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The Effect of Plate and Decoration Color on Consumer Food Waste in Restaurants: A Case of Four Chinese Cities

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Abstract: Food waste hampers global food security, rational use of global resources and environmental sustainability. Food waste is becoming a global problem, especially on restaurants, and it is particularly important to explore more effective measures to reduce food waste. Color psychology studies show that color can influence human behavior, but how colors may affect consumer food waste behavior has not been thoroughly investigated to date. In this study, we aim to investigate whether food plate colors or restaurant decorations affect food waste behavior using a large-scale field survey in four Chinese cities (2160 samples across Beijing, Shanghai, Chengdu, and Lhasa). Our results show that the per capita food waste of all consumers in the surveyed restaurants was 80.21 g per meal, whereas the per capita food waste of those with warm-color plates was 61.83 g per meal. The results suggest that warm plate colors are associated with reduced restaurant consumer food waste. We also show that the restaurant decoration color was found to correlate significantly with the reduced amount of food ordered per capita per meal (both warm and cool colors). Cool colors for plates and decoration have a negative effect on the weight of per capita per meal food eaten. Additionally, other characteristics of consumers, such as their age, education, and income levels, and other factors, such as for the purposes of meals, were found to affect food waste behavior. Our case study suggests that further investigation into the role of color psychology may be warranted to help mitigate consumer food waste.

Keywords: consumer food waste; color psychology; plate color; decoration color; restaurant

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1. Introduction

Food waste has sparked widespread attention globally in recent years. The Food and Agriculture Organization of the United Nations estimated that roughly one third of the world's food (approximately 1.3 billion tons) is wasted from farm to fork every year [1]. There has been a growing body of literature on food waste in different countries such as the United States [2,3], the United Kingdom [4,5], Sweden [6,7] and China [8,9]. Food waste is a threat not only to global food security but also to global resources and environmental sustainability [10,11]. FAO reports that the global annual food waste cost arable land loss, blue water loss, economic cost [12], and lead to carbon dioxide emissions [13]. Research shows 27% of the food produced for human consumption in China is lost or wasted annually [14]. Consumption segment is an important part of food waste [15]. Catering companies generate tremendous amounts of waste [16]. As such, study on food waste in the catering industry is particularly important in recent years.

The effect of color on the human body has been recorded in early civilization such as in ancient Chinese medical texts including *HuangdiNeijing* (literally *The Yellow Emperor's Classic of Medicine*). Health-related theories of "color therapy" believe that color has an

effect on the human body, and the choice of color can affect the health of the body. The book Color Psychology and Color Therapy mentions a description of the historical aspects of color as they relate to superstition, the story of mystics, charms, and color healers [17]. Different colors can evoke distinct feelings and emotions [18,19]. Colors are conveyed to the human brain through the senses and then result in human behavior [20].

Therefore, we hypothesize that the plate color and decoration color will have an effect on consumer food waste behavior. In this study, we study on the influence of plate color and decoration color on consumer food waste behavior in restaurants. The restaurant was chosen as a case study because of its relatively large contribution to total food waste [21], particularly in China [22,23], as well as because of increased frequency of dining out. In the country with the world's largest emerging economy, the restaurant sector in China showed that food wasted is about 11 to 17% of that ordered (by weight) [24]. China promulgated the anti-food-waste law in 2021, and the specific implementation details need to be further studied. Because changing plate and decoration color would be a relatively low-cost measure, our results, if positive, can be potentially implemented as an important strategy for restaurant food waste reduction.

2. Literature Review

Food waste at the consumer segment is affected by factors such as economic development, demographic characteristics, and consumer awareness [15]. Food waste per-capita increases with an increase in per-capita GDP [25]. Reducing consumer food waste requires a good understanding of its causes and the role played by consumers. From the perspective of consumers, the factors affecting food waste can be summarized in three areas: (i) consumer behaviors [26], such as a lack of shopping planning, impulse buying [27], and excessive purchasing [28]; (ii) consumer perception [29], including attitudes [30], dietary knowledge [31], and habits and emotions [32]; and (iii) socioeconomic factors [33], such as income and education [34].

Consumers' food waste is also influenced by other factors, such as the reason for eating [34], restaurant categories and purposes of meals [22]. Diet culture is closely related to food waste, and differences in consumption patterns leads to differences in food waste [35]. In recent years, researchers began to explore whether intervention information had an impact on food waste. Researchers have developed different intervention experiments [36], such as written message interventions [37] and social media interventions [38], to study how intervention information might directly affect consumer food waste behavior. Intervention measures will have a positive impact on consumers, and the intervention effect is affected by the intervention design [39]. The impact of plate color and decoration color in a dining environment on consumer food waste, however, has not been investigated.

The food service sector is responsible for more food waste than households in China. According to the field survey conducted by the Institute of Geographic Sciences and Natural Resources Research of Chinese Academy of Sciences, the total amount of food waste in China's urban catering industry is about 17–18 million tons in 2015, equivalent to 3% of the national grain output [40]. The food waste per capita per meal in China's catering industry is 79.52 g [34], which is higher than that urban households of 5.54 g per capita per meal [29] and rural households of 8.74 g per capita per meal [41].

More recently in psychology, there is an increasing focus on the influence of color on human behavior. Psychologists have observed that different colors can evoke distinct feelings and that human physical and mental health and work performances can be affected positively by colors in varying degrees [42,43]. Experiments show that participants are found to overestimate the diameter of food portions by 1.5% and the visual area of food portions by 3% on plates with rim coloring compared with plates with no coloring [44].

The influence of color on human behavior and cognition provides an important basis for potential consumer behavior interventions [45]. For example, studies show that indoor color affects consumer sentiment and cognitive performance, and wall colors can therefore be an effective interior design factor to positively influence the customers' store selection

and product purchases [46,47]. Violet and blue interiors produced higher levels of positive affective tone and increased purchase intentions when compared with red and orange interiors [48]. It was also found that people feel differently toward warm colors and cool colors [49], such that different colors associated with food may exert distinct effects on appetite [20].

3. Material and Methods

3.1. Questionnaire Design

The questionnaire was designed by the Food Waste Research Group of the Institute of Geographic Sciences and Natural Resources Research of Chinese Academy of Sciences. Before the formal survey, we conducted a pre-survey on restaurants in June 2015. Based on the pre-survey results and consumer feedback, we adjusted the final questionnaire. The food waste survey comprised three questionnaires: restaurant questionnaire, consumer table questionnaire, and weighing questionnaire. Restaurant questionnaire of each restaurant was filled in by restaurant manager to understand the restaurant's consumer flow, turnover, business philosophy, and other information. Consumer questionnaire of each table was filled in by the surveyed consumer who ordered the food or paid the bill to gain information about consumer, such as education level, gender, age, income and dining reason. Weighing questionnaire of each table was filled in by investigators, aimed at identifying the amount and composition of food waste on the table.

3.2. Definition and Sample Selection

Food waste occurs in the food supply chain at all stages. We mainly focus on food waste on the dining table of restaurants in this study. Food waste in this study refers to the weight of the edible, nonliquid portion of the food leftover on all plates on the table after the dining process. Inedible parts such as excipients, bones, or liquid parts in the food surplus, as well as any packed food leftover in dog bags, were excluded.

Food waste data were obtained from a large-scale survey of restaurant food waste in four Chinese cities, namely Beijing (China's capital), Shanghai (China's economic center), Chengdu (famous food resort in western China), and Lhasa (a tourism city on the Tibetan plateau), between June and August 2015. Different areas in each city were selected to sample the food waste behavior of consumers in both the central and more remote areas of the city (Figure 1).

The food waste data are taken primarily from the consumer questionnaire and the weighing questionnaire. Only when both questionnaires were collected and filled out at the same time can a complete questionnaire be considered. Thus, the final sample size chosen for analysis in this work is slightly smaller than that in our previous research [22] because of a stricter screening of removing vacant values related to data processing and analysis. Specifically, a total of 2160 reliable samples from 161 restaurants (542 samples from 46 restaurants in Beijing, 546 samples from 39 restaurants in Shanghai, 798 samples from 50 restaurants in Chengdu, and 274 samples from 26 restaurants in Lhasa) were included in this study.

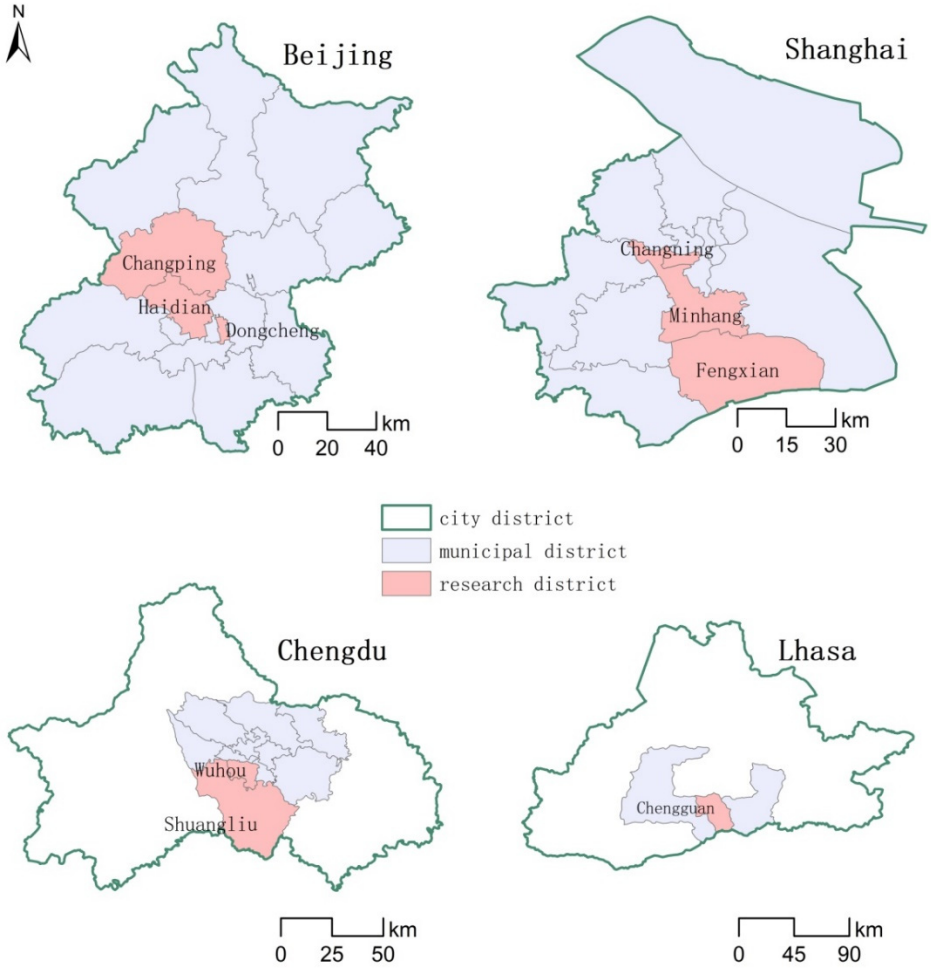

Figure 1. Survey area in four case Chinese cities.

3.3. Field Survey and Direct Weighing

Briefly, stratified random sampling was used, and the number of restaurants surveyed in each city was determined according to the scale and type of restaurants in each city. Sampled restaurants were drawn on the basis of the proportion of different types of restaurants in each city to the total number of restaurants. Relatively large samples were obtained from different cities. Stratified random sampling and field survey were used to obtain specific research samples from the entire catering industry, so the samples are representative. Details on the survey design and sample description can be found in our previous work [22].

The survey covered both lunch and dinner over a full week from Monday to Sunday. We recruited local college students and trained them in research training. Students as investigators who were qualified in the research and training then performed the field surveys of food waste. One dining table was used as a sample for food waste quantification. After the consumer left the restaurant, the restaurant waiter was responsible for sending the plate to the research table where food waste was weighed, and the investigators recruited by the research team calculated food waste using electronic loading balances between 1 g and 5 kg. The food waste weighing location was arranged by the restaurant manager and located out of sight of the consumers.

In the survey process, we also weighed the plate and each dish served at the table before and after it was served to the customer. From this, the weight of food consumed per table was calculated. The remaining edible part was weighed to obtain food waste data. Direct weighing method was used to identify food waste, which is accurate in data

identification. During field research, we measured the residue of each dish in each table according to the type of raw materials.

3.4. Variables Description

According to psychological feelings, colors were divided into warm colors (such as red, orange, yellow, and brown), cool colors (such as green, cyan, blue, and purple), and neutral colors (such as black, gray, and white). In our study, the plate/decoration warm/cool color is used as a binary variable with a value of 1 if the plate/decoration contains warm/cool colors, and 0 if the plate/decoration does not contain cool/warm colors.

The key variables in this study, as summarized and detailed in Table 1, include the plate color (whether the plate color contains warm, cool, or neutral colors), decoration color (whether the decoration color in restaurants contains warm, cool, or neutral colors), and the per capita per meal food waste (per capita per meal food waste, i.e., the amount of total food waste measured by direct weighing divided by the number of people on sample tables). The per capita per meal food ordered was recorded both in terms of the number of dishes and the physical weight. The per capita per meal food eaten was the weight of the food that was eaten by consumers, and the per capita per meal eaten ratio was measured by per capita per meal food eaten divided by per capita per meal food ordered by weight.

Table 1. Definition and description of major variables used in this analysis.

Variable Name	Variable Description	Units of Measurement	Variable Value
Per capita per meal food waste	The per capita per meal food waste of all food ofthe sample tables	gram	The per capita per meal food waste weight of the sample tables
Per capita per meal food ordered by amount	The per capita per meal amount of food ordered measured by number of dishes	number	Per capita per meal number of dishes ordered on sample tables
Per capita per meal food ordered by weight	Theper capita per meal weight of food ordered measured by physical weight	gram	Per capita per meal weightof food ordered on the sample tables
Per capita per meal food eaten by weight	The per capita per meal food eaten by consumers of the sample tables	gram	Per capita per meal weightof the sum of the initial weight of the dishes minus the remaining weight of the dishes ordered on sample tables
Per capita per meal eaten ratio	The ratio of per capita per meal food eaten to per capita food ordered	percentage	Per capita per meal food eaten divided by per capita per meal food ordered by weight
Warm color for plate	Whether the plate color contains warm colors		Binary value; if the plate color contains warm colors the value is 1; otherwise, the value is 0.
Cool color for plate	Whether the plate color contains cool colors		Binary value; if the plate color contains cool colors the value is 1; otherwise, the value is 0.
Warm color for decoration	Whether therestaurant decoration color contains warm colors		Binary value; if the decoration color contains warm colors the value is 1; otherwise, the value is 0.
Cool color for decoration	Whether the restaurant decoration color contains cool colors		Binary value; if the decoration color contains cool colors the value is 1; otherwise, the value is 0.

Table 1. *Cont.*

Variable Name	Variable Description	Units of Measurement	Variable Value
Cities	Case cities		
Beijing	Whether the case city is Beijing		The value is 1 if the case city is Beijing and is otherwise 0.
Shanghai	Whether the case city is Shanghai		The value is 1 if the case city is Shanghai and is otherwise 0.
Chengdu	Whether the case city is Chengdu		The value is 1 if the case city is Chengdu and is otherwise 0.
Lhasa	Whether the case city is Lhasa		The value is 1 if the case city is Lhasa and is otherwise 0.
Price	The restaurant's comprehensive price level, to a certain extent, reflects the restaurant's level	yuan	The price variable refers to the average price per gram of food in the restaurants, which is calculated from the total price of all meals and the total net of serving dish weight.
Time	Mealtime		Binary value; the value is 1 if it is dinner; otherwise, the value is 0.
Age	The age of the respondent		The value varies between 1 and 6, as defined below: 1 (under 20 years old); 2 (21–30 years old); 3 (31–40 years old); 4 (41–50 years old); 5 (51–60 years old); and 6 (over 60 years old)
Tourist	Whether the consumersare tourists		Binary value; if the consumers are tourists, the value of 1; otherwise, the value is 0.
Frequency	The eatingout frequency of consumers in this restaurant		The range of values is 1–5, and the higher the value, the less frequently they eat out in this restaurant
Gender	The gender of the respondent		Binary value;the value is 1 for male and 0 for female.
Frugality	The frugal consciousness of the respondent compared with most people		The range of values is 1–5, and the higher the value, the greater the frugal consciousness.
Income	The monthly income level of the respondent		The range of values is 1–6, with definition as follows: 1 (under 2000 RMB); 2 (2001–4000 RMB); 3 (4001–6000 RMB); 4 (6001–8000 RMB); 5 (8001–10,000 RMB); 6 (10,001–12,000 RMB); 7 (12,001–14,000 RMB); 8 and (above 14,000 RMB)
Edu	The level of education of the respondent		The range of values is 1–6, with definition as follows: 1 (primary school or below); 2 (junior high school); 3 (high school); 4 (university); 5 (masters); and 6 (doctorate)
Farming experience	Whether the respondent has farming experience		If there is farming experience, the value of 1; otherwise, the value is 0.

Table 1. *Cont.*

Variable Name	Variable Description	Units of Measurement	Variable Value
Ordering	Whether the respondentis the one who has ordered food		If the respondent is the one who has ordered food, the value is 1; otherwise, the value is 0.
Dining reason	The reasons for dining		
Business/official	Whether the reason for dining is business/official		It has a value of 1 for business/official; otherwise, it has a value of 0.
Family gathering	Whether the reason for dining is family gathering		It has a value of 1 for family gathering; otherwise, it has a value of 0.
Friend gathering	Whether the reason for dining is friend gathering		It has a value of 1 for friend gathering; otherwise, it has a value of 0.
Working meal	Whether the reason for dining is working meal		It has a value of 1 for working meal; otherwise, it has a value of 0 (reference group).
Not specific	Whether the reason for dining is not specifically mentioned		It has a value of 1 for not specified purpose; otherwise, it has a value of 0.
Others	Whether the reason for dining is other		It has a value of 1 for other purposes; otherwise, it has a value of 0.
Elderly	Whether the respondent has family members above 50 years oldin their household		Thevalue is 1 if there are family members above 50 years old; otherwise, the value is 0.

4. Results

4.1. Effect of Plate and Decoration Color on Food Waste, Food Ordered, and Food Eaten

We collected a total of 2160 samples, including 752 samples with zero food waste reported. This means that not all consumers have food waste behavior. The data showed that consumers of 65.19% of the investigated tables have food waste behavior, and the remaining consumers do not have food waste behavior. There may be measures for consumers to reduce food waste. The per capita food waste of consumers was found to be 80.21 g/capita/meal. Table 2 shows the descriptive statistics of the main variables used in this analysis.

We used per capita per meal food waste as an explanatory variable to establish a model to empirically analyze the food waste behavior of consumers under the influence of different plate and decoration colors. Because the amount of per capita per meal food waste is not less than 0, the Tobit model was adopted to overcome the data interception of the explanatory variables.

Our empirical results as shown in Table 3 confirm that consumer food waste behavior is affected by plate color. When the plate color contains warm colors, the consumer food waste per capita per meal is significantly reduced, and their food waste behavior is positively affected. When the plate color contains cold colors, no statistically significant effect on the food waste behavior of consumers was found. In this context, we speculate that warm colors give consumers a positive feeling that may help reduce food waste.

Table 2. Descriptive statistics of main variables used in this analysis.

Variable Name	Mean	Std. Dev.
Per capita per meal food waste	80.210	117.430
Per capita per meal food ordered by amount	2.188	2.078
Per capita per meal food ordered by weight	1114.556	1768.839
Per capita per meal food eaten	1034.620	1760.131
Per capita per meal eaten ratio	0.917	0.116
Warm color for plate	0.124	0.329
Cool color for plate	0.054	0.225
Warm color for decoration	0.699	0.459
Cool color for decoration	0.106	0.307
Cities		
Beijing	0.251	0.434
Shanghai	0.253	0.435
Chengdu	0.369	0.483
Lhasa	0.127	0.333
Price	0.063	0.122
Time	0.369	0.483
Age	2.477	1.000
Tourist	0.252	0.434
Frequency	3.957	1.380
Gender	0.496	0.500
Frugality	3.783	1.096
Income	3.156	1.963
Edu	3.775	0.880
Farming experience	0.325	0.468
Ordering	0.743	0.437
Dining reason		
Business/official	0.032	0.177
Family gathering	0.193	0.394
Friend gathering	0.277	0.448
Working meal	0.172	0.378
Not specific	0.305	0.460
Others	0.021	0.143
Elderly	0.627	0.484

Note: The sample size is 2160. (N = 2160).

Table 3. Effect of plate and decoration color on per capita per meal food waste.

Variable Name	Coef.	Std. Err.	t	Marginal Effect
Warm color for plate	−26.588 **	11.689	−2.27	−15.914
Cool color for plate	1.762	17.119	0.10	1.055
Warm color for decoration	−6.668	10.631	−0.63	−3.991
Cool color for decoration	−1.907	14.333	−0.13	−1.141
Control variables	Controlled			
_cons	−94.030 ***	46.270	−2.03	

Note: **, *** indicates statistical significance at the 0.05, 0.01 levels, respectively (N = 2160).

The decoration color, however, was found to have no statistical effect on food waste per capita per meal generation. This applies to both warm decoration colors and cool decoration colors. This means that changing the decoration color is unlikely to affect food waste per capita per meal generation by consumers.

Food waste is the product of a consumer's choice of the amount to order as well as to eat. To find a better way to reduce food waste in restaurants from the perspective of color, we attempted to explore the effect of colors on consumer food ordered and food eaten, separately. It is worth noting that consumers cannot see the plate when they are ordering the food, so decoration color can only be used to analyze any effect on food ordered. In China, some restaurants will provide pictures of the dishes at the point of ordering, but

because this picture is a schematic diagram, it differs from the actual dishes and the plates that are served. Although these restaurants may offer menus that include pictures of plates, the plates in the pictures have little resemblance to the actual plates.

The effect of decoration color on consumer food ordered was analyzed from two aspects: Table 4 shows the effect of decoration color on per capita per meal food ordered by amount, and Table 5 shows the effect of decoration color on per capita per meal food ordered by weight. The control variables in Tables 4 and 5 are the same as those in Table 3. Table 4 shows that both warm and cool decoration colors have a significant negative effect on per capita per meal food ordered by amount. Table 5 shows that both warm and cool decoration colors have no effect on per capita per meal food ordered by weight.

Table 4. Effect of decoration color on per capita per meal food ordered by amount.

Variable Name	Coef.	Std. Err.	t	P > |t|
Warm color for decoration	−0.335 ***	0.130	−2.58	0.010
Cool color for decoration	−0.515 ***	0.176	−2.93	0.003
Control variables		Controlled		
_cons	0.926 *	0.550	1.68	0.093

Note: * and *** indicate statistical significance at the 0.10 and 0.01 level, respectively (N = 2160).

Table 5. Effect of decoration color on per capita per meal food ordered by weight.

Variable Name	Coef.	Std. Err.	t	P > |t|
Warm color for decoration	−45.046	110.871	−0.41	0.685
Cool color for decoration	−224.078	150.287	−1.49	0.136
Control variables		Controlled		
_cons	588.343	469.904	1.25	0.211

Note: N = 2160.

We can find the effect of plate and decoration colors on the weight of food eaten per capita per meal in Table 6. The control variables in Table 6 are the same as those in Table 3. Interestingly, cool colors for plates and decoration have a negative effect on the weight of per capita per meal food eaten. It is also interesting that both warm colors for plates and warm colors for decoration have no statistically significant effect on the weight of per capita per meal food eaten. Because consumers eating as much as possible will reduce food waste, these negative effects are necessarily desirable from the perspective of waste.

Table 6. Effect of plate and decoration colors on per capita per meal food eaten by weight.

Variable Name	Coef.	Std. Err.	t	P > |t|
Warm color for plate	−192.817	118.288	−1.63	0.103
Cool color for plate	−325.351 *	176.044	−1.85	0.065
Warm color for decoration	−31.136	110.993	−0.28	0.779
Cool color for decoration	−248.510 *	149.915	−1.66	0.098
Control variables		Controlled		
_cons	677.364	466.685	1.42	0.155

Note: * indicates statistical significance at the 0.10 level. (N = 2160).

Because the eating weight cannot be greater than the ordering weight, the effect of decoration color on eating weight is derived from the effect of decoration color on ordering weight. We therefore researched the effect of the plate and decoration colors on the eating ratio. No significant effect was found for both warm and cool colors of plate or decoration colors (Table 7). It is worth mentioned that warm color for a plate has a positive effect on eating ratio, which is very close to significant.

Table 7. Effect of plate color on per capita per meal eaten ratio.

Variable Name	Coef.	Std. Err.	t	Marginal Effect
Warm color for plate	0.012	0.008	1.62	0.012
Cool color for plate	−0.006	0.011	−0.54	−0.006
Warm color for decoration	0.000	0.007	0.07	0.000
Cool color for decoration	−0.013	0.010	−1.37	−0.013
Control variables		Controlled		
_cons	0.932 ***	0.031	30.48	

Note: *** indicates statistical significance at the 0.01 levels (N = 2160).

4.2. Effect of Other Variables on Food Waste

Our regression analysis reveals that other socioeconomic parameters have statistically significant impacts on food waste (Table 8). It should be noted that, although our previous research [22] reported similar variations of per capita per meal food waste generation among different consumer groups, because of the use of the Tobit and OLS based regression analysis in this study, we were able to control the impact of other factors on food waste when analyzing a specific factor. This enables more robust conclusions over the effect of other socioeconomic variables on food waste generation. These are summarized below.

- The meal time period exerted a significant effect on consumer food waste behavior. Consumers waste more food during dinner, which takes practically more time than at lunch.
- The personal characteristics of consumers significantly affected their food waste behaviors as well. In our study, we find the food waste increases first and then decreases with age, in an "inverted U shape". The education level has a similar impact on food waste as an "inverted U shape". Regarding household income, it was found that the higher the income level, the more food waste was generated.
- The frugal consciousness of consumers had a significant effect on food waste behavior. The more consumers self-report frugal consciousness, the less food waste they generate.
- Food waste behaviors between tourists and nontourists were significantly different. Results suggest that tourists waste more food than nontourists per capita per meal.
- The frequency of consumers dining out in restaurants significantly affects consumer food waste behavior. The less frequently the consumers go to restaurants, the more food waste they generate. This may be because consumers who dine out more frequently are more aware of the quantity, type, and taste of the food in the destination restaurants.
- Meal purposes were found to have a significant impact on consumer food waste behaviors. Consumers who were dining out for a friend gathering wasted more food. This is mainly related to the special *mianzi* culture and hospitality conventions in China.

Table 8. Effect of other variables on per capita per meal food waste.

Variable Name	Coef.	Std. Err.	t	Marginal Effect
Cities				
Beijing	8.000	13.810	0.58	4.882
Shanghai	−7.734	13.929	−0.56	−4.569
Chengdu	−2.185	13.417	−0.16	−1.306
Price	−0.919	28.185	−0.03	−0.550
Time	20.523 ***	7.620	2.69	12.283
Age	40.337 **	15.927	2.53	24.143
Age_sq	−6.754 ***	2.559	−2.64	−4.042
Tourist	35.295 ***	8.307	4.25	21.125
Frequency	6.740 **	2.811	2.40	4.034
Gender	−4.252	7.394	−0.58	−2.545
Frugality	−6.990 **	3.285	−2.13	−4.184

Table 8. *Cont.*

Variable Name	Coef.	Std. Err.	t	Marginal Effect
Income	3.104	2.192	1.42	1.858
Edu	64.441 ***	19.676	3.28	38.570
Edu_sq	−11.014 ***	2.812	−3.92	−6.592
Farming experience	−4.086	8.178	−0.50	−2.445
Ordering dishes	−26.930 ***	8.292	−3.25	−16.118
Dining reason				
Business/official	26.512	21.981	1.21	16.211
Family gathering	15.355	12.607	1.22	9.179
Friend gathering	43.816 ***	11.709	3.74	27.702
Not specific	−24.410 **	11.483	−2.13	−13.370
Others	−26.661	27.723	−0.96	−14.526
Elderly	1.987	7.533	0.26	1.189

Note: **, *** indicates statistical significance at the 0.05, 0.01 levels, respectively (N = 2160).

5. Discussion

There are inconsistencies in the definitions and calculation methods used to measure food waste in the previous papers [50], and some literature is based on secondary data on food waste [25]. We used statistical analysis and quantitative regression to provide more robust results as well as first-hand direct-weighing-based consumer food waste data, which can be more reliable than secondary data based on literature or modeling for the analysis. Therefore, we suggest to conduct more surveys on food waste and obtain first-hand data for research.

According to our results, plate color has different effects on per capita per meal food waste, food ordered, and food eaten. Warm colors may have a positive effect in reducing consumer food waste in restaurants. These results are consistent with the previous research on color psychology: color does affect the mind of consumers and their behavior, and consumers have different feelings and behaviors in response to distinct colors [38]. For example, it was previously claimed that plate color plays an important role in people's perception of food [51]. Because changing the plate color is a relatively low-cost intervention, it may be an impactful way to reduce consumer food waste and one that has not been often discussed in the food waste literature.

The personal characteristics of consumers affected their food waste behaviors, such as age [52,53], education [31,54], and income [55,56], which is consistent with previous research results. It has been previously found that the more aware youths are concerning food waste, the more likely they are to reduce leftovers [26]. Building consumer awareness [54] and perception [29] about food waste is an important measure for reducing food waste. Tourists wasted more food than local residents on a per capita level, which is consistent with previous research [57]. More quantitative research will help to inform policy making and to increase public awareness of the problem in China [58].

Multiple food supply chain actors should take action to measure and reduce food waste [50,59]. There are simple but effective food waste minimization strategies that can lead to a drastic decrease in global food waste generation, such as provide consumers with menu by petite nature [60]. We anticipate that our case study on China can enable more scientific analyses on these effects and promote discussion for efforts and interventions to mitigate against food waste. We believe our case studies and results can contribute usefully in furthering our understanding of the effect of color on consumer food consumption and waste. Food waste behavior of consumers may be affected by COVID-19, and there may be some changes in purchasing and consumption behavior. These need further study.

6. Conclusions and Limitation

6.1. Conclusions

Our results show that the per capita per meal food waste of all consumers in the surveyed restaurants was 80.21 g, whereas the per capita per meal food waste of those

with warm-color plates was 61.83 g. This indicates that warm plate colors may have a positive effect in reducing restaurant consumer food waste. We have also shown that although the restaurant decoration color does not have a statistically significant effect on consumer food waste, it does show a negative effect on per capita per meal food ordered by amount (both warm and cool colors). Cool colors for plates and decoration have a negative effect on the weight of per capita per meal food eaten. This means decorating the restaurant environment with cool colors may help to reduce the weight of food eaten and the possibility of increase food waste, which merits further research.

Additionally, the personal characteristics of consumers, such as age, education, and income levels, and other factors such as for the purposes of meals, were found to affect food waste behavior. Our case study confirms that color psychology may be important in reducing food waste, and it suggests that more research in this area may be valuable for the purposes of mitigating consumer food waste.

6.2. Limitation

Because of methodology and data limitations, our analysis has some unavoidable limitations. First, we have only recorded information on plate color and decoration color in our survey, without specifying different components of the dining environment (e.g., table cloth, wall, and floor) or different shades of the same color (e.g., dark red versus light red). Second, only the one who ordered the food or paid the bill has filled in the questionnaire on individual consumer characteristics such as age, occupation, education, and income, which may not be representative of all consumers on the sample table. Third, other potentially important factors related to consumer food waste behavior, such as the mental state of consumers and the external intervention, are not included and require further analysis. Additionally, meals can vary in size if eaten on weekdays versus on weekends. Last but not least, despite our best efforts, the sample representativeness may still be limited, and wider coverage may be useful for future study.

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