Literature Review

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The rising level of obesity has been a growing concern worldwide (Finucane et al. 2011). In the United States, health issues caused by overweight and obesity, such as cardiovascular diseases and increased mortality rate (Kramer et al., 2012), account for approximately 20% of national medical spending (Cawley and Meyerhoefer, 2012). According to past research, the prevalence of obesity can be attributed to high calorie diets, popularized due to increasingly accessible and low-cost high calorie food (Swinburn et al., 2011; Gortmaker et al., 2011). Other factors, such as lack of knowledge (Krukowski et al., 2006; Elbel, 2011), automatic or habitual choice processes (Marteau, Hollands, and Fletcher, 2012; Wanskink, Just, and Payne, 2009), and preference for convenience (Rozin et al., 2011; Dayan and Bar-Hillel, 2011; Schwartz et al., 2012), were also found to contribute to unhealthy eating patterns and lead to weight gain.

In an attempt to reduce obesity at the population level, policy makers in the United States have made various efforts to target overconsumption of calories (Bray et al., 2012; Swinburn and Ravussin, 2009; Cutler et al., 2003), focusing on calorie and nutritional labeling. For example, the US Food and Drug Administration (FDA) released final regulations in December 2014, requiring restaurants with 20 or more locations to have calorie labels and a suggested daily total calorie intake on all menus (Federal Register, 2014). The focus on menu labeling policies have mainly relied on the assumption that obesity is largely driven by a lack of accurate information (Black, 2014), supported by the argument that the consumers often underestimate the calorie content of their food without correct information (Pomeranz and Brownell, 2008) and past

evidence that some consumers choose healthier food when nutrition information is present at the point of purchase (Roberto, Schwartz, and Brownell, 2009). The popularity of menu calorie labeling as informational interventions can also be explained by the fact that it is a relatively low-cost and easier to implement compared to other interventions such as taxes on unhealthy food or size restrictions on items (Goswami, Dai, and Urminsky, 2017).

However, the heavy reliance on calorie labeling also raises the question of whether such intervention is effective at reducing calorie consumption. First, calorie labeling based on providing persuasive information may be inconsistent as the effectiveness depends not only highly on recipients' literacy (Kutner et al., 2003; Williams, 2003), but also on interpretability of the messages. Moreover, the potential for information-based calorie labeling may be fundamentally limited because most human behavior is driven by automatic processes instead of deliberation upon the consequences of actions (Strack and Deutsch, 2004).

An alternative, non-informational approach of calorie labeling instead focuses on increasing individual's self-regulatory capacity to engage in healthier diet. According to psychological research, the fundamental conflict between hedonic short-term impulses and self-control cognitions involving goals and long-term consequences (Ainslie, 1975; Hoch and Loewenstein, 1991; Hoffmann et al., 2009) is a significant deciding factor on people's food choices. According to this account, identification of self-control conflicts (Bartels and Urminsky, 2015; Myrseth and Fishbach, 2009) and contextual influences on self-control (Ruderman, 1986), such as decision timing (Milkman et al., 2010), menu design (Parker and Lehmann, 2014) and convenience (Rozin et al., 2011), are two important influencing factors of calorie consumption. As a result,

calorie labeling can reduce individuals' calorie intake by promoting cognitions and creating decision contexts that facilitate self-control.

There are four systematic reviews on the impact of calorie labeling on food choices in cafeterias and restaurants, but most of them showed inconsistent results for the effect of calorie labels on reducing calorie choices (Harnack and French, 2008; Krieger and Saelens, 2014; Swartz et al., 2011; Sinclair et al., 2014). The most recent meta-analysis reported a small but statistically significant inverse association between calorie labeling and calories purchased per meal or transaction (-18.13 kcal; 95% confidence interval [CI] = -33.56, -2.70; $p = 0.021$), based on data from 23 comparisons across 19 studies (Long et al., 2014). However, the meta-analysis also found significant between-study heterogeneity. More specifically, studies conducted in non-restaurant settings showed a significant reduction in average calories purchased per transaction compared to control conditions (-58.16 kcal; 95% CI = -102.44, -13.87; $p = 0.01$), whereas studies conducted in restaurants did not show a significant association between menu calorie labeling (-6.70 kcal; 95% CI = -20.21, 6.81; $p = 0.331$) (Long et al, 2014).

Many different factors were proposed as potential sources of such heterogeneity. For example, although not significant, children and adolescents were found to have greater reduction in calories in response to calorie labeling. (Long et al., 2014; Roseman et al., 2013; Tandon et al., 2010; Tandon et al., 2011) In addition, some studies suggested that women tend to show stronger reduction in calories purchased compared to men in response to menu calorie labeling, although the relationship was not consistent across all the studies that presented results by gender. (Krieger, 2013; Bollinger, 2011) Moreover, race/ethnicity, BMI category, and neighborhood

socioeconomic status may also play a role in determining the effect of calorie labeling.

In addition to the factors mentioned above, the way in which calorie labels are presented may influence the effectiveness of the labels in reducing calorie consumption. For example, warning labels were found to outperform calorie labels in many cases (Donnelly et al., 2018). Similar to calorie labels, warning labels aim to induce healthy behavior change by providing health-relevant information to consumers. In contrast to calorie labels, however, warning labels does not only convey information in a straightforward and easy to interpret way, but also communicate an explicit recommendation.

A potential explanation for warning labels having larger effects than common calorie labels is that people may have difficulty understanding the numbers on traditional calorie labels (Downs, Loewenstein, and Wisdom, 2009; Fagerlin, Zikmund-Fisher, and Ubel, 2011; Korfage et al., 2013), and the labels are therefore not as helpful as an aid to consumers in decision making. Indeed, some recent studies showed that calorie information presented in terms of physical activity equivalents (e.g., number of minutes of running to burn off the calories) are more effective in motivating consumers to choose healthier beverages compared to traditional calorie labels due to improved interpretability (Bleich, Barry, Gary-Webb, and Herring, 2014; Bleich, Herring, Flagg, and Gary-Webb, 2012).

There is evidence that graphic labels may have the strongest effects on behavior. Long before studies were conducted on calorie labeling, graphic labels were found to be more effective than text labels for smoking cessation across a variety of outcomes (Noar et al., 2017; Noar, Francis,

et al., 2016; Noar, Hall, et al., 2016; Purmehdi, Legoux, Carrillat, and Senecal, 2017). To examine whether similar patterns generalize to food labels, Thorndike et al. conducted a field study at Massachusetts General Hospital (MGH). The study used a traffic-light food labeling system based on the 2005 U.S. Department of Agriculture My Pyramid recommendations, labeling every item in the cafeteria as either red, yellow, or green. The studied reported that, the proportion of red items purchased dropped from 24% to 21% ($p < 0.001$) during the intervention period, while the proportion of green items increased from 41% to 45% ($p < 0.001$) of all items. (Thorndike et al., 2014)

Another recent study conducted at a hospital cafeteria also showed that more evocative, graphic warning caloric labels on sugary drinks had a much stronger effect at reducing calorie choices, as compared to text warning labels. (Donnelly et al., 2018) While 21.4% of bottled drinks purchased were sugary drinks during the baseline/control period, the percentage was 21.5% during the calorie-label intervention ($p = 0.84$) and 21.0% during the text-warning-label intervention ($p = 0.66$), meaning that neither of these two interventions effectively reduced consumption of sugary drinks. In contrast, the share of sugary drinks was brought down to 18.2% during the graphic warning intervention ($p < 0.001$), which is a 14.8% reduction compared to the baseline consumption.

Based on the inconsistent results of previous studies on calorie labeling and recent studies on graphic labeling, I try test in this study a novel explanation that the ineffectiveness of certain calorie labeling interventions may have little to do with interpretability of the information and may instead be explained by the effects of visual salience on decision making. (Goswami, Dai,

and Urminsky, 2017). According to this account, visual salience plays an import role not only because it ensures information to be noticed, but primarily because it facilitates active deliberation about cues (Shen and Urminsky, 2013) and incorporation of cues into decisions (Weber and Kirsner, 1997). My hypothesis is that visually salient information affects foods choices primarily through a reminder effect, prompting people to consider nutrition rather than merely providing new information. If such hypothesis holds true, I expect to find that even non-informative "mere-reminders" yield similar results as salient new information.

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