Vol.32, Special Issue, pp.147-167, 2020

Journal of Agricultural, Life and Environmental Sciences

RESEARCH ARTICLE

pISSN 2233-8322, eISSN 2508-870X
https://doi.org/10.22698/jales.20200014

Food Label Utilization Rate Analysis Based on Purchasing Situation and Recall Experiments

Ji, J. H.[1], S. H. Kim[2*] and S. H. Lee[3]

[1]Researcher, Department of Agrifood System Research, Korea Rural Economic Institute, Naju 58217, Korea
[2]Research Fellow, Department of Agrifood System Research, Korea Rural Economic Institute, Naju 58217, Korea
[3]Assistant Professor, Department of Agricultural and Resource Economics, Kangwon National University, Chuncheon 24341, Korea

***Corresponding author:** Kim, S. H. (E-mail: skim@krei.re.kr)

Received: 10 September 2020
Revised: 26 September 2020
Accepted: 29 September 2020

A B S T R A C T

The present study evaluated what kind of knowledge could be useful to improve the food label utilization rate by consumers and whether it differed considering the characteristics of the products. A better understanding of the consumer perspective on food label utilization may help stablish future commercial and marketing plans for different products. The collected data revealed that the food label utilization rate may vary depending on the perception of consumers on how important the food label may be during the purchasing process. Therefore, in order to enhance the food label utilization rate by consumers, it is necessary to find ways to promote the food label program and raise awareness among consumers on the importance of food label information.

Keywords: Consumer perception; Food information, Food label, Recall experiment

Introduction

Information asymmetry in the market economy can be one of the factors that negatively affect consumers (Kim et al., 2014). The food labeling system is a system that provides food information necessary to consumers to resolve this information asymmetry. The use of the food labeling system enables consumers to easily grasp the attributes of food and at the same time exercise the right to know, one of the sovereignty of the people.

However, the purpose of the food labeling system may not be fully realized due to the complicated method of providing food information and the lack of awareness of consumers. In this respect, the lack of consumer awareness of food labeling and poor use of food labeling can be pointed out as a problem of the food labeling system. If consumers do not confirm or do not understand the food labeling system, it may be difficult to assess that the food labeling system has fulfilled its intended purpose, and it may be difficult to create additional economic value. Therefore, the use of food labels by consumers has very important economic and policy implications, and research on the use of food labels by consumers is required.

© Journal of Agricultural, Life and Environmental Sciences. This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (http://creativecommons.org/licenses/by-nc/4.0) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

To find out whether consumers actually use food labeling, many previous studies have used a survey method asking consumers whether to use food labeling. However, due to the limitations of the survey method, there can be biased results in the utilization rate of food labels in these studies. In previous studies on the utilization rate of food labeling (Bleich et al., 2015; Zhang et al., 2017; Christoph et al., 2018; Bonanni et al., 2013; Grunert et al., 2010), the utilization rate of food labeling showed a wide difference from 24.5% to 76%.

These differences in the degree of use of food labels may vary depending on the country, product, and social factors, but may occur due to the limitations of the investigation method due to the inaccuracy of the virtual experiment. The hypothetical situation can make the possibility or incentive to give an artificial response in the direction the subject wants than the actual situation (Lee et al., 2015). This means that there is a possibility that the subject will respond positively if the given situation is perceived as good, and respond negatively if it is perceived as bad. Therefore, the results of hypothetical experiments can lead to biased results.

Therefore, in order to accurately evaluate whether the original purpose of the food labeling system is being properly achieved, a method that can reduce the measurement bias of the existing questionnaire survey method and measure the utilization rate of food labeling more precisely will be needed. If we can more accurately measure how much consumers actually use food labeling, it will be of great help in understanding and improving the utilization rate of food labeling from a policy perspective.

Therefore, in order to understand the utilization rate of food labeling by reducing the measurement bias compared to the existing research, this study attempts to measure the utilization rate of food labeling through simple purchase situation experiment and recall questionnaire experiment. The recall question here refers to the experimenter asking the participant to respond to the question by reminding the situation given at the time of the action after the participant has performed a specific action. At this time, as the time point of questioning the participant is far from the time point of action, the reliability of the data obtained through the recollection questioning experiment is likely to decrease (Philip et al., 2008). Therefore, this study first conducted a purchase situation experiment in which the participant can use the food label, and immediately used a recall questionnaire experiment in which the participant was asked to confirm whether or not the food label was used.

Using this purchase situation experiment and recall questionnaire experiment, this study aims to measure the utilization rate of food labeling by reducing the measurement bias, and to derive implications for promoting the food labeling system from the perspective of consumers. To this end, the analysis performed in this study along with the purchase situation experiment and recall questionnaire experiment are as follows. First, in order to find out what kind of knowledge provision is useful to increase the utilization rate of food labeling by consumers, this study analyzed the food labeling utilization rate according to the difference in prior knowledge. Second, this study analyzed whether there is a difference in the food label utilization rate of consumers according to the characteristics of the item.

The reason this study proceeds with such an analysis is that there have been no studies on the types of knowledge provided and the characteristics of items that have an effect on the use of food labeling in previous studies. Existing

studies have analyzed the relationship between specific information or knowledge and the use of food labeling, but no analysis has been made on how different the use of food labeling depends on the type of knowledge. For example, Cavaliere et al. (2017) studied the relationship between the Italian health guide program and consumers' use of food and nutrition information labeling, and it was analyzed that the health guide program was an effective factor in enhancing the consumer's use of food labeling. In addition, Cho and Yoo (2007) studied the nutritional knowledge and food nutrition labeling of high school girls, and found that there was a significant correlation between the level of nutrition labeling confirmation and nutritional knowledge. However, there is a limit to grasping what kind of knowledge is more useful to increase the utilization rate of food labels by consumers from these studies. On the other hand, it was found that no research on the relationship between the characteristics of items and the use of food labels has been conducted. In a study on middle school students' preference for processed foods and the use of food nutrition labeling (Park et al., 2008), they investigated the processed foods that middle school students prefer and analyzed whether middle school students use the food labeling of the item. The analysis of whether consumers' use of food labeling is different according to the characteristics of items has not been conducted.

In complementing the limitations of these preceding studies, the results of this study are considered to provide additional useful information in terms of government food-related policy establishment and corporate market analysis.

Experimental method

Recall questionnaire experiment through online survey

The purchase situation experiment and the recall questionnaire experiment in this study are an experiments in which the participant responds to the question by reminding the subject about the situation given at the time of the purchase action after the participant has made a purchase action in a given situation. This study was conducted in August 2018 in an online survey of consumers across the country.

In this study, first, a product picture was provided on the screen and the product purchase decision was made. In order to reduce the bias that occurs when there is no actual payment in the purchase situation and when the purpose of the experiment is recognized by the experiment participant in advance, this study encourages subjects to participate in the purchase situation experiment without any prior mention of food labeling. The experiment was designed so that 10% of randomly selected participants actually purchase the product. The actual purchase cost of the product was paid by subtracting the product price from the participation fee (10,000 won), and the product was mailed to the participants.

In this study, the product photos disappeared on the screen after the experiment participants made a purchase choice for a product. When the product picture disappears, a question is provided. The recall question experiment was designed to display all the information (brand, country of origin, price, nutrition labeling, organic certification

labeling, GMO labeling, etc.) remembered about the presented product in the purchase selection situation. This recall questionnaire experiment allows participants to grasp how much food labeling is perceived by participants in the purchasing selection process.

On the other hand, if only one product with a food label on the screen is provided, participants can recognize the food label more easily than when actually purchasing the product. Therefore, this study designed an experiment providing pictures of various products with different brands, designs, prices, and food labeling so that participants can choose whether to purchase under conditions similar to the actual purchasing environment. All products used in the experiment consist of products that can be encountered in the actual market, and actual price information of each product is provided together.

Also, whether or not food labeling is used in product selection may be related to consumers' preferences toward time. Therefore, this study included a questionnaire that measures the preference of the experiment participants to the time in order to analyze the food label utilization rate by grasping consumers' preference toward time. In this study, participants were presented with the amount that they could receive after 1 month and the amount that they could receive after 13 months as 20 options, whose discount rate decreases as the order goes backward, and make the participant selects 20 options. This study evaluated the participant's preference toward time at the point where the participant's choice changed during the participant's sequential selection of options. In other words, a participant whose choice was changed at a point close to the last one of the 20 options was considered as a participant with low value for time.

This study was organized by dividing the online survey into three parts. The first part of the survey consisted of a participant's selection of purchased products and a recall questionnaire, and the second part consisted of a survey of participants' demographic information, and the last part consisted of a questionnaire that measures the participants' preference toward time.

Analysis of differences in the utilization rate of food labeling according to the content of knowledge provided

In order to find out what kind of knowledge provision is useful to increase the utilization rate of food labeling, this study provided promotional videos for certification labeling, medical knowledge, and health knowledge and asked participants to choose whether to purchase one product among multiple products. In the next step, a recall questionnaire experiment was conducted to find out which food label participants remembered.

For the experiment, this study selected eggs, buckwheat tea, and cheese as representative products suitable for the experiment. Those products displayed in various brands, designs, prices, and food labels in actual purchasing environments such as hypermarkets and supermarkets. The actual product was photographed and presented to the experimental participants, as shown in <Fig. 1>. Two different products for each item were presented to the participants, one of which was presented with a food label.

Fig. 1. Example of the selection experiment according to provided information.

Before presenting product photos to participants, this study randomly classified participants into four groups. Among the four groups, the first group provided health-related knowledge, the second group provided medical-related knowledge, the third group provided a promotional video for the certification label, and the fourth group provided no knowledge. The contents of knowledge provided to participants in this study are shown in <Table 1>.

Table 1. Information provided by the group

Health related knowledge	"To reduce the intake of food additives, use white milk rather than sweetened milk, water rather than drinks, fish rather than fish cake or canned fish, potatoes or corn or chestnuts rather than snacks, meat dishes rather than ham or sausage, and frozen milk or frozen milk rather than ice cream. If you eat natural foods such as fruit juice, you can reduce the amount of food additives you inadvertently consume. If you eat processed foods or sliced packaged vegetables or fruits, choose a product that contains less additives, and wash or blanch with water to remove food additives before consumption."
Medical related knowledge	"Antibiotics used in livestock have contributed to the emergence of resistant strains such as Salmonella spp., Campylobacter spp., Escherichia coli, and Enterococcus spp. Research from the United States and Europe shows that these resistant strains can infect humans, and that treatment with antibiotics previously prescribed is impossible."
Certification label promotional video	National Certified Agricultural Food Promotional Video

Note: The sources of each information are Wikipedia (Health), Seoul National University College of Medicine, National Health Knowledge Center (Medicine), and the Ministry of Agriculture and Food (National Certified Agricultural Food Promotional Video).

This study focused on the use of certification labels (antibiotics and HACCP) of participants in this experiment. It was measured whether the indication was accurately memorized. At this time, if the participant correctly memorized the certification label on the purchased product, this study considered it as the participant used the food certification

label. On the other hand, if the participant answered that they remembered the information that was not in the actual product, the participant was treated as not using the food label. In addition, this study recorded the number of times participants accurately indicated each product's certification label for each participant.

After the participant's purchase choice and recall questionnaire experiment, this study presented participants a questionnaire consisting of questions about demographic information and questions that measure their preference toward time. The development of the experiment designed in this study to analyze the difference in the utilization rate of food labeling according to the content of knowledge provided is summarized as shown in <Fig. 2>.

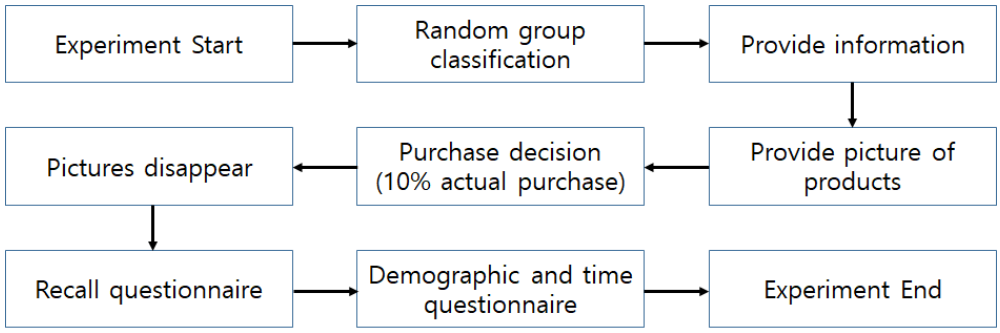

Fig. 2. Diagram of the selection experiment design according to prior knowledge.

Analysis of differences in food labeling utilization rates according to the characteristics of items

In order to find out whether there is a difference in the utilization rate of food labeling among consumers according to the characteristics of the item, this study first asked the participants of the experiment to choose whether to purchase or not purchase various products by item. After the participants selected whether or not to purchase a product, this study conducted a recall questionnaire experiment to find out whether or not they remember a specific certification label(antibiotic-free, HACCP).

This study established the following three hypotheses as it was determined that consumers' use of the certification label may differ depending on the characteristics of the item. The first hypothesis is that in the case of products that are repeatedly purchased frequently, the utilization rate of the certification label is low, and the second hypothesis is that the utilization rate of the certification label is high for fresh food, and the last hypothesis is that the utilization rate of the certification label is low for cheap products.

For the experiment, in this study, actual products were photographed and tested by selecting eggs, buckwheat tea, young leaf vegetables, oyster mushrooms, bean sprouts, cheese, sesame leaves, sesame oil, and acorn jelly, which are representative products suitable for the experiment and have many products marked with the certification label. Those products were presented to the participants as <Fig. 3>.

In addition, in order to verify the first hypothesis that the label utilization rate is low in the case of products that are frequently purchased repeatedly, this study investigated the purchase frequency of each item through a questionnaire.

Fig. 3. Example of a selection experiment according to the characteristics of the items.

This study measured whether participants remember the certification label actually displayed on each product through a recall questionnaire experiment. First, this study showed participants pictures of products with different product characteristics for 10 seconds. Each participant chose whether or not to purchase for three products randomly selected from a total of nine different products. After the purchase selection was completed and the product picture on the screen disappeared, this study required participants to display information (brand, country of origin, price, nutrition labeling, organic certification labeling, GMO labeling, etc.) they remember about the product given in the selection situation set. Through this, this study will be able to determine how much the participants perceive the certification label in the purchase selection process and whether there are significant differences for each product.

In this experiment, if the participant accurately remembered the food certification label displayed on each product presented to the participant, it was considered that the participant used the food certification label. The experimental development of the analysis of the difference in the utilization rate of food labeling according to the characteristics of items performed in this study can be summarized as shown in <Fig. 4>.

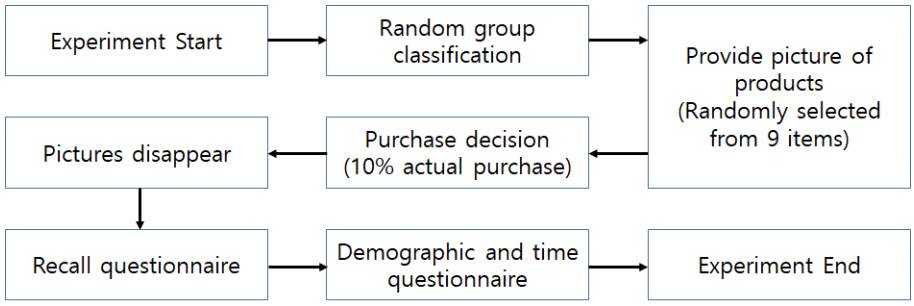

Fig. 4. Design of the selection experiment according to the characteristics of the item.

Estimation method and data

Analysis of differences in food labeling utilization rates according to the content of prior knowledge

Estimation method

In the analysis of the difference in the utilization rate of food labeling according to the content of prior knowledge, the dependent variable has a value ranging from 0 to 3 as many as the number of each product's certification labels remembered by each participant. Since the dependent variable has left and right cutoff values of 0 and 3, a two-limit tobit model can be used as an analysis model. Also, because the dependent variable has a ranking, an ordered logit model also can be considered.

First, in the two-limit tobit model, the continuous latent variable y_i^* consists of an explanatory variable vector x_i, a coefficient vector β, and an error term ε_i. Here, the error term is set to $\varepsilon_i \sim N(0, \sigma^2)$. The value y_i that we can observe considering the latent variable y_i^* in the two-sided truncation of 0 and 3 can be expressed as Equation (1).

$$y_i^* = \beta' x_i + \varepsilon_i, \quad i = 1, 2, ..., I$$

$$\begin{aligned} y_i &= l_i \ \text{ if } y_i^* \le l_i \\ y_i &= \beta' x_i + \varepsilon_i \ \text{ if } l_i < y_i^* < u_i \\ y_i &= u_i \ \text{ if } u_i \le y_i^* \end{aligned} \tag{1}$$

Here, l_i and u_i refer to the left-censoring limit and the right-censoring limit, respectively. From Eq. (1), the likelihood function L, consisting of β and the standard deviation σ of the error term, is obtained as Eq. (2) (Qingbin et al., 1997).

$$L_i(\beta,\sigma) = \prod_{y_i = l_i} \Phi\left(\frac{l_i - \beta' x_i}{\sigma}\right) \prod_{y_i = y_i^*} \frac{1}{\sigma} \phi\left(\frac{y_i - \beta' x_i}{\sigma}\right) \prod_{y_i = u_i} \left[1 - \Phi\left(\frac{u_i - \beta' x_i}{\sigma}\right)\right] \tag{2}$$

In Equation (2), Φ and ϕ refer to the standard normal cumulative distribution function and the standard normal

density function. To estimate the Tobit model, a log likelihood function is created from Equation (2), and parameter estimates are obtained through the maximum likelihood estimation method that maximizes the log likelihood function. At this time, the coefficient β estimated in the Tobit model represents the marginal effect on the mean of the latent variable (Signe et al., 2008).

$$\frac{\vartheta E(y_i^*|x_i)}{\vartheta x_i} = \beta \tag{3}$$

In addition, the ranking logit model can also be used for analysis because the order between the dependent variables has meaning. When j is selected within a certain range, the relationship between the continuous latent variable y_i^* that cannot be observed and the observable y_i can be expressed as Equation (4).

$$y_i^* = \beta' x_i + \varepsilon_i, \quad i = 1, 2, ..., I$$

$$\begin{aligned} y_i &= 0 \text{ if } y_i^* \le \delta_0 \\ y_i &= 1 \text{ if } \delta_0 < y_i^* \le \delta_1 \\ y_i &= 2 \text{ if } \delta_1 < y_i^* \le \delta_2 \\ y_i &= j \text{ if } \delta_{j-1} < y_i^* \end{aligned} \tag{4}$$

In Equation (4), β and x_i refer to the coefficient vector and the explanatory variable vector, and the error term ε_i is assumed to be a logistic distribution. δ_0 to δ_{j-1} indicate the cutoff point of y^*. In the ranking logit model, the probability that consumer i chooses j is expressed as follows.

$$\begin{aligned} \Pr(y_i = j|x_i) &= \Pr(\delta_{j-1} < y_i^* \le \delta_j) \\ &= \Pr(\delta_{j-1} < \beta' x_i + \varepsilon_i \le \delta_j) \\ &= \Pr(\delta_{j-1} - \beta' x_i < \varepsilon_i \le \delta_j - \beta' x_i) \\ &= F(\delta_j - \beta' x_i) - F(\delta_{j-1} - \beta' x_i) \end{aligned} \tag{5}$$

In Equation (5), $F(\cdot)$ means the cumulative logit distribution function of the error term ε_i. The likelihood function for estimating the ranking logit model can be less as shown in Equation (6) (Baek and Kang, 2008).

$$\begin{aligned} L(\delta, \beta) &= \prod_j \prod_{y_i = j} \Pr(y_i = j|x_i) \\ &= \prod_j \prod_{y_i = j} [F(\delta_j - \beta' x_i) - F(\delta_{j-1} - \beta' x_i)] \end{aligned} \tag{6}$$

For ranking logit model estimation, after obtaining the log likelihood function from Equation (6), the parameters are estimated through the maximum likelihood estimation method that maximizes the log likelihood function. Meanwhile, the marginal effect of explanatory variable x_i on the probability that consumer i will choose j in the

ranking logit model estimation can be expressed as Equation (7).

$$\frac{\vartheta \Pr(y_i = j|x_i)}{\vartheta x_i} = \frac{\vartheta F(\delta_j - B'x_i)}{\vartheta x_i} - \frac{\vartheta F(\delta_{j-1} - B'x_i)}{\vartheta x_i} = \beta[f(\delta_{j-1} - B'x_i) - f(\delta_j - B'x_i)] \quad (7)$$

Here, $f(\cdot)$ means the logit distribution function, which is the first derivative of $F(\cdot)$. Meanwhile, the sign of the marginal effect of the explanatory variable x_i may appear opposite to the estimation coefficient E depending on the value of $f(\delta_{j-1} - \beta' x_i) - f(\delta_j - \beta' x_i)$. However, if β is estimated to be a positive (+) sign, the probability that y_i is in the lowest category ($y_i = 0$) decreases as x_i increases by 1 unit, and the probability that y_i is in the highest category ($y_i = j$) increases as x_i increases by 1 unit.

This study assumes that consumers' use of the certification label will differ according to their prior knowledge (treatment effect), age, gender, income, and preference toward time, and the model is set up as shown in Equation (8).

$$Y_i^* = \beta_0 + \beta_1 age_i + \beta_2 sex_i + \beta_3 icm_i + \beta_4 time_i + \beta_5 Tmedical_i + \beta_6 Thealth_i + \beta_7 Tvideo_i + \varepsilon_i \quad (8)$$

Here, age_i is age, sex_i is gender, icm_i is average monthly personal income, $time_i$ is preference toward time, and $Tmedical_i$, $Thealth_i$, and $Tvideo_i$ are variables representing medical knowledge, health knowledge, and promotional video treatment effects, respectively.

Data

<Table 2>summarizes the survey results obtained from participants in the food labeling utilization rate experiment according to the content of prior knowledge. When looking at the ratio of male and female participants out of 617 participants, it was found that male participated slightly more than female at 52.8%. In addition, 29.5% of participants in age 40s participated in the survey, which was 10.4%p higher than those in age 20s. When looking at the participants in terms of monthly average personal income, the proportion of participants with incomes ranging from 2 million won to 2,99 million won was the highest at 22.4%. As a result of measuring the preference toward time of the experimental participants, 54.3% of the participants were considered as participants with relatively low value for time.

Analysis of differences in food labeling utilization rates according to the characteristics of items

Estimation method

Participants in the food labeling utilization rate experiment according to the characteristics of the item may remember only a part of each certification label on the three products, may remember all, or may not remember all. Therefore, although there are both explanatory variables unique to each individual and explanatory variables unique to each alternative, the dependent variable cannot be divided into mutually exclusive categories, so in this analysis,

Table 2. Participant (Sample) statistics Unit: persons,%

Variable		Number of participants	Percentage (%)
Total		617	100%
Sex	Male	326	52.8%
	Female	291	47.2%
Age group	20s	118	19.1%
	30s	163	26.4%
	40s	182	29.5%
	50s	154	25.0%
Monthly average personal income	Low income	468	75.9%
	Less than 1 million won	48	7.8%
	1 million to 1.99 million won	76	12.3%
	2 million to 2.99 million won	138	22.4%
	3 million to 3.99 million won	126	20.4%
	4 million to 4.99 million won	80	13.0%
	High income	149	24.2%
	5 million to 5.99 million won	41	6.7%
	6 million to 6.99 million won	42	6.8%
	7 million to 7.99 million won	29	4.7%
	8 million to 8.99 million won	14	2.3%
	9 million to 9.99 million won	7	1.1%
	10 million won or more	16	2.6%
Time preference	High time value (1 − 10)	282	45.7%
	Low time value (11 − 20)	335	54.3%
Knowledge provided	Medical knowledge	152	24.6%
	Health knowledge	159	25.8%
	Promotional video	150	24.3%
	No knowledge provided	156	25.3%

Note: The variable indicating time preference is binary, which bisects the entire participants into two groups: those who value time higher than the median stage (11 out of 20 stages) and those who value time lower than the median stage.

the logit model was used rather than a polynomial model.

Assuming that there is a continuous latent variable y_{ij}^{*} that determines whether consumer i uses the certification label of product j, the dependent variable y_{ij} can be expressed as follows.

$$y_{ij}^{*} = \beta' x_{ij} + \varepsilon_{ij}$$
$$y_{ij} = 1 \text{ if } y_{ij}^{*} > 0$$
$$y_{ij} = 0 \text{ if } y_{ij}^{*} \leq 0 \tag{9}$$

In Equation (9), x_{ij} is an explanatory variable vector that affects consumer i's use of the certification label of j product, β is a coefficient vector, and ε_{ij} is an error term. At this time, it is assumed that the error term ε_{ij} follows a

logistic distribution. Consumers' use of certification labels is expressed as Equation (10) assuming logistic distribution.

$$p_{ij} = \Pr(y_{ij} = 1|x_{ij}) = \frac{1}{1+e^{-(\beta' x_{ij})}} \tag{10}$$

Here, p_{ij} means the probability that consumer i uses the certification mark of product j, and H means that consumer i has used (remembered) the certification label of product j. Conversely, the probability that consumer i does not use the certification label of product j is as shown in Equation (11).

$$1-p_{ij} = \Pr(y_{ij} = 0|x_{ij}) = \frac{1}{1+e^{(\beta' x_{ij})}} \tag{11}$$

On the other hand, the likelihood function of the logit model can be written as follows.

$$L(\beta) = \prod_{ij} (p_{ij})^{y_{ij}} (1-p_{ij})^{1-y_{ij}} \tag{12}$$

For logit model estimation, the log-likelihood function is obtained from Equation (12), and the β coefficient that maximizes the log-likelihood function is obtained through the maximum likelihood estimation method. On the other hand, the probability that consumer i uses the certification mark of j product against the probability that consumer i does not use the certification mark of j product is as Equation (13).

$$\frac{p_{ij}}{1-p_{ij}} = \frac{1+e^{(\beta' x_{ij})}}{1+e^{-(\beta' x_{ij})}} = e^{(\beta' x_{ij})} \tag{13}$$

If we take the logarithm of both sides of Equation (13), it is summarized as Equation (14).

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta' x_{ij} \tag{14}$$

Equation (14) shows the relationship between the case where the probability of using the certification label is higher than that of the consumer i not using the certification label of product j and the explanatory variables that affect it. On the other hand, the marginal effect of explanatory variable x_{ij} on the probability p_{ij} that consumer i uses the certification label of product j may be small as shown in Equation (15).

$$\begin{aligned}\frac{\vartheta p_{ij}}{\vartheta x_{ij}} &= \frac{\vartheta \Pr(y_{ij}=1)}{\vartheta x_{ij}} = \frac{\vartheta}{\vartheta x_{ij}}\left(\frac{1}{1+e^{-\beta' x_{ij}}}\right) \\ &= \beta\left(\frac{1}{1+e^{-\beta' x_{ij}}}\right)\left(\frac{1}{1+e^{\beta' x_{ij}}}\right) \\ &= \beta p_{ij}(1-p_{ij})\end{aligned} \tag{15}$$

This study assumes that consumers' use of the certification label differs according to their age, gender, income, and preference toward time and the characteristics of the product (purchase frequency, price, whether or not processed food), and the model is set as shown in Equation (16).

$$\ln\frac{p_{ij}}{1-p_{ij}} = \beta_0 + \beta_1 age_{ij} + \beta_2 sex_{ij} + \beta_3 icm_{ij} + \beta_4 time_{ij} + \beta_5 often_{ij} + \beta_6 price_{ij} + \beta_7 processed_{ij} + \varepsilon_{ij} \tag{16}$$

Here, age_{ij} is the age of participant i in the experiment in which the product was used, sex_{ij} is the gender, icm_{ij} is the average monthly personal income, and $time_{ij}$ is the preference toward time. In addition, $often_{ij}$ is the frequency of purchase, $price_{ij}$ is the price of the product, and $processed_{ij}$ is a variable indicating whether or not processed foods are processed.

Data

Sample statistics of participants in the food labeling utilization rate experiment according to the characteristics of the item are shown in <Table 3>. Looking at the ratio of male and female participants out of the total 620 participants, it was found that male participated slightly more than female at 52.6%. In addition, in terms of age distribution, participants in 40s participated in this experiment the most with 27.6%. When looking at the average monthly personal income of the participants in the experiment, the proportion of participants with incomes ranging from 2 million won to 2.99 million won out of the total participants was the highest at 21.6%. As a result of measuring the preference toward time of the experiment participants, the proportion of participants with a high value for time and those with a low value for time out of the total participants showed similar levels.

Analysis result

Analysis of differences in food labeling utilization rates according to the content of prior knowledge

<Table 4> shows the results obtained through the recall question experiment of the food label utilization rate experiment according to the contents of prior knowledge. The memory level refers to the number of certification marks that the participants of each experiment correctly memorize among the certification marks displayed on the products (eggs, buckwheat, cheese) presented in three selection situations, 0 is the value when not remembering any, and 3 is the value when remembering all of them.

In the case of memory level of 3, the group that provided the food certification label promotional video was

Table 3. Participant (Sample) statistics Unit: persons,%

Variable		Number of Sample	Percentage(%)
Total		620	100%
Sex	Male	326	52.6%
	Female	294	47.4%
Age group	20s	121	19.5%
	30s	162	26.1%
	40s	171	27.6%
	50s	166	26.8%
Monthly average personal income	Low income	468	75.5%
	Less than 1 million won	53	8.6%
	1 million to 1.99 million won	83	13.4%
	2 million to 2.99 million won	134	21.6%
	3 million to 3.99 million won	114	18.4%
	4 million to 4.99 million won	84	13.6%
	High income	152	24.5%
	5 million to 5.99 million won	74	11.9%
	6 million to 6.99 million won	22	3.6%
	7 million to 7.99 million won	25	4.0%
	8 million to 8.99 million won	10	1.6%
	9 million to 9.99 million won	12	1.9%
	10 million won or more	9	1.5%
Time preference	High time value (1 – 10)	307	49.5%
	Low time value (11 – 20)	313	50.5%
Participants in the experiment by product	Mushroom	226	12%
	Sesame	196	11%
	Salad	198	11%
	Bean sprouts	226	12%
	Egg	198	11%
	Buckwheat tea	198	11%
	Acorn jelly	196	11%
	Cheese	226	12%
	Sesame oil	196	11%

Note: The variable indicating time preference is binary, which bisects the entire participants into two groups: those who value time higher than the median stage (11 out of 20 stages) and those who value time lower than the median stage.

greater than the group that provided medical and health information. And when the memory level is 0, the group that provided the food certification label promotional video was smaller than the group that provided medical information and health information.

<Table 5> is the result of estimating the data obtained through the experiment on the utilization rate of food labeling according to the content of prior knowledge by the two-limit tobit model and the ranked order logit model. As a result of the estimation, it was found that the use of certification labels was higher for female than for male. In

Table 4. Utilization rate of certification label according to differences in prior knowledge

Unit: persons, % in parentheses

		Gender		Age				Household Income		Time preference	
Memory level		Male	Female	20s	30s	40s	50s	Low income	High income	Short-term Preferred (1-10)	Long-term Preferred (11-20)
Medical information	0	36 (43%)	22 (32%)	10 (37%)	18 (44%)	15 (31%)	15 (42%)	49 (40%)	9 (30%)	24 (39%)	34 (38%)
	1	39 (46%)	36 (52%)	12 (44%)	19 (46%)	25 (52%)	19 (53%)	59 (48%)	16 (53%)	31 (50%)	44 (49%)
	2	9 (11%)	8 (13%)	5 (19%)	4 (10%)	6 (13%)	2 (6%)	13 (11%)	4 (13%)	6 (10%)	11 (12%)
	3	0 (0%)	2 (3%)	0 (0%)	0 (0%)	2 (4%)	0 (0%)	1 (1%)	1 (3%)	1 (2%)	1 (1%)
Health information	0	39 (47%)	30 (39%)	17 (55%)	15 (36%)	19 (48%)	18 (39%)	56 (42%)	13 (50%)	35 (49%)	34 (39%)
	1	31 (37%)	38 (50%)	10 (32%)	20 (48%)	15 (38%)	24 (52%)	60 (45%)	9 (35%)	26 (37%)	43 (49%)
	2	13 (16%)	7 (9%)	4 (13%)	6 (24%)	6 (15%)	4 (9%)	17 (13%)	3 (12%)	10 (14%)	10 (11%)
	3	0 (0%)	1 (1%)	0 (0%)	1 (2%)	0 (0%)	0 (0%)	0 (0%)	1 (4%)	0 (0%)	1 (1%)
Promotional video	0	31 (40%)	19 (26%)	10 (38%)	12 (26%)	15 (35%)	13 (37%)	39 (31%)	11 (44%)	23 (34%)	27 (33%)
	1	24 (31%)	36 (50%)	9 (35%)	21 (46%)	18 (42%)	12 (34%)	51 (41%)	9 (36%)	25 (37%)	35 (43%)
	2	15 (19%)	15 (21%)	6 (23%)	11 (24%)	8 (19%)	5 (14%)	26 (21%)	4 (16%)	16 (24%)	14 (17%)
	3	8 (10%)	2 (3%)	1 (4%)	2 (4%)	2 (5%)	5 (14%)	9 (7%)	1 (4%)	4 (6%)	6 (7%)

Note: Low income and high income are classified into less than 1 million won to 49.9 million won and 5 million won to 10 million won or more, respectively.

the case of female, it can be interpreted that when purchasing food, they look at the product more carefully than male.

In the case of providing medical knowledge and health knowledge, it was analyzed that it did not have an effect on improving the utilization rate of the certification label. This is interpreted as having insufficient aspects for stimulating consumers to actually use food labeling through these medical and health knowledge provided in the short term. However, in the case of providing promotional video, there was a significant positive (+) relationship with the certification label utilization rate. This means that it is necessary to provide more direct and visual information to improve the utilization rate of certification labels. Therefore, it seems necessary to find a way to allow consumers to be more exposed to promotional videos related to food labeling.

Table 5. Estimated coefficients and marginal effects of the two-limit Tobit and ordered logit models

	Two-limit tobit model	Ordered logit model	
		coefficients	marginal effects (y=3)
Age	0.0785 (0.0522)	0.0938 (0.0734)	0.0027 (0.0022)
Female	0.1931* (0.1091)	0.2698* (0.1549)	0.0078* (0.0047)
Income	0.0273 (0.0242)	0.0384 (0.0343)	0.0011 (0.0010)
Time preference	0.0066 (0.0067)	0.0060 (0.0094)	0.0002 (0.0003)
Medical knowledge	-0.0231 (0.1530)	-0.0017 (0.2143)	-0.00005 (0.006)
Health knowledge	-0.1334 (0.1517)	-0.1458 (0.2133)	-0.0042 (0.0062)
Promotional video	0.3224** (0.1523)	0.4725** (0.2196)	0.0136** (0.0069)
Constant	-0.0356 (0.2119)	-	-
σ	1.2499 (0.0530)	-	-
δ_0	-	0.2380 (0.2978)	-
δ_1	-	2.2659 (0.3125)	-
δ_2	-	4.1685 (0.3766)	-
Number of observations	617	617	-
Log likelihood	-811.87	-679.80	-

***, **, *: represent significance levels of 1%, 5%, and 10%, respectively, and standard errors are in parentheses.
δ: are the estimated cut points as presented in equation (4).

Analysis of differences in food labeling utilization rates according to the characteristics of items

<Table 6> shows the participants' food certification label utilization rate obtained from the recall questionnaire experiment of the food label utilization rate experiment according to the characteristics of the item. In the case of sesame oil and acorn jelly, the utilization rate of the certification label was relatively low compared to other items. In particular, eggs showed the highest utilization rate of the certification label compared to other items. In terms of the use of the certification label for other items except buckwheat tea and salad, the use rate of the certification label by female was higher than that of male. In addition, the utilization rate of the certification label for fresh food was slightly higher than that of the processed food.

Table 6. Statistics on the utilization rate of certification labels according to the characteristics of the items

Unit: KRW, %

Item name		Egg	Buckwheat tea	Salad	Mushroom	Bean sprouts	Cheese	Sesame	Sesame oil	Acorn jelly
Price		2,640	3,350	1,810	780	2,240	5,200	990	15,240	3,700
Overall utilization rate		57%	11%	21%	20%	38%	15%	15%	2%	6%
Sex	Male	50%	12%	24%	20%	30%	12%	11%	1%	5%
	Female	65%	10%	18%	21%	45%	17%	19%	2%	7%
Age	20s	53%	13%	20%	13%	24%	4%	9%	0%	7%
	30s	56%	6%	14%	18%	32%	13%	17%	0%	2%
	40s	65%	13%	20%	26%	42%	18%	21%	4%	6%
	50s	49%	12%	29%	23%	48%	20%	11%	2%	9%
Monthly income	Less than 1 million won	65%	12%	12%	10%	30%	15%	6%	0%	13%
	1 million to 1.99 million won	69%	10%	14%	18%	32%	18%	12%	4%	4%
	2 million to 2.99 million won	58%	3%	23%	20%	35%	18%	21%	2%	5%
	3 million to 3.99 million won	57%	17%	21%	22%	46%	14%	23%	3%	6%
	4 million to 4.99 million won	56%	24%	32%	27%	38%	11%	9%	0%	5%
	5 million to 5.99 million won	41%	9%	23%	18%	39%	11%	8%	0%	4%
	6 million to 6.99 million won	50%	0%	20%	0%	50%	0%	0%	0%	0%
	7 million to 7.99 million won	80%	0%	0%	44%	33%	44%	0%	0%	9%
	8 million to 8.99 million won	50%	0%	50%	33%	67%	0%	20%	0%	0%
	9 million to 9.99 million won	25%	25%	25%	0%	0%	0%	40%	0%	20%
	10 million won or more	50%	0%	0%	25%	50%	0%	33%	0%	0%
Time preference	High time value (1 – 10)	57%	10%	21%	18%	40%	17%	16%	1%	9%
	Low time value (11 – 20)	57%	12%	20%	23%	35%	12%	14%	2%	3%
Freshness	Fresh food	-	11%	-	-	-	15%	-	2%	6%
	Processed food	57%	-	21%	20%	38%	-	15%	-	-
Purchase frequency	Everyday	67%	0%	-	0%	0%	-	0%	0%	100%
	2 or 3 times a week	55%	33%	13%	26%	36%	20%	14%	0%	0%
	Once a week	59%	25%	22%	30%	35%	11%	8%	0%	14%
	Once in 2 weeks	63%	0%	22%	27%	51%	18%	18%	0%	20%
	Once a month	53%	9%	36%	17%	42%	11%	21%	4%	5%
	Less than once a month	44%	12%	20%	14%	33%	20%	9%	1%	6%
	Do not purchase	40%	11%	16%	10%	21%	13%	14%	2%	2%

<Table 7> shows the results of estimating the data obtained through the experiment on the utilization rate of food label according to the characteristics of the item. As a result of the estimation, it was found that the older consumers, the higher the tendency to use the certification label. This is a different result from the analysis of the utilization rate of food label according to the content of prior knowledge. Therefore, it is necessary to take a cautious approach to interpreting the estimation results as examining food in more detail by older consumers than younger consumers. However, if there is no prior knowledge, it can be inferred that older consumers tend to look at food in more detail when purchasing food. On the other hand, female have a higher tendency to use certification labels than male. This is the same result as the result of analyzing the utilization rate of the certification label according to the difference in prior knowledge.

Table 7. Estimated coefficients and marginal effects of the logit model

	Coefficient	Marginal effect (dy/dx)
Age	0.2083*** (0.0583)	0.0297*** (0.0083)
Female	0.3565*** (0.1225)	0.0508*** (0.0174)
Income	-0.0423 (0.0289)	-0.0060 (0.0041)
Time preference	-0.0038 (0.0074)	-0.0005 (0.0011)
Purchase frequency	-0.2007*** (0.0401)	-0.0286*** (0.0057)
Price	-0.0356 (0.0277)	-0.0051 (0.0039)
Processed product	-1.0938*** (0.2009)	-0.1559*** (0.0280)
Constant	-0.4034 (0.3102)	-
Number of observations	1,860	-
Log likelihood	-576.85	-

***, **, *: represent significance levels of 1%, 5%, and 10%, respectively, and standard errors are in parentheses.
The number of observations for this analysis is the sum of samples of the analyses presented in this study.

This study established three hypotheses by judging that there is a possibility that consumers' use of the certification label may differ depending on the characteristics of the item. As a result of the verification of the three hypotheses, it was found that the use of the certification label was low in the case of products that are repeatedly purchased frequently. This can be interpreted as the fact that consumers already have sufficient confidence in the products they purchase frequently, so that consumers do not carefully look at food labels than products that they do not purchase often. In addition, processed foods were analyzed to have a lower utilization rate of the certification label compared to fresh foods. In the case of fresh food product brands, there are aspects that are less well known to

consumers than processed food brands, so when purchasing fresh food, consumers purchase using certification labels or other food labels rather than the tendency to purchase products by trusting only the brand of fresh food. Therefore, the estimation result of this study can be interpreted that the utilization rate of the certification label appears higher in the case of fresh food than that of processed food. On the other hand, it was analyzed that the relationship between the price of the product and the utilization rate of the certification label was not significant.

Conclusion

This study attempted to investigate the utilization rate of food label with reduced measurement bias using recall questionnaire experiments, and to derive implications for promoting the food labeling system from the perspective of consumers. To this end, this study analyzed the food label utilization rate according to the difference in prior knowledge and whether there was a difference in the food labeling utilization rate of consumers according to the characteristics of the item.

As a result of the study, it was analyzed that female use food certification more often than male. In addition, female participants were found to remember food certification labels relatively more accurately than male participants. This is consistent with the results of the Korea Rural Economic Research Institute (2018) that male check food labels less than female.

In the case of medical knowledge and health knowledge, it was analyzed that they did not have an effect on improving the utilization rate of the food certification label. This is interpreted as having insufficient aspects for consumers to actually use food label through this knowledge as medical and health knowledge provided in the short term. On the other hand, in the case of the certification label promotional video, there was a significant positive (+) relationship with the utilization rate of the food certification label. This means that it is necessary to provide more direct and visual information to improve the utilization rate of food certification labels. Therefore, it seems necessary to find a way to allow consumers to be more exposed to promotional videos related to food labeling..

In the case of products that are repeatedly purchased frequently, the utilization rate of food certification label was found to be low. This can be interpreted as the fact that consumers already have sufficient confidence in the products they purchase frequently, so that consumers do not carefully look at food labels than products that they do not purchase often.

In addition, processed foods were analyzed to have a lower utilization rate of food certification labels than fresh foods. In the case of fresh food product brands, there are aspects that are less well known to consumers than processed food brands, so when purchasing fresh food, consumers purchase using certification labels or other food labels rather than the tendency to purchase products by trusting only the brand of fresh food. You may have a tendency to decide whether or not. Therefore, the estimation result of this study can be interpreted that the utilization rate of the certification label appears higher in the case of fresh food than that of processed food.

In summarizing the results of this study, it is judged that the rate of use of food labels is significantly different depending on how important consumers are to use food labels. In this regard, raising the level of awareness of the

importance of using food labels by directly promoting the importance of food labeling to consumers is expected to be an effective way to improve the utilization rate of food labels by consumers.

According to the Korea Rural Economic Institute (2018), it was found that adult household members obtain information on food quality or dietary life mainly through 'the people around' or 'broadcasting'. In particular, it was found that adult household members who responded that they obtain food-related information through "broadcasting" mainly obtain information through "TV or radio news programs". Therefore, it is judged that the promotion of food labeling system through broadcasting media or internet that provides direct and visual information can have a good effect of achieving safe and rational food choice for consumers.

Meanwhile, if the information to be considered by the consumer exceeds a certain level, the consumer may not be able to use some food information. In other words, due to excessive provision of food information, the utilization rate between food labels may be mutually affected. The failure to consider the interaction between food labels in this study may be a limitation of this study. It will be a future research task to study how the food label utilization rate is affected by the interaction between food labels. Despite the limitations of these studies, this study is expected to provide useful information in terms of government food-related policy establishment and corporate market analysis.

References

Baek, H. J., Kang, S. H. (2008), "Analysis of the Determinants of Reliability of the National Pension Plan", Korean Social Security Studies 24:1-31.

Bleich, S. N., Wolfson, J. A. (2015) "Differences in consumer use of food labels by weight loss strategies and demographic characteristics", BMC public health 15:1275.

Bonanni, A. E., Bonaccio, M., di C, A., de L, F., Costanzo, S., Persichillo, M., Zito, F., Donati, M. B., de G, G., Iacoviello, L. (2013) "Food labels use is associated with higher adherence to Mediterranean diet: results from the Moli-sani study", Nutrients 5:4364-4379.

Cavaliere, A., De Marchi, E., Banterle, A. (2017) "Investigation on the role of consumer health orientation in the use of food labels", Public Health 147:119-127.

Cho, S. H., Yoo, H. H. (2007) "Awareness of high school students' nutritional knowledge, dietary attitude, dietary habits and food nutrition labeling", Korean J Community Nutr 12:519-533.

Christoph, M. J., Loth, K. A., Eisenberg, M. E., Haynos, A. F., Larson, N., Neumark-Sztainer, D. (2018) "Nutrition Facts Use in Relation to Eating Behaviors and Healthy and Unhealthy Weight Control Behaviors", J Nutr Educ Behav 50:267-274.

Grunert, K. G., Wills, J. M., Fernández-Celemín, L. (2010) "Nutrition knowledge, and use and understanding of nutrition information on food labels among consumers in the UK", Appetite 55:177-189.

Kim, S. Y., Jeon, S. G., Lee, G. I. (2014) "Analysis of Consumer Preference by Beef Grade", JRD 37:1-24.

Korea Rural Economic Research Institute, (2018) 『In-depth Analysis Report on Consumer Attitude Survey for Processed Food』.

Lee, S. H., Han, D. B., Caputo, V., Nayga, R. (2015) "Consumers' Valuation for Reduced Salt Labeling: A Non-hypothetical Choice Experiment", Can. J. Agric. Econ 63:563-582.

Park, S. S., Kim, N. Y., Han, M. J. (2008) "Middle School Students' Preference for Processed Food and Perceptions of Food and Nutrition Labeling", Korean J Food Cook Sci 24:164-173.

Philip, M. C., Denzil, G. F., Ulf-G, G. (2008) "Optimal recall length in survey design", J Health Econ 27:1275-1284.

Qingbin, W., Catherine, H., Jane, K., Fred, S. (1997) "Willingness to pay for rBST-free milk: a two-limit Tobit model analysis", Appl Econ Lett 4:619-621.

Signe H. A. and Eskil, H. (2008) "Estimating the Relative Success of Local Authorities at Labour-Market Integration of Immigrants", Eur J Popul 24:59-86.

Zhang, D., Li, Y., Wang, G., Moran, A. E., Pagán, J. A. (2017) "Nutrition Label Use and Sodium Intake in the U.S", Am J Prev Med 53:220-227.