Sociodemographic Influences on Consumer Concern for Food Safety: The Case of Irradiation, Antibiotics, Hormones, and Pesticides

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*Review of Agricultural Economics* is currently published by American Agricultural Economics Association.

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Over the past several years, consumers have become more concerned about food safety. Of particular increasing interest are the effects of the use of food production practices such as irradiation, antibiotics, hormones, and pesticides on food safety. These concerns have been heightened by extensive media attention and growing general awareness of the relationship between diet and health (Lynch and Lin). There is a tendency for consumer concerns about food safety issues, however, to be exaggerated by the popular press (Jones). In fact, nutritionists and food scientists claim that the United States has the safest food supply in the world (Foster). Some scientists and academicians believe that the only food-safety crisis is that which exists in people's minds as a result of incomplete reporting of scientific information by the media. Jones argued that the level of concern about food safety is dependent on the level of attention it receives in the media.

Consequently, despite overwhelming scientific data and evidence, plus professional judgment attesting to the safety and effectiveness of production practices such as the use of irradiation, antibiotics, hormones, and pesticides at approved levels, many consumers remain concerned about their use in food production or processing. For consumers to feel comfortable with foods treated by these production processes, they must gain consumer acceptance through active education or information programs. Consumer resistance might be diminished if risks eliminated by these production practices are clearly explained. This is particularly important since social science research indicated that the general public overestimates low probabilities of risk associated with food safety due to negative publicity and incomplete information (Aldrich).

Past studies have examined food-safety issues and their relationship to consumer perception and food consumption behavior (e.g., Schafer et al.; Schutz, Diaz-Knauf, and Zeidler; Lin). However, information on the effects of sociodemographic factors on consumer concern for various food safety related production practices such as use of irradiation, antibiotics, hormones, and pesticides is limited. The objective of this study is to estimate the relationship between sociodemographic factors and consumers' concern for use of food production practices. Specifically, this article examines a household main meal planner's concern for: (1) foods that have been treated with irradiation at approved levels; (2) meat from animals that have been given antibiotics at approved levels; (3) meat from animals that have been given hormones at approved levels; and (4) foods that have been grown using pesticides at approved levels.

Knowledge of the relationship between individual characteristics and concern for these food production practices is useful for the design and implementation of food-safety information programs related to the use of these production practices. Food-safety knowledge, attitudes, and behavior vary between population subgroups. Therefore, sociodemographic factors can be used to tailor information and health intervention programs to specific subgroups. For example,
when an informative newsletter explaining irradiation was sent to selected customers of a supermarket, these customers began to buy more of the irradiated fruits in the supermarket because they would keep longer (Cheney). Knowledge about how different population subgroups are concerned about the use of these food-safety-related production practices is also important not only in consumer information and health programs, but also in marketing foods produced using these production practices.

**Empirical Models and Hypotheses**

Four models are developed to examine the relationship between sociodemographic characteristics and main meal-planner concern for use of each of the four production practices: irradiation, antibiotics, hormones, and pesticides. A main meal planner is the individual who selects and determines the content, preparation, and consumption of foods in the household.

Consumer behavior and attitudes are affected by the acquisition of information such as those related to food safety. The fact that information acquisition is affected by individual characteristics is not new in economics (Ippolito and Mathios). For instance, previous research suggests that information acquisition, and consequently behavior, is influenced by various demographic factors such as age and sex (Katona and Mueller); by the marketing environment including urbanization and region (Park, Iyer, and Smith); by education (Schultz); and by time constraints (Becker; Beatty and Smith). Consequently, these factors are hypothesized to be important determinants of an individual's ability to process new information into changed behavior. Hence, the independent variables in this study, selected from the 1991 Diet and Health Knowledge Survey (DHKS), include presence of children, race, sex, employment status, urbanization, age, income, education, and region. The square of age and income are included to determine any nonlinearities in the relationship between these variables and the dependent variables. The independent variables and their means are exhibited in Table 1 while the dependent variables and their means are presented in Table 2. An empirical model is estimated for each type of production practice.

Racial, urbanization, and regional differences are included as independent variables because of possible differences in media exposure (Putler and Frazao) and the marketing environment (Guthrie et al.). For instance, blacks and other non-white races have lower newspaper and magazine readership rates than whites.1 (United States Department of Health and Human Services). Misra and Huang found that consumers of European origin perceived the risk from pesticides to be higher than consumers of other races. Considering this finding and assuming that more negative than positive information is published in newspapers and magazines, it is then hypothesized that white main meal planners are less likely to consider the use of the production practices to be safe than others. Concerning urbanization, it is expected that main meal planners residing in the city or suburban areas are less likely to consider the use of the production practices to be safe than those residing in nonmetro areas, due to more negative media exposure about these practices. Regionally, Lin found that food safety is more important to individuals who live in the Northeast and the South.

Previous studies indicate that women are typically more concerned about food safety because they are often responsible for food and health issues within the household (Steger and Witte). Lin also reported that women perceive food safety as more important in food shopping than do men. Men are also less concerned about the use of pesticides (Ott and Maligaya). Male main meal planners are hypothesized to be more likely to consider the use of the production practices to be safe than female main meal planners.

Since safety concerns have potentially higher costs for young children, it is hypothesized that households with young children (below the age of 18 years) are less likely to consider the use of production practices to be safe than those without children. Using a survey of about 400 consumers, Viscusi, Magat, and Huber revealed that households facing larger

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1Newspaper/magazine readership could result in an individual being more or less likely to consider the use of production practices to be safe depending on the type of information (negative or positive) published in these materials.
Table 1. Description and Means of the Independent Variables Used in the Analyses

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>child</td>
<td>1 if children are present below 18 years old; 0 otherwise</td>
<td>0.43</td>
</tr>
<tr>
<td>black</td>
<td>1 if main meal planner is black; 0 otherwise</td>
<td>0.15</td>
</tr>
<tr>
<td>other</td>
<td>1 if main meal planner is of some other race; 0 otherwise</td>
<td>0.03</td>
</tr>
<tr>
<td>male</td>
<td>1 if main meal planner is male; 0 otherwise</td>
<td>0.19</td>
</tr>
<tr>
<td>employed</td>
<td>1 if main meal planner is employed; 0 otherwise</td>
<td>0.47</td>
</tr>
<tr>
<td>city</td>
<td>1 if main meal planner resides in the city; 0 otherwise</td>
<td>0.32</td>
</tr>
<tr>
<td>nonmetro</td>
<td>1 if main meal planner resides in nonmetro area; 0 otherwise</td>
<td>0.29</td>
</tr>
<tr>
<td>age</td>
<td>age of the main meal planner in years</td>
<td>47.19</td>
</tr>
<tr>
<td>agesq</td>
<td>square of age</td>
<td></td>
</tr>
<tr>
<td>income</td>
<td>household income (in $1,000)</td>
<td>24.04</td>
</tr>
<tr>
<td>incomesq</td>
<td>square of household income</td>
<td></td>
</tr>
<tr>
<td>education</td>
<td>years of formal schooling</td>
<td>11.94</td>
</tr>
<tr>
<td>ne</td>
<td>1 if residence is in the Northeast; 0 otherwise</td>
<td>0.16</td>
</tr>
<tr>
<td>mw</td>
<td>1 if residence is in the Midwest; 0 otherwise</td>
<td>0.25</td>
</tr>
<tr>
<td>west</td>
<td>1 if residence is in the West; 0 otherwise</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Note: Base group includes no children, white, female, unemployed, suburban, and South.

health risks were more likely to undertake protective actions.

The employment variable is included in the analyses because it has been reported that full-time homemakers may be more concerned about food safety because of the perception they have of their roles at home (Douglas). Therefore, unemployed main meal planners are hypothesized to be less likely to consider the use of these production practices to be safe than employed main meal planners. Employment may also reflect the value of time and the cost of gathering food safety information for the household (Becker; Ippolito and Mathios).

Grossman hypothesized that the rate of depreciation for good health increases with age. Consequently, older individuals might be more risk averse to food-safety issues than younger individuals. Then, it is hypothesized that older main meal planners are less likely to consider the use of the production processes to be safe than younger main meal planners. Ott and Maligaya found that older supermarket shoppers expressed more concern about pesticide use than younger shoppers. Misra and Huang observed that the relationship between age and the perceived risk of chemical residues was increasing at a decreasing rate. Regarding income, they found that lower income consumers perceived more risk from chemical residues in fresh produce. Lin, however, did not find a significant income effect on the perceived importance of food safety in food shopping. Income, however, may indicate human capital beyond that given by formal education (Ippolito and Mathios). Therefore, income is expected to have a positive relationship with the probability that foods treated with the production practices are considered safe.

Education is included to reflect possible differences in individual ability to absorb and react to food-safety information. Schultz
hypothesized that education is an important determinant of an individual’s ability to process new information (e.g., regarding food safety) into changed behavior. Since more highly educated individuals may be more likely to read scientific or academic articles or prints and may be more likely to be exposed to technical news sources, education may reflect access advantages if government sources use these media disproportionately (Ippolito and Mathios, p. 472.). Schafer et al. also reported that shoppers with more than high school education appear not to emphasize food safety as much as others. This would lead to the hypothesis that higher educated individuals are more likely to consider the use of production practices at approved levels to be safe.2

For the four production practices being evaluated in this study (Table 2), respondents were asked: “Do you consider the following to be safe or not safe?” Possible responses were “safe,” “not safe,” “don’t know,” and “no answer.” Those who responded “don’t know” and “no answer” were deleted from the analysis. Since the dependent variables are discrete, analyses rely on the use of qualitative choice models. The linear probability model, the probit model, and the logit model are the alternative specifications of qualitative choice models (Pindyck and Rubinfeld). Logit and probit analyses, however, are preferred to the linear probability model when qualitative choice models (e.g., discrete/binary dependent variable) are to be estimated since the latter suffers from a number of deficiencies. One of the deficiencies of the linear probability model is that it allows the predicted values (probabilities) to fall outside the interval between 0 and 1, which is inconsistent with the interpretation of the conditional expectation as a probability. Moreover, the variance of the disturbance term of the model is heteroskedastic, and therefore the standard errors of the ordinary least squares parameter estimates are biased. Further, the disturbance term is not normally distributed. The classical statistical tests are then not applicable (Nayga).

Logit models are employed to circumvent inadequacies of the linear probability model, and because of the dichotomous nature of the dependent variables that are used. The logit model is based on the cumulative logistic probability function and is specified as:

$$P = F(Z) = F(X' \beta) = \frac{1}{1 + e^{-(X' \beta)}}, \quad (1)$$

where Z is a theoretical index determined by a set of explanatory variables X; F(Z) is the cumulative logistic function; e represents the base of natural logarithms (approximately equal to 2.718); and P is the probability that an individual will make a certain choice, given the knowledge of X.

The most suitable technique of estimation when using logit is maximum likelihood. Although this technique requires the use of an iterative algorithm, this procedure assumes the large-sample properties of consistency and asymptotic normality of the parameter estimates so that conventional tests of significance are applicable.

Data

The data set used in this study is the 1991 DHKS from the United States Department of Agriculture. The target individuals in this survey are the main meal preparers or planners in households in the 48 conterminous states who participated in the 1991 Consumer Survey of Food Intakes by Individuals (CSFII). The sample is a stratified clustered sample of census-defined areas. Sampling frames were organized to reflect the current population. The stratification plan took into account geographic location, degree of urbanization, and socioeconomic considerations (United States Department of Agriculture).

Data in this survey were collected by computer-assisted telephone interviews (in-person interviews for those without telephones). A total of 1,925 individuals participated in the DHKS survey. The low-income sample was not
included in the study. Due to incomplete data in some of the variables (i.e., dependent variables, income), 1,112 observations were used in the present analysis. Since the data are from a household sample, sample statistics cannot be compared to the population individual statistics of the United States. Nevertheless, the DHKS sample was determined to be representative at the household level (Lin). Moreover, the means of the variables seem typical of the nation except for the possible underrepresentation of males and employed individuals. However, it should be remembered that the respondents being analyzed in this study are household main meal planners. The variables and their means are exhibited in Tables 1 and 2. As expected, a majority of the respondents considered all four types of food production practices to be unsafe, even at approved levels. Specifically, only 16, 36, 30, and 38 percent of the main meal planners considered the use of irradiation, antibiotics, hormones, and pesticides at approved levels, respectively, to be safe.

Results

The maximum likelihood estimates for the logit analyses are exhibited in Table 3. The significance level chosen for this analysis was 0.05. The change in probabilities of the estimates are also shown in parentheses in Table 3. Standard errors of the estimates are available from the author upon request. No degrading multicollinearity problems were detected based on the collinearity diagnostic tests conducted (as set forth by Belsley, Kuh, and Welsch). Based on the statistically significant estimates, black main meal planners are less likely to consider meat from animals that have been given antibiotics and hormones at approved levels to be safe than do white main meal planners. Blacks are roughly 16 and 10 percent less probable than white main meal planners to consider meat from animals that have been given antibiotics and hormones, respectively, to be safe. Although this result does not conform with prior hypotheses, it is consistent with Flynn, Slovic, and Mertz's finding which indicated that nonwhites are more concerned about food safety than are white consumers.

Consistent with expectations, male main meal planners are more likely to consider foods that have been treated with irradiation, meat from animals that have been given antibiotics and hormones at approved levels, and foods that have been grown using pesticides at approved levels to be safe than do women main meal planners. The changes in probabilities range from 6.2 percent for irradiation to 12 percent for the hormone model. These results are consistent with Lin's finding that females are more likely to consider food safety to be important than males. The Food Marketing Institute's surveys also show that food safety is consistently believed to be more important by female shoppers than by male shoppers. Ott and Maligaya also reported that male consumers are less concerned about pesticide use than female consumers.

Interestingly, main meal planners who reside in nonmetro areas are more likely to consider foods that have been treated with irradiation, meat from animals that have been given antibiotics and hormones at approved levels, and foods that have been grown using pesticides at approved levels to be safe than do others. The changes in probabilities range from 6.6 percent for the hormone model to 12.4 percent for the pesticide model. The reason for these findings is not clear. However, it is possible that respondents who reside in nonmetro areas are less exposed to food-safety-related publicity from the popular press than those who reside in urban or suburban places. It is also likely that those who reside in nonmetro areas grow up around the use of some of these production practices, and therefore are more aware of the scientific effects and production science of such treatments.

Younger main meal planners are less likely to consider meat from animals that has been given antibiotics at approved levels and food that has been grown with approved levels of pesticides to be safe than older main meal planners. The change in probability is about 1 percent for every additional year, ceteris paribus. Previous studies by Ott and Maligaya on
pesticides and by Lin on the importance of food safety in food shopping imply the opposite result. The significant positive sign of the income variable in all four equations suggests that income is positively related to the likelihood of considering the four types of production processes to be safe. The change in probabilities is relatively small at less than 1 percent per $1,000 of income. These results, however, may also reflect differences in the prices of foods processed and not processed by the four methods.

Table 3. Maximum Likelihood and Change in Probability Estimates of the Models

<table>
<thead>
<tr>
<th>Variable</th>
<th>irrad</th>
<th>antib</th>
<th>hormone</th>
<th>pest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-3.116*</td>
<td>-0.436</td>
<td>-1.722*</td>
<td>-1.344*</td>
</tr>
<tr>
<td></td>
<td>(-0.389)</td>
<td>(-0.099)</td>
<td>(-0.356)</td>
<td>(-0.312)</td>
</tr>
<tr>
<td>child</td>
<td>-0.008</td>
<td>-0.099</td>
<td>-0.116</td>
<td>-0.071</td>
</tr>
<tr>
<td></td>
<td>(-0.001)</td>
<td>(-0.022)</td>
<td>(-0.024)</td>
<td>(-0.016)</td>
</tr>
<tr>
<td>black</td>
<td>-0.111</td>
<td>-0.694*</td>
<td>-0.463*</td>
<td>-0.309</td>
</tr>
<tr>
<td></td>
<td>(-0.014)</td>
<td>(-0.158)</td>
<td>(-0.096)</td>
<td>(-0.071)</td>
</tr>
<tr>
<td>other</td>
<td>0.304</td>
<td>0.273</td>
<td>0.028</td>
<td>0.182</td>
</tr>
<tr>
<td></td>
<td>(0.038 )</td>
<td>(0.062)</td>
<td>(0.006)</td>
<td>(0.042)</td>
</tr>
<tr>
<td>male</td>
<td>0.496*</td>
<td>0.488*</td>
<td>0.577*</td>
<td>0.322*</td>
</tr>
<tr>
<td></td>
<td>(0.062 )</td>
<td>(0.111)</td>
<td>(0.120)</td>
<td>(0.074)</td>
</tr>
<tr>
<td>employed</td>
<td>0.068</td>
<td>-0.063</td>
<td>0.095</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>(0.009 )</td>
<td>(-0.014)</td>
<td>(0.019)</td>
<td>(0.014)</td>
</tr>
<tr>
<td>city</td>
<td>-0.049</td>
<td>0.061</td>
<td>0.197</td>
<td>0.037</td>
</tr>
<tr>
<td></td>
<td>(-0.006)</td>
<td>(0.014)</td>
<td>(0.041)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>nonmetro</td>
<td>0.541*</td>
<td>0.493*</td>
<td>0.320*</td>
<td>0.532*</td>
</tr>
<tr>
<td></td>
<td>(0.068 )</td>
<td>(0.112)</td>
<td>(0.066)</td>
<td>(0.124)</td>
</tr>
<tr>
<td>age</td>
<td>-0.037</td>
<td>-0.043*</td>
<td>-0.011</td>
<td>-0.037*</td>
</tr>
<tr>
<td></td>
<td>(-0.004)</td>
<td>(-0.010)</td>
<td>(-0.002)</td>
<td>(-0.008)</td>
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<tr>
<td>agesq</td>
<td>0.0004</td>
<td>0.0003</td>
<td>0.0001</td>
<td>0.0003</td>
</tr>
<tr>
<td></td>
<td>(0.0001)</td>
<td>(0.0001)</td>
<td>(0.0002)</td>
<td>(0.0001)</td>
</tr>
<tr>
<td>income</td>
<td>0.019*</td>
<td>0.019*</td>
<td>0.017*</td>
<td>0.019*</td>
</tr>
<tr>
<td></td>
<td>(0.002 )</td>
<td>(0.004)</td>
<td>(0.003)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>incomesq</td>
<td>-8.5E-8</td>
<td>-5.4E-8</td>
<td>-4.8E-8</td>
<td>-6.2E-8</td>
</tr>
<tr>
<td></td>
<td>(-0.1E-8)</td>
<td>(-0.1E-8)</td>
<td>(-0.1E-8)</td>
<td>(-0.1E-8)</td>
</tr>
<tr>
<td>education</td>
<td>0.112*</td>
<td>0.047*</td>
<td>0.048*</td>
<td>0.099*</td>
</tr>
<tr>
<td></td>
<td>(0.014 )</td>
<td>(0.011)</td>
<td>(0.010)</td>
<td>(0.023)</td>
</tr>
<tr>
<td>ne</td>
<td>0.155</td>
<td>-0.032</td>
<td>-0.113</td>
<td>-0.247</td>
</tr>
<tr>
<td></td>
<td>(0.019 )</td>
<td>(-0.007)</td>
<td>(-0.023)</td>
<td>(-0.057)</td>
</tr>
<tr>
<td>mw</td>
<td>-0.215</td>
<td>-0.052</td>
<td>-0.170</td>
<td>-0.081</td>
</tr>
<tr>
<td></td>
<td>(-0.026)</td>
<td>(-0.011)</td>
<td>(-0.035)</td>
<td>(-0.019)</td>
</tr>
<tr>
<td>west</td>
<td>0.196</td>
<td>-0.026</td>
<td>0.031</td>
<td>0.074</td>
</tr>
<tr>
<td></td>
<td>(0.024 )</td>
<td>(-0.006)</td>
<td>(0.006)</td>
<td>(0.017)</td>
</tr>
</tbody>
</table>

McFadden R² | 0.052 | 0.058 | 0.042 | 0.057 |
Sample Size  | 1112 |

*Statistically significant at the 0.05 level.

Note: Changes in probabilities are in parentheses. The base group includes no children in household, white, female, unemployed, suburban, and South.
Concerning education, results indicate that main meal planners who have more years of formal schooling are more likely to consider foods treated by the four production practices to be safe than lower educated main meal planners. The probability that the main meal planner will consider the foods treated by the production practices to be safe changes between 1 to 2.3 percent per year of schooling among the four models. These results appear to be consistent with Schafer et al.’s finding that shoppers with more than high school education are less concerned about food safety than others. This result may reflect that higher educated main meal planners are more knowledgeable and have a better understanding about these production practices, and therefore are more confident about their scientifically-proven non-negative effect on food safety.

To summarize, generally the most important economic factors that affect the probability that a main meal planner will consider any of the four production practices to be safe are: gender, urbanization, income, education, and to some extent race and age. The presence of children, employment, and regional variables are not statistically significant factors. Interestingly, relatively few significant differences in the empirical results exist among the four types of production practices.

**Concluding Remarks**

The United States is considered to have the safest food supply in the world. Still, many consumers express a lack of confidence in the safety of the food supply. Most scientists and professional experts, however, agree that such concerns are, for the most part, unjustified and may be a reflection of consumers’ unfamiliarity with the technical or scientific aspects of the production processes and of negative publicity from the media. For consumer information programs to be more effective, it is important to know the relationship between individual characteristics of consumers and their perception about the safety of these production practices. Moreover, various population subgroups may face different degrees of food-related health risks (Lin). Therefore, specific information on the sociodemographics of consumers would be helpful in the design and implementation of more effective information programs to promote safe foods to a segmented market. Many educational campaigns in the past may have exhibited disappointing results because their informational content was low and not targeted towards specific consumer groups (Viscusi, Magat, and Huber).

This study examines the effect of sociodemographic factors on the likelihood that the main meal planner considers a particular production practice to be safe. Unlike the few existing studies, the analysis uses a national sample of the household’s main meal planners and investigates the use of four types of production practices: irradiation, antibiotics, hormones, and pesticides. The results generally indicate:

1. Main meal planners who are male, more highly educated, those with higher income, or those residing in nonmetro areas are more likely to consider food that has been treated with irradiation at approved levels to be safe than do others.
2. Main meal planners who are white, male, younger, more highly educated, those with higher income, or those residing in nonmetro areas are more likely to consider meat from animals that have been given antibiotics at approved levels to be safe than do others.
3. Main meal planners who are white, male, more highly educated, those with higher income, or those residing in nonmetro areas are more likely to consider meat from animals that have been given hormones at approved levels to be safe than do others; and
4. Main meal planners who are younger, more highly educated, male, those with higher income, or those residing in nonmetro areas are more likely to consider food that has been grown using pesticides at approved levels to be safe than do others.

Advocates of the use of these production processes should target consumer information programs toward those individuals who are not likely to consider the use of these production
processes to be safe. Based on the present study, these individuals would include those who are female, less educated, those with lower income, or those who reside in suburban and urban areas. This implication is particularly important considering that most main meal planners in the United States are still women who are located in suburban and urban areas. Also, foods produced using these production practices may be valued less by those less likely to consider them to be safe. Therefore, firms marketing foods produced using any of these production practices may have to intensify communication efforts to reach these segments of the population.

This study has a number of simplifying assumptions that could be relaxed in future work. For instance, it is assumed that the survey and the relevant food-safety concern question examined elicited true attitudes. Surveys are hypothetical and subject to many biases since a number of factors related to it can lead to responses that depend on the way the question was asked (Buhr et al.). Future studies could use a non-hypothetical auction method similar to that used by Shogren et al. and Fox for bST milk. Future studies should also examine other factors not examined in the present study such as sources of food-safety information. Source of information may affect the way consumers react to certain kinds of food-safety information. This analysis did not include sources of information variables because they were not available in the DHKS. Respondents in this study include only main meal planners. A similar analysis could be conducted for more diverse subject populations to confirm the robustness of the findings.

[Received December 1995. Final version received May 1996.]

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SOCIODEMOGRAPHIC INFLUENCES ON CONSUMER CONCERN

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Sociodemographic Influences on Consumer Concern for Food Safety: The Case of Irradiation, Antibiotics, Hormones, and Pesticides
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