

Original Research Article

Consumer's Perception of Health and Environmental Hazards of Pesticide use in Conventional Vegetables

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Abstract: In this paper we use a logit model to analyze consumers' perceptions of health and environmental hazards of pesticides residues in daily consumed vegetables. Perception of health hazards can be predicted by consumers' age, belief of presence of residues in consumed vegetables, frequency of consumption. Age and gender were found to be the main predictors of consumers' environmental concerns with female more likely to be concerned.

Keywords: Consumers, logit, pesticides residues, health perceptions, environment.

INTRODUCTION

The use of pesticides in agricultural production is, globally, associated with considerable perceived risk to human health as well as to environmental safety. The international literature had over the years documented consumers' concerns about harmful impact of pesticides residues in daily consumed food items, particularly fresh produce. In earlier studies, pesticides residues have been regarded as a major source of food safety concerns, see for instance (Byrne *et al.*, 1991; Misra, Huang and Ott, 1991; Govindasamy, Italia and Liptak, 1997). More recent studies include Simoglou and Roditakis (2022) conducted in Greece; Nardi, Teixeira, and Ladeira (2020), a meta-analysis covering 128 empirical studies that investigated the key drivers and outcomes of consumers' food safety risk perception. The findings of reveal that the key drivers of consumers' perception include trust, knowledge, subjective characteristics, and socio-demographic characteristics (Nardi *et al.*); gender, confidence in certification, and quality of received information (Simoglou and Roditakis).

Consumers' fears and perceptions of the risk posed by pesticides may draw legitimacy from findings of various studies. In the Saudi environment, several studies investigated prevalence of pesticides residues in domestic foods as well those sold in local markets. Alokail, Abd- Alrahman, Alnaami, Hussain, Amer, Elhalwagy and Al-Daghri (2023) reported high detection rates of moderately hazardous pesticide residues in various crops in KSA. They reported detection rates of 89.7, 88.5, 83.8, and 70.7 percent in food samples collected from central, northern, eastern, and in the western regions of Saudi Arabia. Detection rates were significantly higher in fruits than vegetables. Another study by Almutiriy *et al.*, 2024, reported contamination with 17 different pesticide residues in 40% of the samples of leafy vegetable collected from the Central Market of Jeddah. In about 55% of instances detected pesticide residues exceeded the European Union Maximum Residue Levels (MRLs). Earlier in 2010 Osman *et al.*, detected residues exceeding MRLs in 33% of samples of 160 different domestic vegetables collected from four major big supermarkets in Al-Qassim region. Ramadan *et al.*, (2020) similarly reported a 21% incidence of residues exceeding MRLs in Asir region while Faraj (2019) reported similar results, albeit, to a lesser extent in Riyadh region. The National Pesticide Residue Monitoring Program, NPRM, a joint effort involving the Saudi Food & Drug Authority SFDA, Ministry of Municipal & Rural Affairs, MOMRA, and ministry of Environment, Water & Agriculture, MEAW, has in 2018 reported an 8.7% incidence of violation of MRLs.

Consumers perceptions about pesticides residue in food may bear some important implications to their buying behavior, marketing, environmental policies, and to consumer protection advocates. In Saudi Arabia Alagsam *et al.*, (2023) have shown that consumers are willing to pay an average premium of 86% above the market price for traditional dates to

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buy free-of-pesticides-residues (FPR) dates. They found that consumers education, marital status, shopping contribution, and income were the main drivers of willingness to pay (see: Bashir (2012); and Almarri and Al-Mahish (2021) for similar studies).

In sum the above account of literature reveals that the issue of consumers concerns about pesticides residues have received considerable attention in the international literature. Moreover, findings from studies on pesticides detection rates in Saudi Arabia give credence to perceived consumers fears. There is, however, scarcity in studies assessing the presence consumers concerns and the drivers of such concerns in Saudi Arabia. This study is an attempt to fill such gap.

The purpose of the study is to empirically describe consumer socioeconomic characteristics and perceptions of the impact of pesticide residues on their health and the environment and to analyze the effect of sociodemographic factors on such concerns. Findings of the study carry some important implications to marketing, environmental policies, and to consumer protection advocates.

DATA AND METHODS

The data used in this study comes from a survey conducted through personal interviews with consumers in three major supermarkets in Riyadh city, Kingdom of Saudi Arabia. The survey questions featured: socioeconomic variables including gender, occupation, nationality, age, education, type of residence, income, and household size; variables related to shopping habits and pattern such frequency and place of shopping; and attitude variables including consumers opinions on pesticides residues prevalence, health hazards, environmental concern; as well as consumers’ buying behavior. To reduce sampling bias enumerators were instructed to sample consumers at regular intervals as they enter the supermarket.

Data analysis comprised both descriptive and econometric techniques. Frequency distribution was utilized to describe sample characteristics for socioeconomic and attitudinal variables. A discrete choice model, namely the logit model was used to explain consumers’ perception on health and environmental hazards of pesticide residues.

The logit model:

The selection of logit model was in this analysis is justified as its asymptotic characteristics constrains the predicted probabilities to a range of zero to one. The logit technique is a better procedure for capturing the magnitude of the independent variable effects for qualitative variables than probit models (Amemiya, 1983). The logit model is also favored for its mathematical simplicity and is commonly used in a setting where the dependent variable is binary.

The empirical representation of the logit model is as follows:

$$\log\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \sum_{j=1}^k \beta_{ij} x_{ij} + u_i \dots\dots\dots (1)$$

Where:

$p_i = \text{prob}(y_i = 1)$, and the left-hand side of equation (1) represents the logit or the log of the odds ratio.

(x_{ij}) is a set of explanatory variables

β_{ij} are coefficients to be estimated.

u_i is an error term assumed to follow the logistic distribution:

$$F(z_i) = \frac{\exp(z_i)}{1+\exp(z_i)} \dots\dots\dots (2)$$

Two empirical models were estimated for equation (1):

Model 1: was estimated for the dependent variable “HAZARDRISK” to analyze consumers perception of health hazards associated with pesticides residues in fresh vegetables.

Model 2: was estimated for the dependent variable “ENV” to analyze consumers perception of harmful impact on the environment associated with pesticides residues.

The variables used in the two models are defined in table (1) below.

Table 1: Variables definitions and measurements

Variable	Definition
Dependent:	
Residrisk (mode I1)	consumers perception about health hazards associated with pesticides residues: binary (yes = 1, NO = 0).
Env (mode I2)	consumers perception about harmful impact on the environment associated with pesticides residues: binary (yes = 1, NO = 0).

Variable	Definition
Independent:	
Gender	Gender of respondent: binary (male = 0, female = 1).
Age	Age of respondent: ordinal (< 25 = 1, (25 – 44) =2, >44 = 3).
Edu	Education level of respondent: ordinal (primary or less =1, intermediate to secondary =2, college or above = 3).
Income	Monthly income level of respondent in Saudi Riyals: ordinal (less than 6000 =1, (6000 – 11999) =2, (12000 or more = 3).
Shopf	Frequency of vegetables consumption: ordinal (daily =1, twice a week =2, once a week =3, once every two weeks =4, once a month =5).
Nationality	Nationality of respondent: binary (Saudi = 0, non-Saudi = 1).
Numchild	Number of children in the household: continuous.
Child37	Number of children age 3 to 7 years in the household: continuous.
Cheminv	Respondent's perception on whether there are chemical residues on daily consumed vegetables: binary (yes = 1, NO = 0).
Spousejob	Employment status of respondent's spouse: binary (yes = 1, NO = 0).

RESULTS AND DISCUSSION

Consumers' Socioeconomics Characteristics

One objective of this study is to describe consumers socioeconomic backgrounds that might shape their perceptions on health and environmental hazards of pesticides residues in daily consumed vegetables. Tables (2) through (9) present frequency distributions of the values of some of the socio-economic variables used in the study. A great majority of respondents were males (83.5%, table 2) and almost two thirds were in the young-to-middle (25 – 44) years age group (table 3).

Table 2: Gender of respondent

			Cumulative	Cumulative
Value	Count	Percent	Count	Percent
female	35	16.51	35	16.51
male	177	83.49	212	100.00
Total	212	100.00	212	100.00

Table 3: Age categories of respondents

			Cumulative	Cumulative
Value (years)	Count	Percent	Count	Percent
< 25	30	14.15	30	14.15
25 - 44	137	64.62	167	78.77
> 44	45	21.23	212	100.00
Total	212	100.00	212	100.00

According to table 4 almost half of respondents fall in the monthly income range of (6000 – 11999) Saudi Riyals, SAR. These figures closely resemble the average monthly wages for Saudi workers reported by the General Authority for Statistics (GASTAT): (11198 SAR in public sector, 7339 SAR in private sector, 4750 SAR in non-profit organizations, and 16257 SAR in international agencies with an all average of 10238 SAR).

Table 4: Income categories of respondents

			Cumulative	Cumulative
Value (Saudi Riyals)	Count	Percent	Count	Percent
< 6000	74	34.91	74	34.91
6000 - 11999	104	49.06	178	83.96
12000 or more	34	16.04	212	100.00
Total	212	100.00	212	100.00

As for education level of respondents, about 53% earned a college degree or above while 37% have a secondary education degree (table 5). The sample figures depart from official national averages reported by GASTAT where college degree and above earners represented about 20% while secondary education about 30%. These departures may reflect the composition of major supermarkets goes where the survey was conducted.

Table 5: Education level of respondents

			Cumulative	Cumulative
Value	Count	Percent	Count	Percent
Primary or less	22	10.38	22	10.38
Intermediate to secondary	78	36.79	100	47.17
College or above	112	52.83	212	100.00
Total	212	100.00	212	100.00

Tables 6 shows the frequency distribution of household size for the overall number of children. About half of respondents have 4 children or less and about 38% reported having between 5 to 8 children in their household. According to GASTAT data, the average family size in 2022 ranged between 3.5 to 4.9 for the different regions of Saudi Arabia.

Table 6: Number of children in respondent’s household

			Cumulative	Cumulative
Value (#)	Count	Percent	Count	Percent
4	102	48.11	102	48.11
8	80	37.74	182	85.85
9	30	14.15	212	100

Consumers’ Shopping Habits

Tables 7 and 8 presents frequency distributions of respondents’ shopping frequency and favorite shopping places, respectively. The majority of respondents (62.26%) reported buying vegetables once or twice a week with about 39% reporting a once a week shopping frequency. As for the favorite shopping place, most respondents (about 55%) favored supermarkets.

Table 7: Shopping frequency of respondents

			Cumulative	Cumulative
Value	Count	Percent	Count	Percent
daily	39	18.40	39	18.40
Twice a week	49	23.11	88	41.51
once a week	83	39.15	171	80.66
biweekly	34	16.04	205	96.70
monthly	7	3.30	212	100.00
Total	212	100.00	212	100.00

Table 8: Favorite shopping place of respondents

			Cumulative	Cumulative
Value	Count	Percent	Count	Percent
Local grocery	17	8.02	17	8.02
Central market	14	6.60	31	14.62
supermarket	116	54.72	147	69.34
other	65	30.66	212	100.00
Total	212	100.00	212	100.00

Consumers’ Risk Perceptions

Consumers were quizzed on their perceptions of presence of chemical residues in daily consumed vegetables and on the associated risk to their health and the environment. In table 9, a great majority (77.83%) believe that there are chemical residues in daily consumed vegetables. As reported earlier in this study, several studies have reported various degrees of residues that exceed maximum residue levels. Such concerns may underscore the notion that consumers are informed and the fact that most respondents (53%) have a college education or above further strengthens this notion.

Table 9: Respondents perception about presence of chemicals in daily consumed vegetables

			Cumulative	Cumulative
Value	Count	Percent	Count	Percent
No	47	22.17	47	22.17
Yes	165	77.83	212	100.00
Total	212	100.00	212	100.00

As reported in table 10, about 58% of respondents believe that pesticides residues in daily consumed vegetables pose a risk to their health. In a more pronounced manner, respondents strongly believe that pesticides residues are harmful to their environment. An overwhelming majority of about 87% expressed concerns about environmental hazards associated with pesticides residues (Table 11).

Table 10: Respondents perception about health risks associated with pesticide residues in vegetables

			Cumulative	Cumulative
Value	Count	Percent	Count	Percent
No	90	42.45	90	42.45
Yes	122	57.55	212	100.00
Total	212	100.00	212	100.00

Table 11: Respondents perception of whether using chemicals to grow vegetables is harmful to the environment

			Cumulative	Cumulative
Value	Count	Percent	Count	Percent
No	28	13.21	28	13.21
Yes	184	86.79	212	100.00
Total	212	100.00	212	100.00

Logit Analysis Results

Tables 12 and 13 presents results of the logit models 1 and 2 used to analyze the effect of socioeconomic variables on perceived health hazards and environmental concerns of pesticides residues, respectively. Both models were, overall, significant (prob (LR statistic = 0.00)) meaning the specification of the models has captured the relevant predictors. The models exhibited pseudo R- squared values of 0.15 and 0.25 respectively. Generally speaking pseudo R-squared values tend to be low in discrete choice models and are not accorded the same interpretation and significance as in OLS regression.

Results in table 12 show that socioeconomic variables of gender, education, income, nationality, and family size were not relevant factors in shaping consumers perception of health hazards. All of these variables were not statistically significant factors that influence the probability of held perceptions.

Results indicate that the four variables of: age ($p=0.04$), consumers believe in presence of chemical residues in vegetable (cheminv, $p=0.0013$), frequency of purchasing vegetables (shopf, $p=0.0069$), and employment status of spouse (spousejob, $p=0.0314$) are all statistically important predictors of consumers’ perception of health hazards. Variables (cheminv) and (shopf) have a positive impact on consumers’ perception on chemical health hazards while (age) and (spousejob) bear a negative impact on the dependent variable. In specific terms, a one unit increase in the levels of (cheminv) and (shopf) would, respectively, lead to an expected increase in the odds ratio 3.43 and 1.63 times as indicated by the values of $\text{Exp}(\beta)$ in the last column. Conversely, a one level increase in the variable (spousejob) would diminish the odds ratio 0.41 times.

Table 12: Logit model 1: perception of health hazards associated with pesticides residues in fresh vegetables

Variable	Coefficient(β)	Std. Error	Prob.	Exp(β)
C	-1.337335	1.257160	0.2874	0.262544
Gender	0.074021	0.546331	0.8922	1.076829
Age	-0.566149	0.283926	0.0462	0.567707
Edu	-0.017775	0.273744	0.9482	0.982382
Income	0.017960	0.266169	0.9462	1.018122
Vegfreq	0.183465	0.186781	0.3260	1.201373
Nationality	0.269890	0.397815	0.4975	1.30982
Numchild	0.024189	0.058026	0.6768	1.024484
Child37	0.160982	0.206590	0.4358	1.174664
Cheminv	1.232443	0.384155	0.0013	3.429598
Shopf	0.486655	0.180066	0.0069	1.626865
Spousejob	-0.880596	0.409087	0.0314	0.414536
McFadden R-squared	0.153838			
LR statistic	44.46615			
Prob (LR statistic)	0.000006			

Results for model 2 in table 13 are slightly different from those of model 2. The socioeconomic variables of age ($p=0.0085$) and gender ($p=0.0153$) emerged as the main significant predictors of consumers perception of environmental

hazards of pesticides residues. It follows that female respondents are more likely to perceive of environmental hazards than their male counterparts. Nationality of respondents and shopping frequency approached statistical significance at the 0.1 level of significance.

Table 13: Logit model 2: perception of harmful impact on the environment associated with pesticides residues

Variable	Coefficient(β)	Std. Error	Prob.	Exp(β)
C	-0.424899	2.442472	0.8619	0.653836
Gender	1.551328	0.589208	0.0085	4.717731
Age	0.895177	0.368989	0.0153	2.447769
Edu	-0.605521	0.499586	0.2255	0.54579
Income	0.188331	0.374277	0.6148	1.207233
Nationality	0.837046	0.533520	0.1167	2.309535
Child37	0.212339	0.346207	0.5397	1.236567
Residrisk	0.611544	0.578740	0.2907	1.843275
Shopf	0.466093	0.293656	0.1125	1.593755
Spousejob	-0.611455	0.622145	0.3257	0.542561
McFadden R-squared	0.248410			
LR statistic	41.11001			
Prob (LR statistic)	0.000005			

CONCLUSIONS

In this paper a discrete choice model, namely logit together with frequency tables were used to analyze consumers' perceptions of health and environmental hazards associated with presence of pesticides residues in daily consumed vegetables. Consumers' socioeconomic characteristics as well as perceptions were described using frequency tables. The logit models were used to estimate the impact of consumers' socioeconomic characteristics and other variables on their perceptions regarding health and environmental concerns. Two logit models were estimated. Model 1 assessed the predictors of consumers' perceptions regarding health concerns for pesticides residues. Predictors of consumers' perception of environmental hazards were assessed by model 2.

Frequency distribution analysis revealed that respondents were mainly young-to-middle- age males with: an average income level, a small-to-medium family size, a college or above education. Respondents largely believe in presence of pesticides residues in their consumed vegetables, and for the most part perceive of health and environmental hazards stemming from pesticides residues.

Age, consumers believe in presence of chemical residues in vegetable, frequency of purchasing vegetables, and employment status of spouse were found to be statistically important predictors of consumers' perception of health hazards. Conversely, socioeconomic variables of gender, education, income, nationality, and family size were not relevant factors in shaping consumers perception of health hazards. Concerns about the environment are largely predicted by age and gender with female respondents more likely to be concerned than their male counterparts.

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