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CONSUMERS' PERCEPTION OF FOOD SAFETY RISK FROM VEGETABLES: A RURAL - URBAN COMPARISON

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ABSTRACT

Rapid urbanization brings challenges to managing food safety in Vietnam. Today, consumers pay more attention to the safety of food, particularly vegetables. This paper investigates the impact of consumer perception of food safety risk on self-reported vegetable consumption and then compares the determinants of risk perception between the rural and the urban region. We conducted a survey and observe a decline in self-reported vegetable consumption as a consequence of heightened risk perception among residents in the Hanoi area. The differences, as well as the similarities in the underlying drivers of risk perception, were identified across regions. In both regions, information about food incidents and perceived consequence of hazards associated with vegetables shaped risk perception of vegetables. Respondents' age, education, and trust in food retailers at wet markets determined risk perception in the rural area, but not in the urban region. Personal experience with vegetable poisoning, whether the household was growing vegetables, perceived control over hazards, and trust in responsible institutions only influenced risk perception in the urban region. We suggest that these spatial disparities in behaviours should be taken into account in designing and implementing risk communication programs and food safety policies in Vietnam.

Keywords: food safety, risk perception, rural-urban, Vietnam

JEL Classification: Q18, D12, Q13

1. INTRODUCTION

Vietnam is experiencing rapid urbanization. This shift, while playing a central role in the robust economic growth of the country, also brought challenges to ensuring food safety, particularly in nutritious and perishable categories such as meat, fish, and vegetables. Rapid urbanization has lengthened the distance between primary food producers and final consumers leading to an "information asymmetry" and increased consumer uncertainty about food quality. Urbanization process also affects the way farmers use inputs. The loss of farmland due to urbanization, farmer's poor knowledge and government failure in managing the use and trade of agrochemical inputs have resulted in the overuse or misuse of chemical fertilizers and pesticides in vegetable production. In recent years, farmers have been found to have used highly toxic- even banned pesticides in growing vegetables (Hoi *et al.*, 2016).

Since vegetable is the mainstay of the Vietnamese diet, the fear of chemical residues has made vegetable safety a primary concern of many food shoppers. Consumers were found to view vegetables as the riskiest product among perishable foods (Ha *et al.*, 2019). International experience shows that a high level of risk perception immediately reflects into food consumption, resulting in consumer's avoidance of some food categories (Grunert, 2005). A similar effect also has been seen in Vietnam. We found that due to the concern about vegetable safety, Vietnamese consumers have both reduced vegetable consumption in general, and restricted the type of vegetables that they consume. A proportion of urban families are growing their vegetables in any available spaces, source safe vegetables from their relatives in rural areas, or buy the expensive organic alternative. Consumer's high-risk perception is likely to hinder domestic vegetable production and livelihood of millions of small-scale farmers. These consequences highlight the importance of reducing consumer perception of food safety risk through effective risk communication.

There has been growing recognition of the vital links between institutional trust and food safety risk perception (Hobbs and Goddard, 2015). Lobb *et al.* (2007) found that trust in public authorities reduced risk perception from eating chicken. Similarly, Knight and Warland (2005) reported that trust in the food system was negatively related to risk perception of Salmonella. Since consumers do not possess sufficient knowledge of food hazards, employing trust in those responsible for managing food safety help reduce the complexity that consumers face (Siegrist and Cvetkovich, 2000).

Food safety information plays a vital role in forming risk perception. According to Roberts *et al.* (2016), risk perception is shaped through a complex process including seeking information from various sources, interpreting, then filtering it via direct experience and socio-cultural circumstance. Thus, having experienced a few episodes of food risks, confidence in food safety will drop dramatically when new information about food risk spreads. When this information is captured and exploited by mass media, risk perception will be escalated, causing unwarranted panics (Verbeke, 2005).

Psychometric paradigm provides a useful account of how risk perception of a hazard is linked with risk characteristics of the hazard itself - the extent a hazard is perceived to be known, controllable, and severe (Fischhoff *et al.*, 1978, Slovic, 1992). Risk perceived from chemical

hazards was higher than microbial alternatives because chemical contaminations were believed to be severer, less familiar, and less controllable (Kher *et al.*, 2013). Besides, there was also a link between risk perceptions of the hazards associated with a food product with the overall risk perceived of the food. For instance, Miles and Frewer (2001) noted that the fear of Salmonella made chicken and egg become a risky food to English consumers. The concern of vegetable safety is associated with the worry about pesticide residue in vegetables in Vietnam (Figuié *et al.*, 2004) and China (Cheng *et al.*, 2016). Hence, we argue that there might be a relationship between risk perceptions of hazards associated with a particular food with overall risk perceived from that food due to the two links above.

Social and cultural factors are other key drivers of risk perception (Dosman *et al.*, 2001; Schroeder *et al.*, 2007). According to the cultural theory developed by Douglas and Wildavsky (1983), risk perception is a social-cultural construct. Different people with different social norms and cultural values will perceive risk differently. Since there are disparities between a rural and urban region in terms of social interaction, culture, and economic activities, it is reasonable to expect the differences in food safety risk perception between rural and urban consumers. Although rural and urban consumers are different consumer segments, international studies on food safety risk perception often considered them as a homogenous group. A few research compared risk perception between rural and urban regions. Most of them treated residential location as a dummy predictor of food safety concern or food safety risk perception (Verbeke and Viaene, 2000; Liu and Ma, 2016; Hall and Moran, 2006). The results are mixed, depending on the type of risk or food safety issue under consideration. Verbeke and Viaene (2000) and Liu and Ma (2016) found that urban dwellers perceived a higher food risk and were concerned more about food safety than rural residents. However, Hall and Moran (2006) reported that people living in rural areas ranked higher GMO risks than those living in urban areas. Except for McEachern and Warnaby (2008), there is little discussion about the disparities in food safety risk evaluation between rural and urban consumers in these works. Although studies have recognized rural-urban differences in food safety risk perception, research has yet to comprehensively compare the underlying drivers of risk perception across the regions.

Since food safety is a public concern in Vietnam, many attempts have been made to gain insights into Vietnameses' food safety risk perception (Figuié *et al.*, 2004; Wertheim-Heck *et al.*, 2014a; Nguyen-Viet *et al.*, 2017; Ha *et al.*, 2019). The first three studies did not quantify factors affecting food safety risk perception. The fourth quantified the determinants of food safety risk perception but did not compare the determinants of risk perception between rural and urban regions. Furthermore, the fourth focused on the concern about food safety while the current paper discusses the perception of food safety risk from vegetables. The current paper distinguishes itself from above works in the sense that it 1) considered the relationship between risk perception and food consumption and 2) analyzed rural-urban differences in the factors influencing risk perception.

In this paper, we investigate the impact of food safety risk perception on self-reported vegetable consumption across the rural and urban region in Hanoi, Vietnam. The paper then compares the determinants of risk perception of vegetables between rural and urban regions. The finding would help vendors and policymakers realize the consequence of heightened food safety risk perception and take appropriate steps towards reducing such perception. The study is the first

attempt to consider the influence of various risk characteristics of different hazards associated with a food product on risk perception of the product. This information will support the development of risk communication programs in Vietnam. Also, the study explores, for the first time, the similarities as well as disparities in influencing factors of food safety risk perception between rural and urban settings. These insights will enable decision makers to design effective risk communication strategies that are specific to each region. The paper, thus, provides an opportunity to advance existing knowledge on food safety risk perception.

The remaining part of the paper proceeds as follows: the next section considers material and method; section 3 illustrates study results and discussions, and the last section reflects on policy implications and concludes.

2. MATERIAL AND METHOD

2.1 Study area and consumer survey

We collected data through a consumer survey in Hanoi, Vietnam. A diverse population of more than 8 million habitants of Hanoi allowed us to investigate a heterogeneous group of consumers. Hanoi has urban as well as rural districts, allowing rural-urban comparisons. Rapid urbanization of Hanoi is creating challenges to food safety and security. A high level of concern about vegetable safety of Hanoi residents offers an opportunity to study consumer perception of food safety risk from the product.

We drew a sample from 7 districts including 3 urban, 1 semi-urban and 3 rural districts. These districts are representative of Hanoi in terms of social, economic development and geographical condition. We applied quota sampling with a predetermined quota taken from each selected district. In total, 498 respondents including 230 rural and 268 urban people participated in the face-to-face survey. A detail description of background information on the surveyed respondents can be found in Ha *et al.* (2019).

2.2 Variable measurement and statistics

The questionnaire began with a filter item, asking whether the respondent worries about vegetable safety. The next 4 items were to gather the impact of risk perception on vegetable consumption. Those having a positive response to the filter item above then answered two questions 1) “Due to the concern about food safety, have you avoided eating any particular vegetables in the last two years?, 2) “If yes, please list their names.” This was followed by 2 items to reveal 1) whether the respondent had reduced vegetable consumption during the last two years due to the concern about food safety and 2) if yes, the estimated percentage of vegetable consumption reduction.

Another 27 variables measure the risk perception of vegetables and their potential determinants (Table 1).

Table 1: Variable definition and statistics

Variables/ constructs	Variable definition	Scale	Whole sample (n=498) Mean (SD)	Rural (n=230) Mean (SD)	Urban (n=268) Mean (SD)
PV	Risk perception of vegetables	1-5	3.80 (0.96)	2.15* (0.67)	2.46* (0.59)
Trust in	Local government	1-10	4.11 (2.95)	5.28* (3.15)	3.11* (2.34)
	Central government	1-10	3.56 (2.54)	4.32* (2.75)	2.91* (2.14)
	Supermarkets	1-10	4.46 (2.44)	4.50 (2.66)	4.43 (2.25)
	Farmers	1-10	2.77 (2.18)	3.16* (2.44)	2.44* (1.87)
	Food traders at wet markets	1-10	2.42 (1.85)	2.77* (2.13)	2.13* (1.52)
Perceived knowledge of	Pesticides	1-10	5.17 (2.52)	5.09 (2.68)	5.23 (2.38)
	Bacteria	1-10	4.90 (2.33)	4.76* (2.38)	5.02* (2.28)
	Heavy metal	1-10	4.19 (2.38)	3.97* (2.40)	4.39* (2.36)
	GMO vegetables	1-10	3.38 (2.41)	3.13* (2.41)	3.59* (2.40)
Perceived control over	Pesticide residue	1-10	3.45 (2.19)	3.75* (2.31)	3.20* (2.05)
	Bacteria	1-10	4.93 (2.56)	4.73 (2.48)	5.11 (2.62)
	Heavy metal	1-10	2.86 (2.01)	3.0*6 (2.06)	2.70* (1.96)
	GMO vegetables	1-10	2.70 (2.10)	3.09* (2.27)	2.36* (1.88)
Perceived consequence of	Pesticide residues	1-10	8.20 (1.98)	8.13 (2.05)	8.27 (1.91)
	Bacteria	1-10	7.28 (2.19)	7.12 (2.33)	7.42 (2.06)
	Heavy metal	1-10	7.90 (2.09)	7.58* (2.29)	8.19* (1.86)
	GMO vegetables	1-10	7.41 (2.51)	7.01* (2.73)	7.76* (2.25)
Information about	Food incidents from TV	1-5	3.92 (0.82)	3.81* (0.80)	4.01* (0.84)
	Food incidents from social media	1-5	3.34 (1.27)	2.83* (1.35)	3.78* (1.01)
	Food incidents from relatives/friends	1-5	3.68 (0.93)	3.54* (0.91)	3.81* (0.93)
VegGrow	=1 if the family grow vegetables	0-1	0.60 (0.49)	0.85* (0.36)	0.38* (0.48)
Veg Poisoning	=1 if have been poisoned by vegetables	0-1	0.31 (0.46)	0.31 (0.46)	0.30 (0.46)
Elderly	=1 if >= 60 years old	0-1	0.37 (0.38)	0.48* (0.50)	0.28* (0.44)
Male	=1 if male	0-1		0.12 (0.33)	0.13 (0.33)
Rich	=1 if individual monthly income >=15 mil VND	0-1	0.25 (0.43)	0.09* (0.28)	0.40* (0.49)
Children	=1 if there was at least 01 child in the family	0-1	0.76 (0.43)	0.69* (0.46)	0.81* (0.39)
University	=1 if have a university degree or higher	0-1	0.51 (0.50)	0.25* (0.43)	0.74* (0.44)

*Note: PV denotes perception of food safety risk of vegetables. GMO denotes genetically modified organisms. 22,000 VND=1 USD. * the mean scores at the same row are statistically different at 5%, using independent sample T-test.*

Risk perception of vegetable (PV), the dependent variable, was measured by mean of perceived health risk from consuming vegetables. To measure this variable, we used one item adapted from Schroeder *et al.* (2007): "To what extent do you think that you are exposed to health risk from eating vegetables, in general." Initially, we coded the responses on a scale of 1 (not risky at all) to 10 (extremely risky). For a better interpretation of regression results, this variable was later transformed into 5 point-scale presenting 5 ordered categories of risk perceived (very low, low, moderate, high, and very high).

We proposed 5 constructs. The first one is "Trust." Trust in all institutions was very low, particularly trust in food traders at the wet market. Urban people seem to place a lower level of trust than rural residents (Table 1). Thus, improving trust, especially for urban consumers will be a challenge for food authorities in Vietnam.

"Perceived Knowledge," "Perceived Control" and "Perceived Consequence" are 3 constructs that reflect different risk characteristics of 4 hazards associated with vegetables. "Perceived Knowledge" conveys the degree of knowledge respondents believed they have across various hazards. "Perceived Control" reflects consumers' view about the extent they were able to reduce risk from particular hazards through proper washing and cooking vegetables. "Perceived Consequence" refers to consumer evaluation of negative health impacts from the selected hazards.

Perceived knowledge and perceived control over all selected hazards were meager. The mean scores of perceived knowledge and control of the whole sample were low in the range from 3 to 5 on a scale of 10. As a result, the perceived consequence of all hazards was high with the mean score ranging from 7.3 to 8.2 for the whole sample- meaning that the respondents viewed vegetables as highly dangerous. Furthermore, a correlation analysis of perceived-consequence items uncovered respondents' actual knowledge of food hazards**.** Correlation coefficients among pesticide, bacteria and heavy metal substances ranged from 0.6 to 0.7 (Table 2), suggesting that consumers were unable to distinguish these three hazards. Consumer education on food hazards has an important role to play in Vietnam.

Comparing between regions, perceived knowledge of hazards of rural respondents was lower than urban residents. Rural people reported a higher level of control over all hazards, except bacterial contamination. Consequently, they expressed a lower level of concern across these hazards. The means of perceived knowledge, control, and consequence for bacterial contamination and GMO were statistically significantly different between regions, suggesting that consumers viewed these hazards differently across regions.

"Information" measures the frequency of information acquisitions about food incidents via mass media (T.V), social media (Facebook), and personal source (relatives and friends). Responses were in a range from 1 to 5, where 1 means "never" and 5 means "always" - having heard nearly every day. As expected, rural consumers heard about food incidents less frequently than urban people. This indicates that access to information in the rural region is worse than in the urban area.

The rest are dummy variables presenting economic activities of the household (VegGrow), personal experience with vegetable poisoning (VegPoisoning), and personal characteristics

(demographic variables). "VegGrow" indirectly demonstrates perceived personal control over food safety. Some previous studies reported the relationship between perceived personal control and risk perception. Redmond and Griffith (2004) noted that perceived control of food safety during food preparation was negatively associated with risk perception of food poisoning. Such empirical evidence leads us to expect that when household grows vegetables, this will reduce risk perception of primary food shoppers of the household, as homegrown foods were perceived to be very safe (Ha *et al.*, 2019).

Table 2: Correlation matrix of perceived - consequence items

	Rural (n=230)					Urban (n=268)			
	Pesticide	Bacteria	Heavy metal	GMO		Pesticide	Bacteria	Heavy metal	GMO
Pesticide	1.00	0.66**	0.56**	0.28**	Pesticide	1.00	0.60**	0.74**	0.41**
Bacteria	0.66**	1.00	0.71**	0.56**	Bacteria	0.60**	1.00	0.69**	0.49**
Heavy metal	0.56**	0.71**	1.00	0.72**	Heavy metal	0.74**	0.69**	1.00	0.57**
GMO	0.28**	0.56**	0.72**	1.00	GMO	0.41**	0.49**	0.57**	1.00

*Note: ** correlation is significant at the 0.01 level (2-tailed).*

2.3 Data analysis

Taking regional differences into account, we used Two Sample t-test and chi-square test in analyzing risk perception. A two-sample t-test was compared the mean of variables while chi-square test allowed the comparison of the frequency of response for a particular questionnaire item between the rural and urban subsample. Normality and homogeneity of variance - assumptions of Two Sample t-test were assessed.

We examined the impact of risk perception on vegetable consumption via the Kruskal-Wallis test (Kruskal and Wallis, 1952). This test helps identify whether vegetable consumption reduction levels differed among different groups of respondents, based on their risk perception of vegetables. There are 4 levels of consumption reduction, ranging from 1 to 4. Level 1 implies a decrease of less than 20% of total vegetable consumption compared to two years earlier, 2 (from 20 to 39%), 3 (from 40 to 59%), and 4 (more than 60%). Since the reduction in consumption level was an ordinal variable that is not normalized, the use of the Kruskal-Wallis test that does not rely on normal distribution assumption was appropriate. Respondents would be classified into 5 groups according to 5 corresponding risk perception outcomes (1 to 5). The rank mean of consumption reduction was calculated for each group. We then compared between each pair of the groups using the Kruskal-Wallis test that was followed by the post hoc tests.

The determinants of risk perception of vegetables were identified through the use of principal component analysis (PCA) and then ordered logit regression. Initially, 20 independent variables measuring 5 constructs, as reported in Table 1, were analyzed to detect statistically significant correlation coefficients among these variables. With our large and correlated data set, the use of PCA helped us to choose a fewer number of uncorrelated principal components

while retaining large information of the data set. These components are potential determinants of risk perception. We performed VARIMAX rotation on PCA. We followed the rule of thumb in retaining variables with factor loading above 0.4 in the components (Matsunaga, 2010). Three criteria employed to select the components were (1) Eigenvalue of the component being greater than one, (2) total variance explained by all components selected being higher than 60%, and (3) each component retained accounting for at least 1% of total.

The components retained from PCA, together with social-economic variables (the last seven variables in table 1) were regressed to identify the determinants of risk perception of each region. Since risk perception of vegetables has 5 ordinal outcomes: very low, low, moderate, high, or very high, ordered logit regression was employed.

Using an ordered logit regression model, the perception of food safety risk from vegetables, a latent variable, is modeled as:

$$PV_i^* = \beta X_i + \varepsilon_i \quad (1)$$

where PV_i^* is a latent variable which is linked with each observed ordinal outcome of risk perception, X_i is a vector of independent variables made up of components retained from PCA and social-economic variables of the respondent i, β is a coefficient vector, ε_i represents unobserved error terms.

Ordered logit regression depends on proportional odds assumption and multicollinearity remains a common problem. The result of the approximate likelihood-ratio test of proportionality of odds across response categories was significant for both rural and urban data set $\chi^2(39) = 66.69$, $p = 0.003$ (for rural), $\chi^2(35) = 54.85$, $p = 0.017$ (for urban). The parallel regression assumption was rejected at the 0.01 level for the rural data set and 0.05 level for the urban data set. This test suggests that there is the same set of coefficients across different outcomes of risk perception (very low, low, moderate, high, and very high) for both rural and urban model. For multicollinearity test, correlation coefficients of less than 0.6 of all pairs of independent variables demonstrate multicollinearity was not a problem.

3. Results

3.1 Risk perception of vegetables and the decrease in vegetable consumption

All surveyed consumers stated that they were worried about vegetable safety. Risk perception of vegetables was high for the whole sample (mean = 7.14 out of 10, SD = 2.01). Urban consumers viewed a relatively higher level of food safety risk from vegetables. The two sample T-test shows there was a statistically significant difference between the mean risk perception of vegetables between the two regions (6.77 ± 2.11 for the rural and 7.45 ±1.86 for the urban).

As shown in Table 3, because of food safety concerns, about one-third of respondents reported a decrease in the volume of vegetable intake during the last 2 years. The self-reported reduction was about 8.5% for an average respondent. Majority of them cited that they had excluded some

types of vegetable categories in their diet. Most of the top 10 frequent-cited vegetables that were avoided belong to a leafy category.

Table 3: Changes in vegetable consumption due to food safety concerns

Indicators	Whole sample	Rural	Urban
% of respondents reported vegetable consumption reduction	33.50	34.34	33.84
% of vegetable consumption has been reduced/respondent	8.47	8.46	8.54
% of respondents avoided eating at least one vegetable	89.36	87.50	88.79
Number of vegetables that were avoided eating/respondent	2.23	2.16	2.29
Top 10 vegetables that were frequently avoided eating	pak choy, choy sum, cabbage, broccoli, morning grow, watercress, Thai brinjal, cucumber, bean sprout, and lettuce		

Though risk perception of vegetables was higher in the urban region, the self-reported decrease in vegetable consumption tends to be similar between the rural and urban region. The values of all four indicators in Table 3 are not much different across the two regions. The chi-square test (for the first and the third indicator and two sample T-test (for the second and the fourth indicator) between rural and urban group were insignificant, indicating that the two regions shared the same trend in reduction of vegetable consumption.

The Kruskal- Wallis test illustrated in Table 4 shows a statistically significant difference in vegetable consumption reduction between the different levels of risk perceived from vegetables ($\chi^2(4) = 45.135$, $P = 0.000$). This means at least one group had the mean rank of vegetable consumption reduction different from other groups. The mean rank of consumption reduction level increased with risk perception levels suggesting a positive relationship between risk perception and consumption reduction. The post hoc test in Table 5 further revealed that the mean rank of vegetable consumption reduction differed significantly between level 1 and 5, 2 and 4, 2 and 5, 3 and 5 of risk perception at 5% level. The mean rank of consumption reduction also differed between other pairs of risk perception level such as 1and 3, 1 and 4, 2 and 3, at a 10% level. All of these results confirm that a higher level of risk perception was likely to lead to a significant reduction in vegetable consumption.

Table 4: Risk perception level and vegetable consumption reduction n = 498

Risk perception level	N	Mean rank of consumption reduction level
1	10	178.00
2	34	198.78
3	128	233.01
4	197	237.05
5	129	303.79
$\chi^2(4) = 45.135$, P = 0.000		

Note: Reduction in vegetables consumption is in scale 1-4 with 1 (reduce less than 20%), 2 (reduce 20% -39 %), 3(reduce 40% - 59%), 4(reduce more than 60%); risk perception for vegetables was in a 1-5 scale with 1(very low) and 5(very high). Mean rank of consumption reduction level is calculated by the Kruskal-Wallis test.

Table 5: Results of post hoc test

Compare the mean rank of consumption reduction between risk perception level	$\chi^2(1)$	P
1 and 2	0.93	0.34
1 and 3	2.88	0.09*
1 and 4	3.04	0.08*
1 and 5	8.50	0.04**
2 and 3	3.30	0.07*
2 and 4	4.00	0.04**
2 and 5	18.41	0.00**
3 and 4	0.10	0.74
3 and 5	21.95	0.00**

*Note**, *: significant at 5% and 10% level, respectively, using Kruskal- Wallis test*

3.2 Determinants of risk perception of vegetables

Table 6 shows the results of the PCA analysis. The Kaiser–Meyer–Olkin (KMO) measures of sampling adequacy for rural and urban data sets were at acceptable levels (0.668 for rural and 0.710 for urban). The Bartlett's test of sphericity was significant at $p < 0.000$ for both of the datasets, suggesting that there would be a statistically significant interrelationship between variables. These two tests confirmed that PCA could be performed efficiently on the two datasets. Only components having eigenvalues equal to or greater than 1 were retained. Cronbach's alphas of all the components were higher than 0.6, suggesting acceptable construct reliability (Tavakol and Dennick, 2011). For convenience, we only reported factor loadings with values higher than 0.4.

PCA results were quite diverse in the two areas. We retained 6 components for the rural and 5 components for the urban data set. They contributed to 70.2% and 64.6% of the total variance of the rural and the urban data set, respectively.

Regarding the rural dataset, component 1 and 2 were named "Perceived Consequence" and "Perceived Control," respectively. We split Trust items into two components: 3 (Trust Government and Supermarket) and 6 (Trust Wetmarket). Containing the items "Trust

Farmers," and "Trust retailers at wet markets," component 6 reflect trust in actors at the wet market. Component 4 and 5 were called "Perceived Knowledge" and "Information," respectively.

For the urban data set, 5 components (1 to 5) retained were: "Institutional Trust," "Perceived Knowledge," "Perceived Consequence," "Perceived Control," and "Information." Like the rural data, the last two components were able to explain a rather small amount of variance (under 10%). However, as Jolliffe (2002) argues, these components are not necessarily unimportant predictors in a regression analysis that we report in the next section.

Table 6: Principal components analysis of trust, information, perceived control, perceived consequence, and perceived knowledge by region

	RURAL (n=230)							URBAN (n=268)					
	Component							Component					
Items	1	2	3	4	5	6	Items	1	2	3	4	5
Perceived consequence of heavy metal	.882						Trust in local government	.856				
Perceived consequences of bacteria	.862						Trust in central government	.827				
Perceived consequences of GMO	.782						Trust in farmers	.752				
Perceived consequences of pesticides	.718						Trust in retailers at wet markets	.675				
Perceived control over heavy metal		.888					Trust in supermarkets	.648				
Perceived control over pesticide		.718					Perceived knowledge of heavy metal		.901			
Perceived control over GMO		.707					Perceived knowledge of pesticide		.867			
Perceived control over bacteria		.678					Perceived knowledge of bacteria		.845			
Trust in central government			.847				Perceived knowledge of GMO		.732			
Trust in local government			.786				Perceived consequence of heavy metal			.880		
Trust in supermarkets			.719				Perceived consequences of bacteria			.851		
Perceived knowledge of bacteria				.875			Perceived consequences of pesticide			.777		
Perceived knowledge of pesticides				.861			Perceived consequences of GMO			.731		
Perceived knowledge of GMO				.518			Perceived control over heavy metal				.905	
Food incidence heard from relatives					.810		Perceived control over pesticide				.870	
Food incidence heard from social media					.741		Perceived control over GMO				.752	
Food incidence heard from TV					.659		Perceived control over bacteria				.532	
Trust in retailers at wet markets						.866	Food incidence heard from social media					.792
Trust in farmers						.849	Food incidence heard from relatives					.705
							Food incidence heard from TV					.676
% of total variance explained	20.55	17.12	11.37	8.26	6.94	6.04		20.03	17.16	12.23	8.59	6.60

Urban: The Cronbach's alpha of the 1st, 2nd, 3rd, 4th, 5th component are .816, .797, .840, .744, .631, respectively

Rural: The Cronbach's alpha of the 1st, 2nd, 3rd, 4th, 5th, 6th component are .842, .776, .798, .645, .824, .815, respectively

Table 7 provides the results of ordered logit regression by region. The likelihood ratio chi-square of the rural and urban model was 37.57 and 50.70, respectively, with $p < 0.0001$. This suggests that the two models as a whole were statistically significant, as compared to the null model with no predictors. For brevity, we only reported marginal effects of the highest category of dependent variables - "very high risk."

Table 7: Ordered logit regression results

Variables	Rural		Urban	
	Coefficient	Marginal effect	Coefficient	Marginal effect
Male	-0.486	-0.070	-0.236	-0.044
	(0.405)	(0.058)	(0.356)	(0.066)
Elderly	0.656*	0.094*	-0.063	-0.012
	(0.355)	(0.051)	(0.450)	(0.093)
University	0.067**	0.096**	0.041	0.008
	(0.323)	(0.046)	(0.284)	(0.053)
Children	0.018	0.003	0.229	0.043
	(0.270)	(0.039)	(0.302)	(0.056)
Rich	0.086	0.012	-0.207	-0.039
	(0.450)	(0.065)	(0.252)	(0.047)
Veg Poisoning	0.117	0.017	0.546**	0.102**
	(0.296)	(0.043)	(0.259)	(0.047)
Veg Grow	-0.426	-0.061	-0.429*	-0.080*
	(0.351)	(0.050)	(0.247)	(0.045)
Perceived Knowledge	0.104	0.015	0.185	0.035
	(0.126)	(0.018)	(0.123)	(0.023)
Perceived Consequence	0.310**	0.044**	0.557**	0.104**
	(0.130)	(0.019)	(0.126)	(0.022)
Perceived Control	0.005	0.001	-0.417**	-0.078**
	(0.129)	(0.018)	(0.122)	(0.022)
Information	0.477**	0.068**	0.221*	0.041*
	(0.141)	(0.020)	(0.127)	(0.023)
Trust Government and Supermarket	-0.117	-0.017		
	(0.131)	(0.019)		
Trust Wetmarket	-0.258**	-0.037**		
	(0.127)	(0.018)		
Institutional Trust			-0.249**	-0.047 **
			(0.119)	(0.022)
Count R^2	0.422		0.493	
Mc Kelvey and Zavoina's R^2	0.161		0.193	

*Note: Numbers in brackets are standard errors; **, * : significant at 5%, 10% level, respectively.*

None of the demographic variables was statistically significant in the urban region while only age and gender were statistically significant in the rural region. Rural people aged 60 years and over would be 9.41% more likely to report a very high-risk level of vegetables than those who were younger. Rural participants having a university qualification or higher would be 9.59% more likely to indicate a very high risk of vegetables than those who had not.

Having been poisoned by vegetables and self-provisioned in vegetables significantly determined the risk perceived of vegetables in the urban, but not in the rural region. In the urban region, having experience with vegetable poisoning increased risk perception while growing vegetables for family consumption decreased risk perception.

Regarding the risk characteristic of hazards, the perceived consequence of hazards was positively related to risk perception of vegetables across the regions. In the urban area, it was the most important factor influencing risk perception of vegetables. Perceived control over hazards statistically decreased risk perception of vegetables in the urban, but not the rural area.

The more frequently respondents have heard about food safety events, the higher level of vegetable risk they reported in both regions. One unit increase in information acquisition led to a 6.84% and 4.12% increase in likely reporting of very high risk from vegetables in the rural and the urban area, respectively.

Out of two components of trust in the rural dataset, only the trust in actors at wet market influenced risk perception of vegetables. For urban consumers, their trust in the responsible institutions, in general, determined their risk assessment of vegetables. For both rural and urban participants, a higher level of trust would result in a lower level of risk perceived of vegetables.

4. DISCUSSION

4.1 Risk perception of vegetables and their impact on vegetable consumption

We found a high level of risk perceived from vegetables. Previous studies provide another insight into how vegetable risk was viewed by Vietnamese over time. Figuié *et al.* (2004) are the first to explore consumer perception of food safety in Vietnam. In their study, a sample of 200 Hanoi consumers was asked to "Mention three foodstuffs which are, in your opinion, the most dangerous to your health." They found consumers ranked vegetables as the most dangerous foodstuff, followed by meat, fruit and then fish. 15 years later, Ha *et al.* (2019) surveyed about 500 Hanoi consumers, asking them to rate their health risk associated with 6 perishable food products. The finding was somewhat similar ln that the survey participants again rated vegetable as the riskiest foodstuff, followed by fruit, meat, fish, milk, and egg. The fear of potential risks presented in vegetables remained persistent during a long period even though many social, economic, and institutional changes have taken place in Vietnam. Reducing such fear from consumers' mind will be a challenge for policymakers.

Risk perception in the urban region is higher than that of the rural area. Perhaps, it is due to the lack of urban people's perceived control over vegetable safety. Our survey found that one-third of surveyed urban households engaged in vegetable growing but homegrown vegetables made up only about 10% of the family's vegetable consumption. Thus, most of the urban food

shoppers had to rely on untraceable vegetables purchased from an intermediary in traditional markets. The absence of direct sale between primary food producers in rural regions and end-consumers in urban regions probably evoke the uncertainty about food quality and safety of urban citizens, especially when government management of food safety is considered ineffective. Urban consumers' perceived control over food safety might be low, as a result. Unlike urban households, the majority of rural families grew vegetables with about 40% of the household's vegetable supply being homegrown. Gaining an understanding of agricultural production and having more homegrown vegetables, that are considered to be safe, means that information asymmetry might not be an issue in the rural region. Subsequently, rural subjects tend to perceive a higher level of control over food safety than their urban counterparts. Agreeing with Ha *et al.* (2019), our study highlights that perceived control over food safety is likely to contribute to the difference in food risk perception between the urban and rural region.

A considerable level of risk perceived from vegetables has led to a change in individual vegetable consumption. Majority of surveyed consumers became selective in vegetable consumption by avoiding eating some particular products. Confronting with a high-perceived risk from vegetables, consumers tend to employ optimal risk reduction strategies: maximizing their utility given their available resources. Rather than engaging in a costly information search, the majority of survey participants chose a simpler strategy; that of eating less vegetable than before or stop consuming some types of risky vegetables altogether. This risk-reducing behavior is well documented in previous research. For example, Grunert (2005) pointed out that heightened risk perception led to consumer's avoidance of some types of food or food brands. Similarly, Green *et al.* (2003) found that consumers avoided food which was considered to be risky, such as frozen, imported, ready to eat food or takeaway food. Our research complements the above studies as we illustrate a common characteristic of most of the consumers; they are risk-averse in food consumption.

Our survey uncovered that among the top ten riskiest vegetables listed in the Table 3, the first seven were thought to be contaminated by insecticides while the next two were believed to be associated with growth regulators that are commonly used during vegetable production. For the last one, contamination was believed to be caused by eating lettuce raw which is unfortunately the normal way of consuming the product. Concern about possible contaminations, consumers cut down their vegetable consumption that negatively affects their diet diversity.

Our study confirms the role of risk perception as an underlying driver of food consumption. This finding is comparable to several empirical research across different countries. Pennings *et al.* (2002) and Schroeder *et al.* (2007) reported that perception of beef safety risk related to mad cow disease drove consumer's decision to decrease beef consumption in Germany, Netherlands, US, Canada, Japan, and Mexico. From a policy perspective, our finding and the finding from related works highlight the consequence of heightened risk perception; that is the decline in food consumption. In our case, reducing the perception of vegetable safety risk would help boost demand, contributing to the sustainability of domestic vegetable production in Vietnam.

4.2 Factors affecting risk perception of vegetables

We found notable differences as well as similarities in the determinants of vegetable risk perception between regions. While age and education shaped the risk perception of vegetables in the rural area, none of the demographic characteristics influenced consumer's evaluation of vegetable risk in the urban region.

In the rural region, the influence of age can be explained by the change in perception during the life cycle of a person (Swinbank, 1993). When people are young, they tend to discount the future and the consequence of current consumption habit on their life expectancy. When people are older, their remaining life expectancy decline, their perception would change again. They would perceive a higher risk level than younger people. In line with Worsley and Scott (2000), this study found a positive relationship between age and food safety risk perception.

Rural participants who had a university degree would be 9.59% more likely to indicate a very high risk of vegetables than those who had not. Lee *et al.* (2012) found an inverse relationship between education and risk perception. In contrast, this study found a positive association between these variables for the rural subsample. Perhaps, in the rural region, better education is associated with more frequent access to information on food risk. This, in turn, might lead to higher risk perception. In the urban region, the insignificant effect of demographic factors suggests that a high level of risk perceived of vegetables might spread to all demographic groups in the urban subsample.

Three other disparities between rural and urban region are about the effects of 1) having been poisoned by vegetables, 2) self-provisioning of vegetables, and 3) perceived control of hazards.

In the urban setting, similar to Green *et al.* (2003) and Parry *et al.* (2004), we found that personal experience with food poisoning positively increased food safety risk perception of a particular food. Direct exposure to risk events often enhance consumer's memory and imagination of the hazard (Kasperson *et al.*, 1988). However, such experience was not a predictor of risk perception of rural respondents. The reasons behind such disparity between urban and rural residents can be investigated in future research.

Urban respondents growing own vegetables was 8.1% less likely to perceive the highest level of risk from vegetables than those consuming only purchased vegetables. Perceived control over vegetable safety is the most likely reason for this disparity. We found that despite land scarcity and time constraint, 38% of urban households in our sample were growing vegetables for their consumption. These households undertook desperate initiatives such as growing vegetables on rooftops, or strips of public land around residential buildings or along roads. These families did not use pesticides for their vegetables. Some of them applied chemical fertilizers but in a minimal quantity. Thus, urban respondents with home-grown vegetables would believe that had better control over vegetable safety. Their perceived risk of vegetables, therefore, was lower than those who had not home-grown vegetables.

Perceived control theory can help explain why in the rural region self-provisioning of vegetables did not determine risk perception of vegetables. Unlike urban residents, rural people often have strong social ties with their neighbors and friends (Mair and Thivierge-Rikard,

2010). Rural households that did not grow vegetables might be able to control the safety of their vegetables in many ways. For example, they might obtain "safe vegetables" easily by asking or buying vegetables from their kin and friends whom they trust. Hence, growing vegetable or not would not be related to their risk perception.

Perceived control over hazards statistically decreased risk perception in the urban, but not the rural area. This suggests that improving perceived control over the hazards of urban consumers will help reduce their risk perception of vegetables.

The rural and urban region share three similar determinants of risk perception; 1) perceived consequence of hazards, 2) food risk information acquisition, and 3) trust.

Perceived consequence of hazards was positively related to risk perception of vegetables across regions. In the urban area, it was also the most important influencing factor of risk perception. In order to reduce the concern about vegetable safety, influencing the way consumers view the consequence of food hazards associated with vegetables should be a priority. Consumer education programs to enhance knowledge of food hazards can achieve such an objective.

Information acquired about food safety events significantly determined the risk perception of vegetables in both regions. The more frequently respondents have heard about food safety incidents, the higher level of vegetable risk they cited. This finding indicates a link between food safety risk perception and food risk communication in both regions. According to Kasperson *et al.* (1988), media and social groups can play roles as "amplification stations" of risk. Nguyen-Viet *et al.* (2017) pointed out that a massive volume of media coverage of foodborne diseases and inappropriate food safety practices have escalated public perception of risk associated with food in Vietnam. For example, Vietnam television has been broadcasting a program titled "Say No With Contaminated Food" since April 2016 on three national channels from Monday to Friday. Its purpose was to combat a national problem: contaminated food. Although negative news about food safety (e.g., food poisoning, poor food safety practices), as well as good remedial news (e.g., adoption of Integration Pest Management in crop production, the introduction of Vietnam Good Agricultural Practices products), were disseminated, negative news was reported more frequently than remedial news. Since bad news is often believed to be more trusted, visible and noticeable than good news (Slovic, 1993), food safety scandals frequently spread by media has caused unnecessary anxiety in public.

There were two components of trust in the rural dataset, but only "trust in actors at wet market" influenced risk perception of vegetables. In rural Vietnam, modern food chains, such as supermarkets are in their infancy. Hence, rural consumers mainly participated in wet markets. To ensure vegetable safety, rural consumers might rely on local farmers or local food retailers by placing trust in them. Therefore, actors at the wet markets might be perceived by rural consumers to have a more substantial and direct influence on the safety of their vegetables than supermarkets and the government. Regarding urban consumers, their trust in the responsible institutions determined their risk assessment of vegetables. Perhaps urban respondents perceive that actors at wet markets, supermarkets, and the government all are equally important for ensuring their vegetable safety. As with other studies (Lobb *et al.*, 2007; Kuttschreuter and Hilverda, 2019), we highlighted that institutional trust reduced risk perception. Also,

institutional trust was found to be very low (Table 1). Hence, to lower the anxiety about vegetable safety in Vietnam, improving trust is important.

The current study confirms the linkages between perceived consequence, a risk characteristic of potential hazards with food safety risk perception of vegetables. However, other risk characteristics, for example, perceived knowledge of hazards did not translate into risk perception of vegetables. More empirical research on other food products is needed to retest the link between perceived knowledge, perceived control of hazards with risk perception of these products across regions.

5. Conclusions

Food safety from vegetable consumption remains a concern in Vietnam. Risk perception was higher in the urban region due to a lack of perceived control over vegetable safety by urban dwellers. The impact of risk perception on vegetable consumption has been significant, as demonstrated by the reported decline in vegetable consumption. To cope with the risk, consumers had to avoid particular vegetables, limiting their freedom in eating and diet diversity. Attenuating risk perception of vegetables is important to enhance the sustainability of vegetable production and eliminate economic losses.

In respect to the determinants of food safety risk perception, we found critical regional differences. Some psychological factors including food incident information, perceived consequence over the hazards, and trust shaped risk perception in both regions. However, social factors (age and education) influenced the risk perception of rural consumers only. Other factors like personal experience with vegetable poisoning, whether the household grows vegetables, and perceived control over the hazards were predictors of risk perception solely in the urban region. While trust in actors at the wet markets determined rural consumers' risk perception, trust in all institutions affected urban respondents' risk evaluation.

One practical question to ask here is the role of policy to reduce risk perceived from vegetables. Since risk perception of vegetables was considerable and being affected by information about risk across regions, better risk communication is urgently needed.

Risk information is inadequate in Vietnam. Consumer's limited knowledge of food hazards stems from a lack of consumer education. Frequent negative news on food safety in mass media heightens the concern about food safety. Prudent risk communication should be based on the factual evidence about the risk, not just focusing on bad or negative news but also educating consumers on remedial aspects of food safety. Consumers need unbiased information to form a balanced assessment of risk. Scientific information about food hazards should be easily accessible and understandable to consumers. Since trust in government and food industry is low, risk information should not be communicated by them but by the most trusted sources such as health professionals and environmental organizations, as recommended by Frewer and Miles (2003).

Improving trust is essential for both regions, as trust determined risk perception and trust has severely eroded. Building trust, according to de Jonge *et al.* (2008), requires three elements: care, competence, and openness. Trust in an actor is influenced by the extent to which the actor is perceived by consumers to be competent, honest, and caring of public welfare. In Vietnam, "care," "competence" and "openness" in food safety management is lacking. Consumer's trust in regulators is very low as they have observed a high level of corruption and widespread rent-seeking behavior of government authorities such as food inspectors (Van Hoi *et al.*, 2009). A series of food scandals have severely destroyed consumers' trust in the food industry. To resore trust, the government needs to demonstrate its commitment to reduce corruption and unbiased food safety information to the public. Trust in the food industry would be rebuilt by proving truthful information about food products, complying regulations in food safety and showing genuine concern to consumer's health. Improving trust in actors at wet markets in the rural region and enhancing trust in all responsible institutions in the urban region would help reduce the concern about vegetable safety.

Given the urban-rural differences found in this research, policy intervention should be designed in ways that are tailored to each region. In the rural area, risk communication should reach older adults who were concerned more about vegetable safety. Also, since people with higher education assessed a higher risk of vegetables, there is an opportunity for the food industry and regulators to develop the organic market in the rural region.

In the urban region, the strong effect of growing own vegetable suggests the importance of urban farming which is becoming a norm in big cities in Vietnam and elsewhere in recent years. Hanoi has a current population of over 8.5 million with an annual growth rate of 3.5%. Ensuring food security and food safety for such a growing population is a challengeable task. Previous research found that urban farming plays significant roles in feeding cities, liking actors in the food chain, and strengthen social links within cities (FAO, 2010, Shields, 2013, Lagerkvist *et al.*, 2013). This study found that urban farming contributes to sustainable food consumption by reducing concern about food safety. Hence, urban farming should be encouraged by measures such as enhancing indoor farming technology which is environmentally friendly, strengthening technical extension through stimulating research and providing training to urban dwellers who are interested in farming.

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