TOWARDS HEALTHIER CHOICES: AN INVESTIGATION INTO SUGAR LABEL DESIGN

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Abstract

A pandemic of obesity and diabetes is intensifying in every country, posing a serious challenge to public health and consumer well-being. In order to generate benefits and cost-savings in healthcare, sugar labeling policies are sometimes used in an attempt to nudge consumers towards healthier food choices. Consequently, this research examines how sugar label design would be best implemented for curbing unhealthy choices, by investigating the effect of label designs used for displaying the sugar limit information which underpins consumer responses. Four major attributes of the sugar label are examined; these are symbols, symbol colors, text colors and layout. The investigation utilizes a mixed logit model on Thai conjoint choice data. The results show that a "teaspoon" symbol, symbols in "red" color, text in "black" color, and layouts with the "text on the left and the symbol on the right" generate the most favorable consumer responses to the sugar intake information provided on labels. This suggests an optimal sugar label design for Thai consumers. The paper provides insights into consumer label preference which could be used to promote healthier consumption in Thailand.

Keywords: healthy choice, consumer well-being, decision, sugar label

1. INTRODUCTION

As obesity has become a global phenomenon, the World Health Organization (2015) has urged governments of all countries to combat the growing problem among their respective populations. Although a number of causes inducing obesity, such as inactive behavior, genetics and inadequate sleep, cannot be addressed by legislation (other than spending on informative advertising campaigns), several other causes such

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as calories and sugar intake can be addressed by reshaping consumers' perception towards their food choices.

Consumers who are well-informed about the nutrition and ingredients of their food will be able to make healthier choices. One of the most important sources of information that consumers can rely on is the food label. A number of studies have found significant effects of nutrition information and health warnings on consumers' health choices (Thorndike, Riis, Sonnenberg & Levy, 2014; Becker, Bello, Sundar, Peltier & Bix, 2015; Tórtora, Machín & Ares, 2019; Mhurchu, Eyles, Jiang & Blakely, 2018). Nonetheless, most studies have overlooked sugar limit information, which could be presented on food labels. For example, several literature reviews on food labels did not explore any sugar limit information research (Kiesel, McCluskey & Villas-Boas, 2011; Miller & Cassady, 2015; U.S. Food and Drug Administration, 2018).

In recent years, sugar intake has become a major concern for health officials. Studies have found that reducing the amount of sugar intake can substantially reduce health risks. For example, Yang, Zhang, Gregg, Flanders, Merritt, and Hu (2014) found that participants, who consume about 17 to 21 percent of their daily calorie intake from added sugar, had a 38 percent higher risk of cardiovascular mortality when compared to those for whom this value was only 8 percent. The World Health Organization (2015) has thus announced a recommended amount of sugar intake for an individual to avoid obesity. In recent years, food policy makers have implemented sugar taxes to discourage consumers from overconsumption of sugar (WHO, 2017). They have yet to require the sugar limit information on any food label as initiated by the U.S. Food and Drug Administration (2019). Thus, there are no studies exploring the effect of sugar limit information on consumer choices.

This paper therefore aims to evaluate the impact of different sugar symbol designs on consumer evaluation of sugar labels. Essentially, the paper explores consumer preferences for different attributes of sugar limit infographic labels, which might influence how the labels affect daily sugar consumption. Thus, the aim of this study is to identify appealing infographic designs of sugar limit on food labels that will eventually induce consumers to make healthy choices.

The paper studies these issues from a Thai consumer perspective. Sugar over-consumption among Thais has become a major concern in recent years (Nation, 2019). As shown in Figure 1, Thai sugar consumption is almost three times the world average, and has increased by more than 30 percent during 2009 to 2019, while consumption has remained the same in most other countries in the world.

The article first presents the background information regarding the daily sugar limit and examines relevant literature on label designs. This is followed by the research methodology, in particular, survey

design and estimation strategies. The next section explains the results in terms of which attribute is most effective and its impact on consumers' decisions. The final section then compares the findings with prior work and discusses policy implications.
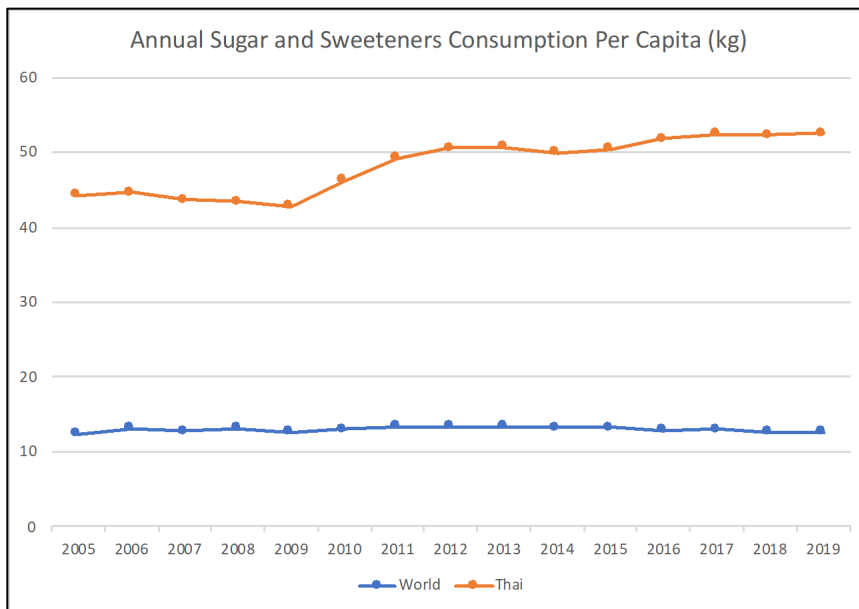

Figure 1: Annual Sugar Consumption of Thai Consumers as Compared to the World Average
Source: Euromonitor International (n.d.).

2. BACKGROUND

2.1 Daily Sugar Limit

The World Health Organization (2015) has recommended that adults and children should limit sugar intake to less than 10 percent of their total energy intake (strong recommendation). This can be further reduced to 5 percent of total energy intake (conditional recommendation). An average individual normally needs 2,000 calories per day, thus the World Health Organization strongly recommends no more than 200 calories from sugar or 12 teaspoons per day. Furthermore, it suggests (under the conditional recommendation) that an individual should take less than 100 calories from sugar or 6 teaspoons. This recommendation is published as a guideline for all countries around the world, including Thailand. Such a recommendation is in line with the recommendation made by the American Heart Association (2018), of 9 teaspoons for men and 6 teaspoons for women. Following the World Health Organization and the American Heart Association (AHA), this paper adopts a daily sugar limit of 6 teaspoons.

2.2 Obesity in Thailand

Teerawattananon and Luz (2017) claimed that obesity prevalence in Thailand has been growing at the same rate as per capita GDP from 1991 to 2014. The trend is also comparable with the growing urban population in Thailand. Overall, the obesity prevalence is higher in urban areas than rural areas for both genders. According to Firestone, Punpuing, Peterson, Acevedo-Garcia, and Gortmaker (2011), the urban environment contributes to the risk of obesity in Thailand. The community wealth concentration and television coverage were found to be highly associated with obesity risk as fast food is heavily marketed on Thai television. People in urban areas have more access to media, which combined with easy access to fast food outlets, compounds the obesity problem. Moreover, the number of fast food restaurants and sweets cafés such as McDonald's, KFC, Burger King, After You, and Secret Recipes are rising in urban areas of Thailand. Thus, this trend explains the higher obesity rate in urban areas in Thailand.

In terms of gender, obesity prevalence was 41 percent for females and 28 percent for males in 2009 (Teerawattananon & Luz, 2017). Male obesity prevalence however rose to 33 percent in 2014, while female obesity prevalence rose only slightly to 43 percent. In terms of age, child obesity prevalence was largest among children at the ages of 12 to 14 years. Adult obesity prevalence was the largest among individuals who are 45 to 59 years old.

2.3 The Concept of Choice Architecture

Choice architecture refers to strategies used to influence consumer decisions through various means of presenting choices to consumers (Thaler & Sunstein, 2008). It is defined as a way to present the available alternatives to decision makers in order for them to reach desirable outcomes. Choice architecture can significantly influence decisions while maintaining consumers' freedom to choose (Thaler, Sunstein & Balz, 2014; Ölander & Thøgersen, 2014). Such a choice architecture approach can be adopted in designing food policies to induce consumers' healthy choices.

There have been several attempts of differentiating choice architecture designs by food policy makers to induce consumers to make healthier food choices such as nutrition label requirements, use of approval symbols, and traffic light labels.

Nutrition labeling is required in most countries. An example is the standard imposed by the U.S. Food and Drug Administration (2019). The required information is standardized worldwide including serving size, serving per container, amount per serving, calories, calories from fat, the information of total amount and the percent daily value of total fat, cholesterol, sodium, total carbohydrate, and protein. Prior work has found that the choice architecture

of nutrition labeling can induce healthier consumption. For example, Thorndike et al. (2014) used a three-month color-coded labeling intervention (red = unhealthy, yellow = less healthy, green = healthy) in phase 1 and added a choice architecture intervention that increased the visibility and convenience of some green items in phase 2. They found that a color-coded label increased the sales of healthy food. The positive effect was enhanced by the choice architecture intervention.

A number of countries have adopted a program where an independent entity requires products to place "an approval symbol" on the front of the product package to signal a healthy choice. This is done to encourage consumers to make healthy food choices as well as to induce food manufacturers to develop healthier products. Such programs are *Europe's Choice Programme* and the *U.S. Smart Choice Program* (Lupton et al., 2010).

One example is Nutrition Australia (2016), which employs a traffic light label using green, amber, and red colors to signal consumers in terms of level of fat content, saturated fat, salt, sugar, and energy in calories. The traffic light is claimed to be a signpost that consumers can use to identify healthier options and to make quick comparisons between similar products. It is also claimed that the traffic light has high performance in terms of healthier choice identification (Malam et al., 2009). The best traffic light scheme consists

of three key elements including traffic light color, text denoting 'high', 'medium, and 'low' and percent of guideline daily amount (%GDAs). The surveys show that the traffic lights can encourage healthier product choice by helping consumers to interpret %GDAs (Malam et al., 2009).

2.4 The Impact of Nutrition Label on Healthy Choice

Consumers possessing nutrition label knowledge tend to effectively use label information. Prior works have also shown that the use of nutrition labels leads to healthier food choices or lower calorie consumption (Weaver & Finke, 2003; Drichoutis, Lazaridis, & Nayga, 2005; Barreiro-Hurlé, Gracia & de-Magistris, 2010; Temple, Johnson, Recupero & Suders, 2010; Morley, Scully, Martin, Niven, Dixon & Wakefield, 2013; Gupta & Dharni, 2016).

Weaver and Finke (2003) studied the real consumption of added sugar by utilizing a continuing survey of Food Intake by Individuals, and the Diet and Health Knowledge Survey from 1994 to 1996 conducted by the United States Department of Agriculture. The results showed that regular use of sugar content on information labels can lower consumption. Temple et al. (2010) conducted a test on nutrition label use and energy intake in the laboratory. The results indicated that the inclusion of nutrition labels lead to lower energy intake.

Roberto, Shivaram, Martinez, Boles, Harris, and Brownell (2012) found that the logo stamped on the front of a package can lead to perception of healthier food choice. From combining this evidence with the performance of the traffic light label discussed earlier, it can be deduced that presenting information in the form of pictures, symbols, colors and easy to assess information is an effective way to communicate to consumers. In other words, the use of "infographics" is an effective way to present information that can induce consumers' healthy choices.

2.5 Effective Label Designs

Accurate and easy-to-understand labels should be considered as part of the strategy to combat obesity (Roberto & Khandpur, 2014). Thus, an effective food label design can lead to healthier consumer choices. According to the literature, there are several areas of focus in designing an effective warning label. This includes salience, wording, layout and placement, and the use of pictorial symbols, which will be discussed in detail in the following section (Wogalter, Conzola & Smith-Jackson, 2002).

Salience
Salient or conspicuous messages increase the likelihood of reading (Strawbridge, 1986). It can also lead to better comprehension (Young & Wogalter, 1990) and recall (Barlow & Wogalter, 1991; Glover & Wogalter, 1997). Thus, a good label design can

actually lead to better compliance. Salient label designs can be achieved through the use of large and bold print, high contrast, and color (Sanders & McCormick, 1993; Gill, Barbera & Precht, 1987; Braun, Sansing, & Silver, 1994). For example, the use of red color can be attractive and garners readers' attention. It has also been found that colored warning labels are perceived as indicating something more dangerous than achromatic labels. One label printed in red led to improved noticeability when compared to a label printed in black color (Braun et al., 1994; Young, 1991)

Wording
An effective warning should consist of (1) a signal word to attract attention, (2) identification of the hazard, (3) explanation of consequences if exposed to the hazard, and (4) directives for avoiding the hazard (Wogalter, Godfrey, Fontenelle, Desaulniers, Rothstein & Laughery, 1987). The commonly adopted signal words recommended for use by the American National Standards Institute (ANSI) are danger, warning, caution, and notice.

Layout and Placement
Presenting information of warnings in the outline format (e.g. bullet points) rather than paragraph format is considered more appealing and easier for readers to process information (Hartley, 1994; Wogalter & Shaver, 2001). More importantly, the location of the message is related

to the effectiveness of the label design.

For an infographic label, there will be both written words and graphics used to convey messages. Thus, the design of the placement of graphics and written information is also important. Studies have found that placing the image on the left-hand side of the text will enhance the processing of the whole message (Beaumont, 1985; Grobelny & Michalski, 2015).

Use of Pictorial Symbols

According to Young & Wogalter (1988), pictorials can enhance memory of a warning. It can also facilitate warning comprehension (Dewar & Arthur, 1999). Another concern that should be addressed is in terms of legibility, which refers to the degree of initial clarity of the warning. This is based on size of the pictorial and is affected by the distance from which it will be viewed (Wogalter et al., 2002). It has been found that pictorials are most effective when they communicate simple and concrete concepts (Murray, Magurno, Glover, & Wogalter, 1998).

Based on previous studies, it can be concluded that the use of nutrition labels can lead to consumers' healthy choices. Moreover, the effective design of the label can be formulated in order to enhance the effect on consumers' healthy choices. An easy-to-understand type is the key for creating an effective label. Currently, there are front-of-package labels such as the healthy choice logo stamp, traffic light labels, and simplified

information regarding the key nutritional aspects of the food. All these examples are presented in the form of infographics which enable the consumers to understand the information easily. Consequently, the next question is what is an appropriate design of infographic, for conveying the message of sugar content (per serving) in respect of the daily sugar limit of 6 teaspoons (as recommended by World Health Organization)?

3. METHOD

Prior studies have identified effective label design by analyzing the self-reported levels of participant comprehension of labels (Canoosamy, Pugo, Gunsam, & Jeewon, 2014; Liu, Hoefkens, & Verbeke, 2015). However, such an approach is rather inflexible and impractical in identifying the optimal label design. This is because there are many attributes in a label, as labels require participants to be presented with a number of design choice combinations.

3.1 The Choice-based Conjoint Design

This study adopted a choice-based conjoint analysis to set up alternatives with a mix of attributes for consumers' selection. The design used was efficient and orthogonal. Four main attributes of the sugar label were included, including sugar symbol, symbol color, text color and label layout. There were three attribute levels for sugar symbol, two

attribute levels for symbol color and text color, and four attribute levels for label layout. Thus, the full factorial conjoint design yielded 48 (3 x 2 x 2 x 4) combinations of design choice. These combinations were blocked into four versions of the questionnaire. Each participant was asked to answer only one of the four versions. Each questionnaire had four choice situations, and each choice situation consisted of three label design alternatives. The use of the block design allows the number of choice sets faced by each individual to be reduced, and thus helps reduce the issue of participant fatigue.

Attribute 1: Sugar symbols

This attribute consists of the sugar symbol used to convey information regarding the sugar intake in respect of the daily sugar limit. Under this attribute, there are three attribute levels which are (1) bar chart (2) sugar cube and (3) teaspoon of sugar. The detailed description of each attribute level is given in the following section.

Bar chart. To convey the message of sugar content (per serving) out of the daily sugar limit, the bar graphic can be used to show such information. Under this attribute level, a bar chart pictogram is used to represent the amount of sugar in the food serving as a proportion of the daily limit. Figure 2 shows the bar chart symbol for a product that contains a sugar intake value of 4 out of the recommended maximum daily sugar intake of 6 teaspoons.

Figure 2: Bar chart as a sugar symbol

Sugar cube. Under this attribute level, a pictogram made up of sugar cubes is used to represent the information on sugar content (per serving) according to the daily sugar limit. Figure 3 shows the sugar cube symbol of a product that contains 4 out of the 6 teaspoons of the recommended maximum daily sugar intake.
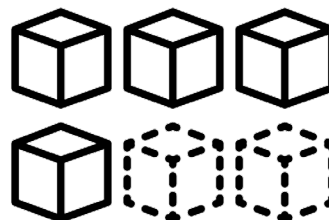

Figure 3: Sugar cube as a sugar symbol

Teaspoon. Under this attribute level, a picture of a teaspoon is used to represent the information regarding sugar content (per serving) according to the daily sugar intake limit. Figure 4 shows the teaspoon sugar symbol of a product that contains 4 out of the 6 teaspoons of the recommended maximum daily sugar intake.
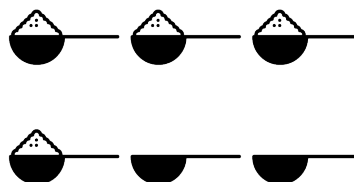

Figure 4: Teaspoon as a sugar symbol

Attribute 2: Picture Color (Symbol Color)

Color can be used to enhance the understanding of risks associated with food products (color red for warning). This attribute has two levels, which are (1) black and (2) red.

Attribute 3: Text Color

For this attribute, color is applied to the text message of the label. This attribute has two levels, namely (1) black and (2) red. The text says:

"The daily sugar intake limit is 6 teaspoons. This product contains 4 teaspoons of sugar."

Attribute 4: Layout

As the positions of written information and pictures can lead to differences in how, and how easily, consumers process information, the label layout was included as one of the attribute focuses. It will be further divided into four attribute levels as follows:

Picture on the left and text on the right (PLTR). For this attribute level, the symbol is positioned in the left half of the box while the text is positioned on the right (Figure 5).

Picture on the right and text on the left (PRTL). For this attribute level, the text is positioned in the left half of the box while the symbol is positioned on the right (Figure 6).
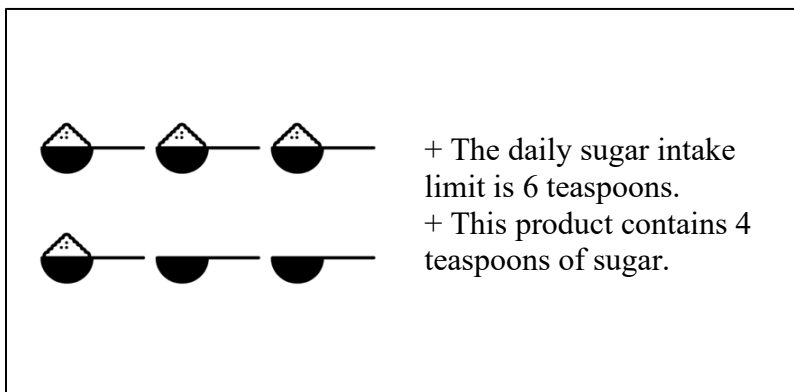
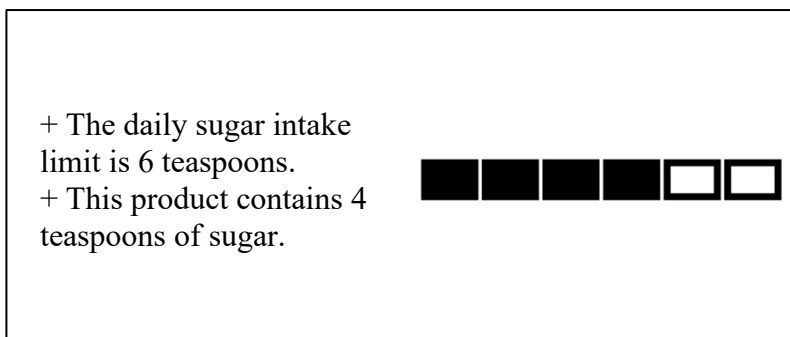Figure 5: Layout with picture on the left and text on the right

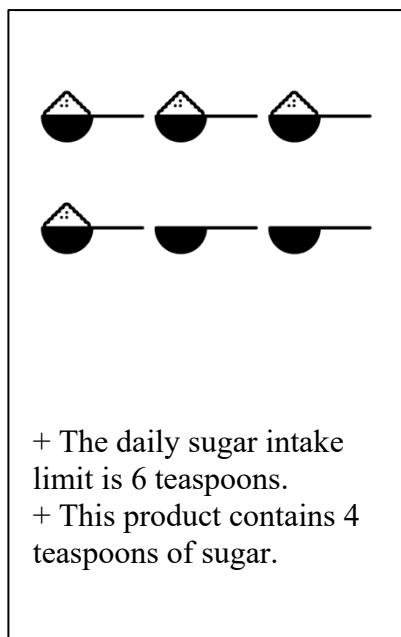Figure 6: Layout with picture on the right and text on the left

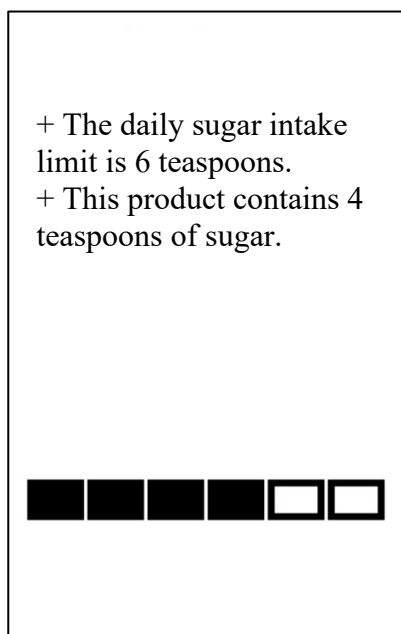Figure 7: Layout with picture at the top and text at the bottom (Left)

Figure 8: Picture at the bottom and text at the top (Right)

Picture at the top and text at the bottom (PTTB). For this attribute level, the symbol is positioned at the top of the box while the text is positioned at the bottom (Figure 7).

Picture at the bottom and text at the top (PBTT). For this attribute level, the text is positioned at the top of the box while the symbol is positioned at the bottom (Figure 8).

3.2 Data Collection

Questionnaires

The questionnaire was designed to collect data on consumers' choices and some of their sociodemographic variables. There are four sets of question designs (Set 1 includes choice set 1-4, Set 2 includes choice set 5-8, Set 3 includes choice set 9-12, and Set 4 includes choice set 13-16). Each participant was given a clear instruction to select only one sugar label of preference in each choice situation (see Figure 9).

The questionnaire was divided into two parts. The first part collected data regarding the sugar intake information label design that participants preferred the most. The second part collected personal information of the participants including several key sociodemographic variables, such as gender and age, as well as self-reported health related characteristics; these included being health conscious or being a hedonistic type of consumer (respondents were asked to choose between whether they were health conscious or hedonistic consumers).
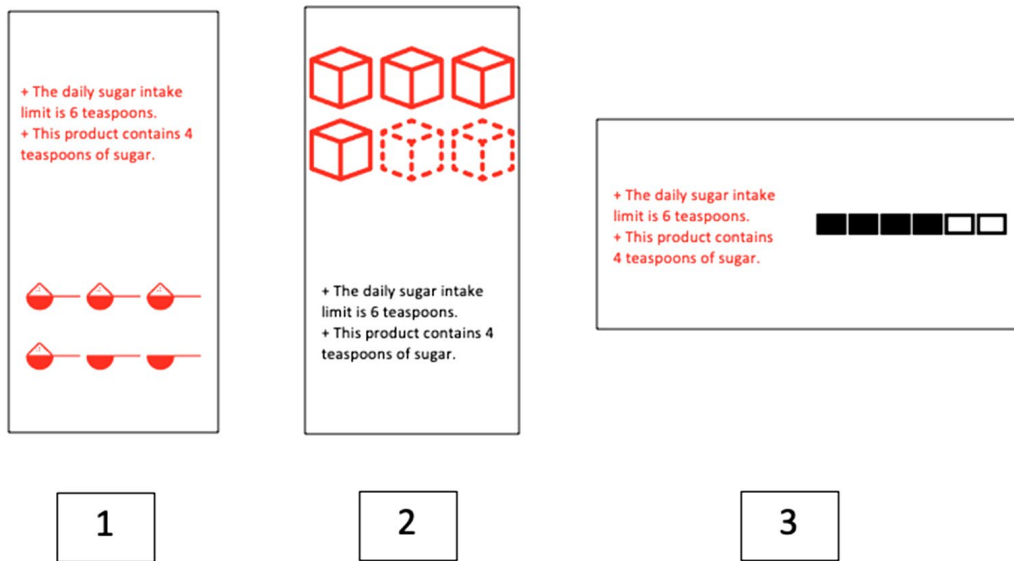
Figure 9: An example of the choice situation

Participants

The sample frame of this study is designed to target the urban population as they exhibit an obvious trend toward obesity in Thailand. The sample frame includes university students at a single University located in Bangkok and its vicinity who are 18 years old or older. The study used convenience sampling to collect data. Each participant was randomly assigned one of the questionnaire versions.

A total of 668 respondents participated in the survey, of which 59 percent were female and 41 percent were male. The mean age was 21 with a minimum of 18, and maximum of 32. Among all participants, 36.4 percent considered themselves to be health-conscious consumers. Table 1 reports summary statistics of the profile of the sample as well as the results from an analysis of variance (ANOVA) of individuals in different sets of questionnaires. From the ANOVA, there were no significant differences between the participants receiving different sets of questionnaires in terms of gender (*p*-value .897), but they did appear to be statistically different in terms of age (*p*-value 0.000) and whether or not they identified as health conscious individuals (*p*-value .082).

3.3 The Models

A mixed logit model was used to investigate the impact of the various label attributes on consumers' sugar label preference. The mixed logit model allowed for individual preference or taste heterogeneity (McFadden & Train, 2000). Each sampled individual (n = 1, … , N) faced a choice among J alternatives (j = 1 , … , J) in each of the choice

Table 1: Profiles of individuals in the sample

Set	No. of individuals	Share of males	Mean age	Min age	Max age	Share of health conscious individuals
1	167	40.1%	21.8	18	27	40.1%
2	172	40.1%	20.3	18	32	41.9%
3	161	43.5%	21.0	18	29	32.9%
4	168	39.9%	20.7	18	26	30.4%
Total	668	40.9%	20.9	18	32	36.4%
p-value of the ANOVA test		.897	.000			.082

situations (T) or choice set (t = 1, …, T). In this study, each individual faced three alternatives in each choice set of the conjoint choice design.

The individual was assumed to consider the full set of offered alternatives in the choice situations and choose the alternative that maximized his or her "utility" (i.e. his or her preference of label design) which can be expressed as the following random utility model:

$$U_{njt} = \boldsymbol{\beta'_n} \boldsymbol{x_{njt}} + \varepsilon_{njt}$$

where $\boldsymbol{x_{njt}}$ is a vector of explanatory variables which includes the attributes of the alternatives and the sociodemographic characteristics of individual n in choice situation t. That is, $\boldsymbol{x_{njt}}$ is the observed attributes of profile j (or alternative j) in the choice set t. $\boldsymbol{\beta_n}$ is an unknown parameter, linking the attribute to the person's utility. ε_{njt} is the error component. In a logit context, the random error component ε_{njt} is assumed to be independently and identically distributed according to a type I extreme value distribution. To take into account the concept that

some part of the error component is correlated over alternatives within individuals, this ε_{itn}, it is divided into two parts:

$$\varepsilon_{njt} = \mu_{njt} + \upsilon_{njt}$$

where μ_{njt} is correlated over alternatives, and another part, υ_{njt} is independent and identically distributed (IID) over alternatives and individuals.

The decision maker is assumed to choose the alternative (*i*) which maximizes his or her utility ($u_{ni} > u_{nj} \forall j \neq i$). Following Train (2003), mixed logit probabilities are the integral of standard logit probabilities over a density of parameters in which choice probabilities can be expressed as:

$$P_{ni} = \int L_{ni}(\beta) f(\beta) d\beta.$$

where $L_{ni}(\beta)$ is the logit probability evaluated at parameter β:

$$L_{ni}(\beta) = \frac{e^{\upsilon_{ni}(\beta)}}{\sum_{j=1}^{J} e^{\upsilon_{nj}(\beta)}}$$

$f(\beta)$ is a density function, and $\upsilon_{ni}(\beta)$ is the observed portion of the utility depending on parameter β.

A mixed logit model allows for heterogenous taste among individuals.

Thus, β varies among individuals. This yields the probability conditional on β_n as:

$$L_{ni}(\beta_n) = \frac{e^{\beta'_n x_{ni}}}{\sum_j e^{\beta'_n x_{nj}}}$$

while the unconditional probability is therefore an integral of $L_{ni}(\beta_n)$ over all possibility of β_n:

$$P_{ni} = \int \left(\frac{e^{\beta' x_{ni}}}{\sum_j e^{\beta' x_{nj}}}\right) f(\beta) d\beta$$

Explanatory Variables.

All attributes, including the sugar symbol, symbol color, text color, and layout, were assumed to have an impact on the consumer's preference of sugar label. In addition to these attributes, the decision of individual consumers may be affected by their gender and whether or not they are health conscious individuals.

Some studies have found that there is different label-use behavior between men and women. Most studies find that women are more inclined than men to read nutrition and ingredient information on food labels (Bender & Derby, 1992; Govindasamy & Italia, 1999; Guthrie, Fox, Cleveland & Welsh, 1995; Wang, Fletcher & Carley,1995). Nayga (2000) also found that, on average, men possess a lower nutrition knowledge than women which supports the findings on the prevalence of nutrition label use among women.

Furthermore, Hess, Visschers, and Siegrist (2012) and Dong (2015) found that health-related variables were the most important group of predictors of label use, and health

conscious consumers tended to use food labels more frequently than non-health conscious consumers. This shows that health-conscious consumers are willing to spend more time studying and evaluating nutrition information and these consumers are more likely to be persuaded by public service announcements.

In summary, the explanatory variables in the model include the categorical variables of sugar symbol (cube symbol, teaspoon symbol, bar symbol), symbol color (red and black), text color (red and black), and layout (Picture on Left Text on Right, Picture on Right Text on Left, Picture Top Text Bottom and Picture Bottom Text Top), as well as the interactions of the main attributes, and individuals' characteristics. In the following calculations, only gender and participants' perception of being health conscious are reported. Calculations using age were also carried out, but were not marginally significant (i.e. *p*-value > .10), hence age was omitted from the final calculations.

Effect coding and the reference group

Effect coding is used to code these categorical variables. For each variable, the reference group was coded as -1 (as opposed to being coded as 0 in the use of dummy coding). Bar symbol, black symbol, black text, label with Picture Bottom Text Top layout, females, and individuals who are not health conscious were used as the reference groups.

Table 2: Model estimates

| Variable	McFadden's pseudo-R squared = 0.5657		
	Coefficient	Std.Error	p-value
Cube	-0.234	0.084	0.005
Spoon	0.951	0.097	0.000
Bar	-0.717	0.111	0.000
Red Picture	0.071	0.040	0.079
Black Picture	-0.071	0.040	0.081
Red Text	-0.037	0.041	0.370
Black Text	0.037	0.041	0.370
Layout:PLTR	0.113	0.065	0.082
Layout:PRTL	0.145	0.064	0.024
Layout:PTTB	-0.043	0.063	0.490
Layout:PBTT	-0.215	0.063	0.001
Cube x Male	0.121	0.072	0.094
Spoon x Male	-0.079	0.087	0.362
Bar x Male	-0.042	0.103	0.686
Red Picture x Male	0.050	0.039	0.192
Black Picture x Male	-0.050	0.039	0.193
Red Text x Male	-0.029	0.039	0.465
Black Text x Male	0.029	0.039	0.465
Layout:PLTR x Male	0.063	0.062	0.310
Layout:PRTL x Male	-0.023	0.060	0.700
Layout:PTTB x Male	-0.039	0.061	0.522
Layout:PBTT x Male	-0.001	0.061	0.982
Cube x Health conscious	-0.017	0.074	0.818
Spoon x Health conscious	0.115	0.091	0.206
Bar x Health conscious	-0.098	0.103	0.342
Red Picture x Health conscious	-0.053	0.040	0.179
Black Picture x Health conscious	0.053	0.040	0.179
Red Text x Health conscious	0.074	0.040	0.062
Black Text x Health conscious	-0.074	0.040	0.062
Layout:PLTR x Health conscious	0.113	0.064	0.078
Layout:PRTL x Health conscious	-0.058	0.063	0.356
Layout:PTTB x Health conscious	-0.110	0.061	0.074
Layout:PBTT x Health conscious	0.054	0.062	0.379
SD.Cube	1.357	0.104	0.000
SD.Spoon	2.038	0.133	0.000
SD.Red Picture	0.399	0.065	0.000
SD.Red Text	0.256	0.084	0.002
SD.Layout:PLTR	0.115	0.148	0.436
SD.Layout:PRTL	0.095	0.128	0.456
SD.Layout:PTTB	0.034	0.113	0.763
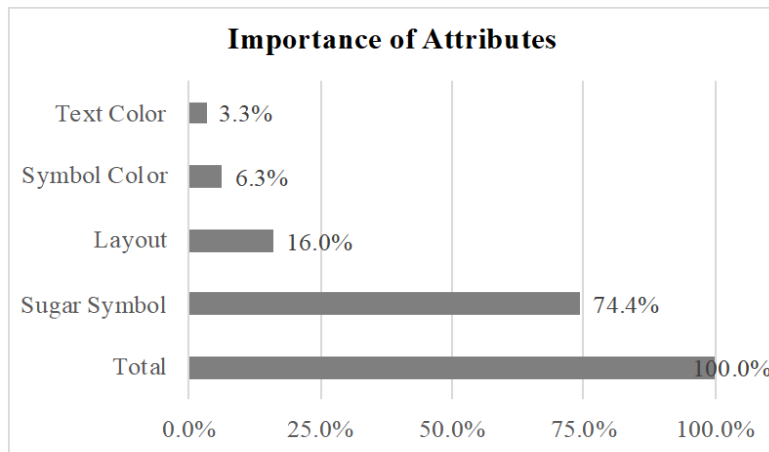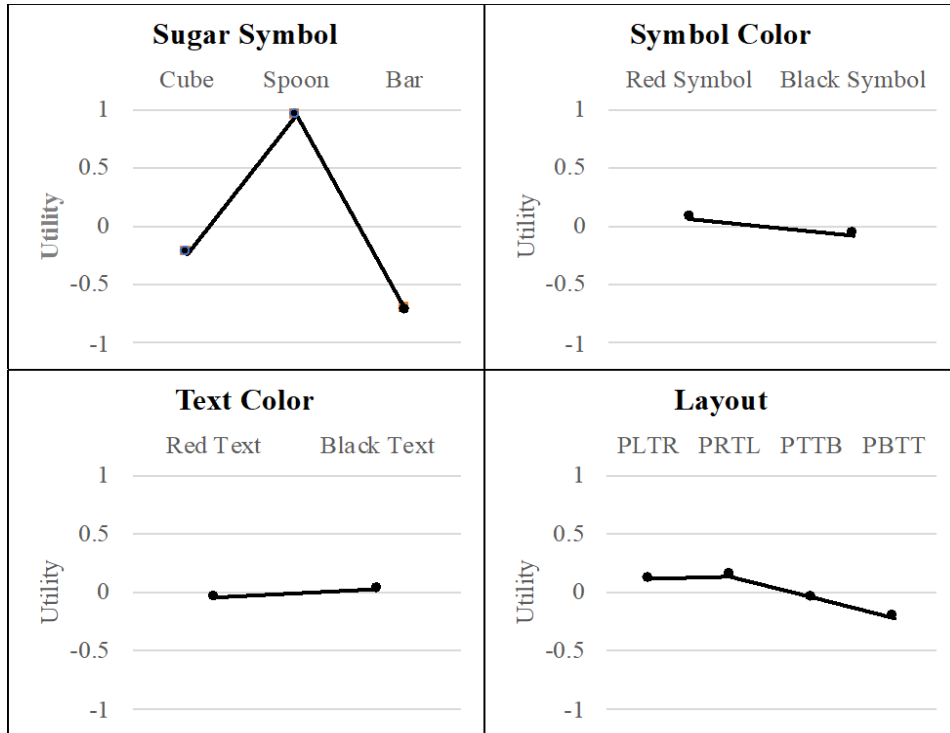
Figure 10: Utilities plots and relative importance of the attributes

4. RESULTS

4.1 The Effects of the Main Attributes of the Label

Table 2 and Figure 10 report the estimation results. Figure 10 displays the utilities plot and relative importance of each main attribute. Among the main attributes, sugar symbol is the design feature with the largest importance for consumer preference of label design. The second most important design feature is the layout, while the least important design feature is the text color.

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The "teaspoon" is the symbol that participants preferred most on the sugar label (*p*-value < 0.01); this was followed by the "cube" and "bar", respectively. This suggests that the "teaspoon" symbol is the best choice for representing the amount of sugar intake.

The red color was preferred significantly more than the black color for the sugar symbol (*p*-value < 0.10). This suggests that the use of red color is the best choice for the sugar symbol. However, the black color of text leads to higher consumer preference as its coefficient is positive, though it is not statistically significant. This suggests that the choice of black color for text on the label should be adopted.

It appears that the layout "Picture on Right and Text on Left" and "Picture on left and Text on Right" both lead to significantly higher consumer preference regarding the sugar label design when compared to other layouts (*p*-value < 0.05). In contrast, the layout "Picture at the Bottom and Text on Top" has the lowest performance regarding consumer preference of label designs (*p*-value < 0.01). This suggests that the layout which should be adopted for sugar limit labels is the horizontal layout.

4.2 The Interaction Effects

Even though the teaspoon symbol was shown to be the best symbol to create consumer preference of the label for both men and women, men slightly prefer the sugar label

more than women when the "cube" sugar symbol was used (*p*-value < 0.10).

Consumers who consider themselves health-conscious tend to prefer the sugar label more if the text color is "red" (*p*-value < 0.10) and when the layout is "PLTR" (*p*-value < 0.10). However, if the layout is "PTTB," it can significantly lower the preference of the label within the "health-conscious" group (*p*-value < 0.10).

5. DISCUSSION

There are several food policies that can be used to fight obesity and induce healthier consumption. This includes the use of dietary guidelines, nutrition labeling for food packages and restaurant menus, regulations on food advertising, tax on unhealthy food and drinks, as well as label design. This study supports the use of an optimal label design to best communicate the amount of sugar in individual products to consumers. Improving the design of nutrition labels helps promote healthier food choices. It requires the nutrition label to be accurate and easy-to-understand (Roberto & Khandpur, 2014), and has become one of the crucial public health goals for policy makers in fighting obesity and improving diet conditions among the their respective population. Referring to the results of previous studies, the use of front-of-package labels has proved to be more accurate in consumers' understanding of nutrition information (Roberto, Bragg, Schwartz, Seamans, Musicus,

Novak, & Brownell, 2012; Vanderlee, Goodman, Yang, & Hammond, 2012). Previous literature further suggests a focus on designing labels that can better grab consumer attention and convey nutrition information in a meaningful manner (Roberto & Khandpur, 2014).

To the authors' knowledge, there is no other study that simultaneously investigates the choice of sugar symbol, the choice of symbol color as well as text color and the layout of the label. This study utilizes a design developed to explore consumer preference for label designs, to assist policy makers in designing an optimal design of label for informing consumers of the daily sugar intake limit and for individual foods and beverages.

Designing an effective sugar label is one of the crucial ways of conveying information to consumers. Based on the results of this paper, it was found that the sugar symbol that contributes to the highest level of consumer preference is the "teaspoon". This is followed by the "sugar cube." Moreover, the symbol color of "red" and the text color of "black" are recommended for the sugar label. The decision of the position of the symbol and the text is also crucial. It plays an important role in the consumer preference of the label. The layout that leads to higher consumer preference is the horizontal layout.

Policy makers or relevant stakeholders should take these findings into account when considering using infographic labels to inform consumers about the daily sugar limit. It is expected that the better design of the label (as preferred by consumers) will lead to a healthier consumer choice. This study also sheds light on how different groups of consumers prefer different designs of sugar label. For health-conscious consumers, the red text color, and the layout "Picture on the left and Text on the right" can increase label preferences. Thus, this can be a starting point for policy makers, who would like to target specific consumer groups that need to pay particular attention to their sugar intake limit. This would lead to the development of policies to induce healthy consumption by consumers, or to reduce unhealthy diet behaviors.

REFRENCES

American Heart Association (2018). Added sugars. Retrieved from https://www.heart.org/en/healthy -living/healthy-eating/eat-smart/ sugar/added-sugars

Barlow, T., & Wogalter, M. S. (1991). Alcohol beverage warnings in print advertisements. In *Proceedings of the Human Factors Society 35th Annual Meeting* (Vol. 35, No. 6, pp. 451-455). Santa Monica, CA: Human Factors Society.

Barreiro-Hurlé, J., Gracia, A., & de-Magistris, T. (2010). Does nutrition information on food products lead to healthier food choices? *Food Policy*, *35*(3), 221-229.

Beaumont, J. G. (1985). Lateral organization and aesthetic preference: The importance of peripheral visual asymmetries. *Neuropsychologia, 23*(1), 103-13.

Becker, M. W., Bello, N. M., Sundar, R. P., Peltier, C., & Bix, L. (2015, October). Front of pack labels enhance attention to nutrition information in novel and commercial brands. *Food Policy, 56*, 76-86.

Bender, M. M., & Derby, B. M. (1992). Prevalence of reading nutrition and ingredient information on food labels among adult Americans: 1982–1988. *Journal of Nutrition Education*, *24*(6), 292-297.

Braun, C. C., Sansing, L., & Silver, N. C. (1994). The interaction of signal word and color on warning labels: Differences in perceived hazard. In *Proceedings of the Human Factors and Ergonomics Society 38th Annual Meeting* (pp. 831-835). Santa Monica, CA: The Society.

Cannoosamy, K., Pugo-Gunsam, P., & Jeewon, R. (2014). Consumer knowledge and attitudes toward nutritional labels. *Journal of Nutrition Education and Behavior, 46*(5), 334-340.

Dewar, R. E., & Arthur, P. (1998). Warning of water safety hazards with sequential pictographs. In H. Zwaga, T. Boersema & H. Hoonhout (Eds.), *Visual information for everyday use: Design and research perspectives* (pp. 111-117). London, UK: Taylor and Francis.

Dong, Z. (2015). How to persuade adolescents to use nutrition labels: Effects of health consciousness, argument quality, and source credibility. *Asian Journal of Communication*, *25*(1), 84-101.

Drichoutis, A. C., Lazaridis, P., & Nayga, R. M., Jr. (2005). Nutrition knowledge and consumer use of nutritional food labels. *European Review of Agricultural Economics*, *32*(1), 93-118.

Euromonitor International. (n.d.). *Market size – Sugar and sweeteners*. Retrieved July 10, 2019, from Euromonitor Passport database.

Firestone, R., Punpuing, S., Peterson, K. E., Acevedo-Garcia, D., & Gortmaker, S. L. (2011). Child overweight and undernutrition in Thailand: Is there an urban effect? *Social Science & Medicine*, *72*(9), 1420-1428.

Gill, R. T., Barbera, C., & Precht, T. (1987). A comparative evaluation of warning label designs. In *Proceedings of the Human Factors Society 31th Annual Meeting* (pp. 476-478). Santa Monica, CA: The Society.

Glover, B. L., & Wogalter, M. S. (1997). Using a computer simulated world to study behavioral compliance with warnings: Effects of salience and gender. In *Proceedings of the Human Factors and Ergonomics Society 41st Annual Meeting* (pp. 1283-1287). Santa Monica, CA: The Society.

Govindasamy, R., & Italia, J. (1999). *Evaluating Consumer Usage of Nutritional Labeling: The influence of socio-economic characteristics* (P Series 36734). Rutgers University, Department of Agricultural, Food and Resource Economics. Retrieved from https://ideas.repec.org/p/ags/rutdps/36734.html

Grobelny, J., & Michalski, R. (2015). The role of background color, interletter spacing, and font size on preferences in the digital presentation of a product. *Computers in Human Behavior*, *43*, 85-100.

Gupta, K., & Dharni, K. (2016). Use and influence of nutrition labeling: an emerging market experience. *Nutrition & Food Science*, *46*(3), 441-456.

Guthrie, J. F., Fox, J. J., Cleveland, L. E., & Welsh, S. (1995). Who uses nutrition labeling, and what effects does label use have on diet quality? *Journal of Nutrition Education*, *27*(4), 163-172.

Hartley, J. (1994). Designing instructional text for older readers: A literature review. *British Journal of Educational Technology*, *25*(3), 172-188.

Hess, R., Visschers, V. H., & Siegrist, M. (2012). The role of health-related, motivational and sociodemographic aspects in predicting food label use: A comprehensive study. *Public Health Nutrition*, *15*(3), 407-414.

Kiesel, K., McCluskey, J. J. & Villas-Boas, S. B. (2011, October). Nutritional labeling and consumer choices. *Annual Review of Resource Economics, 3*, 141-158.

Liu, R., Hoefkens, C., & Verbeke, W. (2015, April). Chinese consumers' understanding and use of a food nutrition label and their determinants. *Food Quality and Preference, 41*, 103-111.

Lupton, J. R., Ballentine, D. A., Black, R. M., Hildwine, R., Ivens, B. J., Kennedy. E. T., Packard, P. T., Sperber, B. R. Steffen, D., & Story, M. (2010). The Smart Choices front-of-package nutrition labeling program: Rationale and development of the nutrition criteria. *American Journal of Clinical Nutrition, 91*(4),1078S-1089S.

Malam, S., Clegg, S., Kirwan, S., McGinigal, S., Raats, M. M., Shepherd, R., Dean, M. (2009). Comprehension and use of UK nutrition signpost labeling schemes. *London, UK: Food Standards Agency*.

McFadden, D., & Train, K. (2000). Mixed MNL models for discrete response. *Journal of Applied Econometrics, 15*(5), 447–470.

Mhurchu, C. Ni, Eyles, H., Jiang, Y., & Blakely, T. (2018, February). Do nutrition labels influence healthier food choices? Analysis of label viewing behavior and subsequent food purchases in a labeling intervention trial. *Appetite, 121*, 360-365.

Miller, L. M. S., & Cassady, D. L. (2015, September). The effects of nutrition knowledge on food label use. A review of the literature. *Appetite, 92*, 207-216.

Morley, B., Scully, M., Martin, J., Niven, P., Dixon, H., & Wakefield, M. (2013). What types of nutrition menu labeling lead consumers to select less energy-dense fast food? An experimental study. *Appetite*, *67*, 8-15.

Murray, L. A., Magurno, A. B., Glover, B. L., & Wogalter, M. S. (1998). Prohibitive pictorials:: Evaluations of different circle-slash negation symbols. *International Journal of Industrial Ergonomics*, *22*(6), 473-482.

Nation. (2019, September 9). *Higher tax on sugary drinks aims to control consumption*. https://www.nationthailand.com/ business/30375992

Nayga, R. M., Jr. (2000). Nutrition knowledge, gender, and food label use. *Journal of Consumer Affairs*, *34*(1), 97-112.

Nutrition Australia. (2016). The traffic light system. Healthy eating advisory service. Retrieved February 4, 2020 from https://heas.health.vic.gov.au/sit es/default/files/HEAS-traffic-light-system.pdf

Ölander, F., & Thøgersen, J. (2014). Informing versus nudging in environmental policy. *Journal of Consumer Policy, 37*(3), 341-356.

Roberto, C. A., Bragg, M. A., Schwartz, M. B., Seamans, M. J., Musicus, A., Novak, N., & Brownell, K. D. (2012). Facts up front versus traffic light food labels: a randomized controlled trial. *American Journal of Preventive Medicine*, *43*(2), 134-141.

Roberto, C. A., & Khandpur, N. (2014). Improving the design of nutrition labels to promote healthier food choices and reasonable portion sizes. *International Journal of Obesity*, *38*, S25-33. doi: 10.1038/ijo.2014.86

Roberto, C. A., Shivaram, M., Martinez, O., Boles, C., Harris, J. L., & Brownell, K. D. (2012). The Smart Choices front-of-package nutrition label. Influence on perceptions and intake of cereal. *Appetite*, *58*(2), 651-657.

Sanders, M. S., & McCormick, E. J. (1993). *Human factors in engineering and design* (7th ed.). *New York, NY: McGraw-Hill*.

Strawbridge, J. A. (1986). The influence of position, highlight-ing, and imbedding on warning effectiveness. In *Proceedings of the Human Factors Society 30th Annual Meeting* (pp. 716-720). Santa Monica, CA: The Society.

Teerawattananon, Y., & Luz, A. (2017). *Obesity in Thailand and its economic cost estima-tion* (ADBI Working Paper No. 703). Retrieved from Asian Development Bank Institute website: https://www.adb.org/sites/defaul

t/files/publication/236536/adbi-wp703.pdf.

Temple, J. L., Johnson, K., Recupero, K., & Suders, H. (2010). Nutrition labels decrease energy intake in adults consuming lunch in the laboratory. *Journal of the American Dietetic Association*, *110*(7), 1094-1097.

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. New Haven, CT: Yale University Press.

Thaler, R. H., Sunstein, C. S., & Balz, J. P. (2014). Choice architecture. In E. Shafir (Ed.), *The behavioral foundations of public policy* (pp. 428-439). Princeton, NJ: Princeton University Press.

Thorndike, A. N., Riis, J., Sonnenberg, L. M., & Levy, D. E. (2014). Traffic-light labels and choice architecture: Promoting healthy food choices. *American Journal of Preventive Medicine, 46*(2), 143-149.

Tórtora, G., Machín, L., & Ares, G. (2019, May). Influence of nutritional warnings and other label features on consumers' choice: Results from an eye-tracking study. *Food Research International, 119*, 605-611.

U.S. Food and Drug Administration. (2018, May 3). Consumer research on labeling, nutrition, diet, and health. Retrieved February 4, 2020 from https://www.fda.gov/food/cfsan-consumer-behavior-research/consumer-research-labeling-nutrition-diet-and-health

U.S. Food and Drug Administration. (2019, April 1). CFR - Code of Federal Regulations Title 21. Retrieved February 4, 2020 from https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?CFRPart=101

Vanderlee, L., Goodman, S., Yang, W. S., & Hammond, D. (2012). Consumer understanding of calorie amounts and serving size: implications for nutritional labeling. *Canadian Journal of Public Health*, *103*(5), e327-e331.

Wang, G., Fletcher, S. M., & Carley, D. H. (1995). Consumer utilization of food labeling as a source of nutrition information. *Journal of Consumer Affairs*, *29*(2), 368-380.

Weaver, D., & Finke, M. (2003). The relationship between the use of sugar content information on nutrition labels and the consumption of added sugars. *Food Policy*, *28*(3), 213-219.

World Health Organization. (2015). WHO calls on countries to reduce sugars intake among adults and children. Retrieved from https://www.who.int/mediacentre/news/releases/2015/sugar-guideline/en/

World Health Organization. (2017). Taxes on sugary drinks: Why do it? Retrieved from https://apps.who.int/iris/bitstream/handle/10665/260253/WHO-NMH-PND-16.5Rev.1-eng.pdf;sequence=1

Wogalter, M. S., Conzola, V. C., & Smith-Jackson, T. L. (2002). Research-based guidelines for warning design and evaluation. *Applied Ergonomics*, *33*(3), 219-230.

Wogalter, M. S., Godfrey, S. S., Fontenelle, G. A., Desaulniers, D. R., Rothstein, P. R., & Laughery, K. R. (1987). Effectiveness of warnings. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *29*(5), 599-612.

Wogalter, M. S., & Shaver, E. F. (2001). Evaluation of list vs. paragraph text format on search time for warning symptoms. In A. C. Bittner, Jr., P. C. Champney, & S. J. Morrissey (Eds.) *Advances in Occupational Ergonomics and Safety IV* (434-438). Amsterdam, Netherlands: IOS Press.

Yang, Q., Zhang, Z., Gregg, E. W., Flanders, W. D., Merritt, R., & Hu, F. B. (2014). Added sugar intake and cardiovascular diseases mortality among US adults. *JAMA Internal Medicine, 174*(4), 516-524.

Young, S. L. (1991). Increasing the noticeability of warnings: Effects of pictorial, color, signal icon and border. In *Proceedings of the Human Factors Society 35th Annual Meeting* (pp. 580-584). Santa Monica, CA: Human Factors Society.

Young, S. L., & Wogalter, M. S. (1988). Memory of instruction manual warnings: Effects of pictorial icons and conspicuous print. In *Proceedings of the Human Factors Society 32nd Annual Meeting* (pp. 905-909). Santa Monica, CA: The Society.

Young, S. L., & Wogalter, M. S. (1990). Comprehension and memory of instruction manual warnings: Conspicuous print and pictorial icons. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *32*(6), 637-649.