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6200 Aurora Ave., Suite 200W, Des Moines, IA 50322-2864

Lydia C. Medeiros[1]* and Jeffrey LeJeune[1]

[1]Ohio Agricultural Research and Development Center, The Ohio State University, 1680 Madison Ave., Wooster, OH 44691, USA

Why Do Consumers Drink Unpasteurized Milk? A Preliminary Mental Model

ABSTRACT

This study aimed to identify factors that distinguish pasteurized from unpasteurized milk consumption for the purpose of developing a preliminary mental model of milk preference among consumers. A focus group sample of consumers (n = 81) from rural or urban areas were asked to participate in study groups organized according to residence and milk preference. This is the report of results obtained from a 76-item quantitative survey completed before the focus groups were conducted. Data were analyzed by chi-square, ANOVA, discriminant analysis and hierarchal linear regression. The finding for this preliminary study is that there are four distinct mental models unique to residence and milk preference. Differences among groups were found for the factors political philosophy, anger, food safety knowledge, institutional trust, reliance on media as their information source, and degree of reliance on the influence of referent others. Even in an area of the United States where public availability of unpasteurized milk is controlled by state laws, the drive to obtain and consume unpasteurized milk through alternate means continues as a health, political, and social issue and is somewhat characteristic of specific population subgroups.

INTRODUCTION

The Department of Agriculture and the Department of Health and Human Services of the United States recommend that Americans consume 2–3 servings of dairy products, such as low-fat fluid milk, yogurt, and cheeses, each day *(34)*. These products are natural sources of calcium important for bone growth and for the prevention of certain diseases such as osteoporosis, obesity, hypertension and diabetes *(17)*. In addition, dairy products provide protein, minerals other than calcium, and essential vitamins *(11)*. Thus, milk should play a key part in the diet of most Americans. McCarron and Heaney *(17)* estimated health care costs savings from conditions such as osteoporosis as $26 billion in year one, with 5-year cumulative savings in excess of $200 billion, if Americans increased milk consumption to recommended

*Corresponding Author: Voice: +1 330.202.3548; Fax: +1 330.263.3677; E-mail: Medeiros.1@osu.edu

minimums. However, it has also long been recognized that human consumption of unpasteurized milk is a vehicle for the transmission of numerous bacteria, of both human and animal origin, that can cause enteric infection.

Because unpasteurized milk sales are illegal in many states *(14)*, it is difficult to estimate the magnitude of the unpasteurized milk consumption problem. However, media reports suggest that a single large producer, Organic Pastures, in California, has reported approximate annual sales of $5.8 million, including sales of unpasteurized milk, cream, cheese, and colostrum *(26)*. Furthermore, one website *(22)* previously claimed that 500,000 consumers drink unpasteurized milk regularly in the United States, although that number is difficult to verify, as sales and availability vary from state to state *(14)*. The Centers for Disease Control and Prevention (CDC) reported 121 outbreaks from dairy consumption in which pasteurization status of the implicated product was known; 73 of these were verified as linked to the consumption of unpasteurized dairy products *(14)*. Seventy-five percent of those outbreaks occurred in states that permit sale of unpasteurized products. However, focusing only on outbreak data misses sporadic illnesses caused by consuming unpasteurized milk, and incidence may be independent of legal sale. In Minnesota, milkborne illnesses were investigated by examining state data from 2001–2010. Of reported cases that were not part of an outbreak, 3.7% were attributed to the consumption of unpasteurized milk *(31)*. Children under age six were disproportionally affected, and the infection was attributed to unpasteurized milk, frequently from their own family dairy.

The compelling information about the legality and health risks of consuming unpasteurized milk is apparently not sufficient to deter the practice among a significant portion of the U.S. population. Attempts to better focus the risk communication message are apparently not yet successful and deserve review. A different approach is to discover the social and behavioral aspects of food safety practices. This approach can be rooted in mental model theory, borrowed from our colleagues in psychology. A mental model is defined as a complex web of knowledge, values and social context influencing how individuals make behavioral decisions *(25)*. The concept of mental modeling assumes that all decisions made by humans are a function of their prior experiences and knowledge, influenced by culture, that forms a model that largely operates subconsciously. The constructs typically shown in mental models are proposed relational behaviors; a stronger mental model is one that is grounded in quantitative data and statistical analysis *(5)*. If the goal of risk communication in food safety training and education is to encourage healthy and safe food practices and choices, understanding how people make their individual behavioral decisions, or their mental models, is fundamental to successful education.

The Risk Information Seeking and Processing model (RISP) *(Fig. 1)* *(6)* was originally developed to measure and understand attitudes and beliefs of consumers exposed to risk hazards. We have previously used the RISP model to develop a mental model of registered dietitians and their food safety education behavior *(21)*, and found it useful as a framework for development of the mental model used by consumers making choices about milk and dairy products they consume. In this preliminary study, the aim was to discover factors that distinguish pasteurized or unpasteurized milk consumption for the purpose of developing a preliminary mental model of milk preference among consumers.

METHODS

Participants and survey

This report used survey data that was collected as part of a small pilot study designed for focus groups. Therefore, the sample size was based on the focus group unit of measure of approximately five to 10 participants per focus group *(24)*. Three independent components were included in the pilot study: (1) a health and nutrition assessment, (2) a milk and dairy product survey, and (3) a one-hour focus group. Only the results of the milk and dairy product survey are presented in this report. Participants were recruited by posters on the University campus and local community bulletin boards, email solicitation through University listservs, and a subject recruitment service provided by the University medical center. Recruitment occurred on both the metropolitan campus (urban) and a regional campus (rural) of the University. All procedures were reviewed and approved for human subjects research by The Ohio State University Institutional Review Board under Protocol 2009B0301.

Eighty-one residents of Ohio (US) participated by completing a 76-item survey about milk and dairy product consumption, and about their food safety knowledge and beliefs. Each subject was assigned to an experimental group based on their milk consumption preferences (pasteurized or unpasteurized milk) and according to their residence, either urban (metropolitan area, 50,000 or more people), or rural (all populations, housing, and territory not included within an urban area), according to the definitions of the U.S. Census Bureau *(33)*. Inclusion criteria were age 18 years or older, consumer of milk and/or dairy products, and the only person in the household participating in this study. Items for the survey were adapted from previously published studies *(7, 8, 9, 13, 20)*. All items were revised to specifically address milk and dairy product consumption. Scaling and variable construction were completed by methods previously reported by Medeiros and LeJeune *(21)*.

Individual characteristics

Characterization of participants was measured nonparametrically as socio/cultural descriptors (gender, age, ethnicity, education, and income), risk hazard experience

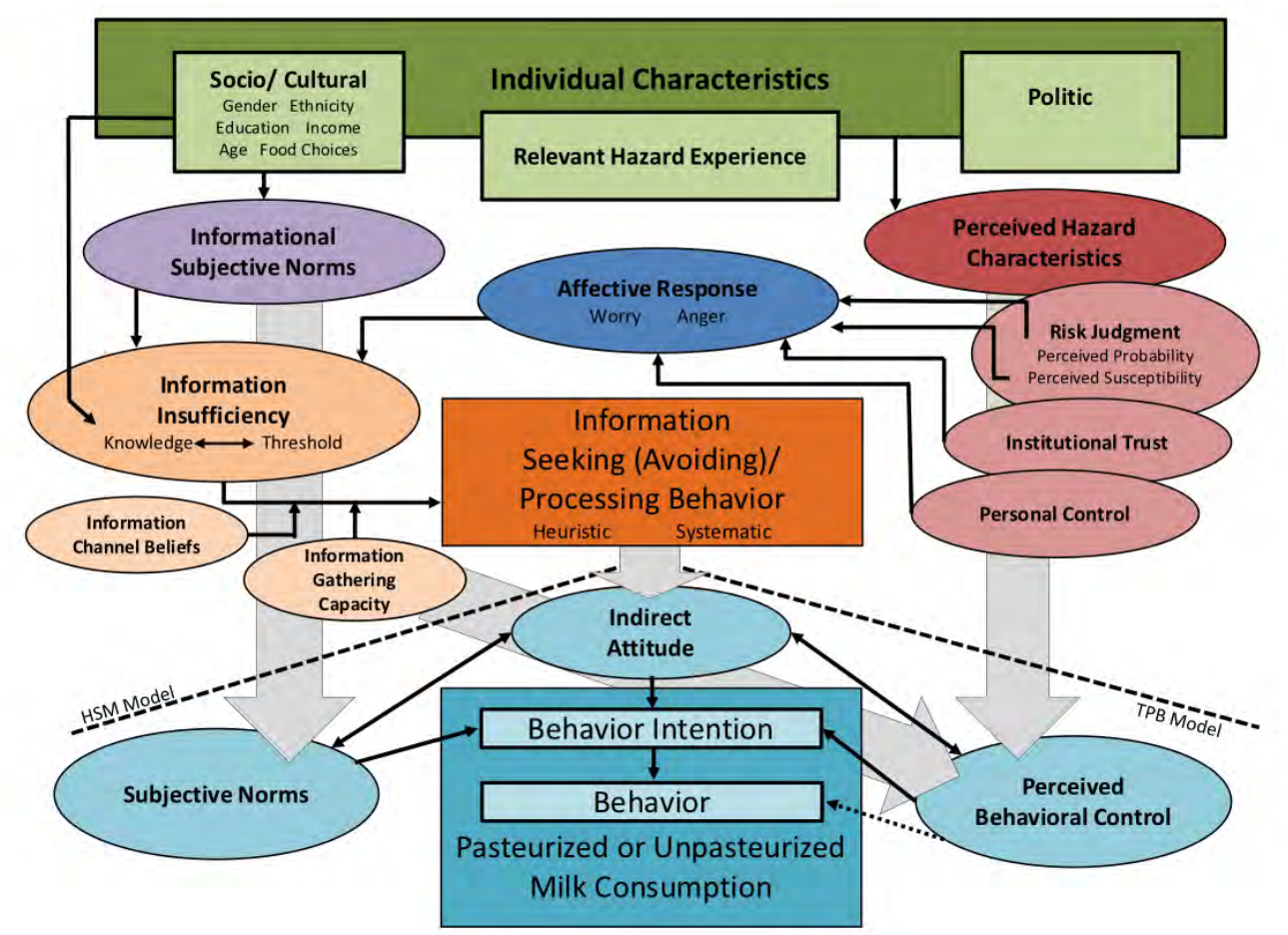

Figure 1. The Risk Information Seeking and Processing Model (5) as adapted for the experimental design of the milk consumption mental model

(prior personal experience or close relative/friend experiencing a foodborne illness), and political philosophy (self-assessment as very liberal to very conservative). Each nominal-scaled item asked participants to select the characteristic that best fit their situation among a list of possible choices.

Perceived hazard characteristics

Risk judgment items measured beliefs about foodborne illness, as the hazard of interest in the study. The items were perceived susceptibility (How likely are you to get a foodborne illness in the future from drinking milk or eating dairy products?) and perceived seriousness (If you were to get a foodborne illness from drinking milk or eating dairy products, how serious would this illness be?). The scale ranged from zero (not very likely) to 10 (very likely). The belief evaluation structure that could influence a person's risk judgment was probed in the variables "institutional trust," which queried the participants' opinions about their perceptions of institutions responsible for preserving the safety of food, and "personal control," which measured perception of the ease of avoiding foodborne illness caused by milk or dairy products. The institutional trust variable was structured from four 5-point Likert-scale items ($\alpha = 0.842$) *(21)*. The personal control item was measured on a 5-point Likert scale *(21)*.

Affect

Participants were asked to respond to three items about how likely they were to feel an emotional response to issues related to the health risks imposed on them from the consumption of milk and dairy products, and how strongly that response was felt. Items measured the degree of worry, anger, and uncertainty felt by the participant. The scales ranged from zero (not very likely) to 10 (very likely) *(21)*.

Informational subjective norm

This variable was structured as the product of two items that measured the participant's normative belief and motivation to comply with that belief. The normative belief item

queried if participants felt that people who are important to them would expect them to stay abreast of information about the food safety of milk and dairy products, and the motivation to comply item asked how much they value other's opinions when they make decisions that could affect their health. Each item was structured on 5-point Likert scales and responses were multiplied to form the single variable *(21)*.

Knowledge

The construct "information insufficiency" was assessed as the difference between measures of information sufficiency (I have a sufficient amount of knowledge about milk and dairy products for my personal use and safety), which is the participant's perception of the adequacy of his or her knowledge, and their actual current knowledge, which is a scaled value calculated from responses to items about the safety of foods known to have food safety risk *(13, 20)*. The information sufficiency item was constructed on a 5-point Likert scale. "Current knowledge" was measured in 16 items with response choices of agree, disagree, or not sure. Two points were scored for each correct response and one point was scored for an incorrect or not sure response. Of the 16 original items, six were deleted because of inadequate internal consistency. The final scale had acceptable internal consistency ($\alpha = 0.753$). For advanced statistical analysis where a continuous-scaled item was needed (e.g., discriminant analysis), the variable "current knowledge" was calculated as the sum of responses from the remaining 10 items (new variable name, current knowledge summed). For statistical analysis that required a Likert-scaled item (e.g., HLM), values for current knowledge were divided into quintiles and ranked from very low (value = 1) to very high (value = 5). This version was used to compare current knowledge to information sufficiency.

Information channels and beliefs

The sources participants use to gain information about the safety of milk and dairy products were measured in two constructs, "media beliefs" and "information source beliefs." Media belief measurements consisted of six 5-point Likert-scaled items that were reduced to four items and refined into two variables by principal component analysis: media bias beliefs ($\alpha = 0.799$), and validity cues beliefs ($\alpha = 0.668$). Information channel sources were queried by four items that measured the amount of attention paid to television, newspapers, radio or private conversations as reliable sources on the safety of milk and dairy products (0 to 10-point preference scale). Data for the four items were summed to form the variable ($\alpha = 0.904$). The ease with which useful food safety information can be found to fulfill the participants' need for food safety information was measured in the variable "information gathering capacity," which was constructed from two items. One item measured the participant's perception of the availability of information sources, and the other measured the usefulness of the information for fulfilling his or her need for information. The two Likert-scaled items were summed to form the variable ($\alpha = 0.815$).

Information processing behavior

The dependent variables for the hierarchical linear modeling (HLM) portion of this study were "heuristic information" processing and "systematic information processing." These variables measured the depth (e.g., superficial or heuristic, in-depth or systematic) at which participants process information about the food safety of milk and dairy products. The heuristic information processing variable was measured in four 5-point Likert-scaled items ($\alpha = 0.625$), and the systematic information processing variable was measured in four 5-point Likert-scaled items ($\alpha = 0.606$).

Data analysis

The software for quantitative data analysis was the Statistical Package for the Social Sciences software (SPSS Version 22.0, Chicago IL). Categorical variables were milk preference (pasteurized or unpasteurized milk and dairy product preference) and residence (urban or rural). Survey data by categorical variables were analyzed by crosstabs and chi-square for non-parametric data. Differences among parametric data variables by categorical variables were analyzed by ANOVA. In all cases, probability levels less than or equal to 95% were accepted as indications of significant difference. When necessary to improve statistical measurements, item data were transformed using principal component analysis to reduce and combine items, or scale reduction analysis to define the best set of items that had the highest internal consistency when summed. Cronbach $\alpha > 0.600$ was accepted for this study for assessing internal consistency *(28)*.

The mental models of milk preference were qualitatively developed from the outcomes of discriminant analysis and hierarchical linear modeling (HLM). Continuous variables were selected for discriminant analysis, including institutional trust, risk judgment items about the likelihood of getting foodborne illness and the seriousness of that illness if contracted, subjective norm, current knowledge summed, informational gathering capacity, media bias beliefs, validity cues beliefs, informational source beliefs, and two measures of affect, worry and anger. The third measure of affect was eliminated in the final discriminant analysis because of poorer analysis statistics when the variable was included.

Heuristic and systematic information processing were the dependent variables for two HLM analyses. The HLM procedure was selected because independent variables were entered into the model in nine sequential levels to account for the variance of each predicting variable independent of the previously entered variables. The first level of the analysis entered variables characterizing the participants' socio/

cultural traits, their previous experience with the hazard of interest in this study, e.g., prior experience with foodborne illness, and their political philosophy, to ascertain their general approach to decision making. The next level of measurement added items on the participants' perception of risk judgment, institutional trust and personal control over infections causing foodborne illness. The affect responses to the hazard (anger, worry and uncertainty) were entered into the model next, followed by the entry of subjective normative beliefs. The next step was to enter measures of the participants' beliefs about information and media channels, their information gathering capacity, or how well they can access and understand information sources about the hazard were entered. Finally, knowledge of food safety as a function of the individual's educational level and belief about the sufficiency of his or her knowledge of milk/dairy safety in order to make an informed decision was entered into the model. The adequacy of the analyses was accessed by model statistics.

Preliminary mental model of milk and dairy preference

All variables in the dataset were evaluated qualitatively for inclusion in the preliminary mental model of milk and dairy preference. Crosstabs, ANOVA, discriminant analysis and HLM quantitative analyses results were used to qualitatively assess the assignment of variables among four models based on residence (two levels) and milk/dairy preference groups (two levels). Cell counts and percentages for the non-parametric variables were assessed for variable significance and for distribution among the four model groups. Data was qualitatively designated as low or high, if clearly distinguishing. Likewise, mean differences and variable significance were used in a similar manner to identify means that were clearly at the lower or higher ends of the variable data distribution. If included in the preliminary model, variables were subjectively judged as "low" or "high" with the meaning that within that variable and the model group, there was a clear difference that distinguished one group from others. All variables judged to be non-distinguishing were omitted from the preliminary mental model.

RESULTS

Individual characteristics

The socio/cultural description of participants in this pilot study is shown in *Table 1*. The distributions of participants in the education and racial/ethnic groups did not differ statistically. There were more females than males in the rural

Table 1. Individual characteristics of study participants

Item	Category	Rural residence (n, % within variable)		Urban residence (n, % within variable)	
		Unpasteurized milk and dairy	Pasteurized milk and dairy	Unpasteurized milk and dairy	Pasteurized milk and dairy
Gender[1]	Male	7, 26.9	0, 0	7, 12.7	15, 27.3
	Female	9, 34.6	10, 38.5	13, 23.6	20, 36.4
Age (years)[2]	18–29	4, 15.4	2, 7.7	1, 1.8	11, 20.0
	30–39	0, 0	0, 0	6, 10.9	5, 9.1
	40–49	3, 11.5	0, 0	10, 18.2	6, 10.9
	50–59	3, 11.5	7, 26.9	3, 5.5	7, 12.7
	60–69	5, 19.2	0, 0	0, 0	3, 5.5
	70–90	1, 3.8	1, 3.8	0, 0	3, 5.5
Education[3]	Primary school	0, 0	0, 0	0, 0	0, 0
	High school	5, 19.2	1, 3.8	1, 1.8	6, 10.9
	Technical school or some college	3, 11.5	1, 3.8	1, 1.8	10, 18.2
	College graduate	8, 30.8	8, 30.8	8, 14.5	9, 16.4
	Postgraduate or professional	0, 0	0, 0	10, 18.2	10, 18.2
Racial/ethnic group[4]	White/non-Hispanic	16, 61.5	10, 38.5	20, 37.0	28, 51.9
	Asian or Pacific islander	0, 0	0, 0	0, 0	1, 1.9
	Black/African-American	0, 0	0, 0	0, 0	4, 7.4
	Multiple ethnicity	0, 0	0, 0	0, 0	1, 1.9

Table 1 Continued on next page.

Table 1. Individual characteristics of study participants (cont.)

Item	Category	Rural residence (n, % within variable)		Urban residence (n, % within variable)	
		Unpasteurized milk and dairy	Pasteurized milk and dairy	Unpasteurized milk and dairy	Pasteurized milk and dairy
Household income (USD)[5]	Less than $45K	12, 48.0	0, 0	6, 11.3	21, 39.6
	$45K–$54K	1, 4.0	1, 4.0	2, 3.8	5, 9.4
	$55K–$64K	0, 0	4, 16.0	2, 3.8	2, 3.8
	$65K–$74K	1, 4.0	0, 0	0, 0	0, 0
	$75K–$84K	1, 4.0	2, 8.0	1, 1.9	1, 1.9
	$85K–$99K	1, 4.0	2, 8.0	4, 7.5	1, 1.9
	$100K or more	0, 0	0, 0	0, 0	0, 0
Risk hazard experience [6, 7]					
Self – medically diagnosed	Don't know	1, 6.3	0	0	2, 5.7
	No	13, 81.3	10, 100.0	18, 90.0	31, 88.6
	Yes	2, 12.5	0	2, 10.0	2, 5.7
Self – limited to self-care	Don't know	4, 25.0	0	2, 10.0	5, 14.3
	No	6, 37.5	9, 90.0	11, 55.0	21, 60.0
	Yes	6, 37.5	1, 10.0	7, 35.0	9, 25.7
Others[8] – medically diagnosed	Don't know	3, 18.8	2, 20.0	3, 15.0	5, 14.3
	No	6, 37.5	6, 60.0	14, 70.0	20, 57.1
	Yes	7, 43.8	2, 20.0	3, 15.0	10, 28.6
Others[8] – limited to self-care	Don't know	4, 25.0	3, 30.0	6, 30.0	8, 22.9
	No	6, 37.5	5, 45.5	6, 30.0	17, 48.6
	Yes	6, 37.5	2, 20.0	8, 40.0	20, 100.0
Political philosophy[9]	Very liberal	1, 6.3	2, 10.5	0	4, 12.1
	Liberal	1, 6.3	6, 31.6	0	6, 18.2
	Neutral	4, 25.0	7, 36.8	2, 20.0	12, 36.4
	Conservative	8, 50.0	2, 10.5	7, 70.0	9, 27.3
	Very conservative	2, 12.5	2, 10.5	1, 1.0	2, 6.1

[1]Gender: Rural, $P = 0.040$; Urban, $P = 0.567$.

[2]Age: Rural, $P = 0.052$; Urban, $P = 0.016$.

[3]Education: Rural, $P = 0.300$; Urban, $P = 0.059$.

[4]Racial/ethnic: Rural, P Not computed; Urban, $P = 0.265$.

[5]Income: Rural, $P = 0.004$; Urban, $P = 0.098$.

[6]Risk hazard experience, Rural: Self–medically diagnosed, $P = 0.347$; Self – limited to self-care, $P = 0.028$; Others–medically diagnosed, $P = 0.431$; Others – limited to self-care, $P = 0.639$.

[7]Risk hazard experience, Urban: Self–medically diagnosed, $P = 0.480$; Self – limited to self-care, $P = 0.735$; Others-medically diagnosed, $P = 0.513$; Others – limited to self-care, $P = 0.404$.

[8]Others = close friends or relatives.

[9]Political philosophy: Rural, $P = 0.777$; Urban, $P = 579$.

residence group ($P = 0.023$), and participants in the rural residence group were statistically older (mean, 49.7 yr.) than those in the urban residence group (mean, 41.8 yr.) ($P = 0.054$). Income among the participants was lower among rural residents ($P = 0.004$). Even though almost 40% of the urban participants were in the lowest income category, for urban resident participants this difference did not rise to statistical significance.

Behavioral beliefs, knowledge and information sources

The continuous-scaled version of the model variables used in discriminant analysis was analyzed by univariate ANOVA and is shown in *Table 2*. There were main effect differences detected for milk-consumption preference for the variables institutional trust ($P > 0.001$), validity cues beliefs ($P = 0.017$), information gathering capacity ($P = 0.022$), and heuristic information processing ($P = 0.007$). For each variable, the pasteurized-milk consumption groups scored higher on the scales than did the unpasteurized-milk consumption groups. Pasteurized-milk consumers had greater trust in institutions responsible for the safety of milk and were more confident in their ability to gather information about the safety of milk and the reliability of that information. However, their style of information processing, compared with the unpasteurized-milk consumption groups, was heuristic, indicating they were more superficial in their perusal of milk safety information.

For residence, there were main effect differences for institutional trust ($P = 0.019$), subjective norm ($P = 0.006$), media bias beliefs ($P = 0.004$), information source beliefs ($P = 0.008$), information gathering capacity ($P = 0.017$), and current knowledge summed ($P > 0.001$). The rural-residence groups scored higher for each of these variables than did the urban-residence groups. Institutional trust and information-related variable outcomes were similar to the outcomes for the milk-consumption group outcomes. Additionally, rural residents were more influenced by family and friends (subjective norm) when choosing the type of milk to consume, and they were more knowledgeable of general food safety principles than were the urban groups (current knowledge summed).

There was a significant interaction between the milk-consumption groups and the residence groups for the variables believe foodborne illness likely and institutional trust. The rural, unpasteurized-milk consumption group scored higher than the other three groups on the scale measuring the likelihood of getting a foodborne illness. The rural, pasteurized-milk consumption group scored the highest on institutional trust, whereas the urban, unpasteurized-milk consumption group scored the lowest on institutional trust.

Discriminant analysis

Seventy-three of 81 observations were included in the discriminant analysis of the continuous variables; excluded observations lacked at least one discriminating variable in the dataset. Three standardized canonical discriminant functions were used to evaluate the analysis. Functions one to three were significant ($P \leq 0.001$), and functions two to three were significant ($P = 0.047$), but function 3 was not significant ($P = 0.772$). Functions one and two were used to discriminate four groups along the axis of a 2-dimentional plot of unstandardized canonical discriminant coefficients. The group centroid for the rural/unpasteurized group was located in the negative range of the X-axis by function one and the positive range of the y-axis by function two. The group centroid for the rural/pasteurized group was located in the positive range on both the x-axis (function 1) and y-axis (function 2). The urban/unpasteurized group centroid was located in the negative range of both the x-axis (function 1) and y-axis (function 2). The fourth group centroid (urban/pasteurized) was located in the remaining quadrant, which was the positive range (function 1) on the x-axis and the negative range (function 2) on the y-axis. Of the 73 observations included, 63.0% were correctly classified by the discriminant analysis.

Standardized canonical discriminant function coefficients are shown in *Table 3*. Regardless of the magnitude of the standardized canonical coefficients or mean difference significance *(Table 2)*, all continuous variables were considered as candidate characteristics in the qualitative construction of the preliminary mental model of milk and dairy preference *(Table 4)*. The key discriminating variables (operationally defined as standardized canonical coefficient greater than six) were institutional trust and current knowledge, e.g., current knowledge sum for discriminant analysis. Means for institutional trust differed by residence ($P \leq 0.001$) and milk/dairy preference ($P = 0.019$), and the interaction was also significant ($P = 0.036$). Current knowledge sum differed by residence ($P \leq 0.001$) and by milk/dairy preference ($P = 0.053$), but the interaction was not significant.

The variables risk judgment-serious, affect-anger, subjective norm, media bias beliefs, validity cue beliefs, information source beliefs, and information gathering capacity were important variables in the discriminant analysis, as defined for this study as standardized canonical coefficients greater than two and less than five. Means for informational gathering capacity differed by residence ($P = 0.017$) and milk/dairy preference ($P = 0.022$). Means for media bias beliefs ($P = 0.004$), information source beliefs ($P = 0.008$), and subjective norm ($P = 0.006$) differed only by residence, whereas validity cues beliefs ($P = 0.017$) differed by milk/dairy preference only. Mean differences were not found for risk judgment-believe foodborne illness serious and affect-anger.

Standardized canonical coefficients less than two were found for risk judgment-believe foodborne illness likely and affect-worry. There was a significant interaction between residence and milk/dairy preference for the variable risk judgement-believe foodborne illness likely ($P = 0.049$), but main effects did not differ. No mean differences were found for affect-worry.

Table 2. Mean differences of mental model of milk and dairy preference components

Variable	Rural residence		Urban Residence		Probability[b]
	Unpasteurized (mean, SEM[a])	Pasteurized (mean, SEM[a])	Unpasteurized (mean, SEM[a])	Pasteurized (mean, SEM[a])	
Believe foodborne illness likely	2.0, 0.36	1.1, 0.46	1.2, 0.32	1.7, 0.24	M, $P = 0.586$ R, $P = 0.793$ MxR, $P = 0.049$
Believe foodborne illness serious	4.1, 0.63	4.9, 0.80	2.8, 0.61	3.9, 0.43	M, $P = 0.119$ R, $P = 0.074$ MxR, $P = 0.805$
Institutional trust	12.0, 0.76	14.5, 0.93	8.7, 0.66	14.3, 0.50	M, $P = 0 > 0.001$ R, $P = 0.019$ MxR, $P = 0.036$
Affect, worry	0.9, 0.54	1.5, 0.68	0.9, 0.48	2.0, 0.36	M, $P = 0.110$ R, $P = 0.698$ MxR, $P = 0.581$
Affect, anger	2.1, 0.57	1.9, 0.70	2.5, 0.51	2.9, 0.37	M, $P = 0.804$ R, $P = 0.200$ MxR, $P = 0.582$
Subjective norm	16.3, 1.42	17.3, 1.80	13.1, 1.27	12.7, 0.96	M, $P = 0.816$ R, $P = 0.006$ MxR, $P = 0.637$
Media bias beliefs	9.4, 0.34	9.6, 0.43	8.5, 0.31	8.5, 8.05	M, $P = 0.793$ R, $P = 0.004$ MxR, $P = 0.826$
Validity cues beliefs	6.4, 0.43	7.5, 0.54	6.2, 0.39	7.1, 0.29	M, $P = 0.017$ R, $P = 0.456$ MxR, $P = 0.816$
Information source beliefs	23.4, 2.74	26.8, 3.47	17.7, 2.52	17.8, 1.86	M, $P = 0.519$ R, $P = 0.008$ MxR, $P = 0.554$
Information gathering capacity	14.1, 1.64	18.0, 2.08	10.3, 1.51	13.9, 1.11	M, $P = 0.022$ R, $P = 0.017$ MxR, $P = 0.930$
Current knowledge summed	15.4, 0.59	16.7, 0.75	12.9, 0.59	13.9, 0.41	M, $P = 0.053$ R, $P = 0 > 0.001$ MxR, $P = 0.807$
Heuristic information processing	10.0, 0.61	10.9, 0.77	9.0, 0.58	11.5, 0.42	M, $P = 0.007$ R, $P = 0.743$ MxR, $P = 0.193$
Systematic information processing	16.0, 0.55	16.1, 0.69	15.8, 0.50	15.6, 0.37	M, $P = 0.930$ R, $P = 0.573$ MxR, $P = 0.785$

[a]SEM = Standard error of mean

[b]M = milk preference, R = residence, MxR = milk preference by residence interaction

Table 3. Components of the mental model of milk and dairy preference

Category	Variable	Discriminant analysis[a]		Hierarchal linear modeling[b]			
		Standardized canonical coefficients		Heuristic information processing[c]		Systematic information processing[d]	
		Function 1 (X axis)[e]	Function 2 (Y axis)[f]	Standardized coefficient (β)	Probability	Standardized coefficient (β)	Probability
	Constant	---	---	---	0.000	---	0.014
Gender	Male	---	---	-0.208	0.119	---	---
	Female			---	---	-0.157	0.181
Ethnicity	White	---	---	-0.485	0.142	0.568	0.065
	Not white (all other ethnicities/races)	---	---	-0.333	0.325	0.524	0.096
Income	< $45,000	---	---	0.120	0.615	0.349	0.120
	$45,000 to $54,000	---	---	0.120	0.477	0.202	0.190
	$55,000 to $64,000	---	---	0.165	0.215	0.021	0.862
	$65,000 to $74,000	---	---	-0.111	0.413	0.384	0.005
	$75,000 to $84,000	---	---	0.121	0.365	0.061	0.621
	$85,000 to $99,000	---	---	-0.002	0.990	-0.017	0.892
Age	18–29 years			0.029	0.859	---	---
	30–39 years	---	---	0.070	0.694	0.306	0.106
	40–49 years	---	---	---	---	0.021	0.889
	50–59 years	---	---	-0.022	0.898	0.374	0.038
	60–69 years	---	---	0.074	0.607	-0.156	0.275
	70–90 years	---	---	-0.270	0.062	0.061	0.659
Personal hazard experience	Foodborne illness, medical care – self	---	---	-0.113	0.357	0.136	0.224
	Foodborne illness, no medical care – self	---	---	-0.042	0.772	0.068	0.609
	Foodborne illness, medical care – others	---	---	0.078	0.503	0.025	0.819
	Foodborne illness, no medical care – others	---	---	0.045	0.746	-0.136	0.258
Political philosophy	Very liberal	---	---	-0.539	0.057	0.155	0.418
	Liberal	---	---	-0.897	0.010	0.557	0.017
	Neutral	---	---	-1.043	0.021	0.684	0.029
	Conservative	---	---	-0.946	0.031	0.334	0.236
	Very conservative	---	---	-0.755	0.011	0.401	0.029
Risk judgment	Believe foodborne illness likely	0.008	-0.179	0.110	0.522	0.123	0.447
	Believe foodborne illness serious	-0.130	0.319	-0.165	0.283	0.195	0.181
Personal control	Personal control over health, disagree	---	---	-0.249	0.123	0.098	0.508
	Personal control over health, neutral	---	---	-0.010	0.935	-0.155	0.191
	Per control over health, strongly agree	---	---	-0.141	0.369	0.106	0.470

Table 3 Continued on next page.

Table 3. Components of the mental model of milk and dairy preference (cont.)

Category	Variable	Discriminant analysis[a]		Hierarchal linear modeling[b]			
		Standardized canonical coefficients		Heuristic information processing[c]		Systematic information processing[d]	
		Function 1 (X axis)[e]	Function 2 (Y axis)[f]	Standardized coefficient (β)	Probability	Standardized coefficient (β)	Probability
Trust	Institutional trust in government	1.032	-0.142	0.406	0.009	-0.039	0.775
Education	High school	---	---	0.300	0.110	-0.362	0.039
	Post high school	---	---	0.158	0.360	-0.100	0.520
	College graduate	---	---	0.185	0.297	-0.265	0.108
Affect	Worry about safety milk/dairy	-0.095	0.022	0.248	0.149	-0.335	0.039
	Anger about safety milk/dairy	0.486	-0.147	0.237	0.206	0.145	0.404
	Uncertainty about safety milk/dairy	---	---	-0.311	0.138	-0.175	0.357
Norms	Informational subjective norm	-0.399	0.134	0.036	0.801	0.143	0.276
Media beliefs and sources	Media bias beliefs	0.013	0.378	-0.098	0.438	-0.351	0.004
	Validity cues beliefs	0.241	-0.062	-0.102	0.444	0.319	0.013
	Information source beliefs	-0.275	0.289	-0.516	0.001	0.485	0.001
	Information gathering capacity	0.374	0.177	0.073	0.600	0.089	0.492
Knowledge	Current knowledge summed	0.067	0.630	---	---	---	---
	Knowledge, very low	---	---	-0.330	0.071	0.191	0.214
	Knowledge, low	---	---	-0.079	0.604	-0.189	0.185
	Knowledge, average	---	---	0.069	0.594	-0.375	0.004
	Knowledge, high	---	---	-0.033	0.839	-0.236	0.123
	Knowledge, very high	---	---	-0.027	0.848	-0.077	0.549
Knowledge sufficiency	Knowledge sufficient, agree	---	---	-0.086	0.518	0.065	0.607
	Knowledge sufficient, not sure	---	---	0.001	0.993	-0.278	0.037
	Knowledge sufficient, disagree	---	---	0.023	0.883	-0.157	0.294
	Knowledge sufficient, strongly disagree	---	---	0.270	0.082	0.076	0.587

[a]Data for all continuous variables included in analysis, with exception of Affect-uncertainty to improve significance of discriminant analysis; 63.0% of cases correctly classified.

[b]Data for continuous and dummy variables included in analysis; excluded variables not shown.

[c]Model, $R^2 = 0.529$, $P = 0.004$; Excluded variable in Heuristic model due to multicollinearity: Gender, Female; Age, 40 to 49 years; Personal Control, Agree; Education, Post Graduate/Professional; Knowledge Sufficiency, Strongly Agree.

[d]Model, $R^2 = 0.593$, $P = 0.001$; Excluded variable in Systematic model due to multicollinearity: Gender, Male; Age, 18 to 29 years; Personal Control, Agree; Education, Post Graduate/Professional; Knowledge Sufficiency, Strongly Agree.

[e]Function 1, $P > 0.001$

[f]Function 2, $P = 0.047$

Table 4. Distinguishing qualitative characteristics of the preliminary mental model of milk and dairy preference[a]

Distinguishing component	Rural residence		Urban residence	
	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized
Socio/cultural characteristics				
Age, 50–59 years	*	High	Low	*
Education, High school	High	*	*	High
Income, $65K–$74K	High	*	*	*
Political philosophy				
Liberal	*	Low	High	High
Neutral	*	Low	*	High
Conservative	High	High	Low	*
Very conservative	High	Low	*	*
Risk judgment				
Believe FBI[b] serious	High	High	Low	Low
Institutional trust	*	High	Low	*
Affect				
Worry	*	*	Low	High
Anger	*	Low	*	High
Subjective norm	High	High	Low	Low
Media bias beliefs	High	High	Low	Low
Validity cues beliefs	Low	High	Low	High
Information source beliefs	*	High	Low	*
Information gathering capacity	*	High	Low	*
Current knowledge summed	*	High	Low	*
Knowledge, average	*	Low	*	*
Knowledge sufficiency, not sure	*	*	*	High
Heuristic information processing	*	*	Low	High
Systematic information processing	*	*	*	*

[a]Distinguishing qualitative components selected based on Chi-Square and ANOVA variable differences ($P \leq 0.05$), discriminating variables in Discriminant Analysis, or significant variables ($P \leq 0.050$) in HLM analysis.

[b]FBI = foodborne illness.

*Non-distinguishing component for milk/residence category.

Hierarchical linear modeling

All dataset variables were entered into HLM regression analysis with heuristic information processing and systematic information processing as dependent variables in two different models *(Table 3)*. The heuristic information processing model was significant ($P = 0.004$), with variables entered into the model accounting for 53% of the variation among the data ($R^2 = 0.529$). The systematic information processing model was also significant ($P = 0.001$), with 59.3% of the variation accounted for in the final model ($R^2 = 0.593$). Variables that achieved at least $P = 0.050$ significance in either of the two models were evaluated as candidate characteristics in the construction of the preliminary mental model of milk and dairy preference. Variables chosen for evaluation are shown in *Table 4*.

Preliminary mental model of milk and dairy preference

The rural/pasteurized group was characterized by a greater number of participants in the 50 to 59 years age group,

conservative political philosophy, a belief that foodborne illness can be serious, high trust in governmental institutions charged with regulation of the safety of the food supply, making of decisions that consider the wishes of others important in their lives when making decisions, use of multiple information sources to learn about food safety and believing what they read or hear, having the capacity and means to find food safety-related information, and being knowledgeable about food safety facts. However, neither rural residence group, regardless of milk/dairy preference, was distinguished by the way in which they process information. The rural/unpasteurized group was similar to the characteristics of the rural/pasteurized group except they characterized themselves as very conservative or conservative in their political views, and they were less likely to view food safety information as valid.

In contrast, the urban/unpasteurized group was liberal in political philosophy, was characterized by low belief in the seriousness of contracting a foodborne illness, had low trust in institutions responsible for the safety of the food supply, were not worried about the safety of drinking unpasteurized milk, made decisions independently of the influence of others, did not utilize information sources to support their decision to drink unpasteurized milk, and were not very knowledgeable of food safety facts. They were also characterized by low heuristic information processing. Like the urban/unpasteurized group, the urban/pasteurized group was liberal. However, this group felt a high degree of worry and anger about the safety of unpasteurized milk. They were not, however, active information seekers and were high heuristic information processors.

Overall, the greatest difference in distinguishing characteristics was between the rural/pasteurized and the urban/unpasteurized groups. The rural/unpasteurized group was similar to their corresponding rural residence group, but the strength of their characteristics was less distinguishing. This qualitative comparison of residence/milk preference groups is consistent with the qualitative outcomes from both discriminant analysis, which divided groups on the basis of participant responses to continuous variables, the HLM models that identified variables that best accounted for variation in the two information processing variables, and the identification of groups that accounted for significant outcomes of Crosstabs and ANOVA analysis.

DISCUSSION

The benefits of milk consumption are documented *(17)*. Nevertheless, there have always been concerns about the safety of milk and dairy products. In addition to bacterial contamination, which was the major concern at the turn of the 20th century, at the turn of the 21st century, more items have been added to the milk debate *(29)*. It would appear from the popular press that consumer concerns over food safety and milk choice continue *(10, 15, 32)*. These issues are especially important because many of them are considered "outrage factors" of risk perception, or those factors that amplify the perception of risks; notably, that they are involuntary, unfamiliar, and artificial, controlled by others, offer little benefit to the individual, or have delayed effects *(36)*. These concerns are not completely unfounded. Indeed, consumption of any food product carries inherent risks. However, what is needed is trusted sources of information that consumers can readily access to inform their decision-making process about how much (if any) and what kinds of dairy products to consume. A problem arises when people incorporate incorrect information into their decision-making heuristics. When it comes to milk and food safety, the conflicting information can lead to serious health consequences.

Prerequisite to consumer behavior change is perception of the hazard as a risk and belief that changing behavior will be likely to change risk (self-efficacy) *(19)*. Lack of behavior change may be a result of a perception that the risk does not apply to them. Most consumers suffer from unrealistic optimism, the belief that they are at less risk for negative food safety outcomes than others *(30)*. Furthermore, these individuals may not seek food safety information *(23)*, or they may have a lack of self-efficacy *(3)*, not feeling that changes made will make any difference in risk, or they may simply determine that the "costs" (e.g., time) involved in acquiring and processing information is too high, a phenomenon also known as the ignorant consumer hypothesis *(18)*.

Provided that risks are perceived, consumers may either do nothing or engage in behavior change, including information-seeking. But once information is found, then the next step in using it is to understand and process the information so that it can become a motivator to decision making. One possible behavioral change that may or may not be coupled with additional information processing includes election either to avoid risks completely by eliminating the food from the diet or to seek additional information. For milk, the first option carries with it unintended health risks. For example, in an older yet still relevant study *(2)*, almost 14% of U.S. households self-reported a food allergy. This rate is eight times higher than the 2% estimated true prevalence. Most (29%) respondents self-reported milk as the cause of these allergies. Based on the mere perception of negative impacts of specific foods, 75% of mothers reported making changes to diet without medical consultation. Such consumer-directed dietary manipulation causing the elimination of dairy products has been reported, resulting in increased severity of disease and even death *(16)*.

In spite of known public health hazards associated with consumption of unpasteurized milk, some consumers continue to accept personal health risk because they believe there are health benefits, such as fewer allergies and resolution of gastrointestinal malabsorption, that outweigh the risks from foodborne infections *(12)*. These beliefs are derived from a complex web of information, values and social context that

operate below the conscious level affecting how individuals define a problem, gather and process information, assess risks and benefits, and make decisions about issues that are communicated to them. The concept of mental models, a well-established theory in psychology and decision science *(25)* may explain why consumers choose to consume unpasteurized milk and dairy, with the result that people's mental models can also limit them to familiar patterns of reasoning and behavior. Effective analyses of these models provide insight into developing targeted risk communications that may broaden the boundaries of a target audience. Using mental models to inform risk communication by identifying what people already know and what they need to know has been the focus of extensive policy and management applications. A shortlist of these applications includes radon *(4)*, fruit and vegetable contamination *(27)*, and agricultural weed management *(35)*. Although such a summary is useful, these studies have also highlighted the underlying motivational and cognitive processes that are reflected in these beliefs, attitudes, and perceptions. Thus, understanding the mental models of unpasteurized milk consumers is critical for the design and delivery of effective and persuasive educational materials aimed at the safe and healthy incorporation of milk and dairy products in the human diet.

Our initial findings for this preliminary study are that there is not a single mental model for milk selection. Rather there are four distinct models unique to milk choice and residence, in part due to the individual worldviews characterized in this study, but strongly due to the simple location of their residence. The rural residents in the study were primarily from dairy-producer families or from communities that economically relied on the dairy industry. Most producer participants sold their milk to processing companies for pasteurization and sell to the public, but some of the families disclosed in the focus group portion of the study (data not shown) that they often withheld unpasteurized milk for family use. Other participants disclosed that they produced milk but distributed all or at least part of their product through cow- or herd-sharing arrangements with non-farm families. Direct sale of unpasteurized milk to the public is not legal in Ohio *(14)*. Still other rural-residing participants stated that they did not drink unpasteurized milk. If they produced milk, the product for personal consumption was first home pasteurized. Rural participants who were not direct producers of milk and who believed unpasteurized milk was unsafe said they purchased only pasteurized milk and dairy products for household consumption.

Rural residence, regardless of milk consumption preferences, shared major worldview characteristics that formed their mental model of milk and dairy preference. They shared a conservative political philosophy, the belief that foodborne illness is a serious health concern, the fact that their decision-making process was a function of the expectations of their referent others, and a belief that food safety information from media was biased. Notable differences were that the participants in the rural/pasteurized group were relatively younger than those in the rural/unpasteurized group, and they had high trust in the institutions charged with maintaining the safety of milk and dairy foods. The rural/pasteurized participants also were seekers of food safety information through a variety of information channels, and with their high information gathering capacity they were also the group (among all four groups) that was distinguished by their correct and current knowledge of food safety practices.

There was a distinct shift in the model characteristics of the unpasteurized milk participants who lived in urban areas and who obtained their unpasteurized milk primarily from herd-share groups. With the exception of their high scores on the liberal political philosophy scale, all other scores for the notable characteristics of the group were on the lower end of the scales scores. They were characterized by a belief that foodborne illness is not a serious health issue, and that government institutions are not trustworthy, and they make their own decisions regarding the type of milk and dairy they consume without the input of referent others or information they might find in media channels. They utilize food safety information only to the extent they feel necessary to get the facts they need, but they are also characterized by low knowledge of food safety.

The fourth group was the urban/pasteurized milk and dairy preference group. Of the groups, this one was a mixture of neutral to liberal political philosophy and self-doubt expressed in their views about the sufficiency of their food safety knowledge. They had mixed views on the bias and validity of food safety information from media channels, and yet they expressed the highest scores on the affect scales worry and anger about the safety of milk and dairy products. Their information processing style was heuristic, which indicates they were not gleaning useful information from their information sources that could guide them to make pro-active decisions about food safety. They purchased pasteurized milk, but the decision was more a function of availability and convenience than an informed choice based on knowledge and the information gathered on the safety of the food product.

We call the mental models that are shown in this pilot study as preliminary, on the basis of the small sample size. In some cases we accepted statistical measures that were below accepted standard *(27)*, as in the case of the internal consistency measures for information processing. Because of the importance of these variables to the model and the understanding that sample size can influence the statistic, we compromised on the standard for this measure (recommended minimum or 0.7 to 0.8) *(27)*. Nevertheless, we found compelling differences among these four groups that indicate the need for further study. There is another objective in the study that is yet to be completed. The preliminary study will be repeated with modifications for lessons learned and with a

larger and more geographically-representative survey sample. Also, we have not yet studied the complete model based on the RISP communication theory *(6)* and the Theory of Planned Behavior *(1)*. The reason is that we probed the participants' attitudes about food safety of milk and dairy product in the focus groups, obtaining information that is needed to craft the survey items that will measure the scope of attitudes and other variables in the Theory of Planned Behavior portion of the full mental model. Once completed, the final mental model will be more representative of the mental models of pasteurized- and unpasteurized-milk preference within the United States. The caveat to this statement is that the diversity of state laws within the United States make milk and dairy preference classification difficult and subject to exceptions. However, for educators who are responsible for creating and delivering risk communication messages to the public, the preliminary mental model provides valuable information on how people form their beliefs and make decisions about the safe consumption of milk. Even though incomplete, sufficient information was found in this study to immediately re-think how to craft educational messages that aim to improve the public health of milk and dairy consumers. There are also clues for institutional regulators about the beliefs of end-users of state laws governing the safety of the milk supply.

There are two take-away messages from this first study of milk and dairy consumption. First, there was not a single mental model of milk and dairy product preference. We have detected at least four different models to date. This, however, is subject to change as we complete our additional objective. The second message is that food safety knowledge and trust in regulatory institutions are important factors influencing milk choices, and that residence location strongly influences the belief structure that characterizes decision-making behavior. This new information shows government officials and educators how to begin re-evaluating their training and educational messages to account for the diversity we have detected among milk consumers, and how they are likely to receive new information.

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