The Study on the Foodborne Diseases of Harbin Consumers and the Influencing Factors of Foodborne Diseases

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Abstract—It was necessary to understand the situation of foodborne diseases infringement on consumers and to verify the relationship between foodborne diseases infringement and consumers. This research investigated the influence degree of foodborne diseases and their influencing factors of the consumers in Harbin through a random survey of 307 people, analyzed survey data with SPSS 20, and established dual- logistic-model. Food safety knowledge (P<0.05) and food safety behavior (P<0.01) had significant statistical differences with whether they were affected by foodborne diseases, while age, educational background, occupation, expenditure on food and special family members also had significant statistical differences with whether they were affected by foodborne diseases (P<0.05).

Index Terms—foodborne diseases, food safety knowledge, food safety behavior

I. INTRODUCTION

A. Introduction

Relevant departments of the state and people have paid increasing attention to the food safety issues, and the governance level of food safety issues reflects, a certain extent, the economic and social development, the sound degree of the laws and the living standards of consumers of a country and society. Millions of people suffer from the diseases caused by unsafe food every year in the world. According to tee statistics from the Centers for Disease Control and Protection, there were 818 foodborne disease incidents, reported by news media, in the United States in 2013 with 13360 victims. However, the reported foodborne disease incidents were less than half the total number of foodborne incidents [1]. Two million people suffer from food borne diseases each year in Canada, and it reaches five million in Australia. According to statistics from the China Centers for Disease Control and Prevention (CDC), one out of every six people get sick each year in the United States, because of the contaminated food, and foodborne diseases occur in about 4 million 800 thousand people each year. Only the direct medical expenses caused by the Salmonella infection, reaches \$365 million each year [2]. If the foodborne diseases cannot be well controlled, it would

result in a serious food safety crisis [3]. According to the statistics of WHO, there are 600 million people affected by the foodborne diseases and 20 thousand people die of foodborne diseases every year in the world [4]. Many consumers, who have been affected by foodborne diseases, have not timely gotten medical treatment, or reported to the testing institutions, which leads to an underestimation of foodborne disease on consumers and its influencing factors can be understood and the feasible measures and reasonable guidance can be carried out, the foodborne diseases would be reduced. It will contribute to maintaining and promoting the improvement of the food safety of all the people, and has a positive impact on Chinese food safety management.

B. Literature Review

The research of the awareness of food safety knowledge. Mindi (2016) studies the food safety knowledge in restaurants with 23 questions about food safety knowledge, including bacteria, the suitable temperature of heating or cooling, raw and cooked food handling and cross contamination. Mindi concludes that the sores of food practices with medical certificates are significantly higher than the sores of food practices without medical certificates, taking training and education levels as control variables [7].

The research on how to improve the food safety knowledge. Sarah (2016) verifies the significant influence of food safety education on improving food safety knowledge through the analysis of the questionnaire survey data of 485 college students. The results show that it is more effective on the respondents who are younger and occasionally cook [8].

An important reason why food safety attracts much attention is that the inappropriate food safety knowledge, attitudes and behavior will cause foodborne diseases and endanger the health of consumers. The researches at home and abroad have focused on the description and analysis of the knowledge, behavior and attitude of food safety, however, few researches study the relationship between foodborne diseases and the knowledge, attitudes and behaviors of food safety. It is necessary to understand the situation of foodborne diseases infringement on consumers.

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II. HYPOTHESES

A. Demographic Statistics Characteristics

The four major influencing factors of age, gender, education and marital status are extracted and the hypotheses are also proposed respectively:

 H_1 : Whether consumers are affected by foodborne disease is significantly associated with their ages; H_2 : Whether consumers are affected by foodborne disease is significantly associated with their genders; H_3 : Whether consumers are affected by foodborne disease is significantly associated with their education; H_4 : Whether consumers are affected by foodborne disease is significantly associated with their marital status.

B. Socio-Economic Characteristics

 H_5 : Whether consumers are affected by foodborne disease is significantly associated with their incomes; H_6 : Whether consumers are affected by foodborne disease is significantly associated with their professions; H_7 : Whether consumers are affected by foodborne disease is significantly associated with their monthly expenditures on food.

C. The Knowledge, Attitudes and Behavior of Food Safety

 H_s : Whether consumers are affected by foodborne disease is significantly associated with their knowledge of food safety; H_s : Whether consumers are affected by foodborne disease is significantly associated with their attitudes of food safety; H_{10} : Whether consumers are affected by foodborne disease is significantly associated with their behavior of food safety.

D. Family Characteristics

Elisa believes that the families have children, the elderly and gravidas will withstand higher food safety risks [9].

 H_{11} : Whether consumers are affected by foodborne disease is significantly associated with the number of their family members; H_{12} : Whether consumers are affected by foodborne disease is significantly associated with whether the family has special members.

III. METHODS

A. Data Sources

The research objects were the consumers in Harbin and seven major markets and malls of Harbin were selected by random sampling. Then the random survey was conducted at each site by randomly intercepting 50 people. Totally 350 questionnaires were issued. After the deletion of incomplete questionnaires, totally of 307 valid questionnaires were issued and the effective recovery rate was 87.7%. The data acquisition time is January to March in 2017.

B. Instrumentation

50 questionnaires were randomly distributed to make the pretest. The questionnaire was anonymously answered. The results of the questionnaire were used for academic research and will not disclose personal information. Besides, the respondents had been specifically informed of the purpose of the investigation and they understand the importance of the serious answer. The face to face interviews were carried out by investigators who were specially trained. When questionnaires were filled, they were collected on the spot after a careful verification. The average answer time of each questionnaire was 20 minutes. The ambiguous problems and the problems, which respondents were confused about, were adjusted. The survey data was input in SPSS 20 by two people for data analysis. P<0.05 was regarded as a significant difference. The Cronbach's a coefficient were used to examine the internal reliability of questionnaire. The result showed that the reliability of the questionnaire was 0.716, which indicates that the questionnaire had good reliability and the internal consistency of questionnaire was good. Finally, meaningful statistical data were concluded through a combined finishing of many parts and the dual logistic regression model was established to analyze the impact of foodborne diseases on consumers and its influencing factors.

C. Questionnaire Design

The design of questions of questionnaire referred to the essence content of relevant research at home and abroad, considered the actual situation and characteristics of the consumers in Harbin China and the purpose and hypothesis of the research. The questionnaire included five parts:

- Were they affected by foodborne diseases?
- Demographic statistics characteristics
- Socio-economic characteristics
- The knowledge, attitudes, behavior and training of food safety
- Family characteristics

The knowledge of food safety was divided into the food hygiene knowledge and the personal and kitchen hygiene knowledge. According to the Ma Zhiying (2012), the problems of the knowledge of food hygiene was divided into oil and vinegar sauce, vegetables and fruits, fish, meat, dairy products, drinks, snacks and cakes [10]. Each category was extracted a common sense question. The knowledge of personal and kitchen hygiene drew lessons from the research of Nevin (2012) and Peter (2003). The details were shown in Table I. The food safety attitudes and food safety behaviors drew lessons from the research of Nevin (2012), Peter (2003), Elisa (2012) and Patricia (2017). The details were shown in Table II. and Table III.

TABLE I. FOOD SAFETY KNOWLEDGE SCALE

	Food hygiene knowledge	Source
1	The repetitively used oil for frying foods belongs to swill-cooked dirty oil	
2	Fried carrots are more conducive to the absorption of B- carotene than uncooked carrots	Ma Zhiying[10]
3	Eat no more than 1 preserved egg made by traditional techniques every week, otherwise it will be harmful to your health	(2012)

	Food hygiene knowledge	Source
4	The fresh milk has the Bus sterilization can	
	store up to 7 days at 2-6 degrees	
5	Soda water cannot balance the pH value of	
5	body or change acid constitution	
6	The quality of Honey cannot be	
0	distinguished by crystallization	
	Personal and kitchen hygiene knowledge	Source
7	Freezing can only prevent bacteria from	
'	breeding, but it cannot kill bacteria	
0	Do not touch the cooked food directly after	Nevin[11]
8	touching raw food	(2012)
0	Vegetables and fruits need to clean before	
9	they are eaten	
10	Poultry and meat should be cleaned first	Peter[12]
10	and cooked later	(2003)

 TABLE II.
 FOOD SAFETY ATTITUDE SCALE

	Food safety attitude	Source
1	I'd like to know more about the food safety problem	Peter r[12]
2	Changing bad food buying habits can avoid some food safety problems	(2003)
3	The canned food cannot be eaten, if its surface is raised (sanlier)	
4	It's important to read instructions of packaged food on their packages (sanlier)	Nevin[11] (2012)
5	Buying food at large stores is more secure than buying food at street vendors	

TABLE III. FOOD SAFETY BEHAVIOR SCALE

	Food safety behavior	Source
1	Pay attention to the date of production when purchasing food	Peter[12] (2003)
2	Buy food in a quality assured shopping mall or supermarket	Elisa[9]
3	Do not use wet chopping board	(2012)
4	Wash your hands with soap before handling the food	Detricia[12]
5	You need to wash your hands before you touch other ingredients after touching raw meat and seafood	(2017)

The family characteristics include the quantitative characteristics of family members, which was divided into one person, two to five persons and six or over six persons. Special family members include the elderly who is over 70 years old, and the child who is under 6 years old, and the gravida. The specific assignments were shown in Table IV.

D. The Selection and Assignment of Variables

If the respondents' answer on the question "have you suffered from diarrhea, vomiting, stomach pain, nausea and other problems due to the food with potential danger during the past 12 months?" was "yes". The respondent was believed to be affected by foodborne diseases.

The demographic statistics characteristics include the age, gender, education and marital status of the respondent. Marital status was divided into "unmarried" and "married". The "unmarried" meat that persons are not in marital relations, and it is relative to the "married", including divorced and widowed, and the specific assignment was shown in Table IV.

The socio-economic characteristics include respondents' income, occupation and expenditure on food. Both of income and the expenses on food took "month" as the measuring time and took "Yuan" as the measurement units. The specific assignments were shown in Table IV.

The scores of the answer to the questions about food safety knowledge were as follows. The wrong answer got zero while the answer got one point. There were totally ten questions and the total score was ten. The score below two was considered as "poor"; the score between three to four was considered as "pass"; the score between five to six was considered as "medium"; the score between seven to eight was considered as "good"; the score over nine was considered as "excellent".

The answers to the questions about food safety attitudes and food safety behaviors were measured with Likert scale. The scores of the answer to each question about food safety attitudes were as follows. "Favor" got five points; "little favor" got four points; and "indifferent" got three points; "little object" got two points; "object" got one point. There were totally five questions and the total score was 25 points. The scores of the answer to each question about food safety behaviors were as follows. "Always" got five points; "sometimes" got four points; "occasionally" got three points; "little" got two points; "never" got one point. There were totally five questions about food safety behavior and the total score is 25 points. The score below four was considered as "poor"; the score between five to nine was considered as "pass": the score between 10 to 14 was considered as "medium"; the score between 15 to 19 was considered as "good"; the score over 20 was considered as "excellent".

TABLE IV. VARIABLES

Variable definition Variable declaration					
	dependent variable				
Food safety incident (Y)	no=0; yes=1				
i	ndependent variable				
$Age(X_1)$	continuous variable				
Gender (X ₂)	male=0; female=1				
Degree (X ₃)	above university =0; university =1; high school=2; junior middle school =3; primary school and below =4				
Marital status (X ₄)	unmarried=0; married=1				
Income (X ₅)	continuous variable				
Profession (X ₆)	The staff of Joint-stock companies and foreign companies =0, Self-employed and private enterprise workers =1; Civil servant, the employees of public institutions and the employees of state- owned enterprises =2; student and teachers =3; others=4				
Expenditure on food (X ₇)	continuous variable				
Food safety knowledge (X ₈)	poor=0; pass=1; medium=2; good=3; excellent=4				
Food safety attitude (X ₉)	poor=0; pass=1; medium=2; good=3; excellent=4				

Food safety behavior	poor=0; pass=1; medium=2; good=3;			
(X ₁₀)	excellent=4			
Number of family	one person=0; two to five persons =1;			
members (X ₁₁)	over six persons=2			
Special family members (X ₁₂)	no=0; yes=1			

IV. RESULTS

A. Descriptive Statistics

The informants include 122 males (39.7%) and 185 females (60.3%). The female informants were more than the male informants, which might be due to the fact that females were primarily responsible for the family food purchases and food preparation. Most of the incomes of respondents were between 3,000 yuan to 8,000 yuan and the most of monthly expenditures on food were below 3,000 yuan. Table V. was the cross tabulate of the variables and whether was affected by foodborne disease.

TABLE V. CROSS TABULATE

	Y	=0	Y=1		Tot	alize
	n	%	n	n %		%
		Gender				
Male	104	39.5	18	34.6	122	39.7
Female	159	60.5	34	65.4	185	60.3
	1	Degree	-			
Above university	68	26.7	7	13.5	75	24.4
University	94	36.9	15	28.8	109	35.5
High school	81	31.8	21	40.4	102	33.2
Junior middle school	11	4.3	8	15.4	19	6.2
Primary school and below	1	0.4	1	1.9	2	0.7
	Pr	ofession				
The staff of Joint- stock companies and foreign companies	66	25.9	27	51.9	93	30.3
Self-employed and private enterprise workers	166	65.1	21	40.4	187	60.9
Civil servant, the employees of public institutions and the employees of state- owned enterprises	9	3.5	3	5.8	12	3.9.
Student and teachers	14	5.5	0	0	14	4.6
Others	0	0	1	1.9	1	0.3
	Food saf	ety know	ledge			
Poor	1	0.4	5	9.6	6	2
Pass	52	20.4	12	23.1	64	20.8
Medium	76	29.8	20	38.5	96	31.3
Good	124	48.6	13	25	137	44.6
Excellent	2	0.8	2	3.8	4	1.3
	Food s	afety atti	tude	-		
Poor	1	0.4	0	0	1	0.3
Pass	1	0.4	0	0	1	0.3
Medium	62	24.3	15	28.8	77	25.1
Good	114	44.7	16	30.8	130	42.3
Excellent	77	30.2	21	40.4	98	31.9
	Food sa	afety beh	avior	-		-
Poor	0	0	2	3.8	2	0.7
Pass	8	3.1	13	25	21	6.8
Medium	10	3.9	8	15.4	18	5.9

Good	177	69.4	21	40.4	198	64.5			
Excellent	60	23.5	8	15.4	68	22.1			
Special family members									
No	No 204 80 41 78.8 245 79.8								
Yes	51	20	11	21	62	20.2			

B. Dual Logistic Regression Model

The dependent variables of the binary logistic regression analysis can only be divided into two categories. "0" meant nonoccurrence and "1" meant occurrence, through which the influence probability of independent variable on whether a dependent variable occurs. The general model of logistic regression as in (1).

$$P_{i} = F(y_{i}) = \frac{1}{1 + e^{-y_{i}}} = \frac{1}{1 + e^{-(\alpha + \beta_{1}x_{1} + \beta_{2}x_{2} + \dots + \beta_{1}x_{i})}}$$
(1)

C. Regression Process

Whether the consumers were affected by foodborne disease was a variable of binary classification, and "0" meant nonoccurrence and "1" meant occurrence. The relationship between Y1 and its influencing factors X1-X15 was analyzed with binary logistic regression model. Firstly, we analyzed the regression parameters and test results which have only one constant without any independent variables. It was found that the Sig value was 0 which meant that it passed the significance test (P<0.05), the B statistic was -1.553 (Table VI).

TABLE VI. THE REGRESSION PARAMETERS AND TEST RESULTS

Statistic	В	S.E,	Wals	df	Sig.	Exp (B)
constant	-1.590	0.152	109.197	1	0.000	0.204

Table VII. was the variable that had not been put into the equation at that time, and the degree of freedom of each variable was one. The variable of food safety behavior (X10) got the highest score of 39.541. Finally, the "backwards: condition" method was chosen after many repeated experiments. "Backwards: condition" method was a backwards stepwise regression method, which took significance test of likelihood ratio statistic which was based on the conditional parameter estimation as the standard to screen non-significant variable and to eliminate the Logistic regression model.

 TABLE VII.
 The Variables which Were not Initially Input Into the Equation

variable	score	df	Sig.
X1	27.526	1	0.000
X2	0.243	1	0.622
X3	12.282	1	0.000
X4	7.032	1	0.008
X5	5.684	1	0.017
X6	6.896	1	0.009
X7	1.603	1	0.206
X8	8.778	1	0.003
X9	0.411	1	0.521
X10	39.541	1	0.000

X11	4.416	1	0.036
X12	0.036	1	0.850
Total statistics	86.225	12.000	0.000

All independent variables were input in step 1 for carrying out the backwards stepwise regression. After 6 steps, the variables in the equation were shown in Table VIII. Table VIII. gave the information of the variables in the equation at that time, including independent variables, the B test statistic value of the regression coefficients of

independent variables, the asymptotic standard error of parameters S.E, the Chi square test statistic value Wals, the degree of freedom df, significance probability Sig, the exponential quantity of the B test statistic Exp (B), etc.

Finally, the variables that were selected in turn were age (X1), education (X3), profession (X6), monthly expenditures on food (X7), food safety knowledge (X8), food safety behavior (X10) and special family member (X12). According to the Table VIII, the final estimation as in (2).

(2)

$$P_{i} = F(y_{i}) = \frac{1}{1 + e^{-y_{i}}} = \frac{1}{1 + e^{-(7.052 - 0.103X_{1} + 0.519X_{3} - 0.882X_{6} + 0.001X_{7} - 0.479X_{8} - 1.122X_{10} - 1.062X_{12})}$$

Step		D	SЕ	Wala	df	Sia	Exp (B)	EXP(B) 95% C.I.	
		В	5.E,	wais		51g.		Lower limit	Upper limit
	X_1	-0.108	0.025	18.682	1	0.000	0.897	0.854	0.943
	X_2	-0.196	0.595	0.108	1	0.742	0.822	0.256	2.639
	X ₃	0.564	0.244	5.358	1	0.021	1.758	1.090	2.834
	X_4	-0.079	0.465	0.029	1	0.865	0.924	0.371	2.299
	X5	-0.001	0.001	1.105	1	0.293	0.999	0.997	1.001
	X_6	-0.902	0.313	8.326	1	0.004	0.406	0.220	0.749
Step 1	X ₇	0.000	0.000	8.959	1	0.003	1.000	1.000	1.000
	X ₈	-0.520	0.236	4.858	1	0.028	0.595	0.374	0.944
	X9	0.184	0.237	0.602	1	0.438	1.201	0.756	1.910
	X ₁₀	-1.134	0.236	23.179	1	0.000	0.322	0.203	0.511
	X ₁₁	-0.002	0.452	0.000	1	0.997	0.998	0.412	2.420
	X ₁₂	-0.983	0.498	3.891	1	0.049	0.374	0.141	0.994
	constant	7.113	1.966	13.083	1	0.000	1227.583		
	X_1	-0.103	0.023	20.014	1	0.000	0.902	0.862	0.944
	X ₃	0.519	0.222	5.453	1	0.020	1.681	1.087	2.599
	X_6	-0.822	0.301	7.445	1	0.006	0.439	0.243	0.793
G. (X ₇	0.001	0.000	9.309	1	0.002	1.000	1.000	1.000
Step 6	X_8	-0.479	0.230	4.328	1	0.037	0.619	0.394	0.973
	X_{10}	-1.122	0.225	24.781	1	0.000	0.326	0.209	0.506
	X ₁₂	-1.062	0.487	4.749	1	0.029	0.346	0.133	0.899
	constant	7.052	1.521	21.503	1	0.000	1155.731		

TABLE VIII. THE VARIABLES IN THE EQUATION

D. Model Test

Table IX. was the test result of Hosmer and Lemeshow test, P>0.05. So we could judge that the parameters of the estimated model mentioned above were significant, and the model was reasonable in statistical sense.

TABLE IX. HOSMER AND LEMESHOW TESTS

Steps	Chi square	df	Sig.
1	8.604	8	0.377
6	9.448	8	0.306

Table X. was the classification table of the model. It shows that total classification accuracy of the model reached 87%. The total classification accuracy of each step was maintained at about 87%. So, the stability of the model was good, and the estimation of the model was reasonable.

TABLE X. CLASSIFICATION TABLE

Observed		predicted			
		Y		Percentage	
		0	1	correction	
First step	Y	246	9	96.5	96.5
		29	23	44.2	42.3
	Total percentage		87.3		
Sixth steps	Y	0.00	246	9	96.5
		1.00	30	22	42.3
	Total percentage		87.3		

E. Hypothesis Test

1) Demographic statistics characteristics

Whether consumers are affected by foodborne disease was significantly associated with ages (P<0.05) and β 1 was -0.103. The hypothesis H1 was verified. Each change of every unit in age (X1) would make the probability ratio of "affected by foodborne disease (Y)" to "unaffected" 1.108 times (exp (0.103)) upon the ratio before the change. Education was significantly associated with the dependent variables (P<0.05), and β 3 was 0.519. The hypothesis H3 was verified. The higher the educational background and the better knowledge structure you had, the less possible got foodborne disease. The hypothesis H2 and H4 were untenable.

2) Socio-economic characteristics

Whether consumers are affected by foodborne disease was significantly associated with professions (P<0.05), and $\beta 6$ was -0.822. The hypothesis H6 was verified. Whether consumers are affected by foodborne disease was significantly associated with their monthly expenditures on food(P<0.05), and $\beta 7$ was 0.001. The hypothesis H7 was verified. Each change of every unit in expenditures on food (X7) would make the probability ratio of "affected by foodborne disease (Y)" to "unaffected" 1.001 times upon the ratio before the change. The hypothesis H5 was untenable.

3) The knowledge, attitudes and behavior of food safety

Whether consumers are affected by foodborne disease was significantly associated with the knowledge and behavior of food safety (P<0.05), and β 8 and β 10 were -0.479 and -1.122. The hypothesis H8 and H10 were verified. Food safety behaviors had great influence on "whether consumers are affected by foodborne disease". Each change of every level in food safety behaviors would make the probability ratio of "affected by foodborne disease (Y)" to "unaffected" 3.07times (exp(1.122)) upon the ratio before the change. The hypothesis H9 was untenable.

4) Family characteristics

Whether the family had special members was significantly associated with whether consumers are affected by foodborne disease (P<0.05) and β 12 was - 1.062. The hypothesis H12 was verified. The probability of "affected by foodborne disease (Y)" in the family with special members was 2.892 times (exp(1.062)) upon to the probability of "unaffected" in the family without special members. The hypothesis H11 was untenable.

V. DISCUSSION

More than 200 different diseases can be transmitted through contaminated food or water, and all countries, no matter the developing countries or developed countries, are facing the potential threat of foodborne disease outbreaks [14]. Through the collation of research data, this research finds that 17% consumers in Harbin had diarrhea, vomiting, stomach pain, nausea and other malaise caused by food with potential danger over the past 12 months, and the ratio is slightly higher than the world average.

Angelillo (2000, 2001) assesses the relationship between knowledge, attitudes, behavior and foodborne disease [15]-[16]. Jiang (2017) believes that cross contamination, improper cooking and improper storage are the important causes of foodborne diseases [17]. Through this study, it is found that the food safety knowledge (X8) and food safety behavior (X10) have statistically significant difference (P<0.05) with the dependent variable-whether consumers are affected by foodborne disease. Food safety behaviors have great influence on whether consumers are affected by foodborne disease. Each change of every level in expenditures on food (X7) would make the ratio of the probability of occurrence of the impact caused by food safety behaviors (Y) to the probability of nonoccurrence 3.07times as the ratio before the change. Besides, age (X1), education (X3), profession (X6), expenditure on food (X7) and special family members (X12) are also significant associated with the dependent variablewhether consumers are affected by foodborne disease (P<0.05). The coefficients respectively are -0.103, 0.519, -0.822, 0.001 and -1.062.

Food is more than a commodity, and the food safety is a public issue associating with the whole society [18]. As the high morbidity, foodborne diseases have become a major hazard affecting the health of people. Education activities of food safety can conduce to guiding consumers to adopt proper food handling methods, which has positive significance in protecting consumers from foodborne diseases [19].

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