

FACTORS INFLUENCING FOOD-WASTE BEHAVIORS AT UNIVERSITY CANTEENS IN BEIJING, CHINA: AN INVESTIGATION BASED ON THE THEORY OF PLANNED BEHAVIOR

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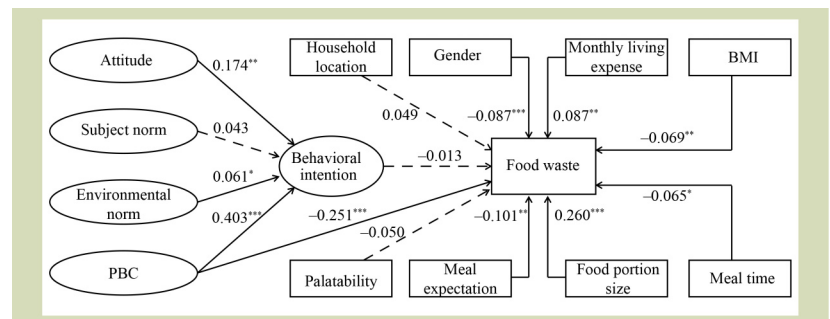
KEYWORDS

university students, food waste behavior, theory of planned behavior, university canteen

HIGHLIGHTS

- Investigate the actual situation of food waste at university canteens in Beijing, China.
- Analyze the influential factors of student food-waste behavior in university canteens.
- Construct the theoretical model of the factors influencing food waste behavior based on the theory of planned behavior.
- Measure the path coefficients of psychological factors, individual characteristics, and dining factors to food waste behavior.
- Suggest some measures to reduce and prevent food waste at university canteens.

GRAPHICAL ABSTRACT



ABSTRACT

Food waste is a major social problem that contributes to the overutilization of natural resources, affecting economic progress and environmental protection. Food waste occurs throughout the whole process of the food supply chain, especially during the consumption stage. As a special group of consumers, the emerging adults at university may have unique food consumption patterns and their food waste behavior in university canteens deserves more attention. To understand the influential factors of the food-waste behavior of students in university canteens, a field survey was conducted at China Agricultural University canteen with 705 respondents. Based on the theory of planned behavior, this paper examines the influencing factors of student food-waste behavior from three dimensions: sociopsychological factors, individual characteristics and dining factors. The results indicate that the percentage of students who waste food is relatively low, at roughly 27%. Perceived behavior control, gender, monthly living expenses, BMI, mealtime, meal expectations and food portion were significantly correlated with student food-waste behavior, among which perceived behavior control had the most prominent correlation, followed by food portion. Behavioral intention, household location and palatability were not significantly correlated with student food-waste behavior. Therefore, it is necessary to promote publicity and education on

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reducing food waste on campus, reinforce the administration of the department of support service, and optimize the food portion in the canteen.

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1 INTRODUCTION

Food waste occurs at all stages of the food supply chain, including production, transportation, processing and consumption^[1], which can lead to adverse effects on human and planetary health, such as increased greenhouse gas emissions, water pollution and waste of production resources, all associated with high socioeconomic costs^[2]. In recent years, reducing food waste, particularly in the consumption stage, has been an important goal attracting global concerns^[3]. According to the Food and Agriculture Organization of the United Nations survey data, about 1.3 Gt of global food production was lost or wasted each year in the food supply chain, accounting for about a third of the total global food production, which would be enough to for over 10% of the undernourished people worldwide^[4]. Postharvest food loss and waste accounted for about 40% of the total food production in developed countries^[5], and it is also rapidly increasing in developing countries. A study on food waste in China at the consumption stage concluded that about 34 Mt of food were wasted in 2018, with a daily per capita food waste of about 67 g^[6]. As an important approach to fulfilling the national strategies of ensuring food security and reducing carbon emissions^[2], preventing food waste has become a long-term goal in China. With the anti-food-waste law established in 2021, it is more critical to understand the contributing factors of consumer food-wasting behaviors and provide more evidence-based information on how to frame strategies to improve management efficiency in the national anti-food-waste campaign.

University students are an important and special group of food consumers who are in their early adulthood (emerging adulthood) of identity and environmental belief formation^[7], and a large number of university graduates will constitute the majority of the social development population. According to the data from China Statistical Yearbook in 2021, the number of students enrolled in various types of colleges and universities reached nearly 44 million in 2020^[8], surpassing the national population of developed countries such as Canada and Australia. Due to their special position within their family, students are frequently in a better position to influence the food consumption of their families. Therefore, this paper examines food waste behavior of university students, explores

the influencing factors and strengthens the corresponding education, which is of great significance in two aspects. It will not only be beneficial for students to form good habits to reduce waste, but also help to promote the social ethos of waste reduction at the macro social level and achieve food security goals.

Previous studies addressed the food-waste behaviors of university students in two major streams. One stream focused on the estimation of cafeteria waste and the structure of wasted food groups. For example, Chinese scholars have conducted large-scale surveys to estimate food waste in college cafeterias and showed that students in university canteens wasted around 68 g of food per meal per capita, which may result in an annual waste of nearly 36 to 37 kg per capita and a total annual waste of about 1.3 to 1.4 Mt for college and university students nationwide^[9]. This number is estimated to be even higher in Beijing, at about 74 g, among which staple food and vegetables account for the highest shares^[10]. Also, Thondhlana et al. estimated the food waste in South African canteens, which indicated that the average daily food waste per student at Rhodes University was about 555 g, with five canteens generating an average of about 2 t of food waste per day^[11]. Food waste university canteens in the USA is also large, reaching an average of 88 g per student^[12].

The other major stream of studies focuses on the causes of student food-waste behaviors. Among the individual characteristics, gender, educational qualifications, native place and family economic conditions are potential influencers of student food-waste behavior. Food waste is more serious among female students versus male students, undergraduate students versus graduate students, southern versus northern students^[13], and students with better family economic conditions^[14]. Among the factors of dining, scholars generally agree that food satisfaction^[15] and food portion size^[16] significantly influence food-waste behavior. The larger the food portion size, and the lower the food satisfaction, the more likely students are to waste food^[14]. More recently, studies have found that food decisions and wasting behaviors can be greatly affected by sociopsychological factors and applied the theory of planned behavior (TPB) to explain university student food-waste behavior. For example, Lorenz et al. employed the theory of planned behavior to study food waste in a German

university cafeteria and concluded that attitude, subject norm and perceived behavioral control significantly affected behavioral intention^[17].

It appears that only a few studies have examined the contributing factors of food-wasting behaviors for this special consumer group in China based on TPB. Based on a sample of 551 university students in Beijing, Tian and colleagues evaluated the impact of attitude, subject norm and perceived behavioral control on food waste, and confirmed that attitude had the dominant influence on food waste^[10]. Wong investigated 156 university students in Hong Kong and identified attitudes and moral norms as the most important influential factors in food-waste generation^[18]. Yang et al. selected 368 students in Jiangsu of China as a research sample, and observed that environmental issues were significantly correlated with attitude, subject norm and perceived behavioral control from the perspective of environmental concern^[19]. Wang et al. also explored the impacts of food taste, food-saving environment and moral norms on waste generation, and found that food taste and moral norms were significant influencing factors^[20]. However, several limitations can be found in these studies. For example, the data collection methods are mostly based on online platforms and these studies tended to focus on only one aspect of dining factors or sociopsychological factors without considering internal and external factors as a whole.

Using on-site survey data, this paper aims to fill the gap by investigating student food-waste behaviors based on an extended TPB model with both internal factors (sociopsychological factors and individual characteristics) and external factors (dining factors). The main findings suggest that perceived behavior control, gender, monthly living expenses, BMI, mealtime, meal expectations and food portion are significantly correlated with student food-waste behavior.

The remainder of the paper is structured as follows, the second section establishes a theoretical model based on the theory of planned behavior, the third section describes the empirical methods and field survey used in this study, the fourth section discusses the results and the final section concludes with recommendations to reduce student food waste and limitations of this study.

2 THEORETICAL FRAMEWORKS

2.1 Sociopsychological factors and food waste

TPB emphasizes behavioral intention as a key factor

influencing individual behavior, and there are three main factors affecting behavioral intention: attitude, subject norm and perceived behavioral control (PBC)^[21]. During their formative years, students are generally educated about food conservation at home, in school and in society, so they have clear perceptions about reducing food waste, which directly affects their behavioral intentions and further reduces food-waste behavior. Attitudes are expressed as positive or negative feelings that individuals project on a psychological level about their own behavior^[22]. University students with formal higher education generally hold negative attitudes toward food waste. Subject norms are expressed as incentives or pressures that individuals receive psychologically and transmitted from the social level, and significant individuals or groups in society that have a significant effect on students influence student intentions regarding food waste. Perceived behavioral control can be used as a proxy for behavioral intentions and accurate perceived behavioral control can directly predict the generation of behavior^[21]. Perceived behavioral control refers to the experiences that individuals have accumulated in their previous experiences and the hindrances that individuals have in predicting the future. Students who have been educated about frugality and thrift in their previous academic life possess a high degree of control over food-waste reduction behaviors, thereby resulting in fewer food-waste behaviors. In addition, this paper will consider the influence of environmental norms on food-waste behavior of students^[23], and the more students are aware of the environmental consequences of food waste, the less likely they are to waste food. Therefore, the stronger the influence of positive attitudes, and subject norms to reduce food-waste behavior, the higher the degree of perceived behavioral control, and the stronger the environmental norm, the stronger the behavioral intention of students to reduce food waste. Therefore, the following hypotheses according to the above analysis are provided:

Hypothesis 1a: Attitude is positively relevant to behavioral intention to reduce food waste.

Hypothesis 1b: Subject norm is positively relevant to behavioral intention to reduce food waste.

Hypothesis 1c: Perceived behavioral control is positively relevant to behavioral intention to reduce food waste and negatively related to food-waste behavior.

Hypothesis 1d: Environmental norm is positively relevant to behavioral intention to reduce food waste.

Hypothesis 1e: Behavioral intention is negatively relevant to food-waste behavior.

2.2 Individual characteristics and food waste

Individual characteristics influence student food-waste behavior, including gender, household location, monthly living expenses and BMI. Male students generally eat more than female students, and when faced with the same portion of food in the campus cafeteria, female students are more likely than male students to cause waste^[10]. People from different geographical areas have different spending patterns and habits. Household location is an important district factor for students, it is relevant to the formation of their perceptions, beliefs and the like, and these are interrelated with food-waste behavior. In terms of monthly living expenses, students with higher living expenses can afford to consume more food and purchase more amounts and types of food accordingly whereas these students are more prone to waste food. BMI is a measure of physical condition; students with higher BMI require more energy for their body, their food intake may increase simultaneously and they are less likely to produce food waste. Hence BMI is inversely correlated with food-waste behavior^[13]. Thus, several hypotheses about the individual characteristics are proposed:

Hypothesis 2a: Gender is relevant to food-waste behavior.

Hypothesis 2b: Household location is relevant to food-waste behavior.

Hypothesis 2c: Monthly living expenses are positively relevant to food-waste behavior.

Hypothesis 2d: BMI is negatively relevant to food-waste behavior.

2.3 Dining factors and food waste

Considering the special characteristics of school cafeterias, student dining in the cafeteria is different from dining in other settings; therefore, dining factors such as palatability, food portion size, mealtime, and meal expectation influence student food-waste behavior. Food consumption is influenced by palatability or contentment with food, which includes the evaluation of food flavors, smell and visual appearance. The higher the degree of evaluation of food in the cafeteria, the more likely that students will finish all of their food at mealtime and less food waste will occur^[14]. Food portion size is a key

factor influencing food-waste behavior on campus. Although the food in the cafeteria usually comes in a variety of portion sizes, such as half versus one, large versus small, the grading of food portions in the cafeteria clearly cannot accommodate all students, and the larger the food portion size, the greater the likelihood that students waste some food^[24]. Due to course schedules and personal habits, students tend to go to the cafeteria at a regular time. Mealtime definitely has a direct effect on student food-waste behavior, and when mealtime is adequate, students are less likely to waste food. Meal expectation, which refers to the student judgment of whether the cuisine meets student expectations when they dine in the canteen, might also affect food-waste behavior. The likelihood of food waste falls if students choose their favorite foods, whereas it increases if the food does not meet their expectations. As a result, the following hypotheses are established:

Hypothesis 3a: Palatability is negatively relevant to food-waste behavior.

Hypothesis 3b: Mealtime is negatively relevant to food-waste behavior.

Hypothesis 3c: Meal expectation is negatively relevant to food-waste behavior.

Hypothesis 3d: Food portion size is positively relevant to food-waste behavior.

Based on the previous analysis of sociopsychological individual and dining factors, this paper proposes the following research framework (Fig. 1).

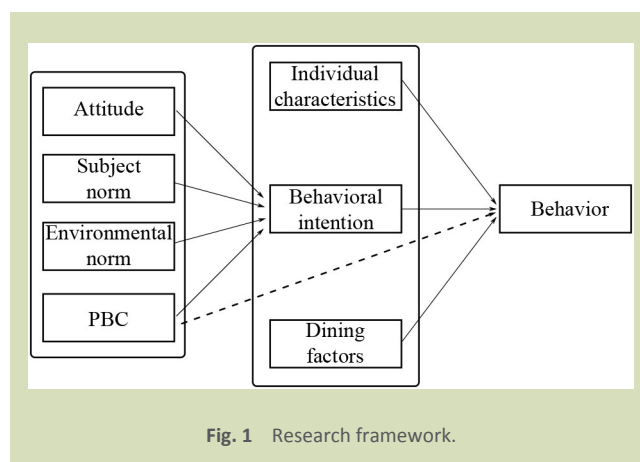


Fig. 1 Research framework.

3 METHODS AND DATA

3.1 Data collection

The data used in this paper comes from a survey conducted in November 2021 in the cafeteria of China Agricultural University (CAU). The reasons for choosing CAU to conduct the survey are as follows. First, CAU is one of the top five agrifood universities in the world, where researchers and students are trained to be more conscious of environmental sustainability and global food security issues. Second, students in CAU come from all over the nation and represent a wide variety of socioeconomic backgrounds, gender identities and systems of belief. Third, as one of the top national universities located in Beijing, the national capital of China, CAU is a place where students are actively involved in the clean-your-plate campaign. With policies and regulations related to food waste enacted by the Beijing Municipal Government, how university students in Beijing respond to anti-food-waste initiatives gained the public attention. During the survey period, 2 weeks in November 2021, the respondents were arbitrarily selected in two cafeterias during lunch and dinner to answer survey questions. To ensure the reliability and accuracy of survey data, a pre-survey was conducted and the surveyors were carefully trained beforehand. Following the survey process, students who came to the cafeteria for lunch and dinner were arbitrary selected by surveyors, and those who agreed to participate in this survey finish a questionnaire after they finished their meal. It took about 5–10 min for each respondent to fill out the questionnaire. A total of 739 questionnaires were collected, and after eliminating some invalid questionnaires such as missing data and illogical data, 705 valid questionnaires were obtained, with an effective rate of around 95%.

3.2 Variable definitions

In this research, we collected two aspects of data for empirical analysis, one of which is the data indicating food-waste behavior and the other is the factors influencing food-waste behavior. In the questionnaire survey, respondents were asked to self-report whether they wasted food during the meal.

The rest of the questionnaire asked the respondents to report information about the factors influencing food-waste behavior, including individual characteristics, and sociopsychological and dining factors (as listed in Table 1). Among them, both sociopsychological and dining factors were scored on a five-point Likert scale, with a score of 1–5 indicating the respondent's level of agreement with the question item (the

higher the score, the greater the level of agreement).

3.3 Econometric model

This paper employs structural equation modeling (SEM) to measure the complex causal relationships among variables, as the theoretical model contains a number of latent variables, such as attitudes and subject norms. Structural equation modeling belongs to a type of multivariate statistics that combines factor analysis and path analysis by drawing structural equation diagrams, integrating the advantages of both analysis methods, illustrating both the factors affecting the main response variables, and showing the specific directions and paths of influence with model diagrams^[28]. Based on the above theoretical foundation, the specific form of SEM established in this paper is:

$$X = \Lambda_X \xi + \sigma \quad (1)$$

$$Y = \Lambda_Y \eta + \varepsilon \quad (2)$$

$$\eta = B\eta + \Gamma\xi + \zeta \quad (3)$$

Equations (1) and (2) above are the measurement models for the structural equations, representing the linear relationship between the latent and observed variables, where, X is the vector of observed variables for the exogenous latent variables, Y is the vector of observed variables for the endogenous latent variables, Λ_X and Λ_Y denote the factor loadings for the exogenous and endogenous latent variables, respectively, and σ and ε are the measurement errors for the exogenous variables. Equation (3) is the structural model, where, η is the endogenous latent variable, ξ is the exogenous latent variable, B and Γ are the coefficient matrices of the endogenous and exogenous latent variables, respectively, and ζ is the unexplained random error term. In this paper, the latent variables, including attitude, subject norm, environmental norm, perceived behavioral control, behavioral intention and palatability, and the rest of the variables are observed variables.

4 RESULTS

4.1 Descriptive analysis

The summary statistics of the sample was presented in Table 2. Of the 705 respondents 175 were male, accounting for 24.8% of the sample. The majority of the sample was aged between 17 and 20 years old (58.6%), followed by those 21–25 years old (34.0%), and the remainder older than 25 years old (7.4%). In our sample, around 73% were undergraduates and the rest 26% were graduated students. Students were divided into urban and

Table 1 Variable definitions

Variable	Definition	Abbreviation
Food waste	A dummy variable indicates whether the food is wasted or not in this meal. Food waste equals 1 if there is waste; otherwise food waste equals 0	Waste
<i><u>Individual characteristics</u></i>		
Gender	Gender equals 1 if the respondent is male; otherwise, Gender equals 0	Male
Household location	Household location equals 1 if the respondent is from the city; otherwise, Household location equals 0	Location
Monthly living expenses	Logarithms of monthly living expenses	Expense
BMI	BMI = weight/height ² (kg·m ⁻²)	BMI
<i><u>Sociopsychological factors</u></i>		
Attitude (AT) ^[25]	Wasting food is bad	AT1
	Wasting food makes me feel unhappy	AT2
	Wasting food makes me feel ashamed	AT3
Subject norm (SN) ^[26]	Others finish all food on their plate and I try to do the same	SN1
	Others think people should finish all their food and their opinion is important to me	SN2
	Others may criticize me if I don't finish all food, their critics make me feel uncomfortable	SN3
Environmental norm (EN) ^[23]	Food waste is an urgent problem for environmental protection	EN1
	My personal actions have consequences for the environment. This also applies to my handling of food	EN2
	If I reduce food waste, I contribute to environmental protection	EN3
Perceived behavioral control (PBC) ^[27]	It is easy for me to make accurate predictions of how much I would eat when purchasing food	PBC1
	Finishing all food on my plate is usually easy for me	PBC2
	I could always finish all food on my plate if I wanted to	PBC3
Behavioral intention (BI) ^[17]	I somewhat expect to have leftovers	BI1
	I generally try not to waste food	BI2
	The likelihood that I will leave food on my plate in the future	BI3
<i><u>Dining factors</u></i>		
Palatability (PA)	The visual appearance of food today (rating from low to high, 1–5)	PA1
	The smell of food today (rating from low to high, 1–5)	PA2
	Tasting of food today (rating from low to high, 1–5)	PA3
Mealtime	My mealtime today is usually long	Time
Meal expectation	My food choice matches my expectation	Expectation
Food portion size	The portion size of my food today is too large	Portion

Note: both sociopsychological and dining factors were scored on a five-point Likert scale, with a score of 1–5 indicating the respondent's level of agreement with the question item (the higher the score, the greater the level of agreement).

rural based on their household location, where 62.8% were from urban areas. The largest number of respondents had an average monthly living expenses of 1000–1999 CNY, accounting for 45.4%; followed by 2000–2999 CNY (37.9%) and more than 3000 CNY (10.9%), and less than 6% respondents had average monthly living expenses of less than 1000 CNY. As for their health status, 71.4% of the respondents

were normal weight ($18.5 \leq \text{BMI} < 24$), 15.9% were underweight ($\text{BMI} < 18.5$), 11.5% were overweight ($24 \leq \text{BMI} < 28$), and 1.3% had a $\text{BMI} \geq 28$.

Table 3 showed that 190 respondents (27.0%) generated waste during meals and 515 respondents (73.1%) did not. By gender, 19 male respondents and 171 female respondents wasted food

Table 2 Basic statistics of the sample of students ($n = 705$)

Variable	Category	Proportion (%)
Gender	Male	24.8
	Female	75.2
Age (years)	17–20	58.6
	21–25	34.0
	> 25	7.4
Monthly living expenses (CNY)	< 1000	5.8
	1000–1999	45.4
	2000–2999	37.9
	> 3000	10.9
University degree	Undergraduate	73.3
	Postgraduate	26.7
Household location	Urban	62.8
	Rural	37.2
Underweight	BMI < 18.5	15.9
Normal weight	$18.5 \leq \text{BMI} < 24$	71.4
Overweight	$24 \leq \text{BMI} < 28$	11.5
Obese	BMI ≥ 28	1.3

Table 3 Frequency of students who produce food waste by gender, university degree, and household location

Variable	Category	Waste		No waste	
		Frequency	Proportion (%)	Frequency	Proportion (%)
Gender	Male	19	10.9	156	89.1
	Female	171	32.3	359	67.7
University degree	Undergraduate	156	30.2	361	69.8
	Postgraduate	34	18.1	154	81.9
Household location	City	134	30.3	309	69.8
	Village	56	21.4	206	78.6

during meals, accounting for 10.9% and 32.3% of the male and female samples respectively, and the proportion of food wasted by females was higher than that of males.

4.2 Test analysis

AMOS 24.0 was used to test the reliability and validity of the scale, and the test of fitness. Referring to the textbook on structural equation modeling^[28] and the analysis of the use of structural equations by existing studies^[29], the Cronbach's alpha value was used in the reliability test to determine the stability and consistency of the scale, KMO test (Kaiser-Meyer-

Olkin) and Bartlett's test of sphericity were used in the validity test, and the absolute fit indices chi-square and freedom ratio, goodness-of-fit index, adjusted goodness-of-fit index, root mean square error of approximation, the incremental fit index, Tucker-Lewis index (non-normed fit index), comparative fit index, and the parsimony-adjusted comparative and normed fit indices were used in the fitness tests to evaluate the fitness of the models and data. Table 4 exhibits the results of the reliability analysis. The overall Cronbach's α value of all latent variables is 0.710, and the individual Cronbach's α values of all the above latent variables except for behavioral intention (with the lowest Cronbach's α value of 0.529) were all greater than 0.6, which was a statistically acceptable, indicating that the

Table 4 Results of reliability and validity test

Latent variable	Observable variable	Cronbach's α	Standardized regression weights	KMO	Bartlett's test	
					Approximate chi-square	Significance
Attitude	AT1	0.766	0.705	0.627	676.500	0.000
	AT2		0.895			
	AT3		0.869			
Subject norm	SN1	0.695	0.834	0.624	436.694	0.000
	SN2		0.854			
	SN3		0.679			
Environmental norm	EN1	0.862	0.866	0.721	1006.122	0.000
	EN2		0.911			
	EN3		0.877			
Perceived behavioral control	PBC1	0.779	0.750	0.643	683.303	0.000
	PBC2		0.897			
	PBC3		0.851			
Behavioral intention	BI1	0.529	0.664	0.608	181.456	0.000
	BI2		0.740			
	BI3		0.783			
Palatability	PA1	0.904	0.917	0.749	1368.673	0.000
	PA2		0.929			
	PA3		0.902			

Note: All the latent variables are defined in Table 1.

scale had good overall reliability. Based on the results from validity analysis, the standardized regression weights of the observed variables in the questionnaire applied were all over 0.5, indicating good measurement convergent validity of the latent variables^[30]. Meanwhile, the minimum value of KMO for each variable was 0.608, which passed Bartlett's test with a significance level of 1%, suggesting that the structural validity of the scale in this study is good and could be analyzed by factor analysis. Based on the results of the fitness test (Table 5), all fitness indexes performed well. Therefore, based on the complexity of the model in this study and the sample size used, which exceeds 500, the model was of acceptable fitness.

4.3 Structural model assessment

Following the theoretical model, the structural equation model was assessed. The bootstrap sampling size was set as 1000, and the percentile confidence intervals and bias-corrected confidence intervals were set as 90%. Table 6 showed the results from the AMOS model hypothesis test and Fig. 2 presented the specific visualization. These showed that all test results were consistent with the hypotheses except for 1b, 1e, 2b

and 3a, indicating that attitude, environmental norm and PBC had a significant impact on behavioral intention, while PBC, individual characteristic (including gender, living expenses and BMI) and dining factors (meal expectation, food portion size and meal time) were all significantly correlated with food-waste behavior.

The results indicated that norms and knowledge about the environmental impact of food waste can possibly improve behavioral intentions of students to reduce waste. Therefore, the formation of environmental norms can be critical for encouraging more people to think hard about how their own behavioral changes can contribute to reducing food waste and benefiting the environment.

As for the paths toward food-waste behaviors, PBC was significantly correlated with behavior, while the correlation between behavior and intention was insignificant. The potential and reasonable reasons may be that the effect of intention on behavior was covered by PBC, as explained in TPB^[21]. Accurate PBC can directly predict the occurrence of a behavior. Based on their previous experiences and personal

Table 5 Results of fitness test

Fit index	Measure	Threshold	Estimate	Interpretation
Absolute fit index	CMIN/DF(NC)	$1 < NC < 3$	2.953	Acceptable
	GFI	> 0.8	0.916	Acceptable
	AGFI	> 0.8	0.891	Acceptable
	RMSEA	< 0.08	0.053	Acceptable
Incremental fit index	IFI	> 0.8	0.923	Acceptable
	TLI	> 0.8	0.907	Acceptable
	CFI	> 0.8	0.922	Acceptable
Parsimonious fit index	PCFI	> 0.5	0.769	Acceptable
	PNFI	> 0.5	0.740	Acceptable

Note: CMIN/DF (NC) refers to chi-square and freedom ratio, GFI refers to goodness-of-fit index, AGFI refers to adjusted goodness-of-fit index, RMSEA refers to root mean square error of approximation, IFI refers to incremental fit index, TLI refers to Tucker-Lewis index (non-normed fit index), CFI refers to comparative fit index, PCFI refers to parsimony-adjusted comparative, and PNFI refers to parsimony-adjusted normed fit index.

Table 6 Results of the structural equation model

Paths specified	Standardized coefficient	P-value	Hypotheses conclusion
AT→BI	0.174	**	1a supported
SN→BI	0.043	ns	1b unsupported
PBC→BI	0.403	***	1c supported
EN→BI	0.061	*	1d supported
BI→Waste	-0.019	ns	1e unsupported
PBC→Waste	-0.251	***	1c supported
Male→Waste	-0.087	***	2a supported
Location→Waste	0.049	ns	2b unsupported
Expense→Waste	0.087	**	2c supported
BMI→Waste	-0.069	**	2d supported
PA→Waste	-0.050	ns	3a unsupported
Time→Waste	-0.065	*	3b supported
Expectation→Waste	-0.101	**	3c supported
Portion→Waste	0.260	***	3d supported

Note: *, ** and *** stand for the significance at 10%, 5% and 1% levels, respectively; ns stands for not significant.

anticipations, university students tend to reduce their food-waste behaviors when they have adequate comprehension of food waste or they could control their behavior easily. Hence, students will increase their self-restraint^[31] and decrease external obstacles to reducing food waste.

Additionally, this study employed the AMOS bootstrap procedure to analyze the total effect, direct effect, and indirect effect of attitude, subject norm, PBC and environmental norm on food-waste behavior. The results were as follows: the standardized total effects of attitude, subject norm, PBC and

environmental norm were -0.002, -0.001, -0.118 and -0.006, respectively, and the standardized indirect effects were -0.002, -0.001, -0.006 and -0.006, respectively. Among the standardized direct effects, except the direct effect of PBC was -0.112, the direct effects of the other factors were 0. In conclusion, student intentions in this research sample were more associated with PBC, which is in accordance with the above discussion.

Gender, monthly living expenses, and BMI were significantly correlated with food-waste behaviors among individual factors.

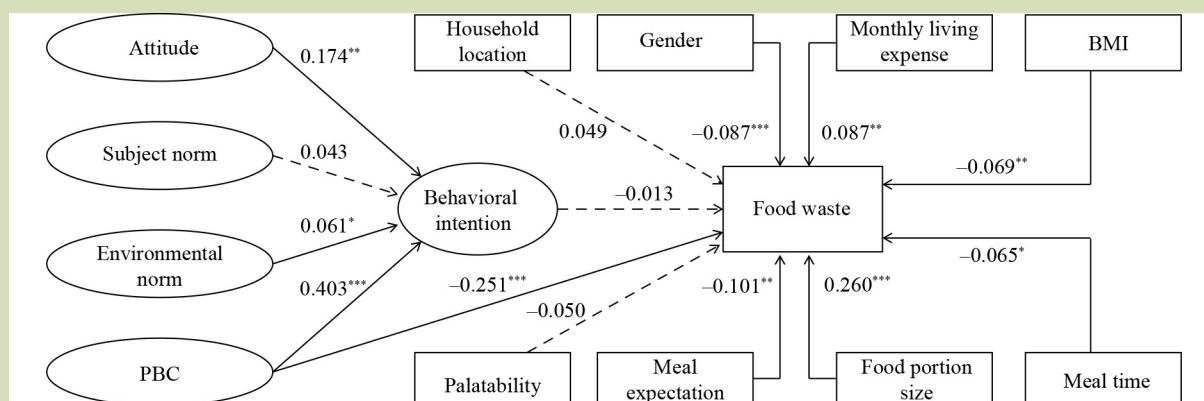


Fig. 2 Standardized coefficients regression path diagram. * $P < 0.1$; ** $P < 0.05$; *** $P < 0.01$. —→, Significant path;→, non-significant path.

The results suggested that female students with greater living expenses were more likely to squander food in university canteens. The fact that cafeteria meal servings were standardized and managed by the cafeteria staff, female students generally ate less and the portion was larger than what they can consume, may be the contributing factor. Another explanation might be that female students were more conscious of how much and what they eat during meals, which increases the likelihood that much food will be wasted. Given that they prioritized their own dietary choices and paid less attention to food waste, students with greater living costs were more likely to waste food during meals.

Both mealtime and meal expectations had significant negative correlations with food-waste behavior, which passed the 10% and 5% significance level test, respectively. This result implies that students were less likely to waste food when mealtime is abundant and food matches meal expectations. The correlation between food portion size and food-waste behavior was significant at the 1% level. The larger the food portion size is, the greater the likelihood of waste. The standardized coefficients of the above three indicators suggested that food portion size was the main dining factor influencing student food-waste behavior, which was related to the high likelihood of food waste. That is because students could not control the size of the food they choose during meals. Students have grown to establish a preference for specific foods in their daily meals, and when they cannot choose their preferred food for some reason, their meal choices do not match their expected choices, which may be related to the high likelihood of waste. Moreover, school logistics managers might have a key role in reducing food waste, which has been overlooked in previous studies. Based on their experience and knowledge of student dietary requirements and preferences, logisticians are able to provide students with healthy, nutritious and popular meal

selections as well as a range of food quantity options in order to prevent food waste linked with dining factors. Mealtime had the least correlation with food waste, which may be explained by the fact that the majority of students had enough mealtime whereas a few students were affected by mealtime due to the tight curriculums.

5 DISCUSSION AND CONCLUSIONS

Based on the theory of planned behavior, this paper examined the three dimensions of individual characteristics, psychological factors, and dining factors that had the greatest influence on the food-waste behaviors of university students. Monthly living expenses and food portion size were positively related to food-waste behavior, while perceived behavioral control, gender, BMI, mealtime and meal expectation were negatively related. Behavioral intention, home location and palatability were not correlated with food waste. In summary, the theory of planned behavior had a moderate capacity to explain the food-waste behavior of university students in China; nonetheless, the food-waste behavior of students was still related to individual differences and dining factors. Priorities should be placed on objective factors such as school cafeteria management with regard to food portions and mealtimes in order to promote food-waste reduction in colleges and universities.

The results indicated that the correlation between perceived behavioral control and food waste behavior was the largest whereas there was no significant correlation between the behavioral intention of reducing food waste and behavior. This may be due to the fact that the effect of perceived behavioral control mostly overlaps with the effect of behavioral intention, namely accurate perceived behavioral control can directly

predict the likelihood of behavior generating^[21]. Therefore, future studies could make better efforts to distinguish the effect of perceived behavioral control and behavioral intention on behavior based on the theory of planned behavior, for research on food-waste behavior in colleges and universities both in China and in other countries.

This study revealed that the number of students who wasted food was low, which contrasted with other institutions (other universities^[14], restaurants^[5], and households^[32] food waste) where food waste is prevalent. This finding was related to the consistent campus atmosphere of food-waste reduction at the surveyed university. As a result, students were less likely to waste food on a personal level as a result of the emphasis of the campus on decreasing waste.

In addition, campus administration departments should have an important role in reducing food waste by raising awareness of the main regulatory body and promoting innovations in providing quality food in various portions, as well as surplus disposal in cafeterias, in order to prevent avoidable food waste caused by single food types, excessive food portions and

unpalatable food. As for surplus disposal, unsold food in the cafeteria that is easy to serve, such as fried meals and snacks, can be offered at a discounted price or given away for free to reduce waste as long as their quality is not affected.

There are some few limitations in this study. Firstly, the study is limited to only one university in Beijing, and the sample is not sufficiently representative. Secondly, the primary response variable in this study is simply whether or not food waste is produced but the specific amount and category of food wasted are not further investigated. Again, the structure of food waste was a weakness of this study, which failed to classify the types of discarded food. Another limitation is that our data collection method did not exactly follow random sampling. In the subsequent studies, the sample population should be enlarged to include students from comprehensive universities, polytechnic universities and normal universities in order to specifically analyze student food-waste behavior in the setting of different types of institutions. To achieve a more accurate assessment of the amount and category of food waste, the logistics department can also be contacted for assistance with food-waste research sampling.

Compliance with ethics guidelines

Hao Fan, Jingjing Wang, Xiaotong Lu, and Shenggen Fan declare that they have no conflicts of interest or financial conflicts to disclose. This article does not contain any studies with human or animal subjects performed by any of the authors.

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