345	−0.199	0.001 **
Indirect effect									
Moral Norm → Food Waste	−0.026	0.014	−1.857	−0.059	−0.003	0.020 *	−0.056	−0.002	0.028 *
Perceived Behavioral Control → Food Waste	−0.006	0.005	−1.20	−0.022	0.000	0.065	−0.018	0.003	0.174
Food Choices → Food Waste	−0.065	0.029	−2.241	−0.124	−0.007	0.025 *	−0.121	−0.005	0.028 *
Direct effect									
Moral Norm → Food Waste	0.000	0.043	0	−0.086	0.080	0.968	−0.083	0.084	0.975
Perceived Behavioral Control → Food Waste	−0.445	0.034	−13.088	−0.509	−0.376	0.001 **	−0.510	−0.377	0.001 **
Food Choices → Food Waste	−0.206	0.048	−4.291	−0.309	−0.118	0.001 **	−0.305	−0.116	0.001 **

[1] Mediator: storing and cooking routines. [2] Estimating of 10,000 bootstrap sample; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

According to Liu et al. [36], the moderating effect of unplanned events was examined by running invariance tests of both the measurement model and the structural model. Prior to the metric invariance test, K-means cluster analysis was used to divide the samples into high unplanned events (n = 623; high score group) and low unplanned events (n = 331; low score group). The equality between the factor loadings of both the high score and low score groups (measurement invariance) was then calculated. First, both the unconstrained model (CFA for both groups without factor loadings) and full-metric invariance model (CFA for both groups with full factor loadings) were created. Table 5 shows the results of comparing these two models. The fit indices of the unconstrained model (RMSEA = 0.043, CFI = 0.938, Tacker-Lewis Index, TLI = 0.925) and the full metric invariance model (RMSEA = 0.043, CFI = 0.937, TLI = 0.927) showed that both models had a good fit to the collected data. Although the Chi-square difference between both models (χ^2 (17) = 29.886) was significant ($p < 0.05$), Chi-square is sensitive to large sample sizes [37]. Therefore, following Jöreskog and Sörbom [38], this study considered invariance when Chi-square was significant under p-value less than 0.005. Based on the thresholds (ΔTLI ≤ 0.02, ΔCFI ≤ 0.01) from Wang and Wang [39], such differences between these two models (ΔCFI = −0.001, ΔTLI = 0.002) can be neglected. The above results support the follow-up step of testing invariance of the two-group structural model.

Table 5. Measurement invariance test.

Models	X^2	*df*	RMSEA	CFI	ΔCFI	TLI	ΔTLI	$\Delta\chi^2$	Full-Metric Invariance
Unconstrained	1288.466	462	0.043	0.938		0.925		$\Delta\chi^2$ (17) = 29.886 (p = 0.027)	supported
Full-metric invariance	1318.352	479	0.043	0.937	−0.001	0.927	0.002		

[1] Two groups: low unplanned event group (n = 331), and high unplanned event group (n = 623). [2] n = 954.

To examine invariance of the structural model, following Liu et al. [36], a Chi-square difference test was conducted to analyze the difference between the unconstrained model (baseline model) and the constrained model (nested model). The path coefficients from household storing and cooking routines to food waste were set to equal in this study, and other path coefficients of both the high score group and low score group were estimated freely. To examine H6, the Chi-square difference between the unconstrained model and constrained model was calculated. A significant Chi-square difference indicates that unplanned events have a moderating effect. Table 6 shows the invariance test

results, which demonstrate that the Chi-square difference was significant ($\Delta\chi^2$ (1) = 8.231 **, p = 0.004), indicating that unplanned events have a moderating effect on the relationship between household storing and cooking routines and food waste. The invariance test results also show that the coefficient estimated from household storing and cooking routines to food waste was −0.354 *** ($p < 0.001$) in the low unplanned events group and 0.001 (p = 0.984) in the high unplanned events group. As expected, when household storing and cooking routines have a higher level of unplanned events, household storing and cooking routines do not have a negative relationship to food waste. Therefore, H6 was supported.

Table 6. Invariance test of the two-group structural model.

	Low Group (n = 331)		High Group (n = 623)		Unconstrained Model X^2 (df = 162)	Constrained Model X^2 (df = 163)	$\Delta\chi^2$ (Δdf = 1)
	Standardized Coefficients	Z-Value	Standardized Coefficients	Z-Value			
Household Storing and Cooking Routines → Food Waste	−0.354	−3.940 ***	0.001	0.020	437.759	445.990	8.231 ** (p = 0.004 $p < 0.01$)

[1] Moderator: Unplanned events. [2] * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; n = 954.

5. Discussion

The results revealed that, in Taiwanese families, moral norms have a significant positive effect on household food storing and cooking routines. The TPB literature on household food waste shows no consistent finding for the relationships among moral norms, intention to reduce food waste, and food waste [2,3,6]. This study found that people who prepare food for their family in Taiwan consider food waste as a reason for feeling guilty, which motivates them to make efforts to preserve food and to change their cooking routines to prevent food waste. Besides, this study also found that family food choice is significantly related to household storing and cooking routines. Using samples in Taiwanese families, this study found that families that have strong concerns about health and food safety are actually more likely to develop effective food preservation methods and cooking routines, resulting in less food waste. Our finding recalls some former literature that reported health-conscious consumers take proactive actions to prevent food waste [16,20].

Although this study found that perceived behavioral control exerted no effect on household storing and cooking routines, perceived behavioral control had a significant negative effect on household food waste. We explain this finding for two reasons. First, the TPB literature indicates that perceived behavioral control and behaviors have both direct and indirect relationships to food waste [4]. Some TPB literature on household food waste also found perceived behavioral control as a strong predictor directly of household food waste [2,40], demonstrating that when consumers recognize their own capability on control food waste, their cognition directly reflects on their actions to prevent food waste. Second, the measurement used in this study for perceived behavioral control captures how participants perceive their own capability on reducing food waste, which has strong direct connection to food waste rather than household storing and cooking routines.

In addition to the effect of household storing and cooking routines on food waste, the findings also confirm the mediating role of household storing and cooking routines on the effect of moral norm and food choices on food waste. Our findings showed that families with better food preservation methods and cooking routines generally waste less food. This study has also found that unplanned events significantly moderate the relationship between household storing and cooking routines and food waste. According to the national data from the Directorate General of Budget, Accounting, and Statistics in Taiwan [41], household consumption of food and beverage decreased from 16.64% to 15.60%, while the spending on restaurants and hotels increased from 9.71% to 12%. These statistics show that although spending on dining out has increased, spending on household food purchase only slightly decreased. It revealed that a certain amount of food might be purchased and stored at home, and is later wasted due to unexpected dining out events.

6. Policy Implications

In 2018, Taiwan's Environmental Protection Administration, under Executive Yuan, launched its "Cherish Food" project. Through public forum lectures and collaborations with green restaurants, this project aimed to raise the public's awareness to food waste, enhance people's skills to handle food, and to reach its zero food waste goal. However, without long-term support, projects like this failed to mainstream the issue of food cherishing or to offer timely and accurate food knowledge to the public. This study found that when a family has a stronger moral awareness and values a healthy diet, these notions motivate them towards behaviors that reduce food waste. Thus, awakening such awareness is crucial in reducing family food waste. In 2013, food education was formally incorporated in Taiwan's public education, mandating relevant health courses to be taught in K-12 (from kindergarten to 12th grade) schools. These courses aim to establish a habit of a healthy diet, and focus on issues of nutrition and health. They lack in building the connection between food and agriculture, and miss the opportunity to change how people consume food through the understanding of the influence food production process has over the environment and the society. Therefore, we propose the enhancement of food and farming education in school. Through experience, the learners would be able to know and appreciate their local agriculture, establish a proper diet, and think critically and deeply about how it affects the environment. It will foster a moral awareness to cherish food and a knowledge of sustainable food production from a younger age. Through the change in attitudes, value systems, and knowledge, it will lead to a positive change in family food consumption behaviors.

In food policy making and food education, we would like to further highlight the differences between "best before" and "use by" in food packaging. As we explained in the literature review and our used scale items [7,8,16,21], "best before" means that the food item will remain delicious and fresh before the noted date while "use by" refers to the date that the food item won't be recommended for eating due to health issues after the certain date. Therefore, the date on "best before" is normally earlier than "use by". Through conducting this study, the research team found some participants actively talked with us and shared that they are always feel confused about these two dates. It implies an opportunity for enhancing such understanding through policy making by asking producers to add explanations on packaging or through food education by sponsoring educational programs or public advertisements to communicate such knowledge.

According to Papargyropoulou et al. [42], re-use of surplus food is a second-best strategy to solve food waste. Through redistributing food surplus to groups in need, resources are effectively utilized again. This will become a relatively significant coping strategy in assistance to Taiwanese families that have seen a steady growth of unplanned dining out behaviors. While Taiwan does have a compost recycling policy in place that recycles unwanted food to either animal feed (swine) or compost, the actual amount of food waste reduction through this method is still lower than the portion that goes into landfill. Therefore, adding another opportunity for edible food to be consumed will become another coping mechanism. The establishment of a food bank system is a common approach widely adopted by countries to encourage the recirculation of food surplus. In this area, Taiwan has long lacked a wholistic planning in both establishing such systems and relevant legislation. At this point, these food banks are mostly run as private welfare groups, governed by local municipalities' codes of autonomy. They are also more focused on recycling ugly produce or near-expiration products from retailers or grocery stores, paying little if any attention at all to recycling household food surplus. In addition, due to the risk of food safety accountability, fresh food, vegetables and fruits, and cooked food are often rejected by food banks. As a result, it becomes difficult for families, even as they foresee possible food surplus, to find a matching agency that can help redistribute it to those in need and avoid food waste before expiration. Therefore, we propose the following paths that the government ought to pursue: (1) explore methods to expand the reach of food banks to family food surplus, (2) establish an accessible platform and its necessary infrastructure to communicate extra food information instantaneously, (3) build up a standardized donation system, and (4) relieve donors and platforms from unnecessary legal liabilities through legislation.

7. Limitations and Future Studies

Although this study has contributed to valuable implications in food waste management, there are still some limitations worth consideration in future studies. First, since this study only examined three antecedents of household storing and cooking routines, future studies are suggested to consider other motives and barriers affecting families on food storing and cooking behaviors, e.g., food expenditures, social–culture values and religions, food safety knowledge, and other potential contextual variables. Second, future research may also investigate the impact of contextual variables on household storing and cooking routines and household food waste, e.g., unexpected food gifts and unpredictable dining out behaviors of family members. Third, cross-cultural comparison of household food waste is needed to develop policies and suggestions for reducing food waste. This study serves as an example to examine household food waste by families in Taiwan. Further studies are needed to investigate household food waste in other cultures and to make an advanced cross-cultural comparison. Finally, we suggest future research to collect qualitative information from families, making the methodology a mixed design with both quantitative and qualitative phases. Compared to the traditional quantitative approach, the qualitative phases might assist researchers to take a deeper look into the how and why of family food waste, making our understanding of family food waste more complete and systematic.

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