

MANDATORY CALORIE DISCLOSURE:
A COMPREHENSIVE ANALYSIS OF ITS EFFECT ON
CONSUMERS AND RETAILERS

ABSTRACT

In 2018 restaurants in the United States will need to provide calorie information on their menus as part of the Patient Protection and Affordable Care Act. In the present research, we examine the efficacy of this legislation in reducing restaurant based food calorie consumption. Specifically, we explore the likely effect of the new policy on both the supply and demand side, that is, consumer and retailer behaviors. To achieve this, two studies are included in this research: a meta-analysis of 186 studies investigating the effect of calorie disclosure on calories selected, and a meta-analysis of 41 studies examining the effect of calorie disclosure on calories offered by retailers. Across these two studies we reveal a significant and unequivocal calorie disclosure effect for menu labels; disclosure results in both fewer calories selected (-27 Calories) and fewer calories offered by retailers (-15 Calories).

Keywords: Calorie Labels, Mandatory Disclosure, Meta-Analysis

The increasing prevalence of obesity has become a major cause for concern in the modern world. With more than 30% of American adults aged 20 and over being classified as obese (Clarke et al 2016), and with the World Health Organization estimating that 2.8 million (5%) of global deaths are attributable to obesity (WHO 2011), innovative approaches in preventing and treating obesity are urgently needed. In addition to a portfolio of interventions focusing on individual and parental education to encourage personal responsibility for food consumption (Dobbs et al 2014), restaurants and other retail food outlets are the latest conscripts in the fight against obesity.

Experts estimate that Americans spend half (50.1%) of their food dollars on meals purchased outside of the home (ERS Food Expenditure Series 2016), with restaurant food sales valued at \$799 Billion (National Restaurant Association 2017), and that food away from home accounts for an average 33% of an individual's total consumed calories (Powell et al. 2012). Given these figures, the retail food environment is a critical aspect of the built environment that can contribute to the prevalence, and most importantly, the prevention of obesity within a population (Binks 2016).

The World Health Organization has recently called for an emphasis on the provision of supportive retail environments to encourage consumers to make healthier food choices (WHO 2016). Suggested strategies that food retailers can implement in influencing consumers into eating better include: the provision of smaller sized servings (Holden et al 2016; Zlatevska et al 2014); in-store signage, e.g. drawing attention to healthier choices; structure, e.g. changing store layout and organization to prompt healthier product selections; and service e.g. making electronic aids and apps available to consumers (Wansink 2017). Another suggested strategy involves the provision of nutritional information at the point of purchase to enhance a consumer's ability to regulate their own food purchase behavior (Binks 2016).

In response to the call to provide consumers with more nutritional information at the point of purchase in food retail establishments, legislation (part of the Patient Protection and Affordable Care Act) was passed in 2010, requiring restaurants in the United States to include calorie information on their menus. Prior to the legislation, some cities (e.g. New York), counties (e.g. King County), and states (e.g. California) had passed their own laws requiring the posting of nutritional information on menu boards in chain restaurants. According to the legislation, menu boards are required to list the name of every menu item on offer, including options like meal combinations, and the calorie counts for each (FDA 2014). Supporters of the legislation argue that consumers are often unaware, or underestimate, the nutritional content of the food they are purchasing. Hence, equipping consumers with caloric information will encourage them to make considered and possibly healthier product selections (Burton et al. 2006; Burton and Kees 2012).

The legislation applies to quick and table service retail establishments that are part of a chain with 20 or more locations. It also covers grocery stores that sell restaurant type food and are part of a chain with 20 or more locations doing business under the same name (FDA 2014). Retailers have until May 2018 to comply with the imposed guidelines. Some retailers have already, voluntarily complied with the legislation. The initial cost of implementing the proposed menu changes is estimated to exceed \$388.43 million for food retailers, with an ongoing cost of compliance of \$55.13 million (FDA 2014).

Because of the large mandatory cost imposed on retailers (VanEpps et al 2016) and the opposition by some industries, there is strong interest in whether the benefits of the proposed legislation will outweigh the expenses and required efforts for restaurants to implement menu labels. Furthermore, given that few obesity-related policy changes have actually been implemented in the United States within the last 10 years (VanEpps et al 2016), there is strong public interest in the success of the proposed menu label policy. Academic

studies investigating the possible effect of calorie labeling initiatives have provided mixed results. For instance, Long et al. (2015) present summary data revealing that disclosure of calories is correlated with selecting fewer calories, whereas other studies (e.g., Schwartz et al. 2011) suggest that calorie disclosure does not affect food choices. Thus, a critical, outstanding question is: will mandatory calorie disclosure in food retail establishments be successful in changing consumer behavior?

In the present research, we examine the likely efficacy of the new legislation. First, we summarize extant research exploring the effect of calorie labeling initiatives. When reviewing previous efforts of synthesizing the existing literature on menu labeling initiatives, we find that existing research has significant methodological shortcomings. In particular, many reviews are not of a meta-analytic nature (that is, they are qualitative, conceptual reviews), and those that are quantitative, suffer from potential biases. The biases include lack of control for moderating variables in the meta-analysis and strong limitation in synthesized studies resulting in small sample sizes (6–38 studies). These two problems make it difficult to come to conclusions about general effects.

To shed light on the likely overall calorie disclosure effect, we present a meta-analytic approach using multilevel modeling techniques. This meta-analysis method accounts for the potential sources of bias mentioned above and relies on 186 synthesized cases (representing an analysis of 1,677,265 consumption choices). In particular, our meta-analysis accounts for various sources of heterogeneity by including moderators into the model and by capturing dependencies imposed by the nested structure of experiments from the same authors as well as situations where multiple interventions are compared to the same control condition, thus further reducing bias in estimates (Neumann and Böckenholt 2014; Janakiraman, Syrdal and Freling, 2016). Our findings based on this robust estimation indicate a significant and

unequivocal calorie disclosure effect for menu labels on consumer behavior: consumers select fewer calories following disclosure.

Furthermore, we also note that the majority of prior research focuses on consumers' reaction to new labels and less on the actions of the supply side. However, retailers and their menu adjustments play a key role in the ultimate success of any policy, independent of the calorie information disclosure and consumer reactions (Moorman et al 2012). Obligatory incentives often drive the behavior of information providers, sometimes for the better and sometimes for the worse (Lowenstein et al. 2014). Without a comprehensive examination of the effect of calorie disclosure on both the sides of the consumer and the retailer, determining whether or not the legislation will have substantial, broad-based effects is difficult. Following this rationale, we present a second study to investigate likely supply-side adjustments to the new legislation. We perform a meta-analysis of 41 studies (representing an analysis of 33,029 menu items) examining the calories offered by retailers before and after menu changes began to voluntarily be implemented in the United States. Our findings reveal that disclosure of calorie information also significantly leads to lower calorie offerings by food retailers.

The Effect on Consumer Behavior

The implementation of mandatory calorie disclosure on menu boards at the point of purchase is expected to have a positive effect in encouraging consumers to make healthier food choices (Burton et al 2015). However, although momentum has continued to gather around menu labeling policies with widespread support by consumers (national polls show that between 67% and 83% of people support calorie disclosure (Roberto et al 2009)), evidence supporting the efficacy of the initiative remains unclear.

Multiple studies have investigated the impact of mandatory calorie disclosure on restaurant menus across many academic disciplines, but have reached little consensus as to the overall effect the legislation will have on consumers. For example, Bollinger et al. (2011),

Roberto et al. (2010), and Hammond et al. (2013) conduct experiments illustrating that calorie disclosure reduces energy consumption. In contrast, Schwartz et al. (2012) and Downs, Wisdom, and Lowenstein (2015) perform field experiments and find no significant calorie reduction related to changes in consumers' food choices. The observational results of Dumanovsky et al. (2011) and Girz et al. (2012) even suggest an increase in calories consumed following disclosure.

However, it is not only individual studies which have come to conflicting conclusions regarding the magnitude of the effect of calorie disclosure on a consumer's food selections. We identified eight review studies that synthesized experimental research on calorie consumption measures (see Appendix A). Some of the reviews report that disclosure is effective in reducing the number of calories selected for a meal. For example, Littlewood et al. (2016, p. 1) conclude that the results of their review show a "statistically significant effect" of menu labeling where overall calories ordered was reduced by 100 Calories. Long et al. (2015) found a much smaller but also significant decrease of 18 Calories selected per meal. Yet, Sinclair et al. (2014) found no significant reduction in their review of studies that tested calorie content labels (without additional contextual information).

What could explain the contradictions in research findings on the influence of calorie disclosure? After reviewing the nine summary studies, we make several key observations that seem to provide plausible explanations about the mixed results among the existing reviews. First, five of the eight studies (Harnack and French 2008; Swartz et al. 2011; Lazareva 2015; Fernandes et al. 2016; Van Epps et al. 2016) represent qualitative reviews where the research team summarized experimental data under the lens of several key criteria, often subjectively grouped by two to three raters. In contrast to a quantitative meta-analysis, such narrative review can be biased by the views of the raters or the selection of studies (Rosenthal and DiMateo 2001). Moreover, qualitative groupings and analyses suffer from lack of

transparency and assessment standards, such as the use of established effect sizes that account for study precision or statistical methods that are deployed to neutrally determine final conclusions.

We also find that the three review studies that represent traditional quantitative meta-analyses were based on low sample sizes with between 12 and 19 reported effect sizes (Littlewood et al. 2016; Long et al. 2015; Sinclair et al. 2014). Any outcomes based on such a small number of effect sizes could be biased because of sampling variance or a very restrictive sampling framework (DerSimonian and Laird 1986). When reviewing the three studies more closely, we also find that the selection criteria of these reviews have been limited in terms of regions, publication status, years of publication, and labeling methods (see Appendix B). These sampling limitations reduced the pool of synthesized studies and may have created an unrepresentative subsample of all available studies.

In addition to the restricted sample sizes, the three existing meta-analyses did not account for moderating variables when estimating the average effect size. The three reviews present qualitative and subgroup analyses to investigate the impact of study characteristics. A subgroup analysis only allows investigating one variable at a time, and conducting multiple tests raises the risk of false-positive results because of chance alone (Yusuf et al. 1991).

To address issues concerning generalizability of the results from existing quantitative reviews and to shed light on the overall effect of calorie disclosure on consumer food choices, we remove the restrictions above and perform a comprehensive meta-analysis of 186 Calorie label intervention versus control (no intervention) comparisons. Furthermore, to gain a better understanding of heterogeneity across the different studies, we carry out a meta-regression on different study characteristics as well as a multilevel modelling estimation. Meta-regression is an extension to subgroup analysis, simultaneously allowing accounting for the effects of both continuous and categorical moderators (Thompson 2002).

Study 1: The Effect of Calorie Disclosure on Consumer Behavior

Meta-Analysis Method

Studies relevant for the meta-analysis were initially identified through a search of ABI/Inform, ProQuest Digital Dissertations, Business Source Premier, Web of Science, PsychInfo, Scopus, Google Scholar, and other databases using the following keywords: menu labeling, restaurant labeling, calories on menu, calorie disclosure, nutritional information on menu, Patient Protection and Affordable Care Act. References in articles found in our search were also examined to identify further studies. The search was not restricted to particular years of publication, country of data collection, or languages.

Intervention and Study Characteristics

A study was deemed eligible for inclusion in the meta-analysis if it involved a disclosure of calorie information on a (real or hypothetical) restaurant menu as an intervention. In an example of calorie disclosure on a real restaurant menu, participants in Platkin (2014) were provided with a Burger King menu from which they were asked to choose food items. Whereas, in an example of a hypothetical restaurant menu, participants in Dodds et al (2014) were asked to make their selections from a menu, not specific to a branded restaurant, but which did contain a selection of foods commonly found at quick service restaurants.

Studies included in the analysis were not restricted to a particular food category, or eating occasion. Rather, studies examined the selection of both food and beverages, and these were across both unhealthy (e.g., Lee and Thompson 2016) and perceived healthy (e.g. Kreiger et al. 2013) categories¹. We included studies that collected data only at lunch (e.g., Temple et al 2011), only at dinner (e.g., Liu et al 2012), or across different meal times (e.g., Vanderlee and Hammond 2013). Furthermore, for the purpose of the analysis, retail

¹ Given the opposition to enforcing calorie labeling by the pizza industry, we also examined the effect of labeling for pizza separately.

restaurants were defined as either quick-service (e.g., Yamamoto et al. 2005) cafeterias (e.g., Holmes et al. 2013) or table service (e.g., Fotouhinia-Yepes (2013), exploring a labeling intervention in a fine dining restaurant and Liu et al (2012) exploring a labeling intervention in a table service restaurant chain (Chilli's).

Both field and laboratory based studies were included in the meta-analysis. Studies that manipulated calorie (or kilojoule which was converted to calorie, e.g., Morley et al. 2013) disclosure along with another contextual intervention (e.g., calories plus traffic light symbols (e.g. Hammond et al. 2013)), calories plus energy expenditure (e.g. Platkin et al 2014) and calories plus additional nutrients (Burton et al. 2006)), were also included in the analysis. However, studies that manipulated only a symbol and not calories (e.g., heart healthy stickers on menu items) were excluded from the analysis (Freedman and Connors 2011; Levin 1996; Sharma et al. 2011; Vyth et al 2010). Burton et al. (2015) was also excluded from the analysis, because it explored the nutrition facts panel rather than calorie disclosure on restaurant menus. Conditions that did not provide an intervention of calorie disclosure, but did manipulate another contextual variable instead (e.g. traffic lights, Dodds et al. 2014) were not included in the meta-analysis.

Studies included in the meta-analysis were a mixture of between subject, within subject, and other designs. In the between subject designs participants were randomly assigned to an intervention of calorie disclosure or a control group involving no calorie disclosure (e.g. Hammond et al. 2013)². In within subject designs, all participants in the study made selections from a control menu containing no calorie information, and an intervention menu that did (e.g. Reale and Flint 2016). Other designs included cross-sectional study designs, difference in difference, pre-post, and pre-post with control. Cross sectional designs involved studies where purchase data was obtained from restaurants located in cities that had

² In an exception to this, Bassett al (2008) was also classified as a between subject design, where the comparison was between people who did (intervention) and did not (control) notice the calories posted on the Subway menu.

implemented labeling (intervention) compared to comparable (based on socio-demographic factors and the brand name) restaurants in cities that had not implemented calorie labeling on their menus (control, e.g. Seenivasan and Thomas 2016). Difference-in-difference designs involved first taking the difference between treatment and baseline for study participants exposed to the calorie information. Then, this result was subtracted from the difference between the original and matching period for study participants who were not exposed to calorie information (e.g. Finkelstein et al 2011). Pre-post study designs involved purchase data from restaurants both before (control) and after they implemented calorie labels on their menus (intervention) (e.g., Pulos and Leng 2010). Pre-post with control designs involved purchase data where before-labeling and after-labeling differences within a restaurant (intervention) were compared to before and after differences in purchase data from a comparable (control) location where mandatory labeling was not in effect (e.g. Elbel et al 2013).

Outcome

To be eligible for inclusion, studies were required to report on the number of calories selected or purchased (e.g., Krieger et al. 2013) following calorie disclosure on a food retail menu³. One study was excluded because it provided information about the proportion of items selected from the menu, rather than the amount of calories selected (Davis-Chervin et al. 1985). Likewise, both Driskell et al. (2008) and Hwang and Lorenzen (2008) were excluded from the analysis because their outcome variables were not of interest.⁴ All necessary information was extracted from the published articles, protocols, and commentaries related to each study. In some cases, where raw data were not available, assumptions and calculations

³ In some cases, articles reported on the calories consumed as the variable of interest (Aaron, Evans, Mela 1995; Girz et al 2012; Hammond et al 2013; Harnack et al 2008; Hoefkens et al 2008; James et al 2015; Platkin et al 2014; Roberto et al 2010; Temple et al 2011; Vanderlee, Hammond 2013). We also ran an analysis comparing differences between calories selected and consumed in our multilevel model and found no significant differential effect of this outcome variable.

⁴ Use or nonuse of nutrition labels and willingness to pay more for healthier food items, respectively.

were made from the figures included in the articles or the explanation of the results in text⁵. Two studies (Mayer et al. 1987; Webb et al. 2011) examining the effect of calorie disclosure on menus could not be included because of lack of data even though they fit the eligibility criteria.

A total of 186 studies reported in 54 articles representing 1,677,265 meal choices were included in the meta-analysis (see Appendix C for a summary of effects sizes for the included studies). Of the studies included in the meta-analysis, 68 percent reported a reduction in calories (ranging from - 400 Calories (Temple et al 2011) to -1 Calorie (Pulos and Leng 2011). For studies reporting an increase in consumption, the range varied between 1 Calorie (Lee and Thompson 2016) and 217 Calories (Temple et al 2011).

Moderators

One of the greatest strengths of a meta-analysis is investigating not only one average effect of interest, but also how moderating variables lead to differences in these effects (Janakiraman, Syrdal and Freling, 2016). For each effect included in the meta-analysis, three expert raters independently coded the potential moderators (see Table 1 for a summary). There was 95 percent agreement among the raters on the coding of the moderator variables. In cases of disagreement, the lead author made a judgement call.

Potential moderators accounted for in the meta-analysis were related to either (1) study or (2) demographic characteristics. The former includes the labeling intervention (calories only versus calories plus a contextual intervention), study design (between-versus within-subject vs. other designs), actual versus hypothetical choice scenarios⁶, healthiness (whether the food category was unhealthy or not), restaurant type (table service vs. other restaurant services), eating occasion (lunch only versus dinner only vs. other), and food type

⁵ For example, in Rainville et al (2010) the raw differences, standard deviations, and the number of menu days were provided in Table 12 as was the t value for the differences taking into account the control. These data were used to calculate the standard error while the sample size was calculated using the number of menu days times the average number of participants per school.

⁶ The category lab and field was highly correlated with the category actual and hypothetical choice scenario; therefore, we have used only one of these categories (actual, hypothetical choice) as a moderator.

(pizza vs. beverage vs. other). Demographic characteristics include gender (females only, males only, both males and females), BMI (whether, on average, participants in the study had a normal BMI of under 25, or an overweight BMI of 25 or over), and whether the meal selected was intended only for a child (<18 years) or not. In addition, we follow the suggestion of Rosenthal and DiMatteo (2001) to include a control variable for the publication year of a study. Specifically, we add to the model the time lag between the publication year of each study and the first data point in our research synthesis.

INSERT TABLE 1 ABOUT HERE

Effect-Size Measure

For the effect-size measure of our meta-analysis, we computed the raw mean differences, as well as the corresponding standard errors, for the calorie selection between the intervention and the control⁷. Using the raw means instead of standardized measures (which divide the raw means by a study's standard deviation) provides two advantages: (1) we can easily interpret the results (possible calorie reductions) and (2) our effect size is 100% scale-free. That is, using a raw metric allows us to strictly separate the impact of calorie disclosure on means from study-to-study differences in standard deviation (Bond Jr., Wiitala, and Richard 2003).

To evaluate the effect magnitudes provided by the synthesized meta-analysis data, we produced a funnel plot (Sterne and Egger 2001), which maps effect estimates from individual studies against a measure of study precision (e.g., standard errors). A visual inspection of the funnel plot of our data (see Figure 1) shows that the scatter resembles a symmetrical inverted funnel with fairly evenly spread data points. This pattern suggests that the risk of publication bias across studies is low. Moreover, we find that the center of the funnel is in the negative

⁷ Where studies did not report the p-value, but did report significance, effect size calculations were based on a conservative p-value of 0.05 (or 0.01, 0.001 where stated in the original paper). For insignificant effects, a conservative p-value of 0.5 was used. Where sample size for each cell was not provided in the original paper, an assumption of equal cell sizes was made for between subject designs.

region of the effect scale, suggesting an average effect of a calorie reduction across the 186 studies.

INSERT FIGURE 1 ABOUT HERE

Model and Estimation

For our meta-analysis, we use the Metafor package (Viechtbauer 2010) and obtain the estimates through maximum likelihood estimation. The mixed-effects model⁸ estimate consists of three levels: the first level encompasses the effect sizes, the second incorporates conditions where multiple interventions were compared to the same control condition in a study⁹, and the third level adds the articles that provide the comparisons. All independent variables in the model are grand-mean centered to provide an average estimate of the effect size across all conditions (Janakiraman, Syrdal and Freling, 2016). The independent variables are included in level 1 if they vary within studies; otherwise they are included in level 3. A correlation matrix can be found in Appendix E. These specifications lead to the following meta-analysis equations:

Levels 1 and 2 – Effect Size Model and Shared Control Comparisons

$$(1) \quad ES_{ijk} = \beta_{00} + \beta_{11} PIZZA_{ijk} + \beta_{12} BEVERAGE_{ijk} + \beta_{13} LABEL_{ijk} + \beta_{14} FEMALE_{ijk} + \beta_{15} MIXED_{ijk} + \beta_{16} CHILDREN_{ijk} + \beta_{17} OVERWEIGHT_{ijk} + \beta_{18} HEALTHY_{ijk} + r_{ijk} + v_{ij},$$

Level 3 –Article Specific Characteristics

$$(2) \quad \beta_{00} = \gamma_{000} + \gamma_{100} WITHIN_k + \gamma_{200} BETWEEN_k + \gamma_{300} TABLESERVICE_k + \gamma_{400} LUNCH_k + \gamma_{500} DINNER_k + \gamma_{600} SCENARIO_k + \gamma_{700} YEARS_k + u_k,$$

where subscript i is used for the effect sizes for multiple within article studies ($i = 1, \dots, 186$), subscript j for the comparisons of multiple within article interventions that shared a control condition ($j = 1, \dots, 130$) and subscript k is used for the individual articles used in the analysis

⁸ Precision weighting was used in our analysis, where the observations are weighted by the inverse variance.

⁹ In some cases two or more different interventions are compared to the same control condition (e.g. Harnack et al. 2008). This creates further dependencies in the data. We follow the procedure outlined in Neumann, Böckenholt and Sinha (2016) to add another level in the model to control for this data structure.

($k = 1, \dots, 54$). Moreover, r_{ijk} represents the random effect (on level 1), v_{ij} the random effect on level 2 (the effect size comparisons that shared a control), and u_{kj} the random article effect (on level 3). The vectors u_k , v_{ij} and r_{ijk} are specified to follow a multivariate normal distribution with the dispersion matrices T_u , T_v and T_r .

Results

Table 2 exhibits the results from the overall multilevel model including all moderators of the effect. The explanatory power of our model reveals that 99.9% of the variance between articles, 13.4% of the variance among shared base conditions, and 39.2% of the variance among effect sizes is captured by our tested independent variables.¹⁰ Our intercept shows that on average there is a significant reduction of 27 Calories selected by consumers following calorie disclosure ($\gamma_{00} = -27.21, p < .001$)¹¹.

In addition to the average calorie reduction, our multilevel model identifies a number of moderators for the effect of disclosure on consumer behavior. We find that the calorie reduction is significantly stronger for overweight individuals ($\gamma_{13} = -66.85, p < .001$), females ($\gamma_{13} = -75.16, p < .01$), table-service restaurant settings ($\gamma_{13} = -29.61, p = .02$) as well as hypothetical choice scenarios ($\gamma_{13} = -42.88, p = .01$). We also find that the calorie reduction is more effective for lunch meals ($\gamma_{13} = -26.62, p = .03$) than for other eating occasions, and marginally more effective for samples containing a mixture of males and females ($\gamma_{13} = -45.55, p = .06$), but marginally less effective for healthy meals ($\gamma_{13} = 24.87, p = .07$). Our meta-analysis suggests no statistically significant differences in effect sizes based on different labeling techniques, children versus other subject groups, or particular experimental design comparisons (within vs. between vs. other). We also find no significant trend pattern in

¹⁰ The model does not explain much variation at the shared control condition level since we have no moderators included on this level. The addition of the mid-level was done to account for any correlations among studies that share a comparison with the same control condition.

¹¹ We ran a sensitivity analysis (removing Bollinger et al 2010 from our data) and found that the findings are not affected by this single data point, with little change to the estimated coefficients. That is, all tested moderating variables have the exact same level of significance, while the average calorie reduction effect is about the same.

reported effect sizes over the years and no significantly different consumer behavior for various food types across our data.

Having established a robust effect of calorie disclosure on consumer behavior, we next turn our examination to the effect of calorie disclosure on supply side adjustments.

INSERT TABLE 2 ABOUT HERE

Study 2: The Effect of Calorie Disclosure on Retail Behavior

Although the calorie disclosure legislation has widespread consumer backing, support from retailers is mixed. Some retail chains such as McDonald's and Starbucks have already, voluntarily complied with the legislation, though, many retailers are still actively fighting the legislation, with some asking for exemptions because of fear of the increasing cost of compliance and a possible negative effect on sales (Roberto et al. 2009). For example, the ruling has faced strong opposition from the pizza industry (the American Pizza Community) who have argued that they should be exempt from calorie labeling because of the complexity and cost of implementing the scheme on their menus given the customizable nature of their product offerings (Roberto et al. 2009). Instead, they have pushed for an alternate bill, the Common Sense Nutrition Disclosure Act. Under this alternate bill, pizza chains would not have to post calories in store and would not have to post total per item calories, rather calories per single serve (as determined by the retailer).

However, advocates of the new legislation argue that in addition to positive consumer-driven impact, the legislation could also have favorable supply-side effects. In particular, mandatory calorie labels may encourage the restaurant industry to reformulate their product offerings such that they also contain less calories (Van Epps et al. 2016). To uncover this possible retailer reaction, in study 2 we use a meta analytic approach to examine how calorie disclosure affects the number of calories offered by restaurants.

Meta-Analysis Method

The search strategy adopted in study 2 was the same as that utilized in study 1. The key difference in the meta-analytic methodology adopted between the two studies was the primary outcome examined. To be eligible for inclusion in study 2, studies were required to report on the amount of calories offered by retailers both before and after restaurants had voluntarily started to disclose caloric information on their menus following the announcement of the legislation in 2010. Studies included in the meta-analysis were a mixture of between subject design (where the difference in calories offered was examined between restaurants that did voluntarily implement calorie disclosure and restaurants that did not), within subject (the calorie offerings were compared for the same restaurant before and after voluntary disclosure), and pre post with control designs (where the calorie offerings were compared for the same restaurant before and after voluntary disclosure with restaurants that that did not disclose calories for the same time period).

A total of 41 studies reported in 7 articles representing 33,029 menu items were included in the meta-analysis examining the effect of calorie disclosure on calories offered by retailers (see Appendix D for a summary of included studies). Again, we computed the raw mean differences as well as the corresponding standard errors for the calories offered between the intervention and the control. A visual inspection of the funnel plot of our data (see Figure 2) shows that the scatter resembles a symmetrical inverted funnel with fairly evenly spread data points. Of the studies included in the meta-analysis, 66 percent reported a reduction in calories (ranging from -200.8 (Bleich et al 2016) to -0.5 Calorie (Bleich et al 2015)). For studies reporting an increase in calories, the range varied between 0.5 Calories (Bleich et al 2015) and 113 Calories (Namba et al 2013).

INSERT FIGURE 2 ABOUT HERE

In study 2, we perform a random-effects meta-regression and include several potential moderators in our model to account for potential differences based on various study and

demographic characteristics captured in the data.¹² For our analysis of calorie adjustments across retailers, we control for study design (within vs. between vs. other comparisons), the food category (healthy or not), the food type (beverage vs. pizza vs. other food) and whether the meal selected was intended only for a child (<18 years) or not. In addition, we account for the time interval between the calorie adjustments, that is, how many years had passed between menu adjustments. Table 3 provides a summary of all tested variables included in the analysis.

INSERT TABLE 3 ABOUT HERE

Model and Estimation

We again estimate the model using maximum likelihood and the Metafor package (Viechtbauer 2010). All independent variables in the model are grand-mean centered (a correlation matrix can be found in Appendix F), resulting in the following effect size (ES) equation:

$$(3) \quad ES = \beta_0 + \beta_1 \text{ BETWEEN} + \beta_2 \text{ WITHIN} + \beta_3 \text{ CHILDREN} + \beta_4 \text{ PIZZA} + \beta_5 \text{ HEALTHY} + \beta_6 \text{ TIMESPAN} + r,$$

where r is the random effect across studies with a multivariate normal distribution (T_R).

Results

Similar to the study 1 meta-analysis examining demand-side policy reactions, our proposed meta-analysis suggests a good fit to the data, explaining 73% of the variation in calorie reductions across retail menu offerings. On average retailers reduce their nutritional offerings by about 15 Calories ($\beta_1 = -15.34$, $p < .001$) after introducing food labels (see Table 4).

INSERT TABLE 4 ABOUT HERE

¹² While we do have a nested structure for study 2 (effect sizes within studies), the limited number of level 2 data does not allow for estimating an extra effect for studies.

We find that this effect seems to be even stronger for between-case comparisons, which indicate additional menu calorie reductions of around -86.20 ($p < .01$). Within-case designs, the time period between comparisons, age and whether the food category is considered healthy or not does not result in significant effect differences for our data.

General Discussion

The central focus of the present research was to investigate the effect of mandatory calorie disclosure on food retail menus on both consumer choices (study 1) and retail practice (study 2). Our multilevel model, across all study characteristics and sample demographics ($k = 186$), shows that when calories are disclosed on food retail menus, consumers select 27 fewer calories per meal on average. Moreover, calorie disclosure on food retail menus encourages those who are overweight to reduce their selection by an additional 67 Calories per meal. We also find that females are more responsive than males to adjusting their intake (reduction of an additional 75 Calories) following calorie disclosure, and a marginal effect was found when the sample was comprised of a mixture of males and females (reduction of an additional 46 Calories). Given that these two results are surprising, and in particular, that mandatory calorie disclosure has a greater effect for overweight individuals, and that our meta-analysis is bound by the available data, we encourage future research to explore why the effect may occur. We also highlight that even though the majority of studies where participants were, on average, overweight, depicted an actual choice; half of these were lab studies, and not field based experiments. The calories selected for lab studies were greater (on average -115 Calories) than the calories selected for field based studies (on average -48 Calories). Thus, the result could be a reflection of overweight individuals underreporting their consumption, rather than a measurement of actual consumption behavior.

Our results also positively identify that fewer calories are selected following disclosure at table service restaurants and specifically for lunchtime meal choices (30 and 27

Calories, respectively). While our meta-analysis does not allow insights into the underlying mechanism, it could be that individuals are more likely to notice calorie information on a menu during a sit-down meal, and when they are more likely to be making individual choice selections, such as at lunchtime. Future research should further explore both the proportion of individuals who notice calories on restaurant menu boards and the factors that may encourage consumers to better notice the caloric information included on menus.

Moreover, our meta-analysis also suggests that consumer calorie reduction is greater for intentions (reduction of 43 Calories) compared to actual behavior. One possible explanation could be that people have good intentions, but struggle to follow through when faced with the actual choice. The short run versus the long run impact of calorie disclosure on actual purchase behavior and their motivations are great avenues to expand consumption behavior research.

According to our analysis and data, calorie disclosure for healthy meals also results in a significantly smaller effect (reduction of 2 Calories per meal), everything else being equal. The result suggests that consumers distinguish between healthy and other food categories and may regard the former as less problematic in terms of nutrition value.

In addition to the meta-analysis on the impact of calorie disclosure on consumer behavior, our work sheds light on supply-side adjustments as a result of mandatory calorie disclosures. To the best of our knowledge, it is the first research to synthesize the reactions of retailers to the new legislation. We performed a meta-analysis of 41 studies comparing the effect of calorie content differences on menu items between restaurants that did, and did not, voluntarily introduce menu labeling efforts once the legislation was first announced in 2010. According to our analysis, we find that retailers also respond to mandatory disclosure of calorie information, by reducing on average 15 Calories per menu item.

The calorie reduction effect across menu items is also stronger for between subject designs in study 2, that is, when comparing between retail outlets that did implement calorie disclosure on their menus and those, comparable, retail outlets that did not. In these cases, retail outlets reduced their menu items by additional 86 Calories; however, we note that this result is based on only a selection of six studies. We encourage future research to further explore this effect.

Limitations and Research Directions

While our model accounting for both study and demographic characteristics presents a very good fit, there is the possibility for future work to examine additional heterogeneity sources, which could not be tested in our meta-analytic framework. For example, we couldn't find any product-type effect on consumer's food consumption. While we were bound by the menu items that were tested across the data pool of our studies, future experiments could investigate which specific food items (in addition to healthy ones) significantly alter consumer's energy intake. Likewise, there may be very distinct labelling techniques that could not be tested in our analysis but may further enhance consumer perceptions of nutrition value. In particular, it would be worthwhile to conduct experimental studies that compare how each label element (contextual information, style of presentation etc.) influences choice beyond calorie information alone.

Furthermore, a general limitation of meta-analysis is the sample size of included studies to test certain moderators. For instance, our non-significant effect for children could be related to the limited number of cases which clearly refer to children. How supply and demand side changes vary for different target groups is another fruitful area for the next wave of primary research.

Finally, our findings on the supply-side reactions toward policy changes raise several questions. A possible limitation of study 2 relates to a self-selection bias by the restaurants in

our intervention condition. The use of non-experimental, field data meant that we examined supply side adjustments by restaurants that introduced menu labelling after the legislation was announced in 2010. Were retailers' calorie reductions driven by the legislation or other phenomena? Hence, future research should closely monitor retailer menu adjustments over time once the legislation is enforced by those retailers who have not already voluntarily disclosed calorie information. Against this background, the interplay of calorie reduction and portion sizes modifications is another crucial research stream that requires attention from regulators and policy makers

Implications

For many consumers, making healthier food choices in-store is hard to do. Recent research has suggested that the food retail environment may override an individual's ability to control their consumption behavior (Larson and Story 2009). However, retail stores are also an opportune place to harness marketing power to prevent obesity. Providing consumers with nutritional information on menus is believed to be an avenue by which food retailers can positively encourage consumer to make better nutritional choices. Though, given the cost of implementing, and to date, the reported mixed effects of calorie disclosure, there has been considerable controversy surrounding the legislation. The legislation was announced in 2010, and its enforcement has been delayed each year because of retailer opposition.

The findings of our research reveal a promising effect of calorie disclosure and have relevant implications for both retailing practice and public policy. Overall, our two meta-analyses show that when restaurants are required to release information on the calorie content of their foods, they will reduce the offered calorie count in response, while consumers simultaneously select less calories. Thus, the net effect on consumer's nutrition is likely larger than estimated in previous consumer studies which neglect the impact of retailer menu adjustments. It is uncertain if the two effects are entirely complementing each other, but,

when combining the average effects of both the supply side and demand side identified in our work, a minimum of 42 Calorie reduction per person and per meal could occur. Hence, even with these conservative numbers, people are likely to decrease their calorie consumption by at least 126 units during a single day, potentially much more depending on the number of menu items they tend to consume per meal. Hill, Wyatt, Reed, and Peters (2003) suggest that an increase in people's energy intake of as little as 50–100 Calories per day is enough to account for the rise in obesity. Furthermore, with a possible effect of a total calorie reduction of 110 units per meal for overweight individuals, the upcoming legislation seems specifically promising for the population group that could benefit the most from healthier nutrition.

In conclusion, even though the retail food environment has often traditionally been criticized for its potential contribution to the prevalence of obesity within a population, the results of our study show that it is well placed to constructively assist in the fight against obesity: restaurants can encourage consumers to make healthier choices in store when the appropriate information is provided. The expected behavioral effects found in our study reveal both supply-side and demand-side adjustments to calorie disclosure, providing promise for the legislation's potential influence on the rising rates of obesity.

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Table 1

Study 1: Coded moderators and prevalence

Moderators	Categorical Coding	Studies
Study characteristics		(k =186)
Labeling Intervention	Calories & more (1) ^a	65
	Calorie alone (2)	121
Study Design	Between subject (1)	102
	Within subject (2)	19
	Other design (3) ^b	65
Study Scenario	Hypothetical choice (1)	70
	Actual choice (2)	116
Healthiness	Healthy food category (1) ^c	27
	Other food category (2)	159
Restaurant Type	Table service (1)	35
	Other type (2) ^d	151
Eating Occasion	Lunch (1)	75
	Dinner (2)	20
	Other (3) ^e	91
Food Type	Pizza (1) ^f	3
	Beverage (2)	11
	Other Food (3)	172
Demographic characteristics		
Gender	Females only (1)	26
	Males only (2)	12
	Mixed gender (3)	148
BMI	Overweight (1) ^g	26
	Normal weight (2)	160
Age	Children's meal (1) ^h	30
	Adult meal (2)	156
Control Variables		
Years		186

^a Calories and contextual elements included, for example, exercise expenditure required to burn off calories, traffic light labeling, other nutritional information, recommended caloric intake

^b Other designs included; cross sectional, difference in difference, pre-post, pre-post with control

^c Salads and pastas as well as sandwich chains such as Subway (based on the findings of previous research investigating health halos of restaurant chains (Chandon and Wansink 2007)) were classified as healthy

^d Other restaurants types included quick service (QS) and cafeteria (C)

^e Other eating occasions included snacks, as well as data collected across both lunch and dinner

^f Given the opposition to enforcing calorie labeling by the pizza industry, we also examined the effect of labeling for pizza separately

^g Sample on average was overweight (BMI ≥ 26)

^h The meal selected was intended for a child <18 years old

Table 2

Study 1 estimates for the overall model

		β
Intercept		-27.21***
Study Characteristics		
Label Intervention	Calories and Other	-10.72
Study Design	Between Subject	12.15
	Within Subject	11.84
Study Type	Scenario	-42.88*
Healthiness	Healthy	24.87 [†]
Restaurant Type	Table Service	-29.61*
Eating Occasion	Lunch	-26.62*
	Dinner	-25.42
Food Type	Pizza	-82.31
	Beverage	-3.90
Demographic Characteristics		
Gender	Female	-75.16**
	Mixed Gender	-45.55 [†]
BMI	Overweight	-66.85***
Age	Children	9.21
Control Variables		
Years		0.12
k (studies)		186
N (articles)		54
Variance Level1 (T_u)		0.001 *
Variance Level 2 (T_v)		760.0 ***
Variance Level 3 (T_r)		503.0 ***
AIC		2109.24
BIC		2170.52

[†] $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

We used dummy coding (0,1) such that the coefficients are interpreted as a difference compared to another category.

Table 3

Study 2: Coded moderators and prevalence

Moderators	Categorical Coding	Studies
Study characteristics		(k = 41)
Study Design	Between subject (1)	6
	Within subject (2)	30
	Other design (3) ^a	5
Healthiness	Healthy food category (1) ^b	4
	Other food category (2)	37
Food Type	Pizza (1) ^c	2
	Beverage (2)	3
	Other Meal Item (3)	36
Demographic characteristics		
Age	Children's meal (1)	7
	Adult meal (2)	34
Control variable		
Time factor	Treatment time window	41

^a Other designs included pre-post with control

^b Salads and sandwiches (based on the findings of previous research investigating health halos of restaurant chains (Chandon and Wansink 2007)) were classified as healthy

^c Given the opposition to enforcing calorie labeling by the pizza industry, we also examined the effect of labeling for pizza separately

Table 4

Study 2 estimates for the overall model

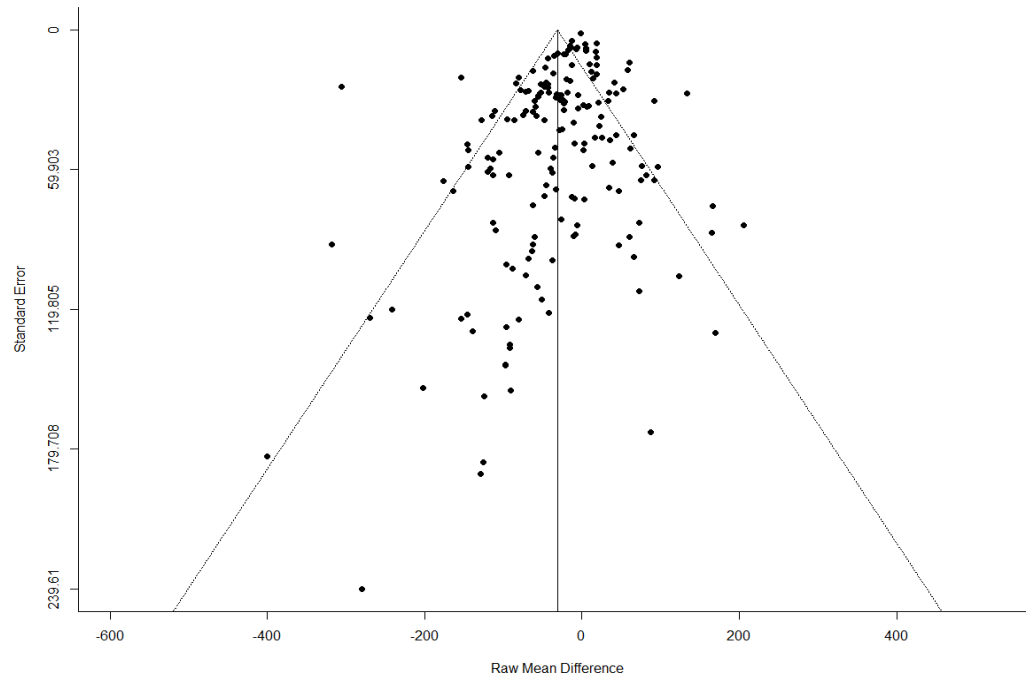
		β
Intercept		-15.34***
Study Characteristics		
Study Design	Between Subject	-86.21**
	Within Subject	-35.60
Healthiness	Healthy	-14.63
Food Type	Pizza	4.75
Demographic Characteristics		
Age	Children	7.34
Years		-1.69
k (studies)		41
N (articles)		7
R2		73.00%
AIC		427.2
BIC		440.9
Variance (T _R)		119.29

† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

We used dummy coding (0,1) such that the coefficients are interpreted as a difference compared to another category.

Figure 1

Funnel plot study 1^a



^aWe removed three outliers (Elbel et al 2011 (male and female), Tandon et al 2011 (children)) from the figure who had an $SE > 250$, however, these data points were included in the overall analysis. We also ran the multilevel model with three outliers ($SE > 250$) removed and found no difference in our results.

Figure 2

Funnel plot study 2

