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Jane Kolodinsky
University of Vermont

Sean Morris
University of Vermont

Orest Pazuniak
University of Vermont

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How consumers use mandatory genetic engineering (GE) labels: evidence from Vermont

Jane Kolodinsky[1] · Sean Morris[1] · Orest Pazuniak[1]

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Abstract

Food labels legislated by the U.S. government have been designed to provide information to consumers. It has been asserted that the simple disclosures "produced using genetic engineering" on newly legislated U.S. food labels will send a signal that influences individual preferences rather than providing information. Vermont is the only US state to have experienced mandatory labeling of foods produced using genetic engineering (GE) via simple disclosures. Using a representative sample of adults who experienced Vermont's mandatory GE labeling policy, we examined whether GE labels were seen by consumers and whether the labels provided information or influenced preferences. Nearly one-third of respondents reported seeing a label. Higher income, younger consumers who search for information about GE were more likely to report seeing a label. We also estimated whether labels served as information cues that helped reveal consumer preferences through purchases, or whether labels served as a signal that influenced preferences and purchases. For 50.5% of consumers who saw a label, the label served as an information cue that revealed their preferences. For 13% of those who saw the label, the label influenced preferences and behavior. Overall, for 4% of the total sample, simple GE disclosures influenced preferences. For a slight majority of consumers who used a GE label, simple disclosures were an information signal and not a preference signal. Searching for GE information, classifying as female, older age and opposing GE in food production significantly increased the probability that GE labels served as an information source. Providing such disclosures to consumers may be the least complex and most transparent option for mandatory GE labeling.

Keywords Genetic engineering · Bio-engineering · Labeling · GMO · GE · Genetically modified organism · Consumer behavior · Information

Abbreviations

BE	Bio-engineered
CATI	Computer aided telephone interview
FDA	Food and drug administration
GE	Genetically engineered
GM	Genetically modified
GMO	Genetically modified organism
USDA	United States Department of Agriculture
WTP	Willingness to pay

✉ Jane Kolodinsky
Jane.Kolodinsky@uvm.edu

Sean Morris
Sean.Morris@uvm.edu

Orest Pazuniak
Orest.Pazuniak@uvm.edu

[1] CDAE, University of Vermont, Morrill Hall, Burlington, VT 05405, USA

Introduction

Labels play a significant role in facilitating consumer choice in the case of credence goods; goods for which consumers cannot determine through search nor experience whether a product contains an attribute or quality they prefer (Caswell 1998; Caswell and Mojduszka 1996; Fulton and Giannakas 2016). Credence characteristics can impact the liking of food (Fernqvist and Ekelund 2014).

Labels typically provide information to consumers about a desired or undesired attribute, without changing their preference for that attribute (Nelson 1970, 1974). However, it has been asserted that "produced using genetic engineering" labels not only provide consumers with information, but may also send a signal that influences individual preferences. If labels signal more than information by influencing consumer preferences either for or against Genetically engineered (GE) foods, consumers lose autonomy and self-determination in their decision making (Siipi and Uusitalo 2011).

Vermont is the only US state to have experienced mandatory labeling of foods produced using GE. Simple disclosures, "produced using genetic engineering" or "partially produced using genetic engineering," were required on foods during July of 2016. Federal labeling legislation, signed into law by President Obama on 27 July 2016, superseded all pending state legislation (A bill: S. 764 2016). However, labels on packaged goods persisted for months and are still seen on a variety of food packaging. In early May of 2018 the United States Department of Agriculture (USDA) released a set of proposed disclosure labeling rules for genetically modified foods. These proposed rules include five main disclosure alternatives, only one of which is a simple text disclosure on packaging (USDA n.d.). The new language also changes the abbreviations GE, GM, or GMO to BE for bio-engineered. Because this study examined labeling before USDA's suggested wording change to BE, this paper uses GE nomenclature.

Using a representative sample of adults who experienced Vermont's GE labeling policy, this study is designed to answer two research questions: who saw the mandatory labels and, given a label was seen, was the label an informational signal or a signal that influenced preferences? This research contributes to the food labeling in general, and GE literature specifically. It is the first study to utilize data on mandatory GE labels in the United States to identify consumer characteristics associated with seeing "contains GE" in the actual marketplace. Additionally, importantly, the study examines characteristics of respondents associated with using label information to reveal preferences and characteristics associated with using labels to form preferences. This information is useful to policy makers currently designing both the federally legislated mandatory label symbol and associated label disclosure.

Literature review

The empirical literature presents mixed findings about the informational versus signaling impact of GE labels on consumer attitudes and/or preferences. Even less is known about how labels will impact consumer purchase decisions. Because the US marketplace has not experienced mandatory GE labeling, all research has been hypothetical, with the exception of Kolodinsky and Lusk (2018).

Hu et al. (2005) conducted experiments on the telephone with respondents to assess consumer utility for labeled or non-labeled GM bread products and found that a hypothetical mandatory labeling requirement resulted in higher consumer utility. Two controlled experiments concerning hypothetical consumption choices conducted by Costanigro and Lusk (2014) concluded that the signaling effects of GE labels on two types of foods were minimal and likely too small to be able to consistently detect. Similarly, Kolodinsky (2008) found that rBST labeling on milk provided cognitive information instead of sending signals associated with subjective feelings. Bansal et al. (2013) used an experimental auction approach in India and found that the informational cue of labeling was stronger than any negative signaling cue.

Research has also found labels to be a signal that influences attitudes and/or preferences. Huffman et al. (2003) used an auction-based experiment to conclude that labeling bias had a significant impact on participant decision making. Kanter et al. (2009) present experimental evidence that labeling non-rBST milk produced a stigma effect that reduced consumers' willingness to purchase conventional milk. Lusk and Rozan (2008) conducted a mail survey to elaborate an econometric model which demonstrated that consumers who believed that the US government had a mandatory labeling policy were more likely to believe that GM food was unsafe. Comparing the mandatory labeling requirements in the EU with the voluntary requirements in Canada, Gruère et al. (2008) conclude that mandatory labeling may actually have removed consumer choice because high costs of segmenting may have reinforced bias against foods with GE. Bukenya and Wright (2007) found similar results. In the only study of actual mandatory labeling situation in the US, Kolodinsky and Lusk (2018) compared Vermonters' opinions of GE foods with a national control group of respondents from regions outside of Vermont and New England before and after the enactment of the Vermont legislation. After controlling for key demographic characteristics, their difference-in-difference model found that Vermonter opposition towards GE technologies in food production decreased by 19%. That is, Vermonters were less opposed to GE after the mandatory labeling law went into effect.

While the above studies highlight labels as an informational cue or preference shifting signal, there is scant research on how information or signals translate into consumer behavior. Cook et al. (2002) found that a positive 10% change in attitude reduced the number of people with a strong intention not to purchase GE foods by 10.08%. Vecchione et al. (2014) found significant correlations between attitudes and behavior, and knowledge and behavior. Willingness to pay (WTP) studies using either survey or experimental approaches consistently find that consumers require a discount to purchase foods produced using GE. The general finding across studies is a lower WTP for GE goods when compared to non-GE goods ranging from 1 to 21% and \$0.023 to \$0.90 per unit of respective product (Bruno and Campbell 2016; Bukenya and Wright 2007; Colson et al. 2011; Huffman et al. 2003; Wachenheim and VanWechel 2004). While a premium for non-GM goods is common, between 32 and 53% of consumers are never willing to pay any premium (Bruno and Campbell 2016; Loureiro and Bugbee 2005; Loureiro and Hine 2002). However, whether a

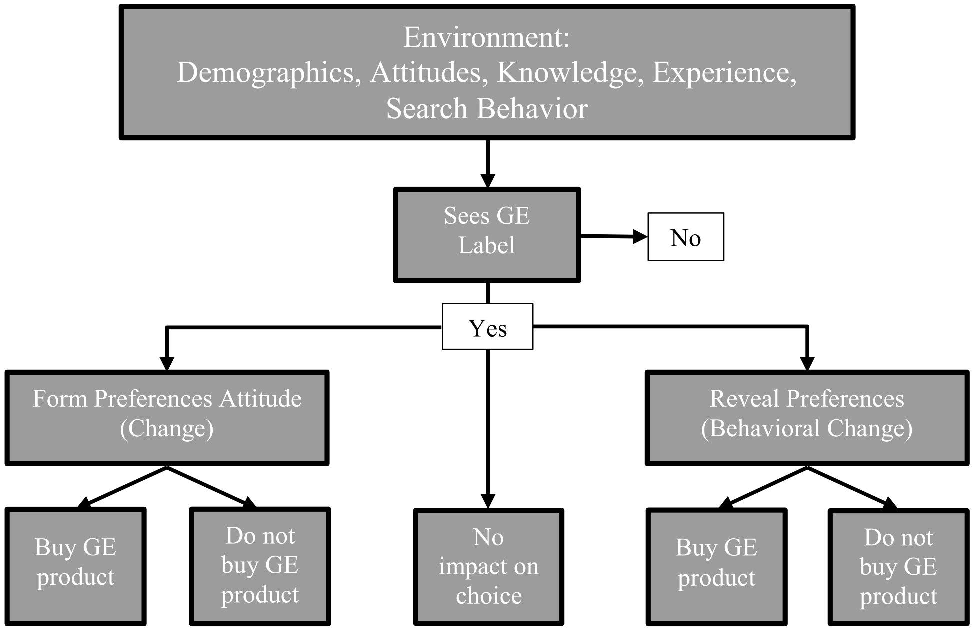

Fig. 1 Model of impact of GE labels on consumer decision making

label acts as an information cue that reveals preferences for non-GE alternatives or serves as a signal that forms preferences is not known from experimental WTP studies that introduce hypothetical labeling scenarios. Did the labels change preferences and lead to a lower WTP? Or, did the labels serve as an informational cue that revealed less preference and thus lower WTP for GE foods?

To date, there is no consistent answer in the literature as to whether mandatory GE labels provide information or send a signal that changes preferences. In short, we know little about how labeling policy actually impacts consumer choices. This study seeks to fill this void using data from Vermont, the only US example of mandatory "produced or partially produced using genetic engineering" disclosures.

Conceptual model

The study of consumer behavior has long recognized the importance of both cognition and affect on choice (see, for example, Peter and Olson 2009). Cognition refers to thinking, including knowledge and beliefs about a product. Affect refers to feelings, including liking and disliking a product. There are several other significant theoretical perspectives commonly employed to examine the impact of mandatory GE labels on consumer behavior. First, we consider *consumer autonomy theory*, which draws from philosophical ethics and emphasizes the role of free choice in consumer decision making (Beauchamp 2005; Beauchamp and Childress 2001; Markie 2007; Siipi and Uusitalo 2008). Autonomous choice is one in which a consumer refers to their self-determination to make choices in the marketplace. Autonomy assumes authenticity; that is, authentic desires come without coercion or influence (Siipi and Uusitalo 2011). This is not incongruent with *revealed preference theory* in microeconomics in which preferences are given in a choice situation and are revealed through purchase (Samuelson 1938).

Both the ideas of autonomy and revealed preferences allow empirical modeling with choice as the outcome, and both assume that preferences are given and drive choice behavior. Neither theory stipulates that choices made are inherently "good" or "bad," only that consumer preferences are the basis of choice. A third theory is stigma theory, rooted in transdisciplinary risk theory and found in the fields of sociology, marketing, communication, and consumer behavior (see, for example: Ellen and Bone 2008; Gregory et al. 2001; Link and Phelan 2001; Scholderer and Frewer 2003). Stigma implies a negative reaction by consumers. For example, if a label implies a product is risky, consumers may not make a purchase. Given the possibility of both stigma and reassurance of labels, we must not assume that consumers will only have negative reactions to a product characteristic, but also consider the possibility that labels might have the opposite effect, as found by Kolodinsky and Lusk (2018).

We conceptualize the above discussion into the model in Fig. 1. Environmental variables, including consumer demographics, attitudes, beliefs, knowledge, experience with labels, and search behavior impact whether or not people observe a GE label. Given a label is observed, there are three paths. The first is that the label influences consumer attitudes, either stigmatizing or reassuring them about GE technologies used in food production. In this scenario, labels form consumer preferences and influence behavior. The second path is that labels inform consumers that the product was produced using GE. It does not form their preferences, but helps to reveal preferences, prompting the consumer to either choose or avoid the product. The third path is that the label is observed but is of no consequence in a purchase decision.

Data

Our study uses data from a survey of Vermont residents conducted in the fall of 2016 and the spring of 2017. The study was approved by the institutional review board of the University. All interviewers were trained and administered computer-aided telephone interviews (CATI). Response data were secured electronically on a password-protected server at the University of Vermont. The sample of called respondents was drawn using area code exchanges for landlines and cellphones in Vermont. Respondents who were not currently living in Vermont or under the age of 18 were screened out. Follow-up calls were placed at various days and times of the week if there was a busy signal or no answer. Any given phone number was called a maximum of three times. Consistent with current trends in phone subscriptions, a majority of the respondents (64.0%) were reached on a cell phone.

A total of 1034 responses were collected; 942 respondents had complete information required for the multivariate analysis. The results based on a group size of 942 have a margin of error of ±3.19% with a confidence interval of 95%. The sample is similar to Vermont with regard to income distribution, gender, race, and ethnicity. As is typical with phone surveys, the sample is older and more educated than the general population. Telephone surveys still reach a large portion of the population (Marken 2018). A majority of respondents were either opposed or very opposed to the use of GM in food production, about one-fifth were neutral, and a little over one-fifth were supportive. More than half of all respondents identified GM as a "transfer of genes that would not occur in nature," a modified version of the definition used by the World Health Organization (2014).[1] Almost a quarter of respondents reported that they search for information about GE (active search), while almost one-half reported paying attention to information if it "catches their eye" (passive search). A majority of respondents consult front of package labels, use ingredient lists, utilize nutrition information, and notice organic and natural labels on foods. Table 1 provides a summary of key demographic and response characteristics for the respondents.

Table 1 Summary statistics for selected demographic and response

Variable	Proportion
Data collection period (n = 942)	
Fall 2016	41.4%
Spring 2017	58.6%
Gender (n = 942)	
Female	52.7%
Male	47.3%
Age (continuous) (n = 942)	54.9
Standard deviation	16.6
Education (n = 942)	
Less than a bachelor's degree	49.2%
Bachelor's degree or more	50.8%
Income (n = 942)	
Income less than $50,000	44.7%
Income greater than $50,000	55.3%
Hispanic/Latino (n = 923)	
Not Hispanic/Latino	98.2%
Hispanic/Latino	1.8%
Race (n = 903)	
White	96.9%
American Indian or Eskimo	1.3%
Black or African American	1.0%
Asian or Pacific Islander	0.8%
Some other race	0.0%
In a family with children (n = 942)	
In a family with children	28.7%
Not in a family with children	71.3%
Support of GMOs in food supply (n = 916)	
Strongly support	6.1%
Somewhat support	15.7%
Have no opinion	21.4%
Somewhat oppose	24.0%
Strongly oppose	32.8%
Identify GM (n = 942)	
Identify GM as "Transfer of genes that would not occur in nature"	55.5%
Identify GM as "Transfer of genes that would/might occur in nature"	44.5%
Search attributes (n = 942)	
Active search	22.9%
Passive search	47.2%
Consults product info on front of package	52.3%
Consults ingredient list	79.7%
Consults nutrition information	80.8%
Notices organic food label	59.3%
Notices "natural" food label	51.0%

Figure 2 identifies the paths taken by the sample of respondents with regard to seeing a label, whether the label

[1] WHO defines genetically modified foods as: "organisms (i.e. plants, animals or microorganisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination."

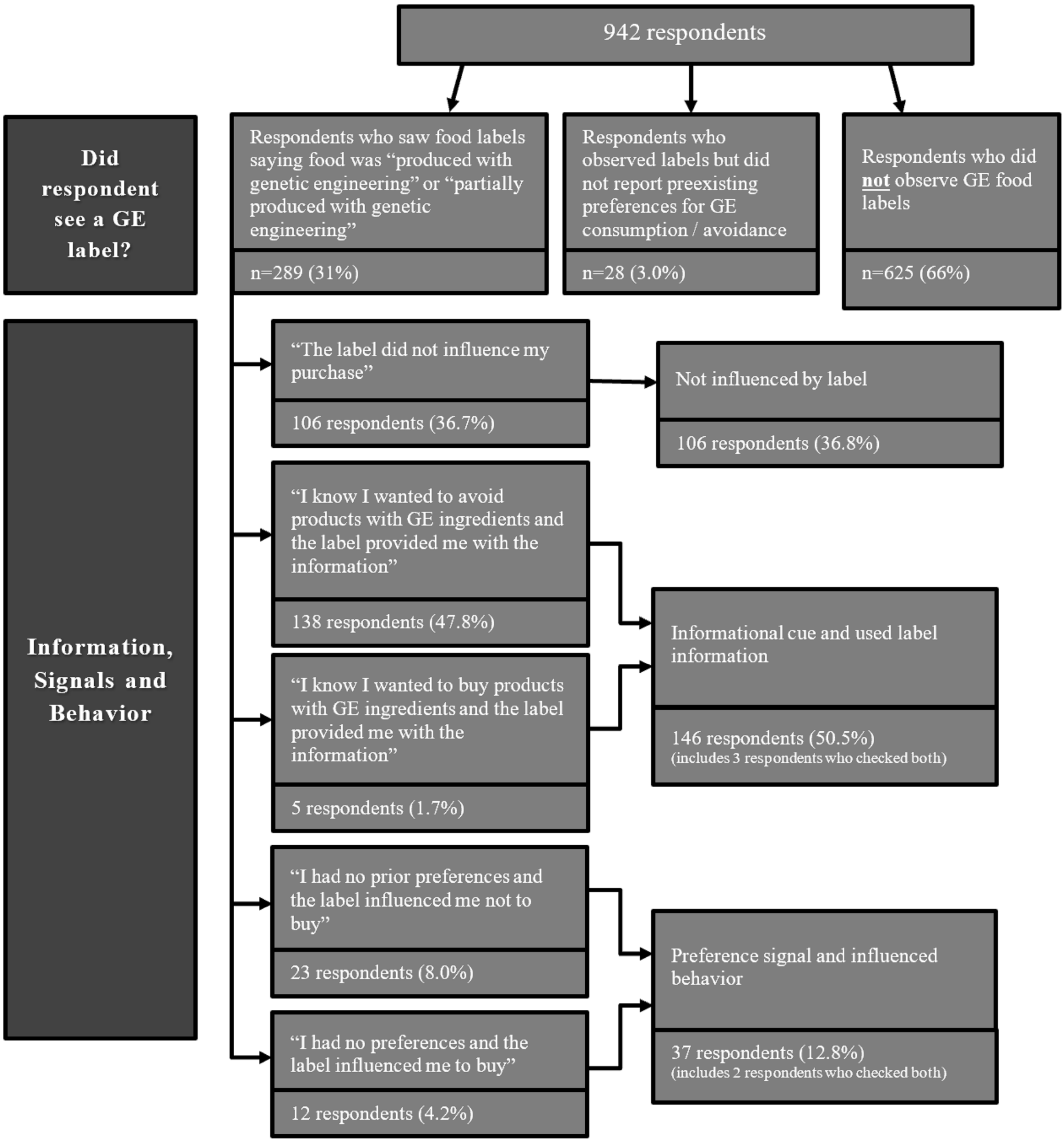

Fig. 2 Breakdown of respondents who saw and used and did not use GE labels in purchasing decisions

was an information cue that revealed preferences or a signal that changed attitudes which led to behavior.

Statistical model

This analysis used Heckman's (1979) sample selection model to examine whether an individual saw a label and, if so, whether and how purchasing behaviors changed as a result. To do this, a categorical "preference/choice category" variable was constructed to specify three groups

Table 2 Sample selection model estimates of seeing a GE label and use of label information

Variable	Binomial probit estimate: saw label	Marginal effects of estimates		
		Did not use label	Information cue and used label	Preference signal and used label
Income \$50,000 or greater	0.070** (0.031)	0.008 (0.145)	−0.025 (0.211)	0.016 (0.168)
"GMO" is transfer of genes that would not occur in nature	0.033 (0.031)	−0.078 (1.904)	0.100 (0.663)	−0.021 (0.267)
Spring data collection	−0.025 (0.030)	−0.090 (0.168)	0.060 (0.138)	0.029 (0.286)
Female	−0.029 (0.030)	−0.168** (0.071)	0.179** (0.066)	−0.010 (0.409)
Bachelor's/professional degree	0.049 (0.031)	0.005 (2.758)	−0.059 (0.241)	0.053 (0.110)
Family with children	−0.012 (0.034)	−0.059 (0.277)	0.086 (0.190)	−0.026 (0.170)
Age	−0.004*** (0.000)	−0.003 (0.003)	0.005* (0.002)	−0.001 (0.002)
Oppose or strongly oppose GE	−0.019 (0.042)	−0.332*** (0.065)	0.441*** (0.052)	−0.108** (0.050)
Support or strongly support GE	0.027 (0.047)	0.365*** (0.096)	−0.269* (0.159)	−0.095 (0.105)
Active search dummy	0.245*** (0.050)	−0.470*** (0.072)	0.456*** (0.086)	0.013 (1.396)
Passive search dummy	0.131*** (0.039)	−0.437*** (0.064)	0.351*** (0.096)	0.085 (0.158)
Consults product information on front of packaging (low fat, reduced calorie, etc.)	−0.094*** (0.032)			
Consults ingredient list	0.026 (0.045)			
Consults nutrition information	0.004 (0.044)			
Looks for labeling indicating food is organic	0.023 (0.037)			
Looks for labeling indicating food is "natural"	0.073** (0.034)			
Estimated probability at data means		.36	.49	.15

N = 942 respondents. Standard errors in parentheses. Multinomial logit with selection computed marginal effects at the mean

***, **, *Indicate significance at the 1%, 5%, and 10% level

of respondents who observed labels. These groups are described in the tree diagram in Fig. 2.

We first estimated the probability of seeing the label using a binomial probit model. The first stage model included the variables income (dummy = 1 for income greater than \$50,000), define GMO (dummy = 1 if respondent indicated a transfer of genes that would not occur in nature), time period (dummy = 1 for Spring 2017 vs. Fall 2016), gender (dummy = 1 for female), education (dummy = 1 for Bachelor's or professional degree), family with children (dummy = 1 if household has children under the age of 18 present), age (continuous), opposition to GMOs used in food production (dummy = 1 if opposed or strongly opposed), support for GMOs used in food production (dummy = 1 if support or strongly support), active seeking of information on GMOs (dummy = 1 if seek out information), passively seeking information on GMOs (dummy = 1 if pays attention if it "catches my eye"), use of other types of food labels (dummy = 1 if uses "natural" labels; dummy = 1 if uses organic labels), uses front of package information (low fat, reduced calorie, etc.) (dummy = 1 if yes), consults ingredient list (dummy = 1 if yes), and consults nutrition information (dummy = 1 if yes).

We next estimated the preference/choice category of the respondent with a sample selection/multinomial logit model that provided marginal effects at the means (MEMs) which accounted for the first stage of whether or not a label had been observed.

Results

Column 1 of Table 2 presents results of the first state binomial probit that estimated whether or not the respondent saw the label. The variables age, actively seeking information on GMOs, passively seeking information on GMOs, and consultation of information on the front of packaging were significant and negatively associated with seeing a GE label. Being above median income, active and passive search, and using natural labels increased the probability of seeing the label.

Columns 2, 3 and 4 of Table 2 present results of the second stage multinomial logit model that predicted preference/choice categories, given a label was seen. The predicted group percentages at the mean values of the independent variables were 36% for not being influenced by the label, 49% for using the label to reveal preexisting preferences, and 15% for being influenced by the label without a preexisting preference. The model estimates parallel the descriptive data: 36% of respondents reported not being influenced by the labels they saw, 49% used the label information to reveal their preference, and 15% reported being influenced by the label.

In the multinomial logit model, gender was significant for the first two preference categories. That is, being a female was related to a respondent being less likely to not be influenced by the label and more likely to use the label as information that helped reveal their preferences through a purchase. Opposition to GE was significant for all three types of preference categories at the 1% level. Respondents who reported being opposed to the use of GMOs in the production of food were more likely to use the label information to reveal their preferences through purchase and less likely to either not use the label or to use the label as a signal that influenced preferences and purchase decisions. Support for GE increased the probability of not using the label and decreased the probability of the label information being used to reveal preference through purchase. Both active and passive seeking of information significantly decreased the probability of not using the label and increased the probability of using the label as information that helped reveal preferences through purchase.

Discussion and conclusion

The answer to our first research question, "did consumers see the mandatory GE label?" is yes, in part. More than one-third of respondents reported seeing GE label. This figure is similar to that found by Christoph et al. (2018) for the percentage of participants that used nutrition facts labels frequently (31.4%). Of these, about two-thirds of label readers used ingredient lists (Christoph et al. 2018). Others have reported that about half look for ingredients on labels (Ollberding et al. 2011). In the present study, purchase decisions were not affected for about one-third of respondents who saw GE labels. An FDA study found that 57% of people who don't use labels "buy what their family likes" (Lin et al. 2016). Our results are not out of line with other food label use. However, while there is a large body of literature about characteristics of people who use labels and whether label use leads to behavior change, there is scant literature on the prevalence of label use with regard to specific ingredient characteristics not on the ingredients list, but available elsewhere on a food package Thus, there are few comparisons that can be made with our results concerning GE label use and previous research.

Our second research question was, did labels convey information or change preferences? For about half of respondents who saw labels, the label provided information on which they based their purchases of GE-containing or GE-free foods. For about 15% of respondents, the label served as a signal that formed preferences and influenced their purchases of GE-containing or GE-free foods. Estimates using a multivariate model predicted responses that fell into these three categories within 2% points of the raw data values.

For about one in eight consumers who saw the label and 4% of the total sample, the mandatory GE disclosure acted as a signal to inform preferences and influence behavior. Further, 47.8% of these people used the label to avoid foods produced using GE and almost 1.7% used the label to purchase such foods. As noted by Costanigro and Lusk (2014), there is little evidence of a negative signaling effect of labels. In our study, it was less than 2% of the sample. Lack of significant predictor variables for those respondents who did not have preexisting preferences suggests that consumers whose preferences may be influenced by labels may not be easily identified.

For one in two consumers who saw the label, and 15.5% of the total sample, labels acted as an information cue. These consumers used the label to reveal their preferences. The majority of these, 96.5%, desired to avoid foods produced using GE, and 3.5% used the information to purchase foods produced using GE. Gender (female), age (older), being opposed to GE used in food production and actively or passively searching for information were characteristics that increased the probability of using labels as an information cue. This indicates that about 15% of consumers will avoid GE foods if they are labeled with a simple disclosure.

For more than one in three consumers who saw the label and 11% overall, the label was not related to a purchase decision. Gender (male), being supportive of GE used in food production, and not actively or passively searching for information were characteristics that increased the probability of not using label information.

As the US government moves forward with the implementation of the National Bioengineered Food Disclosure Standard, our results show that, for a slight majority of respondents who indicated they used the labels with simple disclosures, labels were an informational source that helped with decision making. For a small percentage of respondents, labels were a signal that influenced preferences and purchase behaviors. Simple disclosures on labels are only one of five proposed ways to provide consumers with information. Websites listing more information, phone numbers on packaging to call or text message for product information, "scan here for more information"-type QR codes, and "Bioengineered" icons are also proposed. This study cannot provide any insight into these other disclosure methods. That said, because simple disclosures provided the information consumers needed to make their purchase decisions, this method makes sense. Full information is on the package, there is no complexity or extra time or equipment needed to access the information, and the information does not act as a warning against GE for 96% of consumers included in this study.

Groups supportive and opposed to GM both use arguments based on sustainability, environmentalism, and social and economic development, but the exact long-term benefits and risks posed by the use of GM remain unclear (Kolodinsky 2018; Perry et al. 2016; Zhang et al. 2016). Additionally, while at the present time foods produced using GE have not been found to harm health, there is an emergence of literature highlighting shortcomings in research about the benefits of GE on society (Catacora-Vargas et al. 2018). US consumers will be increasingly able to make choices about consumption of GE foods with the implementation of mandatory labeling of products produced using GE, expected in 2020 (USDA 2018). Consumers need information in order to make utility maximizing decisions in the marketplace. Based on evidence from the only policy initiative in the US that required mandatory GE labels, we conclude that simple disclosures work. For those that use labels, simple disclosures provide information that aids in decisions that maximize consumer utility.

Based on our results, it is unlikely that mandatory GE labels with a simple disclosure will cause a collapse of GE agricultural production methods, as feared by label opponents. Instead, they should help markets work more effectively. By providing information, consumers who desire to either purchase or avoid GE foods can make decisions that meet their needs. This result is similar to that found with voluntary rBST free labels; the labels provide information for consumers (Kolodinsky 2008). Consumers who do not read GE labels will continue to rely on product characteristics that meet their needs.

There are limitations of this study. The data used in this study are cross sectional, thus this analysis is limited in the extent to which any kinds of causal links can be determined. This study was completed in only one US state. As is typical with phone surveys, the sample is older and more educated than the general population. However, it is important to note that telephone surveys still reach a large portion of the population (Marken 2018). Despite these limitations, this is the only study that we know of examining the signaling effect of a mandatory GE labeling policy in the U.S., as Vermont has been the only state to implement such a policy.

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Jane Kolodinsky, PhD, is a Professor and Chair of the Community Development and Applied Economics (CDAE) Department at the University of Vermont and Director of the Center for Rural Studies. Dr. Kolodinsky specializes in applied economics-the application of the concepts of demand, consumer behavior, and marketing principles to improve consumer wellbeing.

Sean Morris holds an MS degree in Community Development and Applied Economics from the University of Vermont.

Orest Pazuniak holds an MS degree in Community Development and Applied Economics from the University of Vermont.