BMJ Open

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-063614
Article Type:	Original research
Date Submitted by the Author:	07-Apr-2022
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Keywords:	Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, NUTRITION & DIETETICS, HEALTH ECONOMICS

Cost-Effectiveness Analysis of the Federal Menu Calorie Labeling and Obesity-Associated Cancer Burdens in the United States

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Short Running Head: Cost-Effectiveness of Menu Calorie Labeling to Prevent Cancer

Word Count: 3367

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Abbreviations: AMPM, Automated Multiple Pass Method; BMI, Body Mass Index; CDC, Centers of Disease Control and Prevention; CI, Confidence Interval; DiCOM, Diet and Cancer Outcome Model; FDA, Food and Drug Administration; FNDDS, Food and Nutrient Database for Dietary Studies; MEC, Mobile Examination Center; NCHS, National Center for Health Statistics; NHANES, National Health and Nutrition Examination Survey; PSA, Probabilistic sensitivity analysis; SD, Standard Deviation; SE, Standard Error; USDA, United States Department of Agriculture; UI, Uncertainty Interval

ABSTRACT

Objective To assess the impact of menu calorie labeling on reducing obesity-associated cancer burdens in the United States (US).

Design Cost-effectiveness analysis using a probabilistic cohort state-transition model.

Setting Policy intervention.

Participants 235 million adults aged 20+ years.

Interventions The policy effects on reducing 13 obesity-associated cancers among US adults and population subgroups by age, sex, and race/ethnicity over a simulated lifetime were evaluated in two scenarios: (1) effects on consumer behaviors; and (2) additional effects on industry reformulation. The model integrated nationally representative demographics, calorie intake from restaurants, cancer statistics, associations of policy with calorie intake, dietary change with BMI change, BMI with cancer rates, and policy and healthcare costs.

Main outcome measures Health and economic gains were estimated among the total population and population subgroups defined by age, sex, and race/ethnicity. Net costs and incremental cost-effectiveness ratio were assessed from societal and health care perspectives. Probabilistic sensitivity analyses incorporated uncertainty in input parameters and generated 95% uncertainty intervals (UIs).

Results Considering consumer behavior alone, the menu calorie labeling was estimated to be associated with a reduction of 28 000 (95% UI: 16 300-39 100) new cancer cases and 16 700 (9610-23 600) cancer deaths, a gain of 111 000 (64 800-158 000) quality-adjusted life years, and a saving of $1480 million ($884 million-$2080 million) in cancer-related medical costs among US adults. The policy was associated with net cost savings of $1460 ($864-$2060) million and $1350 ($486-$2260) million from healthcare and societal perspectives, respectively. Additional industry reformulation would substantially increase policy impact. Greater health gains and cost savings were observed among young adults, Hispanic and non-Hispanic Black individuals.

Conclusions Study findings suggest that menu calorie labeling is associated with lower obesity-related cancer burdens and reduced healthcare costs. Policymakers may prioritize nutrition policies for cancer prevention in the US.

(Word Count: 299)

Keywords: obesity, cost-effectiveness, menu calorie labeling, cancer incidence, cancer death, medical cost

INTRODUCTION

Obesity affects 1 in 3 Americans and is an established risk factor for 13 types of cancers, such as endometrial, liver, breast, prostate, and colorectal cancers.[1] Obesity-associated cancer represents 40% of all newly diagnosed cancer cases and contributes to $147 billion in costs in healthcare each year.[1-6] Rates of obesity-associated cancers are also rising disproportionally among young adults.[5 7] Substantial health and economic burdens highlight the need to prioritize cost-effective strategies to reduce obesity-associated cancers in the US.

Diet is one of the few modifiable factors for both obesity and obesity-associated cancers.[2 8] Restaurant meals account for 1 in 5 calories consumed by US adults, including 9% of calories from full-service restaurants and 12% from fast-food restaurants,[9] is an important target for improving population diet. Restaurant meals can have very high calories, with a mean energy of 1362 kcal/meal and 969 kcal/meal in popular meals from randomly selected full-service and fast-food restaurants, respectively.[10] Consistently, individuals who cook less frequently at home consume more daily calories than those who cook more at home.[11] Thus, reducing calories consumed from restaurant meals has the potential to reduce daily calorie intake and subsequent obesity and obesity-related cancer burdens.

To help consumers make lower-calorie choices, the Affordable Care Act mandated that all chain restaurants with 20 or more outlets post calorie information on menus and menu boards for all standard menu items.[12] The FDA published the final rules for this policy in 2016, which was subsequently implemented in 2018. Interventional studies demonstrate that menu calorie labeling reduces total energy intake by consumers.[13 14] Such policy can also motivate restaurant reformulation to lower calorie contents or introduce healthier food options.[15-20] Prior research suggests that this policy is associated with substantial reductions in incident cardiovascular diseases and type 2 diabetes and net savings of over $10 billion.[21] However, the health and economic benefits of the policy for obesity-associated cancers have not been evaluated. This study aimed to address the knowledge gap by evaluating the cost-effectiveness of the federal menu calorie labeling and obesity-associated cancer burdens among US adults.

METHODS

Study Overview

The Diet and Cancer Outcome (DiCOM), a probabilistic cohort state-transition model,[22 23] was used to perform an economic evaluation of the menu calorie labeling and obesity-associated cancer rates among 235 million US adults over a simulated lifetime (Supplementary Figure 1). The model integrated independent parameters from different data sources, including nationally representative population demographics, dietary intake, and cancer statistics; association estimates of policy intervention with diet, diet change with body mass index (BMI), and BMI with cancer risks; and policy and health-related costs from established sources (**Table 1**). This study used de-identified datasets and was exempt from institutional review board review and follows the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) reporting guidelines.

Table 1. Key input parameters and data sources in the Dietary Cancer Outcome Model (DiCOM)

Model Input	Outcome	Estimates	Distribution	Comments	Data Source
1. Simulated population	Population	Mean consumption of calories was 332 kcal/d from full-service or fast-food restaurants (Supplementary Tables 1, 8-9)	γ	Stratified by age, sex, race/ethnicity; 32 subgroups	NHANES 2013-2016
2. Policy effect[1]					
a) Consumer behavior	Policy effect	7.3% (4.4%-10.1%)	β	One-time effect	Meta-analysis of labeling interventions on reducing calorie intake, Shangguan et al., 2019, American Journal of Preventative Medicine
b) Industry response	Policy effect	5% (Appendix 1 and Appendix Table 1)	β	Assumption: no reformulation in the 1st year of policy intervention; Restaurants will replace the high-calorie menu items with low-calorie options or reformulate the menu items in years 2 to 5 of the intervention to achieve a 5% reduction in calorie contents	Calorie changes in large chain restaurants from 2008 to 2015, Bleich et al. 2017, Prev Med; Higher-Calorie Menu Items Eliminated in Large Chain Restaurants, Bleich et al. 2018, American Journal of Preventative Medicine
3. Effect of added sugar intake on BMI (kg/m^2)[1]	Dietary effect	Among individuals with: BMI <25: 0.0015 per kcal BMI ≥25: 0.003 per kcal	Normal	Assumption: 55 kcal per day reduction in calorie intake would lead to 1 pound weight loss within 1 year, with no further weight loss in the future	Hall et al., 2018, JAMA; Hall et al., 2011, Lancet
4. Etiologic effect of BMI on cancer outcomes[1]	Cancer outcome	RRs ranged from 1.05 to 1.50 (Supplementary Table 2)	Lognormal	BMI change and cancer incidence	Continuous Update Project (CUP) conducted by the World Cancer Research Fund (WCRF)/American

					Institute for Cancer Research (AICR)
5. Cancer statistics[1]	Cancer incidence[3] and survival	Appendixes 2-3, Appendix Tables 2-3 and Supplementary Tables 3-4	β	Stratified by age, sex, and race/ethnicity	NCI's Surveillance, Epidemiology, and End Results Program (SEER) Database; CDC's National Program of Cancer Registries (NPCR) Database
6. Healthcare related costs[1,2]	Medical expenditures, productivity loss, and patient time costs	Appendix 6, Appendix Table 6 and Supplementary Tables 6-7	γ	Stratified by age, and sex	NCI's Cancer Prevalence and Cost of Care Projections; Published literature
7. Policy costs[1,2]	For government and industry	Appendix 5 and Appendix Tables 4-5	γ	Administration and monitoring costs for government; compliance and reformulation costs for industry	FDA's budget report; Nutrition Review Project; and FDA's RIA
8. Health-related quality of life (HRQOL)[1]	For 13 types of cancers	Ranged from 0.64 to 0.86 (Appendix 4 and Supplementary Table 5)	β	EQ-5D[4] data from published literature by cancer type	Published literature

Abbreviations: BMI, Body Mass Index; FDA, Food and Drug Administration; NCI, National Cancer Institute; NHANES, National Health, and Nutrition Examination Survey; UK, United Kingdom.
1. Uncertainty distributions were incorporated in the probabilistic sensitivity analyses. Uncertainties in each parameter were presented in supplemental materials (Table TS3 and Tables S3-9).
2. If the source did not provide uncertainty estimates, we assumed the standard errors were 20% of the mean estimate to generate gamma distribution.
3. Time-varying input parameter, for which the model accounted the secular trends. Details were provided in the Supplements.
4. EQ-5D is a standardized instrument developed by the EuroQol Group as a measure of health-related quality of life that can be used in a wide range of health conditions and treatments.

Simulated US Population

Because FDA's final rules on menu calorie labeling were published in 2016 and implemented in 2018, we used 2015-2016 as the baseline and assumed a closed cohort for this analysis. We combined the 2013-2016 National Health and Nutrition Examination Survey (NHANES) to approximate the baseline and simulate the US adult population aged 20+ years in 32 subgroups stratified by age (20-44, 45-54, 55-64, 65+), sex (men, women), and race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, Other) (Supplementary Table 1). This closed cohort of US adults was modeled through their lifetime up to 80 years from baseline or until death.

Calorie Consumption from Restaurants

Mean calorie consumption from full-service and fast-food restaurants, demographics, and prevalence of overweight or obesity were estimated using data collected from participants with at least one valid 24-hour diet recall, in every 32 strata. Following FDA's estimates,[12] we assumed that policy would affect 56.5% of calories consumed at full-service restaurants and 100% at fast-food restaurants. The National Cancer Institute method was used to estimate the usual intake distribution by statistically adjusting for within vs. between variance in dietary recalls.[24-26] The complex survey design was incorporated in all statistical analyses to ensure the representativeness of study findings to the non-institutionalized US adults.

Policy Association with Calorie Consumption

Policy association was obtained from a systematic review and meta-analysis of food labeling interventions that reported a 7.3% (95% CI: 4.4%-10.1%) reduction in calories consumed per meal following calorie labeling (Appendix 1 and Appendix Table 1).[14] We assumed that the policy would have a one-time effect over one year, with no further change over time. Potential policy impact on industry reformulation was derived from studies of restaurant menu items following the passage and initial period of partial implementation of the final rules. Between 2012-2014, among 66 of the 100 largest US chain restaurants, replacing higher-calorie menu items with lower-calorie items led to a 1-5% calorie reduction per menu item.[18 19] Among 44 chain restaurants with menu calorie information available in 2008, the calories per menu item fell by 7% between 2008 and 2015.[17] Therefore, we chose 5% as the mid-point for the potential policy impact on industry response, which may include discontinuation of existing high-calorie menu items and/or introduction of lower-calorie menu items. For both scenarios, we conservatively assumed that there would be some compensatory increased calorie intake outside of restaurants so that only half of all calories reduced from restaurant meals would translate into long-term reductions in daily calories.

Calorie Reduction and Obesity-Associated Cancer Risk

To estimate the relationships between calorie intake and obesity-associated cancers, we associated the multivariate-adjusted association of change in calorie intake (kcal/day) with change in BMI (kg/m^2) and the estimates of BMI and cancer risks. Based on an established energy-weight dynamic model that accounted for long-term impacts of calorie reduction on weight and metabolic expenditure, we assumed that each 55 kcal/day calorie reduction leads to 1 pound weight loss over one year among overweight or obese adults, with no further reduction thereafter.[27 28] Because long-term observational studies suggest that weight change for an equivalent change in dietary intake is about twice as large in overweight or obese adults than normal-weight adults,[29 30] we conservatively applied half of this estimate to individuals with normal weight. For each of 13 obesity-related cancers, the estimated change in risk for each 5 kg/m^2 change in BMI was derived from the systematic reviews and meta-analyses of multivariable-adjusted prospective cohort studies conducted by the World Cancer Research Fund/American Institute for Cancer Research Continuous Update Project and the International Agency for Research on Cancer (Supplementary Table 2).[2]

Cancer Incidence, Mortality, and Health-Related Quality of Life

Age-adjusted cancer incidences in 2015 were obtained from the National Program of Cancer Registries and the Surveillance, Epidemiology, and End Results (SEER) program. We projected the cancer incidence from 2015 to 2030 based on the 2006-2014 trend using the Average Annual Percent Change method.[31] We then combined the projected incidence rates with the projected US population from the National Interim Projections[32] to account for changes in population age distribution over time. We further applied the cohort-period method to estimate cancer incidence in the closed cohort of US adults in each of 32 groups as they age (Appendix 2, Appendix Table 2, and Supplementary Table 3). The 5-year relative survival rates for each cancer were extracted and converted to an annual probability of death (Appendix 3, Appendix Table 3, and Supplementary Table 4).[33-35] Health-related quality of life data were obtained from publications that reported EuroQol-5 Dimension utility weights for each cancer among US patient population (Appendix 4 and Supplementary Table 5).

Policy and Health-Related Costs

Policy costs included government costs to administer, monitor, and evaluate the policy and industry costs to comply with the policy and reformulate their products (in scenario 2).

Government costs were estimated from FDA's budget report and Nutrition Review Project (Appendix 5 and Appendix Tables 4-5).[36 37] Industry compliance and reformulation costs were based on the FDA's regulatory impact analysis that included initial and recurring nutrition analysis of standard menu items and menu replacement, provision of nutrition information, employee training, and legal review and accounted for restaurant size and type, reformulation type, and compliance period.[12]

Direct medical costs for cancer care were extracted from the SEER-Medicare linked database for three phases of cancer care: initial, continuing, and end-of-life (Appendix 6, Appendix Table 6, and Supplementary Tables 6-7).[31 38] For individuals without cancer, the direct medical costs were estimated based on Medical Expenditure Panel Survey (MEPS) data and insurance claims.[23 39 40] Indirect costs including productivity loss due to disability or missed workdays and patient time costs were derived from publications using MEPS data.[41-44]

Cost-Effectiveness Analysis

Following the guidelines on cost-effectiveness in health and medicine,[45] we evaluated the policy impact by projecting the numbers of new cancer cases and cancer deaths averted and quality-adjusted life-years (QALYs) gained and cost-effectiveness from both healthcare and societal perspectives. The healthcare perspective assessed net costs as the difference between government costs for implementing the policy and the direct medical costs of cancer care. The societal perspective assessed the net costs as the difference between total policy costs (including both government and industry costs) and health-related costs saved (including direct and indirect costs of cancer care). All costs were inflated to 2015 US dollars using the Consumer Price Index or

Personal Health Care Index, with all costs and QALYs discounted at 3% annually.[45] Incremental cost-effectiveness ratios (ICERs) were calculated as net costs divided by the difference in QALYs between policy vs. no policy. ICERs falling below a willingness-to-pay threshold of $150,000 per QALY gained were considered to be cost-effective.[46 47] Cost-effectiveness analysis was further conducted among population subgroups by age, sex, and race/ethnicity to evaluate policy associations with health disparities.

One-way sensitivity analyses were performed by varying input parameters, including reducing the outside-the-restaurant calorie compensation level to 25% or increasing it to 75%, altering coverage of the FDA's final rule to all calories from full-service restaurants, reducing the diet-BMI associations to half or doubling the estimates, incorporating an estimated 2% annual increase in medical expenditures associated with cancer care, and altering annual discounting rates from 3% to 0% or 5%. We also evaluated impacts at a 10-year time horizon for stakeholders interested in shorter-term health gains and economic benefits. Probabilistic sensitivity analyses (PSAs) were conducted to incorporate uncertainty in all input parameters jointly (**Table 1**). A total of 1000 Monte Carlo simulations were performed, and 95% uncertainty intervals (UIs) were estimated based on the 2.5 and 97.5 percentiles of 1,000 simulations. All analyses were conducted using SAS (Version 9.4) and R (Version 3.3.1).

Patient and Public Involvement

This study used de-identified datasets and did not involve patients or the public in the design, or conduct, or reporting, or dissemination plans of our research.

RESULTS

Population Characteristics

The simulated cohort of US adults in 2015-2016 had a mean age of 47.8 years, with 65.0% being non-Hispanic white adults and 71.4% were overweight or obese (Supplementary Tables 8-9). A mean of 332 daily calories was consumed from full-service or fast-food restaurants. Higher levels were consumed among younger adults aged 20-44 years (425 kcal/day), men (388 kcal/day), non-Hispanic black (361 kcal/day), and Hispanic (367 kcal/day) adults, in comparison to other corresponding subgroups.

Health Gains

The menu calorie labeling was estimated to reduce calories consumed from restaurants by a mean of 24 kcal/day (7.2% of calories consumed from restaurants) among US adults, and total daily calories by 12 kcal/day. Accounting for potential industry reformulation would reduce the mean intake by an additional 16 kcal/day, and total daily calories by 8 kcal/day.

Based on changes in consumer behavior alone, the policy was associated with a reduction of 28,000 (95% UI: 16,300-39,100) new cancer cases and 16,700 (9,610-23,600) cancer deaths, and a gain of 111,000 (64,800-158,000) QALYs among 235 million US adults over a median follow-up of 34.4 years (**Table 2 and Figure 1**). By cancer type, the greatest numbers of new cancer cases averted were cancers of endometrial (N [95% UI]: 5,700 [2,380-9,190]), liver (5,180 [2,800-7,730]), kidney (5,090 [2,670-7,730]), post-menopausal breast (4,840 [2,010-8,230]), and pancreas (1,400 [756-2,100]). The greatest numbers of prevented cancer deaths were estimated for cancers of liver (4,530 [2,410-6,760]), post-menopausal breast (3,080 [861-5,650]),

endometrial (2,060 [957-3,220]), kidney (1,980 [1,080-2,920]), and pancreas (1,230 [661-1,830]).

Based on additional industry response, the total estimated health gains approximately doubled, preventing 47,300 (35,400-59,100) new cancer cases and 28,200 (21,100-35,300) cancer deaths, and gaining 189,000 (140,000-236,000) QALYs, with similar rankings of the types of new cancer cases and cancer deaths prevented.

Table 2. Estimated health gains and costs of the federal menu calorie labeling on reducing the obesity-related cancer burdens in the US over 10 years and a lifetime (US population=235,162,844)[1]

	Menu Calorie Labeling Policy			
	10 Years		Lifetime	
	Consumer Behavior Median (2.5% to 97.5%)	**Consumer Behavior + Industry Response** Median (2.5% to 97.5%)	**Consumer Behavior** Median (2.5% to 97.5%)	**Consumer Behavior + Industry Response** Median (2.5% to 97.5%)
New Cancer Cases Averted, N (95% UI)				
Endometrial cancer	692 (276 to 1100)	1130 (716 to 1550)	5700 (2380 to 9190)	9920 (6630 to 13600)
Liver cancer	366 (144 to 615)	626 (386 to 887)	5180 (2800 to 7730)	8550 (5960 to 11300)
Kidney cancer	584 (290 to 884)	980 (689 to 1280)	5090 (2670 to 7470)	8620 (6200 to 11000)
Breast cancer (postmenopausal)	670 (256 to 1110)	1080 (658 to 1520)	4840 (2010 to 8230)	8520 (5610 to 12200)
Pancreatic cancer	170 (83 to 257)	273 (183 to 367)	1400 (756 to 2100)	2380 (1690 to 3140)
Esophageal adenocarcinoma	179 (56 to 304)	286 (159 to 411)	1350 (485 to 2230)	2330 (1440 to 3280)
Colorectal cancer	189 (97 to 284)	319 (225 to 418)	1050 (561 to 1600)	1780 (1230 to 2370)
Multiple myeloma	75 (37 to 117)	122 (81 to 169)	690 (384 to 1090)	1150 (775 to 1630)
Stomach cancer (cardia)	54 (6 to 109)	98 (51 to 165)	647 (261 to 1140)	1090 (644 to 1660)
Thyroid cancer	105 (58 to 161)	176 (123 to 243)	516 (206 to 914)	951 (576 to 1420)
Advanced prostate cancer	66 (17 to 118)	107 (57 to 162)	339 (138 to 561)	577 (352 to 836)
Gallbladder cancer	29 (16 to 42)	46 (34 to 60)	314 (213 to 438)	512 (399 to 648)
Ovarian cancer	33 (15 to 56)	53 (33 to 78)	147 (44 to 282)	254 (110 to 420)
Total	3300 (1750 to 4720)	5230 (3870 to 6790)	28000 (16300 to 39100)	47300 (35400 to 59100)
Cancer Deaths Prevented, N (95% UI)				
Liver cancer	168 (59 to 287)	287 (174 to 410)	4530 (2410 to 6760)	7510 (5200 to 9980)
Breast cancer (postmenopausal)	68 (33 to 106)	111 (74 to 149)	3080 (862 to 5650)	5590 (3230 to 8310)
Endometrial cancer	52 (20 to 86)	87 (55 to 121)	2060 (957 to 3220)	3520 (2390 to 4700)
Kidney cancer	70 (29 to 110)	114 (74 to 154)	1980 (1080 to 2920)	3320 (2430 to 4300)
Pancreatic cancer	88 (38 to 138)	143 (93 to 195)	1230 (661 to 1830)	2080 (1480 to 2740)
Esophageal adenocarcinoma	76 (21 to 131)	122 (69 to 178)	1150 (403 to 1930)	1990 (1210 to 2820)
Colorectal cancer	34 (17 to 53)	57 (40 to 77)	706 (369 to 1080)	1200 (839 to 1600)
Stomach cancer (cardia)	22 (2 to 48)	40 (19 to 68)	541 (230 to 947)	907 (538 to 1400)
Multiple myeloma	18 (8 to 30)	29 (18 to 42)	420 (239 to 662)	691 (481 to 980)
Gallbladder cancer	13 (7 to 20)	21 (15 to 28)	267 (181 to 369)	436 (341 to 551)
Advanced prostate cancer	9 (3 to 15)	13 (7 to 19)	163 (65 to 280)	273 (163 to 404)
Ovarian cancer	8 (3 to 15)	13 (7 to 20)	107 (39 to 191)	181 (94 to 290)
Thyroid cancer	1 (1 to 2)	2 (1 to 3)	23 (11 to 38)	38 (24 to 58)
Total	654 (320 to 970)	1080 (746 to 1400)	16700 (9610 to 23600)	28200 (21100 to 35300)
Life Years Gained	678 (288 to 1040)	1120 (738 to 1490)	76400 (43400 to 109000)	130000 (96900 to 162000)
QALYs Gained	4280 (2170 to 6250)	7030 (4960 to 9090)	111000 (64800 to 158000)	189000 (140000 to 236000)

Changes in Health-Related Costs, Cancer Only ($, millions)[2,3]				
Healthcare (medical) cost	-192 (-277 to -100)	-319 (-403 to -227)	-1480 (-2080 to -884)	-2500 (-3090 to -1900)
Patient time cost	-7.33 (-10.9 to -3.56)	-12.2 (-15.8 to -8.39)	-102 (-144 to -62.2)	-172 (-216 to -131)
Productivity loss	-48.7 (-70.1 to -24.5)	-80.4 (-102 to -56.7)	-608 (-865 to -363)	-1030 (-1290 to -780)
Policy Implementation Costs ($, millions)[2,3]				
Government cost	13.2 (11.4 to 15.9)	13.1 (11.4 to 15.7)	18.5 (14.5 to 25.1)	18.5 (14.4 to 25.5)
Administration	9.08 (8.59 to 9.60)	9.07 (8.64 to 9.50)	9.07 (8.61 to 9.56)	9.09 (8.62 to 9.55)
Monitoring	4.09 (2.40 to 6.74)	4.00 (2.35 to 6.63)	9.40 (5.45 to 16.1)	9.38 (5.30 to 16.3)
Industry cost	505 (480 to 535)	631 (599 to 667)	820 (762 to 889)	1120 (1040 to 1210)
Compliance	505 (480 to 535)	506 (480 to 533)	820 (762 to 889)	823 (757 to 889)
Reformulation	-------	124 (107 to 146)	-------	296 (249 to 353)
Net Costs, Cancer Only ($, millions)[2,3,4]				
Societal perspective	270 (156 to 389)	233 (119 to 356)	-1350 (-2260 to -486)	-2570 (-3460 to -1650)
Healthcare perspective	-179 (-263 to -86.3)	-305 (-390 to -214)	-1460 (-2060 to -864)	-2480 (-3070 to -1880)
ICER (dollars/QALY)[5]				
Societal perspective	64500 (26100 to 187000)	33600 (13300 to 72400)	Dominant	Dominant
Healthcare perspective	Dominant	Dominant	Dominant	Dominant

Abbreviations: ICER, Incremental Cost-Effectiveness Ratio; QALY, quality-adjusted life years.

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.
2. Health-related costs were inflated to 2015 US dollars using the Personal Health Care (PHC) index. Policy intervention costs were inflated to 2015 US dollars using the Consumer Price Index. Negative costs represent savings.
3. Costs are medians from 1000 simulations so may not add up to totals.
4. Net costs were calculated as policy costs minus health-related costs from reduced cancer burden. The societal perspective includes healthcare costs, patient time costs, productivity costs, and policy implementation costs; the government perspective included policy costs relevant to policy implementation and program monitoring and evaluation, and medical costs.
5. ICER threshold was evaluated at $150,000/QALY. Dominant represents less costly and more effective than the “no-policy intervention” scenario.

Economic Impacts

Implementing the policy would cost the government $19 (95% UI: $15-25) million and the restaurant industry, $820 ($762-889) million in compliance costs over a lifetime (**Table 2**). The policy was associated with savings of $1480 ($884-2080) million in direct medical costs, $608 ($363-865) million in productivity loss costs, and $102 ($62-144) million in patient time costs. Potential industry reformulation would cost the restaurant industry an additional $296 ($249-353) million to implement but would also result in greater healthcare savings, including $2,500 ($1,900-3,090) million, $1,030 ($780-1,290) million and $172 ($131-216) million in reduced direct medical, productivity loss, and patient time costs, respectively.

From both the healthcare and social perspectives, implementing the menu calorie labeling policy among US adults over a lifetime would be cost-saving. With changes in consumer behavior alone, the net cost savings were estimated to be $1,460 ($864-2,060) million and $2,480 ($1,880-3,070) million from the healthcare and societal perspective, respectively. With additional industry response, estimated cost savings increased to $1,350 ($486-2,260) million from the healthcare perspective and $2,570 ($1,650-3,460) million from the societal perspective.

Policy Impacts Among Population Subgroups

Among population subgroups, the consumer response to the policy was estimated to result in greater health gains per 100,000 individuals among adults aged 20-44 years (15 new cancer cases averted) and 55-64 years (16 new cancer cases averted) than older age groups (aged 65+ years; 6 new cancer cases averted); Hispanic and non-Hispanic Black individuals than Non-Hispanic White group (22 vs. 9 and 17 vs. 9 new cancer cases averted) (**Table 3**). The numbers of cancer

deaths averted, life-years and QALYs gained, health-related costs saved, and net costs among population subgroups followed a similar pattern (Supplementary Tables 10-11 and Supplementary Figures 2-5). For instance, the policy was associated with more cancer deaths prevented per 100,000 individuals among younger adults aged 20-44 years than older adults aged 65+ years (10 vs. 3 cancer deaths averted) and Hispanic and non-Hispanic Black adults than non-Hispanic White individuals (14 vs. 5 and 11 vs. 5 cancer deaths averted). Adding potential industry reformulations resulted in larger health gains among adults aged 45-54 (128% increase in new cancer cases averted) and non-Hispanic White adults (84% increase in new cancer cases averted).

Table 3. Estimated new cancer cases and deaths prevented by the federal menu calorie labeling policy in the US by age, sex, and race/ethnicity, over a lifetime[1]

	Consumer Behavior		Consumer Behavior + Industry Response	
	N (95% UI)	Per 100,000 individuals (95% UI)	N (95% UI)	Per 100,000 individuals (95% UI)
New Cancer Cases Averted				
Age				
20-44	15700 (6170 to 25100)	15.0 (5.89 to 24.0)	28000 (18000 to 37500)	26.7 (17.2 to 35.8)
45-54	2810 (-2110 to 8030)	6.61 (-4.97 to 18.9)	6420 (1390 to 11600)	15.1 (3.27 to 27.2)
55-64	6330 (3540 to 9400)	15.7 (8.76 to 23.3)	8640 (5790 to 11800)	21.4 (14.3 to 29.1)
≥65	2740 (795 to 4650)	5.77 (1.68 to 9.80)	4060 (2070 to 5950)	8.55 (4.36 to 12.6)
Sex				
Female	15100 (6650 to 24000)	12.5 (5.51 to 19.8)	25900 (17400 to 34900)	21.4 (14.4 to 28.9)
Male	12500 (4920 to 20100)	10.9 (4.30 to 17.6)	21100 (13500 to 29100)	18.4 (11.8 to 25.4)
Race/Ethnicity				
Non-Hispanic White	14300 (4310 to 24500)	9.16 (2.77 to 15.7)	26300 (16000 to 36700)	16.9 (10.3 to 23.6)
Non-Hispanic Black	4720 (1820 to 8100)	16.6 (6.37 to 28.4)	7630 (4750 to 11100)	26.8 (16.7 to 38.9)
Hispanic	7700 (3560 to 11500)	21.5 (9.93 to 32.2)	11200 (7060 to 15300)	31.3 (19.7 to 42.6)
Other	1150 (-240 to 2440)	7.60 (-1.59 to 16.2)	1990 (652 to 3310)	13.2 (4.33 to 22.0)
Cancer Deaths Prevented				
Age				
20-44	10200 (4170 to 16400)	9.73 (3.98 to 15.7)	18100 (11700 to 24500)	17.3 (11.2 to 23.4)
45-54	1730 (-853 to 4240)	4.07 (-2.01 to 9.97)	3650 (1040 to 6240)	8.58 (2.44 to 14.7)
55-64	3320 (1760 to 4930)	8.21 (4.36 to 12.2)	4480 (2890 to 6090)	11.1 (7.15 to 15.1)
≥65	1200 (285 to 2130)	2.53 (0.60 to 4.48)	1800 (848 to 2720)	3.79 (1.79 to 5.73)
Sex				
Female	7810 (3290 to 12600)	6.47 (2.73 to 10.5)	13400 (8850 to 18500)	11.1 (7.33 to 15.3)
Male	8510 (3500 to 13900)	7.44 (3.06 to 12.1)	14400 (9300 to 20000)	12.6 (8.13 to 17.5)
Race/Ethnicity				
Non-Hispanic White	7920 (2180 to 13900)	5.08 (1.40 to 8.94)	14700 (8770 to 20900)	9.45 (5.64 to 13.5)
Non-Hispanic Black	3010 (1000 to 5370)	10.6 (3.51 to 18.8)	4990 (2950 to 7380)	17.5 (10.4 to 25.9)
Hispanic	4960 (2360 to 7560)	13.8 (6.58 to 21.1)	7190 (4480 to 9870)	20.0 (12.5 to 27.5)
Other	565 (-246 to 1350)	3.75 (-1.63 to 8.97)	1070 (273 to 1870)	7.12 (1.81 to 12.4)

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.

Sensitivity Analyses

In PSA, based on consumer responses alone, the menu calorie labeling was cost-saving over a lifetime in 93% of 1000 simulations and cost-effective (<$150,000/QALY) in the remaining 7% from the societal perspective, and was cost-saving in over 98% of 1000 simulations from the healthcare perspective. Adding the additional industry response increased the probability of cost-savings to nearly 100% of the simulations for both the societal and healthcare perspectives (**Figure 2**).

Evaluating health gains, costs, and cost-effectiveness at 10 years, the policy remained cost-saving from the healthcare perspective and was cost-effective from the societal perspective, with an ICER of $64,500 (26,100-187,000) per QALY based on consumer response alone and $33,600 (13,300-72,400) per QALY with additional industry response. The cost-effectiveness of this policy was most sensitive to varied assumptions of the diet-BMI estimates and annual discounting rates (Supplementary Tables 12-13 and Supplementary Figure 6).

DISCUSSION

This study estimated that the federal menu calorie labeling policy, based on consumer response alone, was associated with a reduction of approximately 28,000 new cancer cases and 16,700 cancer deaths among US adults over a lifetime, and net savings of $1,350 and $1,460 million from societal and healthcare perspectives, respectively. Incorporating additional modest industry responses, these health and economic gains were approximately doubled. Greater health gains were expected among younger, middle-aged subgroups, Hispanic, and non-Hispanic Black

individuals compared with other subgroups. Findings were robust to a range of probabilistic and one-way sensitivity analyses.

Our study findings supported that nutrition policies can have meaningful health and economic impacts on cancer prevention in the US. In this case, a modest change in mean calorie consumption, distributed across the population, was estimated to achieve important reductions in obesity-related cancer burdens among US adults. Using the best available estimates, our study further suggested that the federal menu calorie labeling policy is cost-effective in the short term and cost-saving in the long term in reducing obesity-associated cancer burdens. Many preventive medical screenings are cost-effective, but none of them achieve net savings. For example, among a large cohort of women born in the 1960s over a lifetime, mammography screening starting at age 45 years was estimated to have an ICER of $40 135/QALY.[48] Colonoscopy screening starting at age 45 years among U.S. adults achieved an ICER of $33 900/QALY.[49] Prostate-specific antigen screening had an ICER of $70 831 to $136 332/QALY among U.S. males beginning at 40 years of age over a lifetime.[50] In contrast, population-based nutrition interventions could be a cost-saving strategy for cancer prevention. Thus, while we shall continue the efforts of increasing the screening rates, we also need to consider population-based strategies to improve nutrition for cancer prevention in the US.

Our findings also indicated the importance of assessing potential industry response, which could nearly double health and economic benefits. The additional impacts of industry reformulation in response to nutrition-related policies have been reported in other studies focused on obesity-associated cancer, diabetes, and cardiovascular diseases.[21 51-53] Our new findings build on this recent work and highlight the importance of potential strategies to encourage industry reformulation under the federal menu calorie labeling framework to further improve the health benefits and cost-effectiveness of such policies.

In addition, our results showed that population-based nutrition policies such as menu calorie labeling can potentially narrow diet-associated cancer disparities. We found greater health gains and economic impacts among racial/ethnic minorities compared to non-Hispanic whites, likely due to higher diet-associated cancer burdens among minorities.[54] However, labeling policies may have fewer effects on food purchasing behaviors among minorities or socioeconomically disadvantaged groups. Prior studies reported that individuals with higher education and income attainment were more likely to notice and use the menu calorie labels when ordering foods in fast-food or full-service restaurants compared to socioeconomically disadvantaged groups,[55-57] and multi-racial individuals were less likely to notice and use menu calorie labels in fast food restaurants than non-Hispanic whites.[55] Previous studies also showed that literacy or numeracy could be a barrier to label use.[58 59] Thus, it is important for labeling policies to be paired with nutrition education to effectively reduce diet-associated health disparities.

Potential limitations should be considered. First, as a modeling study, our investigation does not provide the impact of real-world policy implementation on the health and economic outcomes of federal menu calorie labeling. However, conducting randomized controlled trials of national nutrition policy interventions is extremely difficult and often implausible while simulation modeling can provide complementary evidence with the flexibility to assess different policy scenarios that help inform policymaking. Second, this evaluation did not include the potential benefits of menu calorie labeling on other health outcomes such as diabetes and cardiovascular diseases. Considering such outcomes is likely to be associated with greater health gains and cost savings.[21 60 61] Third, menu calorie labeling could have a greater effect among subgroups with higher levels of income and education and non-Hispanic white adults[55-57] and thus exacerbating health disparities. Due to the lack of consistent policy effect sizes among populations with different socioeconomic statuses, we were unable to integrate this into our modeling. Forth, we only modeled the impact of menu calorie labeling on calories although the policy may also result in potential changes in the nutritional quality of the restaurant meals. The majority of current restaurant meals consumed by American adults – 70% of meals consumed from fast-food restaurants and 50% consumed from full-service restaurants – are of poor nutritional quality, and the remainder is only of intermediate nutritional quality, with very few being ideal.[9] If the policy also improves the quality of restaurant meals, the total reduction in obesity-associated cancer burdens could be greater than our current estimates.

CONCLUSIONS

Study findings suggest that menu calorie labeling is associated with lower obesity-related cancer rates and reduced costs. Policymakers may prioritize nutrition policies for cancer prevention in the US.

SUMMARY BOXES

What is already known on this topic

- Obesity-associated cancer burdens are rising in the US and restaurant meals often contain high levels of calories, increasing the risk of obesity.
- The federal menu calorie labeling policy may reduce obesity-associated cancer rates by helping consumers identify lower-calorie choices and spurring restaurant reformulations.
- The potential health and economic impact of this policy on reducing the obesity-related cancer burden in the US and cancer disparity among demographic populations remain unknown.

What this study adds

- Our novel findings suggest that the federal menu calorie labeling policy would prevent meaningful numbers of obesity-related cancers and produce net cost savings in the US; Greater health gains and net savings were observed among young adults and racial/ethnic minorities.
- Our results suggest the need to consider and prioritize nutrition-related policy interventions as cost-effective or cost-saving strategies for cancer prevention; government and advocacy strategies to ensure and encourage industry reformulations should be prioritized.

Ethics approval: This study used de-identified datasets and was exempt from institutional review board review.

Data sharing: Data described in the manuscript, codebook, and analytic code will be made available upon request.

Transparency Statement: The author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

Dissemination Declaration: Dissemination to the simulated population is not applicable.

Contributors: MD contributed to the data curation, formal analysis, visualization, original draft preparation, review and editing; CFG contributed to the data curation, review and editing; FFC, HE and DDK contributed to software; JBW, PW, DDK, DSM, YCW, and DM contributed to the review and editing; FFZ contributed the conceptualization, methodology, review and editing, supervision, and funding acquisition. All authors approved the final version. FFZ acts as the guarantor of the study.

Role of the funding source: This study was supported by NIH/NIMHD 1R01MD011501. The funding sources had no role in the design or conduct of the study; collection, management, analysis, or interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.

Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted work. JBW reports leadership or fiduciary role in the US Preventive Services Task Force. DK reports research funding from the National Institutes of Health, Arnold Ventures, Pharmaceutical Research and Manufacturers of America, Sarepta Therapeutics, and Janssen

Therapeutics; consulting fees from Panalgo and the American College of Physicians. DM reports research funding from the National Institutes of Health, Gates Foundation, Rockefeller Foundation, and Vail Institute for Global Research; consulting fees from Acasti Pharma, Barilla, Danone, and Motif FoodWorks; participating on scientific advisory boards of start-up companies focused on innovations for health including Beren Therapeutics Brightseed, Calibrate, DayTwo, Elysium Health, Filtricine, Foodome, HumanCo, January Inc., Perfect Day, Season, and Tiny Organics; and chapter royalties from UpToDate. All of the above is outside the submitted work. No other relationships or activities could appear to have influenced the submitted work.

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Figure 1. Estimated New Cancer Cases and Deaths Prevented by Federal Menu Calorie Labeling Policy in the US by Cancer Type over a Lifetime

Figure 2. Probabilistic Sensitivity Analyses (PSA) for Cost-Effectiveness of the Federal Menu Calorie Labeling Policy over 10 years and a Lifetime

Legend: Values are presented in cost-effectiveness planes of net costs ($millions) versus incremental quality-adjusted life years (QALYs). For each policy scenario, each colored dot represents one of the 1000 simulations, with the largest dot showing the median incremental cost-effectiveness ratio (ICER, $/QALY); and the ellipse representing the 95% UIs. Results are presented from the societal perspective and the healthcare perspective. Negative values indicate cost savings.

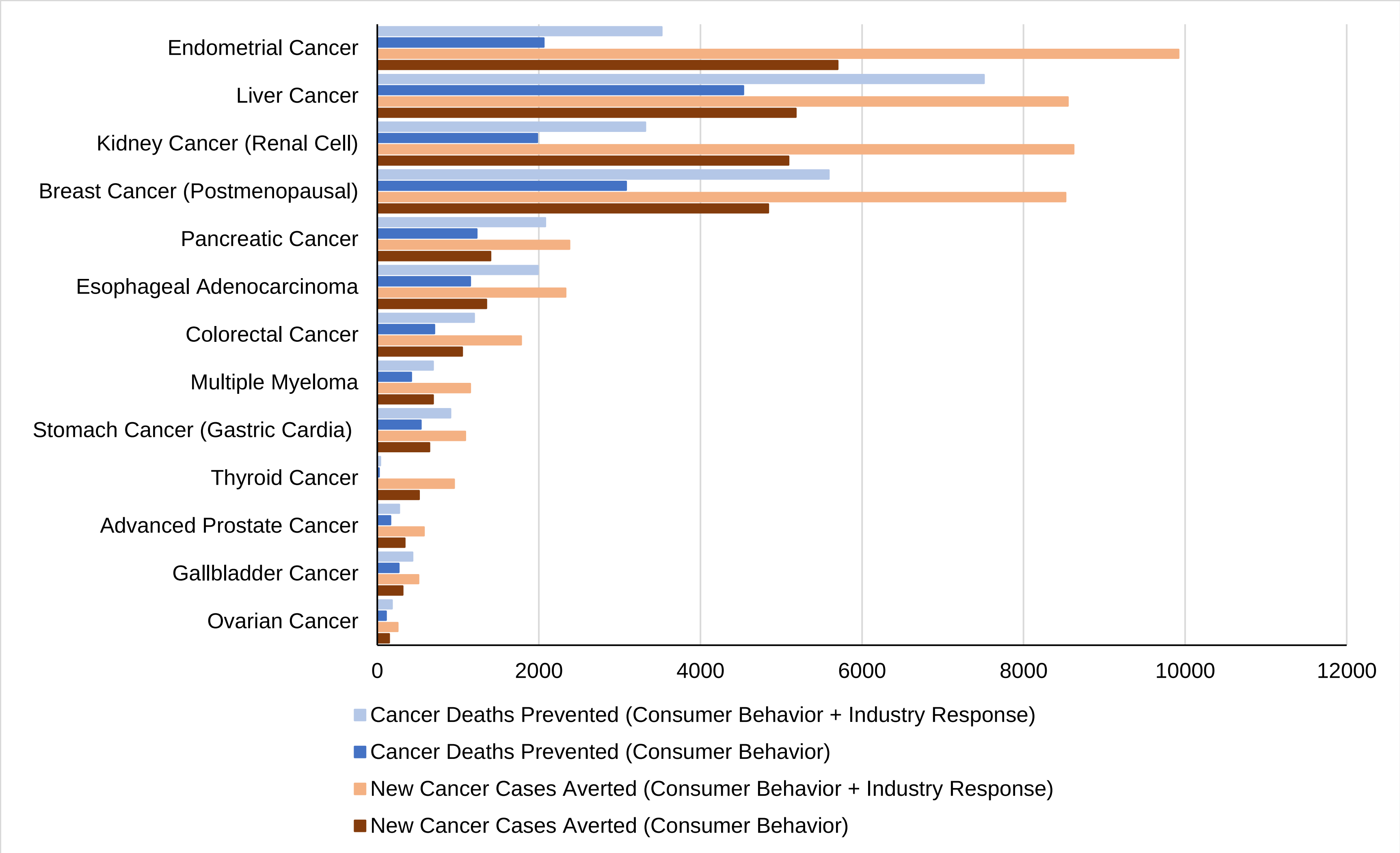
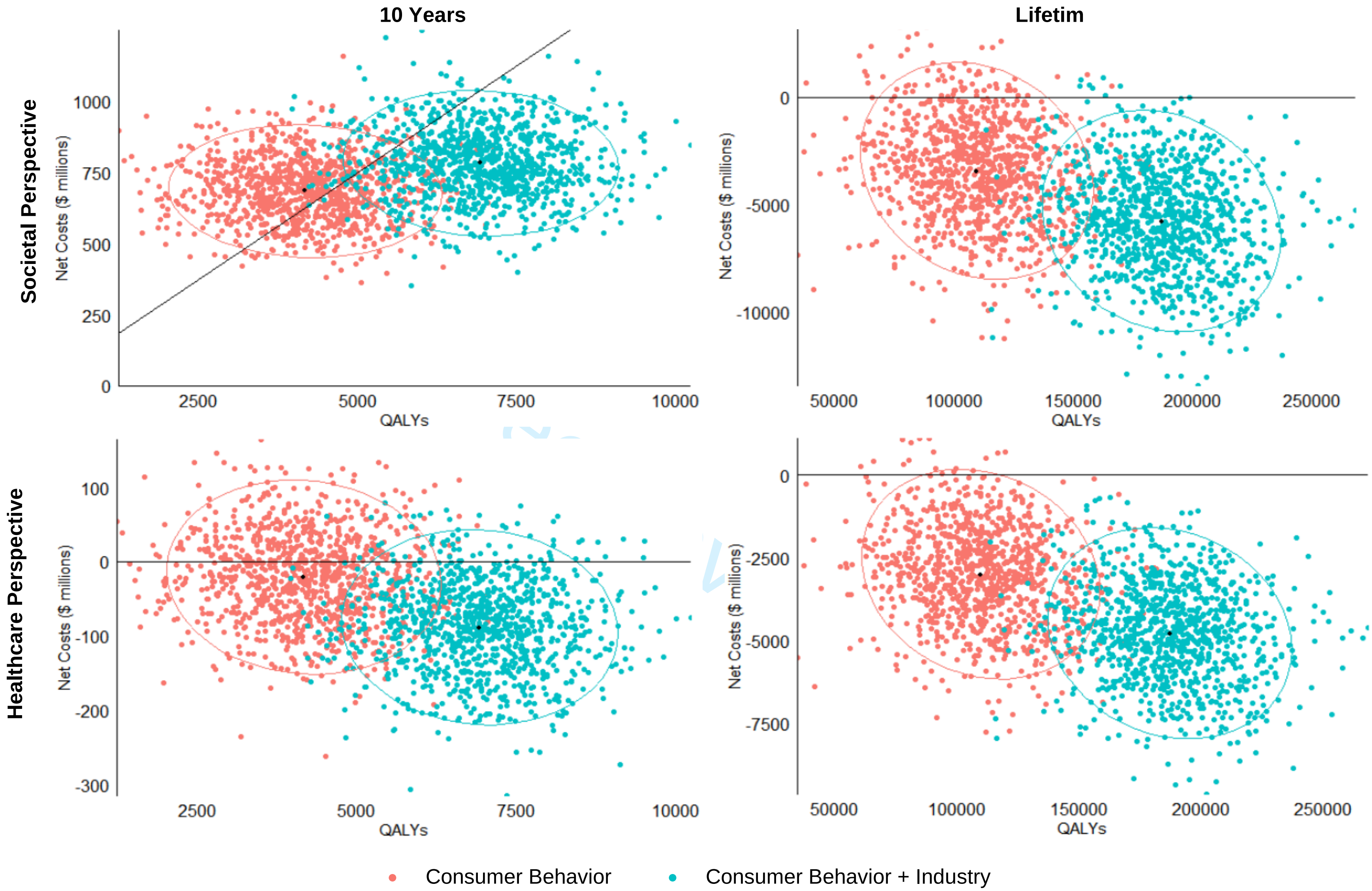


Figure 1. Estimated New Cancer Cases and Deaths Prevented by Federal Menu Calorie Labeling Policy in the US by Cancer Type over a Lifetime



Values are presented in cost-effectiveness planes of net costs ($millions) versus incremental quality-adjusted life years (QALYs). For each policy scenario, each colored dot represents one of the 1000 simulations, with the largest dot showing the median incremental cost-effectiveness ratio (ICER, $/QALY); and the ellipse representing the 95% UIs. Results are presented from the societal perspective and the healthcare perspective. Negative values indicate cost savings.

Figure 2. Probabilistic Sensitivity Analyses (PSA) for Cost-Effectiveness of the Federal Menu Calorie Labeling Policy over 10 years and a Lifetime

Title Cost-Effectiveness Analysis of the Federal Menu Calorie Labeling and Obesity-Associated Cancer Burdens in the United States

Supplementary Table 1. Defining Population and 32 Subgroups

Supplementary Table 2. Relative Risk Estimates of Etiologic Relationships Between Body Mass Index (BMI) and 13 Types of Cancers

Supplementary Table 3. Baseline Incidence Rates of 13 Cancers among US Adults by 32 Subgroups

Supplementary Table 4. Baseline 5-year Relative Survival Rates of 13 Cancers among US Adults by 32 Subgroups

Supplementary Table 5. Health-Related Quality of Life Among US Cancer Patients Aged 20 Years or Older, by Cancer Type and Phase of Care

Supplementary Table 6. Baseline Medical Costs, Productivity Loss, and Patient Time Costs Among US Cancer Patients Aged 20 Years or Older, by Cancer Type and Phase of Care

Supplementary Table 7. Baseline Medical Costs, Productivity Loss, and Patient Time Costs Among the General Population Aged 20 Years or Older in the US, by 32 Subgroups

Supplementary Table 8. Characteristics of US Adults Aged 20 Years or Older Participated in the NHANES, 2013-2016

Supplementary Table 9. Consumption of Calories from Full-Service and Fast-Food Restaurants among US Adults Participated in 2013-2016 NHANES, by 32 Subgroups

Supplementary Table 10. Estimated New Cancer Cases Averted by the Federal Menu Calorie Labeling in the US by Age, Sex, Race/Ethnicity, and Cancer Type, Over a Lifetime

Supplementary Table 11. Estimated Cancer Deaths Reduced by the Federal Menu Calorie Labeling in the US by Age, Sex, Race/Ethnicity, and Cancer Type, Over a Lifetime

Supplementary Table 12. Estimated Health Gains and Costs Associated with the Federal Menu Calorie Labeling on Reducing Cancer Burdens in the US Over a Lifetime, One-Way Sensitivity Analyses at 25% and 75% Calorie Compensations Outside the Restaurant Settings

Supplementary Table 13. Estimated Health Gains and Costs Associated with the Federal Menu Calorie Labeling on Reducing Cancer Burdens in the US Over a Lifetime, One-Way Sensitivity Analysis, Assuming all Full-Service and Fast-Food Restaurants were Covered by the Policy

Supplementary Figure 1. Diet and Cancer Outcome Model (DiCOM)

Supplementary Figure 2. Estimated Reduced New Cancer Cases and Deaths Associated with the Federal Menu Calorie Labeling in the US by Age, Sex, Race/Ethnicity, and Cancer Type, Over a Lifetime

Supplementary Figure 3. Estimated life Years and QALYs Gained Associated with the Federal Menu Calorie Labeling in the US by Age, Sex, and Race/Ethnicity, Over a Lifetime.

Supplementary Figure 4. Estimated Changes of Health-Related Costs Associated with the Federal Menu Calorie Labeling in the US by Age, Sex, Race/Ethnicity, and Cancer Type, Over a Lifetime

Supplementary Figure 5. Estimated Net Costs from Societal and Healthcare Perspectives Associated with the Federal Menu Calorie Labeling in the US by Age, Sex, and Race/Ethnicity, Over a Lifetime

Supplementary Figure 6. One-Way Sensitivity Analysis of Net Costs of the Federal Menu Calorie Labeling and Obesity-Associated Cancer Rates to Varying Assumptions of Key Input Parameters From (A) Societal Perspective and (B) Healthcare Perspective

Supplementary Table 1. Defining population and 32 subgroups

Subgroups	Age	Sex	Race/Ethnicity
1	20-44y	Female	NHW
2	20-44y	Female	NHB
3	20-44y	Female	HISP
4	20-44y	Female	OTH
5	20-44y	Male	NHW
6	20-44y	Male	NHB
7	20-44y	Male	HISP
8	20-44y	Male	OTH
9	45-54y	Female	NHW
10	45-54y	Female	NHB
11	45-54y	Female	HISP
12	45-54y	Female	OTH
13	45-54y	Male	NHW
14	45-54y	Male	NHB
15	45-54y	Male	HISP
16	45-54y	Male	OTH
17	55-64y	Female	NHW
18	55-64y	Female	NHB
19	55-64y	Female	HISP
20	55-64y	Female	OTH
21	55-64y	Male	NHW
22	55-64y	Male	NHB
23	55-64y	Male	HISP
24	55-64y	Male	OTH
25	65+y	Female	NHW
26	65+y	Female	NHB
27	65+y	Female	HISP
28	65+y	Female	OTH
29	65+y	Male	NHW
30	65+y	Male	NHB
31	65+y	Male	HISP
32	65+y	Male	OTH

Supplementary Table 2. Relative risk estimates of etiologic relationships between body mass index (BMI) and 13 types of cancers

Cancer Type	No. of Studies	No. of Events	Source	Evidence Grading	RR (95% CI) Per 5 kg/m^2	Statistical Heterogeneity
Endometrial	26	18,717	CUP, 2013	Convincing ↑risk	1.50 (1.42-1.59)	I^2=86.2% P<0.0001
Esophageal (adenocarcinoma)	9	1,725	CUP, 2016	Convincing ↑risk	1.48 (1.35-1.62)	I^2=36.7% P=0.13
Kidney	23	15,575	CUP, 2015	Convincing ↑risk	1.30 (1.25-1.35)	I^2=38.8% P=0.03
Liver	12	14, 311	CUP, 2015	Convincing ↑risk	1.30 (1.16-1.46)	I^2=78.3% P=0.000
Gallbladder	8	6,004	CUP, 2015	Probable ↑risk	1.25 (1.15-1.37)	I^2=52.3% P=0.04
Stomach (cardia)	7	2,050	CUP, 2016	Probable ↑risk	1.23 (1.07-1.40)	I^2=55.6% P=0.04
Breast (post-menopausal)	56	80,404	CUP, 2017	Convincing ↑risk	1.12 (1.09-1.15)	I^2=75% P<0.001
Pancreas	23	9,504	CUP, 2011	Convincing ↑risk	1.10 (1.07-1.14)	I^2=19% P=0.20
Multiple myeloma	20	1,388	IARC, 2016[30]	Sufficient (IRAC) ↑risk	1.09 (1.03-1.16)	Not reported
Prostate (advanced)	24	11,149	CUP, 2014	Probable ↑risk	1.08 (1.04-1.12)	I^2=18.8% P=0.21
Thyroid	22	3,100	IARC, 2016[30]	Sufficient (IARC) ↑risk	1.06 (1.02-1.10)	Not reported
Ovary	25	15,899	CUP, 2013	Probable ↑risk	1.06 (1.02-1.11)	I^2=55.1% P=0.001
Colorectal	38	71,089	CUP, 2017	Convincing ↑risk	1.05 (1.03-1.07)	I^2=74.2% P=0.000

Supplementary Table 3. Baseline incidence rates of 13 cancers among US adults by 32 subgroups

Subgroup	Colorectal Cancer		Endometrial Cancer		Esophageal Adeno-carcinoma		Female Breast (Postmeno.)		Gallbladder Cancer		Kidney Cancer		Liver Cancer		Multiple Myeloma		Ovarian cancer		Pancreatic Cancer		Advanced Prostate Cancer		Stomach Cancer (Gastric Cardia)		Thyroid Cancer	
	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE
1	8.53	0.38	6.54	3.66	0.05	4.18	0.00	0.00	0.05	2.57	3.83	3.16	0.49	4.18	0.38	4.66	4.31	0.27	107	3.46	0.00	0.00	0.10	3.82	28.97	0.69
2	7.78	0.74	5.04	0.59	0.03	0.20	0.00	0.00	0.07	2.46	3.57	0.50	0.56	0.20	102	0.27	2.98	0.45	103	0.26	0.00	0.00	0.09	2.25	13.12	0.95
3	6.09	0.55	7.49	3.32	0.03	3.07	0.00	0.00	0.06	2.48	3.73	3.16	0.42	3.07	0.33	3.71	3.95	0.46	0.86	0.87	0.00	0.00	0.09	2.27	20.97	113
4	6.36	110	6.56	113	0.02	0.15	0.00	0.00	0.07	2.58	187	0.40	0.32	0.15	0.38	0.23	4.49	0.70	0.74	0.25	0.00	0.00	0.09	2.36	24.88	2.21
5	9.20	0.39	0.00	0.00	0.42	5.22	0.00	0.00	0.04	0.02	5.91	4.53	0.60	5.22	0.48	5.26	0.00	0.00	122	2.06	0.21	0.02	0.43	4.32	6.93	0.34
6	7.94	0.78	0.00	0.00	0.29	0.30	0.00	0.00	0.04	0.02	5.47	0.65	117	0.30	148	0.34	0.00	0.00	100	0.28	0.56	0.09	0.34	3.42	2.36	0.42
7	6.15	0.54	0.00	0.00	0.31	3.85	0.00	0.00	0.04	0.02	4.04	3.82	0.82	3.85	0.57	0.18	0.00	0.00	0.83	0.20	0.13	0.68	0.34	3.53	3.80	0.44
8	6.21	0.85	0.00	0.00	0.31	0.47	0.00	0.00	0.05	0.02	3.68	104	159	0.47	0.70	140	0.00	0.00	0.82	0.29	0.41	0.09	0.36	3.52	5.70	0.84
9	4127	0.76	38.53	0.73	103	0.21	124.56	128	0.68	5.99	14.03	0.44	3.10	0.21	3.60	0.22	17.09	0.49	7.70	0.32	0.00	0.00	0.88	6.74	37.84	0.73
10	53.14	192	25.73	134	0.59	0.60	12173	2.88	154	5.87	16.08	106	5.17	0.60	1129	0.89	1175	0.90	10.91	0.87	0.00	0.00	0.94	5.38	25.80	134
11	33.92	178	33.43	153	0.59	0.52	77.25	3.45	2.27	193	16.00	104	3.83	0.52	4.86	0.58	14.57	100	6.26	0.66	0.00	0.00	0.81	5.61	37.29	184
12	35.77	3.15	35.84	3.07	0.65	0.66	9182	4.82	170	6.05	7.78	192	3.27	0.66	2.55	0.70	17.07	151	5.17	0.81	0.00	0.00	0.85	5.53	37.73	2.90
13	53.97	0.87	0.00	0.00	5.61	0.36	0.00	0.00	0.36	7.15	29.16	0.64	9.24	0.36	5.09	0.27	0.00	0.00	10.63	0.38	10.88	0.16	3.65	0.23	13.29	0.43
14	6129	2.20	0.00	0.00	150	102	0.00	0.00	0.47	5.07	32.82	161	13.29	102	12.34	0.99	0.00	0.00	14.12	105	25.31	0.58	190	0.33	6.41	0.71
15	38.05	194	0.00	0.00	2.75	106	0.00	0.00	0.43	4.83	24.48	127	16.38	106	5.23	0.60	0.00	0.00	7.95	0.74	6.02	0.38	196	0.34	8.56	0.76
16	42.81	3.85	0.00	0.00	2.88	2.28	0.00	0.00	0.37	4.93	18.63	3.06	18.71	2.28	3.70	0.82	0.00	0.00	7.62	105	3.70	0.50	2.51	0.17	12.57	136
17	59.74	0.89	90.00	109	2.12	0.35	305.45	2.02	175	0.15	26.14	0.59	9.41	0.35	8.68	0.34	26.19	0.59	2178	0.54	0.00	0.00	172	0.15	34.42	0.67
18	86.11	2.62	83.71	2.60	130	121	306.22	4.92	4.08	0.57	3153	158	18.22	121	23.28	137	19.79	125	3137	158	0.00	0.00	192	0.39	27.72	148
19	58.14	2.91	69.51	3.28	164	133	218.85	7.01	4.59	0.68	29.93	173	17.38	133	9.33	0.97	2129	145	17.15	132	0.00	0.00	187	0.34	39.44	197
20	52.83	4.48	60.22	4.45	149	197	233.48	8.33	2.44	0.50	13.91	2.72	12.58	197	6.13	0.96	23.98	2.79	13.44	143	0.00	0.00	157	0.13	4174	3.08
21	88.14	1.11	0.00	0.00	15.54	0.73	0.00	0.00	0.93	0.11	53.65	0.87	37.93	0.73	13.24	0.43	0.00	0.00	29.95	0.65	47.05	0.34	9.19	0.36	16.24	0.48
22	12139	3.41	0.00	0.00	4.30	2.72	0.00	0.00	2.06	0.41	69.05	2.57	75.50	2.72	30.69	171	0.00	0.00	39.72	195	9141	122	4.87	0.68	9.12	0.92
23	84.75	3.65	0.00	0.00	8.01	2.98	0.00	0.00	107	0.11	5105	2.35	6105	2.98	13.65	122	0.00	0.00	23.36	158	32.10	121	5.15	0.70	11.12	109
24	83.77	5.72	0.00	0.00	4.97	4.85	0.00	0.00	122	0.11	27.95	3.81	54.13	4.85	10.32	139	0.00	0.00	19.14	2.87	22.70	131	5.16	0.96	16.04	175
25	147.25	198	86.90	140	4.53	0.62	429.43	3.20	5.87	0.40	42.37	102	15.56	0.62	20.59	0.73	38.18	0.97	55.49	120	0.00	0.00	4.36	0.34	24.59	0.74
26	155.86	5.74	100.81	4.21	3.10	198	398.07	8.74	9.68	143	50.03	3.07	20.61	198	50.31	3.20	29.78	2.45	7193	3.94	0.00	0.00	3.41	0.52	22.57	198
27	117.47	5.72	66.40	4.47	3.61	3.17	285.07	11.57	11.44	175	45.35	3.33	38.69	3.17	24.20	2.52	32.78	2.88	5154	3.79	0.00	0.00	3.89	0.60	29.50	2.55
28	109.32	10.15	52.12	5.29	3.51	4.72	266.14	14.52	7.02	170	26.14	4.17	35.77	4.72	14.41	2.43	23.90	2.89	46.15	5.64	0.00	0.00	4.11	0.28	28.15	3.08
29	18107	2.47	0.00	0.00	29.02	1.10	0.00	0.00	3.59	0.36	88.69	163	40.30	1.10	34.26	107	0.00	0.00	72.36	153	80.74	0.61	19.38	0.77	17.34	0.69
30	217.23	8.36	0.00	0.00	7.29	3.98	0.00	0.00	6.24	1.14	97.13	5.16	68.31	3.98	69.18	4.66	0.00	0.00	75.66	4.94	130.67	2.34	8.81	155	10.03	160
31	182.00	9.21	0.00	0.00	15.50	5.01	0.00	0.00	6.79	164	87.20	5.26	78.18	5.01	33.10	3.44	0.00	0.00	6188	4.77	66.33	2.57	11.49	178	15.87	2.11
32	144.37	13.43	0.00	0.00	10.56	7.52	0.00	0.00	4.75	102	54.45	7.24	79.16	7.52	22.48	3.35	0.00	0.00	5145	6.82	5184	2.78	11.34	2.12	13.86	2.28

Supplementary Table 4. Baseline 5-year relative survival rates of 13 cancers among US adults by 32 subgroups

Subgroup	Colorectal Cancer		Endometrial Cancer		Esophageal Adeno-carcinoma		Female Breast (Postmeno.)		Gallbladder Cancer		Kidney Cancer		Liver Cancer		Multiple Myeloma		Ovarian Cancer		Pancreatic Cancer		Advanced Prostate Cancer		Stomach Cancer (Gastric Cardia)		Thyroid Cancer	
	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE
1	0.740	0.012	0.916	0.009	0.223	0.018	0.000	0.000	0.095	0.095	0.953	0.009	0.409	0.057	0.852	0.043	0.780	0.015	0.379	0.038	0.000	0.000	0.477	0.099	1.000	0.001
2	0.652	0.024	0.775	0.027	0.223	0.018	0.000	0.000	0.286	0.064	0.856	0.029	0.144	0.113	0.837	0.048	0.736	0.036	0.530	0.064	0.000	0.000	0.502	0.205	0.993	0.004
3	0.659	0.022	0.900	0.013	0.223	0.018	0.000	0.000	0.309	0.092	0.864	0.021	0.403	0.081	0.713	0.075	0.716	0.024	0.493	0.062	0.000	0.000	0.236	0.116	0.992	0.002
4	0.694	0.027	0.910	0.016	0.223	0.018	0.000	0.000	0.286	0.064	0.819	0.043	0.321	0.077	0.787	0.122	0.737	0.029	0.371	0.076	0.000	0.000	0.667	0.193	1.000	0.002
5	0.682	0.012	0.000	0.000	0.140	0.034	0.000	0.000	0.302	0.117	0.886	0.010	0.251	0.037	0.696	0.041	0.000	0.000	0.275	0.032	0.768	0.057	0.284	0.045	0.997	0.002
6	0.601	0.027	0.000	0.000	0.160	0.031	0.000	0.000	0.357	0.096	0.779	0.027	0.157	0.045	0.606	0.057	0.000	0.000	0.151	0.046	0.780	0.086	0.672	0.274	0.949	0.025
7	0.621	0.022	0.000	0.000	0.330	0.108	0.000	0.000	0.357	0.096	0.847	0.020	0.227	0.047	0.635	0.064	0.000	0.000	0.157	0.044	0.470	0.118	0.152	0.055	0.993	0.007
8	0.635	0.029	0.000	0.000	0.287	0.172	0.000	0.000	0.357	0.096	0.840	0.033	0.152	0.032	0.649	0.108	0.000	0.000	0.230	0.066	0.805	0.180	0.545	0.133	0.992	0.008
9	0.738	0.007	0.889	0.006	0.300	0.065	0.918	0.003	0.153	0.045	0.846	0.011	0.283	0.027	0.682	0.027	0.614	0.012	0.195	0.017	0.000	0.000	0.384	0.060	0.997	0.002
10	0.666	0.015	0.751	0.022	0.290	0.174	0.810	0.009	0.155	0.059	0.834	0.025	0.145	0.035	0.626	0.034	0.497	0.034	0.177	0.029	0.000	0.000	0.457	0.144	0.990	0.008
11	0.725	0.016	0.869	0.012	0.751	0.217	0.881	0.008	0.224	0.062	0.879	0.018	0.242	0.038	0.617	0.047	0.595	0.025	0.209	0.035	0.000	0.000	0.257	0.079	0.983	0.005
12	0.731	0.018	0.893	0.012	0.308	0.060	0.926	0.007	0.210	0.082	0.810	0.037	0.287	0.051	0.686	0.071	0.640	0.027	0.307	0.055	0.000	0.000	0.357	0.152	0.991	0.005
13	0.704	0.007	0.000	0.000	0.255	0.020	0.000	0.000	0.321	0.072	0.790	0.009	0.171	0.011	0.627	0.023	0.000	0.000	0.136	0.012	0.858	0.010	0.253	0.024	0.964	0.007
14	0.612	0.015	0.000	0.000	0.186	0.085	0.000	0.000	0.371	0.127	0.793	0.020	0.117	0.019	0.616	0.037	0.000	0.000	0.138	0.022	0.814	0.020	0.148	0.059	0.970	0.027
15	0.652	0.015	0.000	0.000	0.222	0.050	0.000	0.000	0.151	0.082	0.742	0.019	0.181	0.016	0.640	0.044	0.000	0.000	0.101	0.021	0.729	0.029	0.257	0.060	0.945	0.019
16	0.721	0.017	0.000	0.000	0.308	0.110	0.000	0.000	0.751	0.153	0.799	0.027	0.239	0.023	0.594	0.066	0.000	0.000	0.162	0.039	0.865	0.040	0.298	0.080	0.960	0.018
17	0.694	0.007	0.878	0.004	0.322	0.043	0.918	0.002	0.273	0.035	0.793	0.010	0.208	0.015	0.630	0.019	0.531	0.011	0.117	0.009	0.000	0.000	0.334	0.041	0.994	0.002
18	0.621	0.014	0.667	0.015	0.298	0.039	0.830	0.007	0.151	0.043	0.805	0.022	0.219	0.028	0.609	0.027	0.371	0.028	0.112	0.018	0.000	0.000	0.440	0.113	0.971	0.012
19	0.673	0.016	0.816	0.013	0.241	0.131	0.879	0.006	0.173	0.044	0.769	0.021	0.211	0.025	0.535	0.042	0.473	0.025	0.104	0.019	0.000	0.000	0.279	0.101	0.969	0.009
20	0.714	0.017	0.847	0.013	0.298	0.039	0.911	0.006	0.151	0.061	0.785	0.032	0.288	0.033	0.631	0.051	0.555	0.031	0.164	0.027	0.000	0.000	0.281	0.140	0.987	0.008
21	0.666	0.006	0.000	0.000	0.257	0.013	0.000	0.000	0.190	0.045	0.760	0.008	0.202	0.007	0.603	0.016	0.000	0.000	0.111	0.007	0.878	0.006	0.255	0.016	0.954	0.009
22	0.579	0.013	0.000	0.000	0.178	0.072	0.000	0.000	0.261	0.105	0.758	0.019	0.140	0.012	0.545	0.028	0.000	0.000	0.080	0.014	0.786	0.014	0.148	0.046	0.945	0.039
23	0.628	0.014	0.000	0.000	0.135	0.033	0.000	0.000	0.203	0.081	0.717	0.018	0.170	0.013	0.541	0.037	0.000	0.000	0.078	0.015	0.777	0.017	0.281	0.053	0.899	0.028
24	0.654	0.015	0.000	0.000	0.237	0.082	0.000	0.000	0.148	0.069	0.698	0.025	0.268	0.017	0.485	0.050	0.000	0.000	0.122	0.023	0.885	0.019	0.257	0.061	0.967	0.022
25	0.610	0.005	0.799	0.006	0.182	0.024	0.907	0.003	0.179	0.018	0.679	0.010	0.119	0.010	0.420	0.012	0.323	0.008	0.057	0.003	0.000	0.000	0.231	0.023	0.958	0.005
26	0.551	0.012	0.552	0.016	0.170	0.143	0.806	0.008	0.217	0.043	0.709	0.024	0.097	0.020	0.407	0.022	0.210	0.021	0.059	0.009	0.000	0.000	0.264	0.068	0.894	0.023
27	0.579	0.013	0.699	0.017	0.190	0.073	0.858	0.008	0.125	0.023	0.677	0.022	0.087	0.014	0.353	0.027	0.298	0.022	0.049	0.009	0.000	0.000	0.257	0.060	0.889	0.020
28	0.599	0.013	0.735	0.020	0.180	0.022	0.900	0.007	0.115	0.030	0.614	0.032	0.187	0.017	0.440	0.040	0.356	0.029	0.043	0.008	0.000	0.000	0.187	0.067	0.858	0.023
29	0.615	0.005	0.000	0.000	0.212	0.011	0.000	0.000	0.134	0.025	0.680	0.008	0.119	0.007	0.402	0.011	0.000	0.000	0.075	0.004	0.717	0.007	0.220	0.013	0.935	0.015
30	0.498	0.014	0.000	0.000	0.164	0.069	0.000	0.000	0.209	0.076	0.705	0.024	0.134	0.019	0.459	0.027	0.000	0.000	0.049	0.011	0.569	0.017	0.174	0.052	0.810	0.068
31	0.544	0.013	0.000	0.000	0.155	0.035	0.000	0.000	0.144	0.046	0.668	0.020	0.107	0.012	0.398	0.028	0.000	0.000	0.066	0.011	0.674	0.017	0.141	0.032	0.786	0.048
32	0.625	0.013	0.000	0.000	0.126	0.049	0.000	0.000	0.263	0.071	0.653	0.026	0.182	0.014	0.431	0.037	0.000	0.000	0.080	0.013	0.733	0.020	0.255	0.042	0.800	0.039

Supplementary Table 5. Health-related quality of life among US cancer patients aged 20 years or older, by cancer type and phase of care

Cancer Type	Cancer Phase	Health Related Quality of Life mean (SE)	Source
Endometrial	Overall	0.80 (0.14)	Naik et al.[31]
Esophageal Adenocarcinoma	Overall	0.69 (0.26)	Wildi et al.[32]
Kidney	Overall	0.78 (0.14)	Pickard et al.[33]
Liver	Overall	0.79 (0.19)	Naik et al.[31]
Gallbladder	Overall	0.79 (0.19)	Naik et al.[31]
Stomach (gastric cardia)	Initial: Continuous: End of Life:	0.84 (0.25) 0.86 (0.24) 0.65 (0.33)	Zhou et al.[34]
Female Breast (post-menopausal)	Initial: Continuous: End of Life:	0.78 (0.19) 0.81 (0.20) 0.64 (0.16)	Yabroff et al.[35]
Pancreas	Overall	0.65 (0.30)	Müller-Nordhorn et al.[36]
Multiple myeloma	Overall	0.79 (0.19)	Naik et al.[31]
Advanced Prostate	Initial: Continuous: End of Life:	0.78 (0.20) 0.76 (0.19) 0.59 (0.15)	Yabroff et al.[35]
Thyroid	Overall	0.85 (0.13)	Naik et al.[31]
Ovary	Overall	0.77 (0.17)	Pickard et al.[33]
Colorectal	Initial: Continuous: End of Life:	0.760 (0.19) 0.835 (0.20) 0.643 (0.26)	Färkkilä et al.[37]

Supplementary Table 6. Baseline medical costs, productivity loss, and patient time costs among US cancer patients aged 20 years or older, by cancer type

Cancer type	Sex	Age	Medical costs			Productivity loss			Patient time cost		
			Initial	Continuous	End-of-life	Initial	Continuous	End-of-life	Initial	Continuous	End-of-life
Esophageal Adenocarcinoma	Female	<65	95439	6853	156417	4884	3757	15027	650	500	2001
		≥65	79532	6853	104278	6984	5372	21489	1187	913	3652
	Male	<65	95787	6450	155612	4884	3757	15027	650	500	2001
		≥65	79822	6450	103742	6984	5372	21489	1187	913	3652
Stomach (Gastric Cardia)	Female	<65	85291	3977	155636	4884	3757	15027	650	500	2001
		≥65	71076	3977	103758	6984	5372	21489	1187	913	3652
	Male	<65	94144	4282	160695	4884	3757	15027	650	500	2001
		≥65	78453	4282	107130	6984	5372	21489	1187	913	3652
Liver	Female	<65	40173	5859	95782	4884	3757	15027	650	500	2001
		≥65	40173	5859	95782	6984	5372	21489	1187	913	3652
	Male	<65	41161	7363	97473	4884	3757	15027	650	500	2001
		≥65	41161	7363	97473	6984	5372	21489	1187	913	3652
Pancreatic	Female	<65	112154	8672	164911	4884	3757	15027	650	500	2001
		≥65	93462	8672	109941	6984	5372	21489	1187	913	3652
	Male	<65	112911	11697	169673	4884	3757	15027	650	500	2001
		≥65	94092	11697	113115	6984	5372	21489	1187	913	3652
Advanced Prostate	Male	<65	23652	3201	93363	3715	2858	11432	650	500	2001
		≥65	19710	3201	62242	6549	5038	20152	1187	913	3652
Colorectal	Female	<65	61593	3159	126778	10330	7946	31784	650	500	2001
		≥65	51327	3159	84519	7479	5753	23012	1187	913	3652

	Male	<65	62174	4595	128507	10330	7946	31784	650	500	2001
		≥65	51812	4595	85671	7479	5753	23012	1187	913	3652
Endometrial	Female	<65	32129	1535	105262	4884	3757	15027	650	500	2001
		≥65	26775	1535	70175	6984	5372	21489	1187	913	3652
Ovarian	Female	<65	98788	8296	149573	4884	3757	15027	650	500	2001
		≥65	82324	8296	99715	6984	5372	21489	1187	913	3652
Gallbladder	Female	<65	40173	5859	95782	4884	3757	15027	650	500	2001
		≥65	40173	5859	95782	6984	5372	21489	1187	913	3652
	Male	<65	41161	7363	97473	4884	3757	15027	650	500	2001
		≥65	41161	7363	97473	6984	5372	21489	1187	913	3652
Kidney (Renal Cell)	Female	<65	46077	6255	110765	4884	3757	15027	650	500	2001
		≥65	38397	6255	73843	6984	5372	21489	1187	913	3652
	Male	<65	46048	6018	117123	4884	3757	15027	650	500	2001
		≥65	38374	6018	78082	6984	5372	21489	1187	913	3652
Breast (Postmenopausal)	Female	<65	27693	2207	94284	5985	4604	18416	650	500	2001
		≥65	23078	2207	62856	4752	3655	14620	1187	913	3652
Thyroid	Female	<65	40173	5859	95782	4884	3757	15027	650	500	2001
		≥65	40173	5859	95782	6984	5372	21489	1187	913	3652
	Male	<65	41161	7363	97473	4884	3757	15027	650	500	2001
		≥65	41161	7363	97473	6984	5372	21489	1187	913	3652
Multiple Myeloma	Female	<65	40173	5859	95782	4884	3757	15027	650	500	2001
		≥65	40173	5859	95782	6984	5372	21489	1187	913	3652

	Male	<65	41161	7363	97473	4884	3757	15027	650	500	2001
		≥65	41161	7363	97473	6984	5372	21489	1187	913	3652

Supplementary Table 7. Baseline medical costs, productivity loss, and patient time cost among general population aged 20 years or older in the US, by 32 subgroups

Age group, years	Sex	Race/ethnicity	Medical costs		Productivity loss		Patient time cost	
			Annual general costs	End-of-life costs	Annual general costs	End-of-life costs	Annual general costs	End-of-life costs
20-44	Female	NHW	4020	40000	2040	8160	226	904
		NHB	3100	40000	2040	8160	226	904
		Hispanic	2355	40000	2040	8160	226	904
		Other	2617	40000	2040	8160	226	904
	Male	NHW	2022	40000	2040	8160	226	904
		NHB	2279	40000	2040	8160	226	904
		Hispanic	1145	40000	2040	8160	226	904
		Other	1803	40000	2040	8160	226	904
							226	904
45-54	Female	NHW	5371	40000	2040	8160	226	904
		NHB	5712	40000	2040	8160	226	904
		Hispanic	3196	40000	2040	8160	226	904
		Other	4082	40000	2040	8160	226	904
	Male	NHW	3812	40000	2040	8160	226	904
		NHB	3639	40000	2040	8160	226	904
		Hispanic	3612	40000	2040	8160	226	904
		Other	2560	40000	2040	8160	226	904
							226	904
55-64	Female	NHW	7300	40000	2040	8160	226	904
		NHB	5479	40000	2040	8160	226	904
		Hispanic	4607	40000	2040	8160	226	904
		Other	3951	40000	2040	8160	226	904
	Male	NHW	6519	40000	2040	8160	226	904
		NHB	6455	40000	2040	8160	226	904
		Hispanic	5077	40000	2040	8160	226	904
		Other	6320	40000	2040	8160	226	904
≥65	Female	NHW	8997	40000	4409	8160	607	904
		NHB	9585	40000	4409	8160	607	904
		Hispanic	8847	40000	4409	8160	607	904
		Other	8625	40000	4409	8160	607	904
	Male	NHW	9334	40000	4409	8160	607	904
		NHB	7367	40000	4409	8160	607	904
		Hispanic	5640	40000	4409	8160	607	904
		Other	7461	40000	4409	8160	607	904

Supplementary Table 8. Characteristics of US adults aged 20 years or older participated in the NHANES, 2013-2016

Characteristics (N=10064)		**Calorie Consumption**, kcal/day
Age, years	47.8 ± 0.41	
Age groups, years, N (%)		
20-44	4319 (44.5)	425 ± 4.38
25-54	1704 (18.3)	315 ± 5.39
55-64	1725 (17.3)	271 ± 4.90
≥65	2316 (19.9)	192 ± 3.83
Sex, N (%)		
Male	4829 (48.3)	388 ± 4.53
Female	5235 (51.7)	279 ± 4.04
Race/ethnicity, N (%)		
Non-Hispanic White	3944 (65.0)	320 ± 4.76
Non-Hispanic Black	2069 (11.2)	361 ± 6.55
Hispanic	2668 (14.9)	367 ± 4.44
Other	1383 (8.90)	325 ± 8.12
Education, N (%)		
Less than high school graduate	2178 (14.2)	311 ± 5.14
High school graduate	2249 (21.6)	332 ± 5.72
Some college	3070 (33.1)	341 ± 4.92
College graduate	2562 (31.0)	332 ± 7.10
Family income to poverty ratio, N (%)		
<1.30	3862 (28.3)	325 ± 4.87
1.30-1.84	2842 (26.7)	333 ± 4.55
1.85-2.99	1725 (20.4)	344 ± 6.73
≥3.00	1635 (24.5)	328 ± 7.01
Body mass index (BMI), kg/m^2	29.3 ± 0.16	
Weight status, N (%)		
Underweight (BMI<18.5)	145 (1.36)	341 ± 17.5
Normal weight (BMI=18.5-24.9)	2671 (27.2)	327 ± 4.81
Overweight/Obese (BMI≥25)	7163 (71.4)	334 ± 4.01

Supplementary Table 9. Consumption of calories from full-service and fast-food restaurants among US adults participated in 2013-2016 NHANES by 32 subgroups

Age group, years	**Sex**	**Race/ethnicity**	**Baseline consumption**, g/day (mean ± SE)
20-44	Female	NHW	357 ± 6.47
		NHB	397 ± 8.98
		Hispanic	364 ± 6.77
		Other	334 ± 11.3
	Male	NHW	485 ± 9.00
		NHB	508 ± 12.3
		Hispanic	500 ± 13.7
		Other	466 ± 14.1
45-54	Female	NHW	270 ± 9.38
		NHB	266 ± 7.85
		Hispanic	265 ± 9.11
		Other	228 ± 14.6
	Male	NHW	374 ± 11.3
		NHB	388 ± 17.4
		Hispanic	355 ± 15.0
		Other	338 ± 20.2
55-64	Female	NHW	231 ± 5.25
		NHB	249 ± 9.58
		Hispanic	234 ± 7.99
		Other	216 ± 10.2
	Male	NHW	315 ± 9.55
		NHB	314 ± 18.3
		Hispanic	307 ± 9.90
		Other	298 ± 11.1
≥65	Female	NHW	164 ± 4.71
		NHB	156 ± 6.07
		Hispanic	158 ± 5.27
		Other	137 ± 5.43
	Male	NHW	235 ± 7.43
		NHB	220 ± 7.07
		Hispanic	218 ± 8.07
		Other	198 ± 20.0

Supplementary Table 10. Estimated new cancer cases averted by the federal menu calorie labeling in the US by age, sex, race/ethnicity, and cancer type, over lifetime (U.S. population=235,162,844)[1]

Cancer Type	Policy Scenario	20-44 y		45-54 y		55-64 y		65 + y	
		Female	Male	Female	Male	Female	Male	Female	Male
Endometrial									
Age	*consumer behavior*	3300 (696 to 6090)		591 (-990 to 2160)		1140 (433 to 1940)		656 (107 to 1190)	
	+industry response	5960 (3360 to 8890)		1340 (-208 to 2980)		1600 (928 to 2430)		926 (396 to 1460)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	1630 (-711 to 4080)	0	-136 (-1590 to 1430)	0	757 (140 to 1500)	0	572 (38 to 1070)	0
	+industry response	3080 (829 to 5780)	0	369 (-1100 to 1950)	0	1110 (463 to 1830)	0	780 (245 to 1290)	0
Non-Hispanic Black	*consumer behavior*	763 (-157 to 1710)	0	258 (-23 to 543)	0	283 (73 to 528)	0	47 (-43 to 150)	0
	+industry response	1240 (316 to 2200)	0	372 (93 to 668)	0	355 (146 to 604)	0	77 (-13 to 176)	0
Hispanic	*consumer behavior*	910 (74 to 1790)	0	290 (-48 to 596)	0	42 (-83 to 185)	0	43 (-16 to 102)	0
	+industry response	1460 (580 to 2340)	0	399 (66 to 703)	0	89 (-35 to 233)	0	64 (5 to 122)	0
Other	*consumer behavior*	19 (-312 to 402)	0	165 (41 to 319)	0	54 (3 to 109)	0	-6 (-26 to 14)	0
	+industry response	150 (-174 to 546)	0	191 (68 to 344)	0	68 (18 to 124)	0	0 (-21 to 21)	0
Breast (Postmenopausal)									
Age	*consumer behavior*	2530 (263 to 5040)		373 (-1070 to 1950)		1210 (480 to 2130)		742 (137 to 1380)	
	+industry response	4670 (2330 to 7350)		1040 (-390 to 2680)		1710 (1010 to 2640)		1040 (433 to 1700)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	1370 (-659 to 3750)	0	-224 (-1570 to 1210)	0	832 (170 to 1670)	0	660 (57 to 1280)	0
	+industry response	2660 (490 to 5220)	0	234 (-1130 to 1770)	0	1200 (535 to 2040)	0	902 (291 to 1570)	0
Non-Hispanic Black	*consumer behavior*	567 (-110 to 1300)	0	182 (-34 to 431)	0	267 (89 to 487)	0	43 (-40 to 136)	0

	+industry response	912 (240 to 1680)	0	271 (55 to 536)	0	329 (149 to 554)	0	71 (-13 to 166)	0
Hispanic	*consumer behavior*	581 (44 to 1200)	0	231 (-14 to 474)	0	32.9 (-72 to 154)	0	42 (-12 to 100)	0
	+industry response	934 (368 to 1600)	0	312 (71 to 563)	0	76 (-34 to 198)	0	61 (6 to 123)	0
Other	*consumer behavior*	1 (-310 to 384)	0	182 (40 to 353)	0	74 (9 to 148)	0	-7 (-35 to 22)	0
	+industry response	128 (-187 to 541)	0	210 (71 to 386)	0	94 (29 to 170)	0	1 (-27 to 31)	0
Kidney (Renal Cell)									
Age	*consumer behavior*	2930 (864 to 5040)		581 (-364 to 1540)		1180 (526 to 1810)		428 (28 to 805)	
	+industry response	5240 (3110 to 7390)		1230 (244 to 2210)		1590 (941 to 2250)		651 (248 to 1030)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	338 (-137 to 844)	1040 (-536 to 2790)	-42 (-332 to 273)	53 (-791 to 884)	172 (34 to 339)	677 (88 to 1240)	147 (18 to 280)	192 (-170 to 536)
	+industry response	646 (173 to 1180)	2020 (410 to 3750)	58 (-236 to 383)	379 (-452 to 1250)	251 (109 to 420)	898 (326 to 1470)	199 (72 to 335)	320 (-35 to 661)
Non-Hispanic Black	*consumer behavior*	170 (-35 to 384)	88 (-454 to 620)	60 (-5 to 128)	136 (-96 to 410)	79 (26 to 139)	85 (-81 to 258)	13 (-12 to 40)	44 (9 to 79)
	+industry response	280 (69 to 502)	343 (-202 to 898)	87 (22 to 157)	203 (-30 to 475)	97 (43 to 157)	119 (-45 to 295)	21 (-4 to 48)	56 (22 to 90)
Hispanic	*consumer behavior*	267 (21 to 527)	895 (-21 to 1920)	92 (-4 to 184)	230 (-25 to 503)	14 (-27 to 60)	94 (8 to 196)	15 (-6 to 36)	9 (-29 to 50)
	+industry response	425 (166 to 697)	1290 (371 to 2320)	123 (27 to 218)	305 (49 to 570)	29 (-12 to 76)	127 (41 to 232)	22 (2 to 44)	21 (-17 to 63)
Other	*consumer behavior*	5 (-47 to 66)	75 (-103 to 274)	34 (12 to 59)	3 (-64 to 77)	13 (2 to 25)	33 (10 to 58)	-1 (-6 to 4)	8 (-18 to 37)
	+industry response	27 (-26 to 89)	147 (-29 to 347)	38 (17 to 64)	17 (-52 to 91)	16 (5 to 28)	41 (19 to 67)	1 (-4 to 6)	11 (-15 to 40)
Liver									
Age	*consumer behavior*	3210 (1000 to 5540)		701 (-200 to 1760)		1000 (477 to 1580)		275 (17 to 551)	
	+industry response	5560 (3130 to 8130)		1340 (397 to 2480)		1340 (804 to 1950)		432 (174 to 719)	
Race/Ethnicity									

Non-Hispanic White	*consumer behavior*	170 (-125 to 597)	1150 (-258 to 3130)	18 (-168 to 236)	-82 (-844 to 807)	113 (36 to 227)	520 (108 to 1020)	75 (6 to 155)	116 (-110 to 365)
	+industry response	367 (53 to 855)	2120 (498 to 4300)	78 (-105 to 319)	215 (-537 to 1150)	159 (77 to 280)	668 (287 to 1220)	100 (35 to 189)	198 (-26 to 454)
Non-Hispanic Black	*consumer behavior*	143 (-27 to 346)	85 (-678 to 1050)	53 (2 to 120)	213 (-146 to 705)	51 (14 to 100)	118 (-112 to 393)	7 (-7 to 26)	37 (-4 to 88)
	+industry response	231 (53 to 458)	429 (-312 to 1460)	74 (24 to 147)	306 (-41 to 823)	63 (28 to 115)	163 (-58 to 447)	12 (-2 to 32)	52 (11 to 107)
Hispanic	*consumer behavior*	239 (19 to 570)	1150 (93 to 2490)	99 (3 to 215)	321 (15 to 703)	14 (-30 to 72)	113 (19 to 233)	17 (-5 to 41)	8 (-33 to 54)
	+industry response	384 (132 to 756)	1600 (529 to 3050)	132 (36 to 257)	409 (106 to 820)	31 (-13 to 90)	150 (55 to 276)	25 (3 to 50)	20 (-19 to 70)
Other	*consumer behavior*	2 (-56 to 82)	99 (-125 to 379)	38 (9 to 77)	-1 (-101 to 125)	15 (0 to 34)	38 (5 to 76)	0 (-8 to 7)	9 (-28 to 53)
	+industry response	26 (-32 to 108)	183 (-31 to 483)	43 (15 to 85)	18 (-80 to 152)	19 (5 to 40)	48 (17 to 91)	2 (-5 to 10)	14 (-23 to 59)
Pancreatic									
Age	*consumer behavior*	764 (262 to 1340)		81.6 (-186 to 388)		404 (193 to 651)		148 (21 to 286)	
	+industry response	1350 (820 to 1990)		269 (4 to 595)		540 (327 to 793)		227 (96 to 370)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	121 (-44 to 367)	247 (-120 to 768)	-48 (-159 to 87)	-16 (-246 to 245)	87 (26 to 175)	218 (48 to 432)	63 (3 to 131)	58 (-54 to 189)
	+industry response	229 (50 to 493)	490 (99 to 1060)	-11 (-124 to 134)	73 (-154 to 363)	122 (56 to 218)	283 (115 to 507)	87 (27 to 163)	98 (-12 to 238)
Non-Hispanic Black	*consumer behavior*	60 (-10 to 158)	18 (-80 to 128)	24 (-1 to 54)	30 (-20 to 87)	32 (9 to 63)	19 (-16 to 62)	5 (-6 to 19)	10 (2 to 19)
	+industry response	98 (21 to 207)	64 (-36 to 184)	34 (9 to 67)	44 (-4 to 102)	39 (17 to 72)	27 (-9 to 70)	9 (-2 to 23)	13 (5 to 23)
Hispanic	*consumer behavior*	68 (5 to 150)	194 (13 to 422)	26 (-4 to 60)	46 (-5 to 105)	4 (-11 to 22)	18 (-3 to 44)	6 (-2 to 14)	2 (-8 to 12)
	+industry response	108 (40 to 201)	273 (92 to 518)	36 (7 to 70)	63 (11 to 124)	10 (-5 to 28)	26 (6 to 53)	8 (0 to 18)	5 (-5 to 15)
Other	*consumer behavior*	-2 (-27 to 30)	18 (-29 to 72)	17 (4 to 33)	0 (-20 to 23)	8 (1 to 16)	10 (3 to 19)	0 (-4 to 3)	2 (-6 to 13)
	+industry response	9 (-17 to 43)	36 (-9 to 94)	19 (7 to 36)	4 (-16 to 28)	10 (3 to 18)	13 (5 to 22)	1 (-3 to 5)	4 (-5 to 14)

Esophageal Adenocarcinoma									
Age	*consumer behavior*	715 (43 to 1480)		92 (-296 to 501)		419 (136 to 719)		128 (-60 to 309)	
	+industry response	1300 (602 to 2100)		293 (-102 to 708)		556 (270 to 858)		206 (20 to 390)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	45 (-25 to 125)	406 (-228 to 1100)	-9 (-55 to 41)	26 (-368 to 419)	30 (7 to 58)	345 (64 to 630)	27 (5 to 50)	92 (-88 to 263)
	+industry response	91 (17 to 179)	815 (174 to 1560)	7 (-40 to 60)	179 (-210 to 578)	43 (20 to 73)	449 (174 to 739)	35 (14 to 59)	155 (-17 to 330)
Non-Hispanic Black	*consumer behavior*	10 (-2 to 22)	10 (-28 to 50)	3 (-1 to 8)	11 (-7 to 32)	5 (2 to 9)	67 (-7 to 22)	1 (-1 to 3)	4 (0 to 7)
	+industry response	16 (4 to 29)	28 (-11 to 69)	5 (1 to 9)	16 (-2 to 37)	6 (3 to 11)	9 (-4 to 25)	1 (0 to 3)	5 (2 to 8)
Hispanic	*consumer behavior*	28 (2 to 57)	196 (-2 to 414)	9 (-1 to 20)	46 (-7 to 112)	2 (-3 to 8)	24 (3 to 47)	2 (-1 to 4)	2 (-7 to 12)
	+industry response	44 (17 to 76)	280 (80 to 504)	13 (2 to 24)	63 (7 to 130)	3 (-1 to 10)	32 (11 to 56)	3 (0 to 5)	4 (-4 to 15)
Other	*consumer behavior*	-1 (-10 to 11)	10 (-16 to 41)	6 (1 to 11)	0 (-12 to 13)	2 (0 to 5)	7 (2 to 12)	0 (-1 to 1)	2 (-4 to 8)
	+industry response	3 (-6 to 15)	21 (-6 to 52)	75 (2 to 12)	2 (-10 to 15)	3 (1 to 6)	8 (4 to 13)	0 (-1 to 1)	2 (-3 to 9)
Colorectal									
Age	*consumer behavior*	584 (183 to 1090)		79 (-90 to 289)		251 (126 to 412)		117 (19 to 224)	
	+industry response	1050 (605 to 1610)		201 (23 to 426)		341 (209 to 514)		175 (81 to 289)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	67 (-51 to 261)	169 (-107 to 569)	-35 (-106 to 64)	-17 (-151 to 163)	52 (11 to 111)	126 (21 to 262)	55 (11 to 115)	44 (-36 to 129)
	+industry response	144 (-2 to 382)	358 (40 to 790)	-12 (-80 to 97)	38 (-99 to 233)	75 (30 to 146)	168 (62 to 313)	73 (28 to 138)	70 (-7 to 162)
Non-Hispanic Black	*consumer behavior*	31 (-9 to 88)	38 (-48 to 144)	11 (-1 to 29)	26 (-13 to 79)	19 (7 to 36)	14 (-17 to 49)	3 (-4 to 12)	8 (1 to 17)
	+industry response	53 (9 to 119)	78 (-8 to 203)	17 (4 to 36)	36 (-2 to 91)	23 (11 to 41)	20 (-9 to 56)	6 (-1 to 15)	11 (3 to 21)
Hispanic	*consumer behavior*	45 (2 to 113)	185 (25 to 409)	20 (1 to 43)	57 (9 to 114)	3 (-7 to 16)	21 (2 to 44)	4 (-1 to 11)	1 (-8 to 11)

		+industry response	73 (18 to 155)	256 (84 to 504)	26 (8 to 51)	70 (23 to 129)	6 (-3 to 20)	28 (10 to 53)	6 (1 to 13)	4 (-5 to 14)
	Other	consumer behavior	-2 (-21 to 26)	20 (-31 to 89)	7 (-1 to 19)	1 (-20 to 26)	4 (0 to 11)	8 (1 to 16)	-1 (-3 to 2)	3 (-6 to 13)
		+industry response	6 (-13 to 36)	41 (-9 to 115)	9 (1 to 21)	5 (-15 to 31)	6 (1 to 12)	10 (4 to 19)	0 (-2 to 3)	4 (-5 to 14)
Thyroid										
Age		consumer behavior	374 (114 to 751)		10 (-69 to 125)		84 (44 to 144)		34 (7 to 68)	
		+industry response	683 (349 to 1130)		67 (-17 to 200)		117 (70 to 187)		52 (22 to 91)	
Race/Ethnicity										
	Non-Hispanic White	consumer behavior	96 (-59 to 382)	52 (-59 to 273)	-28 (-85 to 56)	-15 (-64 to 58)	21 (1 to 62)	28 (1 to 73)	20 (2 to 47)	8 (-9 to 31)
		+industry response	205 (-15 to 563)	131 (-26 to 395)	-8 (-63 to 92)	3 (-43 to 85)	33 (5 to 80)	40 (12 to 90)	28 (9 to 58)	14 (-3 to 40)
	Non-Hispanic Black	consumer behavior	29 (-10 to 113)	7 (-10 to 36)	8 (-1 to 24)	3 (-3 to 12)	12 (6 to 22)	2 (-2 to 8)	1 (-2 to 5)	1 (0 to 2)
		+industry response	52 (-1 to 153)	16 (-4 to 50)	12 (2 to 30)	5 (-1 to 15)	14 (8 to 26)	3 (-1 to 10)	2 (0 to 7)	2 (1 to 3)
	Hispanic	consumer behavior	68 (1 to 201)	59 (6 to 151)	15 (-5 to 39)	13 (2 to 30)	2 (-4 to 12)	4 (0 to 9)	2 (-1 to 6)	0 (-1 to 3)
		+industry response	113 (22 to 276)	84 (26 to 189)	21 (2 to 48)	16 (6 to 35)	4 (-2 to 15)	5 (2 to 12)	3 (0 to 8)	1 (-1 to 3)
	Other	consumer behavior	-4 (-38 to 59)	13 (-13 to 56)	6 (-4 to 20)	1 (-7 to 12)	5 (2 to 10)	5 (3 to 8)	-1 (-2 to 1)	0 (-2 to 3)
		+industry response	12 (-25 to 82)	23 (-2 to 70)	8 (-1 to 23)	3 (-5 to 14)	6 (3 to 11)	6 (4 to 9)	0 (-2 to 2)	1 (-1 to 4)
Multiple Myeloma										
Age		consumer behavior	370 (113 to 743)		78 (-46 to 242)		181 (85 to 308)		63 (7 to 128)	
		+industry response	653 (327 to 1120)		164 (29 to 357)		243 (142 to 385)		97 (41 to 169)	
Race/Ethnicity										
	Non-Hispanic White	consumer behavior	27 (-34 to 138)	102 (-61 to 375)	-14 (-50 to 50)	-4 (-96 to 139)	24 (3 to 67)	96 (25 to 204)	20 (1 to 52)	23 (-23 to 83)
		+industry response	64 (-22 to 204)	207 (0 to 544)	-1 (-38 to 74)	29 (-60 to 199)	36 (9 to 87)	125 (52 to 246)	28 (8 to 65)	39 (-5 to 111)

Non-Hispanic Black	*consumer behavior*	39 (-9 to 135)	22 (-63 to 178)	14 (-1 to 43)	27 (-15 to 95)	19 (4 to 45)	11 (-22 to 60)	4 (-4 to 17)	10 (2 to 22)
	+industry response	66 (1 to 183)	65 (-30 to 242)	22 (4 to 55)	38 (-3 to 113)	24 (9 to 54)	18 (-13 to 71)	6 (-1 to 20)	13 (5 to 26)
Hispanic	*consumer behavior*	26 (0 to 79)	111 (12 to 277)	7 (-5 to 24)	25 (-3 to 68)	2 (-4 to 11)	15 (3 to 32)	2 (-1 to 7)	0 (-5 to 7)
	+industry response	43 (6 to 110)	154 (50 to 340)	10 (0 to 30)	33 (6 to 82)	4 (-2 to 15)	19 (8 to 39)	3 (0 to 9)	1 (-3 to 9)
Other	*consumer behavior*	0 (-7 to 11)	8 (-11 to 41)	7 (3 to 12)	0 (-10 to 12)	1 (1 to 4)	4 (1 to 9)	-0 (-1 to 1)	1 (-3 to 6)
	+industry response	2 (-4 to 16)	16 (-3 to 53)	8 (4 to 13)	1 (-8 to 15)	2 (0 to 5)	5 (2 to 11)	0 (-1 to 1)	1 (-2 to 6)
Stomach (Gastric Cardia)									
Age	*consumer behavior*	338 (49 to 803)		58 (-99 to 264)		182 (70 to 347)		54 (-19 to 149)	
	+industry response	607 (241 to 1140)		141 (-20 to 378)		240 (129 to 420)		86 (15 to 190)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	18 (-19 to 77)	208 (-55 to 648)	-9 (-31 to 25)	24 (-128 to 233)	15 (4 to 37)	145 (35 to 304)	14 (3 to 28)	34 (-36 to 124)
	+industry response	43 (-6 to 117)	380 (51 to 886)	-1 (-24 to 38)	86 (-67 to 322)	22 (9 to 47)	187 (77 to 364)	18 (8 to 35)	58 (-9 to 160)
Non-Hispanic Black	*consumer behavior*	7 (-2 to 21)	6 (-19 to 44)	2 (0 to 6)	7 (-5 to 24)	3 (1 to 7)	3 (-6 to 15)	0 (0 to 2)	3 (1 to 5)
	+industry response	12 (2 to 28)	19 (-8 to 62)	3 (1 to 7)	10 (-2 to 29)	4 (2 to 8)	5 (-4 to 17)	1 (0 to 2)	3 (2 to 6)
Hispanic	*consumer behavior*	15 (1 to 39)	63 (-7 to 170)	5 (0 to 13)	16 (-4 to 45)	1 (-2 to 5)	7 (0 to 18)	1 (0 to 3)	1 (-3 to 5)
	+industry response	24 (6 to 52)	95 (21 to 214)	7 (2 to 16)	22 (3 to 54)	2 (-1 to 6)	10 (3 to 23)	1 (0 to 3)	2 (-2 to 7)
Other	*consumer behavior*	-1 (-7 to 10)	5 (-14 to 34)	5 (2 to 9)	0 (-8 to 12)	1 (0 to 3)	4 (1 to 9)	0 (-1 to 1)	1 (-3 to 6)
	+industry response	2 (-5 to 14)	12 (-7 to 46)	6 (3 to 10)	2 (-6 to 15)	2 (0 to 4)	5 (2 to 10)	0 (-1 to 1)	2 (-2 to 7)
Gallbladder									
Age	*consumer behavior*	161 (67 to 263)		51 (8 to 100)		76 (47 to 109)		29 (11 to 51)	
	+industry response	282 (181 to 396)		86 (43 to 138)		101 (73 to 137)		44 (25 to 66)	

Race/Ethnicity										
	Non-Hispanic White	*consumer behavior*	24 (-10 to 71)	19 (-13 to 61)	0 (-25 to 30)	1.97 (-17 to 24)	19 (5 to 38)	23 (6 to 42)	16 (3 to 31)	6 (-5 to 17)
		+industry response	47 (10 to 99)	39 (5 to 88)	9 (-16 to 42)	9 (-10 to 34)	27 (12 to 48)	29 (13 to 50)	21 (8 to 37)	9 (-1 to 21)
	Non-Hispanic Black	*consumer behavior*	27 (-6 to 70)	2 (-17 to 26)	11 (0 to 24)	6 (-4 to 18)	14 (4 to 26)	4 (-4 to 12)	2 (-2 to 7)	2 (0 to 4)
		+industry response	45 (11 to 93)	11 (-8 to 38)	15 (4 to 29)	9 (-1 to 21)	17 (8 to 30)	5 (-2 to 14)	4 (-1 to 9)	3 (1 to 5)
	Hispanic	*consumer behavior*	32 (2 to 73)	42 (-10 to 106)	10 (-4 to 26)	14 (-2 to 34)	3 (-5 to 11)	7 (1 to 15)	3 (-1 to 7)	0 (-3 to 4)
		+industry response	53 (19 to 96)	65 (11 to 130)	15 (1 to 31)	19 (3 to 39)	5 (-2 to 14)	9 (3 to 18)	4 (1 to 9)	1 (-2 to 5)
	Other	*consumer behavior*	0 (-11 to 18)	3 (-6 to 15)	6 (1 to 13)	0 (-4 to 5)	3 (0 to 7)	3 (1 to 5)	0 (-1 to 1)	1 (-1 to 3)
		+industry response	5 (-7 to 24)	7 (-2 to 19)	7 (2 to 14)	1 (-3 to 6)	4 (1 to 8)	3 (1 to 5)	0 (-1 to 2)	1 (-1 to 3)
Advanced Prostate										
Age		*consumer behavior*	163 (9 to 360)		37 (-54 to 146)		106 (33 to 194)		35 (-14 to 91)	
		+industry response	300 (130 to 507)		85 (-6 to 203)		142 (67 to 240)		56 (9 to 119)	
Race/Ethnicity										
	Non-Hispanic White	*consumer behavior*	0	86 (-24 to 267)	0	-1 (-80 to 98)	0	75 (9 to 162)	0	24 (-23 to 80)
		+industry response	0	162 (32 to 350)	0	30 (-48 to 144)	0	100 (36 to 199)	0	40 (-5 to 102)
	Non-Hispanic Black	*consumer behavior*	0	3 (-61 to 97)	0	21 (-17 to 69)	0	16 (-13 to 51)	0	8 (2 to 17)
		+industry response	0	34 (-33 to 145)	0	31 (-5 to 83)	0	22 (-7 to 57)	0	11 (4 to 20)
	Hispanic	*consumer behavior*	0	59 (8 to 133)	0	13 (-3 to 37)	0	9 (2 to 20)	0	1 (-3 to 5)
		+industry response	0	82 (28 to 163)	0	18 (1 to 44)	0	12 (5 to 23)	0	2 (-2 to 7)
	Other	*consumer behavior*	0	3 (-10 to 21)	0	0 (-7 to 8)	0	4 (2 to 8)	0	1 (-3 to 5)
		+industry response	0	8 (-5 to 28)	0	1 (-5 to 9)	0	5 (3 to 9)	0	2 (-2 to 6)

Ovarian									
Age	*consumer behavior*	66 (-10 to 180)		16 (-20 to 75)		31 (11 to 69)		28 (11 to 61)	
	+industry response	129 (16 to 277)		33 (-6 to 102)		45 (17 to 87)		37 (19 to 75)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	34 (-25 to 147)	0	-4 (-38 to 54)	0	20 (2 to 55)	0	25 (8 to 57)	0
	+industry response	71 (-23 to 220)	0	7 (-30 to 72)	0	30 (6 to 71)	0	32 (15 to 70)	0
Non-Hispanic Black	*consumer behavior*	11 (-5 to 41)	0	4 (0 to 13)	0	6 (3 to 13)	0	1 (-1 to 5)	0
	+industry response	19 (-3 to 56)	0	6 (0 to 17)	0	8 (4 to 16)	0	2 (0 to 6)	0
Hispanic	*consumer behavior*	21 (-2 to 67)	0	8 (-1 to 21)	0	1 (-3 to 8)	0	1 (-1 to 5)	0
	+industry response	34 (1 to 91)	0	11 (3 to 26)	0	3 (-1 to 10)	0	2 (0 to 6)	0
Other	*consumer behavior*	-8 (-19 to 13)	0	6 (2 to 13)	0	2 (1 to 5)	0	0 (-1 to 1)	0
	+industry response	-3 (-15 to 21)	0	7 (3 to 14)	0	3 (1 to 6)	0	0 (-1 to 2)	0

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.

Supplementary Table 11. Estimated cancer deaths reduced by the federal menu calorie labeling in the US by age, sex, race/ethnicity, and cancer type, over a lifetime (U.S. population=235,162,844)[1]

Cancer Type	Policy Scenario	20-44 y		45-54 y		55-64 y		65 + y	
		Female	Male	Female	Male	Female	Male	Female	Male
Breast (Postmenopausal)									
Age	*consumer behavior*	2490 (260 to 4980)		151 (-204 to 521)		285 (129 to 479)		126 (30 to 227)	
	+industry response	4610 (2290 to 7240)		336 (-26 to 725)		396 (237 to 598)		178 (82 to 284)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	1350 (-652 to 3690)	0	-55 (-373 to 278)	0	165 (33 to 327)	0	103 (10 to 204)	0
	+industry response	2620 (480 to 5150)	0	54 (-264 to 419)	0	238 (105 to 401)	0	139 (47 to 244)	0
Non-Hispanic Black	*consumer behavior*	560 (-109 to 1280)	0	85 (-11 to 200)	0	95 (32 to 173)	0	13 (-12 to 40)	0
	+industry response	901 (238 to 1660)	0	126 (26 to 247)	0	117 (53 to 196)	0	21 (-4 to 49)	0
Hispanic	*consumer behavior*	572 (45 to 1180)	0	76 (-7 to 163)	0	9 (-21 to 44)	0	10 (-3 to 24)	0
	+industry response	922 (364 to 1570)	0	104 (21 to 193)	0	21 (-9 to 57)	0	15 (2 to 30)	0
Other	*consumer behavior*	0 (-306 to 378)	0	39 (9 to 76)	0	15 (2 to 31)	0	-1 (-6 to 3)	0
	+industry response	125 (-185 to 532)	0	45 (16 to 84)	0	19 (6 to 35)	0	0 (-5 to 5)	0
Liver									
Age	*consumer behavior*	2840 (897 to 4890)		628 (-181 to 1570)		852 (411 to 1340)		227 (18 to 455)	
	+industry response	4900 (2760 to 7190)		1200 (345 to 2210)		1140 (689 to 1650)		357 (146 to 587)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	139 (-108 to 504)	1040 (-237 to 2780)	15 (-147 to 207)	-70 (-749 to 722)	98 (31 to 196)	440 (93 to 858)	63 (6 to 130)	97 (-88 to 297)
	+industry response	310 (42 to 719)	1900 (449 to 3830)	67 (-93 to 276)	199 (-478 to 1040)	137 (67 to 240)	565 (241 to 1020)	85 (30 to 159)	161 (-18 to 369)

Non-Hispanic Black	*consumer behavior*	134 (-25 to 317)	72 (-601 to 932)	49 (3 to 110)	193 (-133 to 632)	43 (12 to 85)	100 (-95 to 336)	6 (-6 to 22)	29 (-4 to 69)
	+industry response	214 (51 to 425)	382 (-273 to 1280)	68 (23 to 133)	276 (-37 to 729)	54 (24 to 97)	139 (-49 to 377)	10 (-2 to 27)	41 (8 to 83)
Hispanic	*consumer behavior*	199 (17 to 473)	1020 (88 to 2210)	87 (2 to 189)	285 (13 to 630)	12 (-26 to 62)	99 (18 to 201)	15 (-4 to 35)	6 (-28 to 46)
	+industry response	316 (111 to 623)	1430 (482 to 2690)	116 (31 to 223)	365 (94 to 729)	26 (-11 to 78)	131 (48 to 242)	21 (3 to 43)	17 (-15 to 59)
Other	*consumer behavior*	2 (-47 to 68)	90 (-110 to 339)	32 (7 to 65)	-2 (-88 to 108)	12 (0 to 28)	30 (4 to 61)	0 (-6 to 6)	7 (-22 to 42)
	+industry response	22 (-28 to 93)	168 (-26 to 434)	36 (13 to 71)	15 (-70 to 130)	16 (4 to 32)	39 (14 to 74)	1 (-4 to 8)	11 (-18 to 46)
Endometrial									
Age	*consumer behavior*	1190 (309 to 2140)		251 (-248 to 785)		394 (177 to 659)		213 (51 to 378)	
	+industry response	2100 (1200 to 3110)		512 (26 to 1060)		548 (325 to 817)		302 (139 to 472)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	440 (-210 to 1170)	0	-42 (-511 to 440)	0	206 (36 to 399)	0	173 (13 to 319)	0
	+industry response	858 (218 to 1620)	0	114 (-351 to 606)	0	298 (127 to 491)	0	234 (76 to 388)	0
Non-Hispanic Black	*consumer behavior*	412 (-90 to 937)	0	139 (-9 to 293)	0	157 (42 to 295)	0	26 (-24 to 83)	0
	+industry response	666 (177 to 1210)	0	201 (51 to 361)	0	195 (81 to 338)	0	42 (-8 to 97)	0
Hispanic	*consumer behavior*	315 (22 to 645)	0	105 (-22 to 222)	0	16 (-33 to 70)	0	19 (-7 to 44)	0
	+industry response	505 (197 to 854)	0	144 (21 to 261)	0	34 (-14 to 89)	0	28 (3 to 54)	0
Other	*consumer behavior*	8 (-99 to 139)	0	51 (13 to 99)	0	17 (1 to 36)	0	-3 (-10 to 5)	0
	+industry response	50 (-56 to 187)	0	58 (21 to 107)	0	22 (6 to 41)	0	0 (-8 to 7)	0
Kidney (Renal Cell)									
Age	*consumer behavior*	1050 (284 to 1830)		263 (-153 to 695)		506 (225 to 778)		182 (20 to 338)	
	+industry response	1880 (1100 to 2680)		539 (106 to 977)		679 (402 to 954)		276 (112 to 429)	
Race/Ethnicity									

Non-Hispanic White	*consumer behavior*	57 (-23 to 159)	332 (-183 to 922)	-16 (-128 to 106)	26 (-351 to 396)	72 (14 to 138)	287 (42 to 525)	66 (9 to 124)	81 (-68 to 219)
	+industry response	111 (27 to 224)	663 (123 to 1280)	22 (-90 to 146)	168 (-199 to 552)	105 (46 to 171)	378 (138 to 623)	89 (33 to 148)	133 (-12 to 272)
Non-Hispanic Black	*consumer behavior*	67 (-16 to 162)	48 (-225 to 326)	24 (-2 to 53)	59 (-40 to 171)	30 (10 to 56)	35 (-32 to 106)	5 (-5 to 16)	16 (3 to 28)
	+industry response	113 (25 to 218)	174 (-96 to 461)	34 (9 to 64)	87 (-14 to 199)	37 (17 to 63)	49 (-17 to 121)	8 (-2 to 20)	20 (7 to 33)
Hispanic	*consumer behavior*	111 (9 to 229)	367 (0 to 792)	30 (-3 to 62)	118 (-15 to 261)	6 (-13 to 29)	47 (5 to 98)	7 (-2 to 17)	4 (-12 to 23)
	+industry response	177 (67 to 305)	522 (168 to 968)	40 (8 to 74)	157 (23 to 303)	13 (-5 to 36)	64 (22 to 116)	11 (1 to 21)	9 (-7 to 28)
Other	*consumer behavior*	3 (-23 to 34)	33 (-40 to 122)	15 (5 to 28)	0 (-28 to 33)	5 (1 to 11)	16 (5 to 29)	-1 (-3 to 2)	4 (-8 to 17)
	+industry response	13 (-12 to 45)	63 (-10 to 156)	17 (7 to 30)	6 (-22 to 39)	6 (2 to 12)	20 (9 to 33)	0 (-2 to 3)	5 (-6 to 18)
Pancreatic									
Age	*consumer behavior*	656 (220 to 1160)		74 (-166 to 350)		362 (175 to 581)		131 (20 to 250)	
	+industry response	1160 (707 to 1730)		243 (1 to 535)		483 (293 to 708)		199 (87 to 321)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	101 (-40 to 310)	213 (-100 to 659)	-44 (-143 to 78)	-13 (-216 to 221)	79 (24 to 158)	193 (44 to 384)	56 (3 to 117)	50 (-45 to 162)
	+industry response	196 (42 to 425)	420 (85 to 911)	-10 (-111 to 120)	67 (-140 to 326)	111 (51 to 198)	250 (102 to 448)	78 (25 to 146)	84 (-10 to 203)
Non-Hispanic Black	*consumer behavior*	48 (-7 to 125)	16 (-72 to 117)	22 (-1 to 49)	27 (-18 to 78)	29 (8 to 57)	18 (-15 to 56)	5 (-5 to 17)	9 (1 to 17)
	+industry response	78 (18 to 162)	57 (-33 to 164)	31 (9 to 62)	39 (-3 to 91)	36 (15 to 65)	24 (-8 to 63)	8 (-1 to 20)	12 (4 to 19)
Hispanic	*consumer behavior*	55 (5 to 118)	175 (13 to 374)	24 (-4 to 53)	42 (-5 to 97)	4 (-10 to 20)	16 (-2 to 40)	5 (-2 to 13)	1 (-7 to 10)
	+industry response	88 (33 to 158)	245 (83 to 462)	32 (6 to 63)	57 (10 to 113)	9 (-5 to 25)	23 (5 to 48)	8 (1 to 16)	4 (-4 to 13)
Other	*consumer behavior*	-2 (-23 to 25)	16 (-23 to 63)	14 (3 to 27)	0 (-18 to 20)	7 (1 to 14)	9 (3 to 17)	0 (-3 to 3)	2 (-5 to 11)
	+industry response	7 (-14 to 36)	32 (-7 to 82)	16 (6 to 30)	3 (-14 to 24)	9 (2 to 16)	11 (5 to 19)	1 (-2 to 4)	3 (-4 to 12)

Esophageal Adenocarcinoma									
Age	*consumer behavior*	631 (33 to 1320)		78 (-255 to 423)		348 (113 to 584)		101 (-42 to 239)	
	+industry response	1150 (520 to 1870)		246 (-96 to 601)		457 (225 to 699)		161 (19 to 302)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	40 (-23 to 112)	366 (-206 to 1000)	-8 (-47 to 36)	24 (-314 to 359)	24 (6 to 47)	283 (55 to 516)	22 (4 to 41)	71 (-65 to 202)
	+industry response	81 (15 to 160)	732 (157 to 1400)	5 (-34 to 51)	152 (-176 to 495)	35 (16 to 59)	366 (142 to 602)	28 (11 to 48)	119 (-13 to 253)
Non-Hispanic Black	*consumer behavior*	9 (-1 to 20)	9 (-25 to 45)	3 (0 to 7)	10 (-6 to 28)	4 (1 to 8)	6 (-6 to 18)	1 (-1 to 2)	3 (0 to 5)
	+industry response	14 (3 to 26)	25 (-10 to 62)	4 (1 to 8)	14 (-2 to 33)	5 (2 to 9)	8 (-3 to 21)	1 (0 to 3)	4 (1 to 6)
Hispanic	*consumer behavior*	25 (2 to 52)	164 (2 to 354)	3 (-1 to 13)	40 (-7 to 99)	1 (-3 to 7)	21 (3 to 42)	1 (-1 to 4)	1 (-6 to 10)
	+industry response	40 (15 to 68)	235 (70 to 425)	5 (0 to 16)	55 (6 to 114)	3 (-1 to 8)	28 (10 to 50)	2 (0 to 4)	4 (-4 to 12)
Other	*consumer behavior*	-1 (-9 to 10)	9 (-14 to 35)	5 (1 to 9)	-1 (-10 to 10)	2 (0 to 4)	6 (2 to 10)	0 (-1 to 1)	1 (-3 to 7)
	+industry response	3 (-6 to 14)	18 (-5 to 46)	6 (2 to 10)	1 (-8 to 12)	2 (1 to 5)	7 (3 to 11)	0 (-1 to 1)	2 (-3 to 7)
Colorectal									
Age	*consumer behavior*	430 (139 to 779)		56 (-48 to 184)		150 (77 to 241)		63 (13 to 119)	
	+industry response	764 (450 to 1160)		133 (23 to 268)		203 (126 to 304)		95 (46 to 153)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	49 (-36 to 181)	119 (-75 to 391)	-21 (-65 to 40)	-10 (-89 to 97)	32 (7 to 67)	72 (11 to 150)	31 (6 to 63)	22 (-17 to 64)
	+industry response	106 (4 to 261)	248 (28 to 545)	-6 (-49 to 59)	24 (-60 to 140)	46 (20 to 85)	96 (36 to 176)	41 (16 to 76)	35 (-3 to 81)
Non-Hispanic Black	*consumer behavior*	26 (-7 to 70)	27 (-36 to 104)	8 (0 to 21)	18 (-9 to 53)	13 (4 to 24)	9 (-10 to 31)	2 (-2 to 7)	5 (0 to 10)
	+industry response	44 (9 to 94)	58 (-7 to 145)	12 (4 to 26)	25.1 (-1 to 61)	15 (7 to 27)	13 (-6 to 36)	3 (-1 to 9)	6 (2 to 12)
Hispanic	*consumer behavior*	36 (2 to 88)	136 (21 to 300)	13 (0 to 27)	37 (5 to 74)	2 (-4 to 10)	13 (2 to 28)	2 (-1 to 7)	1 (-5 to 6)

	+industry response	58 (17 to 120)	188 (65 to 366)	16 (5 to 32)	45 (14 to 84)	4 (-2 to 13)	18 (6 to 33)	4 (0 to 8)	2 (-3 to 8)
Other	*consumer behavior*	-1 (-15 to 20)	16 (-21 to 65)	5 (-1 to 11)	0 (-12 to 15)	2 (0 to 6)	5 (1 to 9)	0 (-2 to 1)	1 (-3 to 6)
	+industry response	5 (-9 to 27)	30 (-5 to 83)	6 (1 to 13)	2 (-9 to 17)	3 (1 to 7)	6 (2 to 11)	0 (-1 to 2)	2 (-2 to 7)
Stomach (Gastric Cardia)									
Age	*consumer behavior*	286 (45 to 672)		50 (-84 to 224)		149 (58 to 282)		42 (-14 to 113)	
	+industry response	513 (196 to 965)		120 (-14 to 321)		196 (105 to 342)		67 (13 to 145)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	14 (-16 to 63)	178 (-46 to 545)	-7 (-26 to 20)	21 (-109 to 194)	13 (4 to 30)	118 (29 to 248)	11 (3 to 22)	27 (-26 to 95)
	+industry response	34 (-5 to 95)	322 (43 to 766)	-1 (-19 to 30)	74 (-58 to 270)	18 (7 to 38)	152 (63 to 296)	14 (6 to 27)	45 (-6 to 121)
Non-Hispanic Black	*consumer behavior*	5 (-1 to 17)	2 (-11 to 29)	2 (0 to 5)	6 (-5 to 22)	2 (1 to 5)	3 (-5 to 13)	0 (0 to 1)	2 (1 to 4)
	+industry response	9 (2 to 22)	7 (-5 to 43)	2 (1 to 6)	9 (-2 to 26)	3 (2 to 6)	4 (-3 to 15)	1 (0 to 2)	3 (1 to 5)
Hispanic	*consumer behavior*	13 (1 to 35)	57 (-6 to 154)	5 (0 to 12)	14 (-3 to 38)	1 (-1 to 4)	6 (0 to 15)	1 (0 to 2)	0 (-2 to 4)
	+industry response	22 (5 to 47)	86 (20 to 194)	6 (2 to 14)	19 (3 to 46)	1 (-1 to 5)	8 (2 to 19)	1 (0 to 3)	1 (-1 to 6)
Other	*consumer behavior*	-1 (-5 to 7)	4 (-9 to 25)	4 (2 to 8)	0 (-7 to 10)	1 (0 to 3)	3 (1 to 7)	0 (-1 to 1)	1 (-2 to 5)
	+industry response	1 (-3 to 9)	9 (-4 to 34)	4 (2 to 8)	2 (-5 to 12)	1 (0 to 3)	4 (2 to 8)	0 (0 to 1)	1 (-2 to 5)
Multiple Myeloma									
Age	*consumer behavior*	220 (65 to 441)		51 (-29 to 150)		112 (54 to 186)		42 (6 to 84)	
	+industry response	380 (202 to 657)		105 (20 to 215)		151 (89 to 232)		63 (27 to 111)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	11 (-13 to 52)	59 (-34 to 221)	-8 (-32 to 31)	-3 (-59 to 83)	15 (2 to 41)	58 (15 to 123)	14 (1 to 35)	15 (-14 to 54)

	+industry response	26 (-7 to 81)	122 (1 to 321)	-1 (-23 to 45)	19 (-37 to 123)	22 (6 to 53)	75 (32 to 147)	19 (6 to 44)	26 (-3 to 71)
Non-Hispanic Black	*consumer behavior*	17 (-4 to 63)	14 (-40 to 115)	10 (0 to 29)	17 (-10 to 59)	12 (3 to 28)	7 (-14 to 38)	2 (-3 to 11)	6 (1 to 12)
	+industry response	29 (1 to 83)	44 (-20 to 159)	15 (3 to 37)	24 (-1 to 70)	15 (6 to 34)	11 (-8 to 45)	4 (-1 to 13)	7 (3 to 15)
Hispanic	*consumer behavior*	16 (0 to 51)	72 (9 to 193)	5 (-3 to 17)	15 (-2 to 42)	1 (-3 to 8)	10 (2 to 22)	2 (-1 to 5)	0 (-3 to 5)
	+industry response	28 (5 to 71)	100 (31 to 244)	7 (0 to 21)	21 (4 to 51)	3 (-1 to 10)	13 (5 to 26)	3 (0 to 6)	1 (-2 to 6)
Other	*consumer behavior*	0 (-3 to 6)	5 (-7 to 27)	4 (2 to 7)	0 (-6 to 7)	1 (0 to 2)	3 (1 to 6)	0 (-1 to 1)	1 (-2 to 4)
	+industry response	1 (-2 to 8)	10 (-2 to 36)	4 (2 to 8)	1 (-5 to 9)	1 (0 to 3)	4 (2 to 7)	0 (-1 to 1)	1 (-1 to 4)
Gallbladder									
Age	*consumer behavior*	136 (58 to 229)		44 (7 to 86)		65 (40 to 93)		24 (9 to 41)	
	+industry response	239 (153 to 341)		74 (36 to 119)		86 (61 to 117)		36 (20 to 53)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	22 (-10 to 64)	15 (-10 to 52)	0 (-23 to 27)	2 (-14 to 19)	16 (4 to 32)	19 (6 to 36)	13 (2 to 25)	5 (-4 to 14)
	+industry response	43 (9 to 90)	32 (4 to 72)	8 (-15 to 37)	8 (-8 to 27)	23 (10 to 40)	24 (11 to 42)	17 (6 to 30)	8 (-1 to 18)
Non-Hispanic Black	*consumer behavior*	24 (-5 to 61)	2 (-14 to 21)	10 (0 to 21)	4 (-3 to 14)	12 (4 to 23)	3 (-3 to 10)	2 (-2 to 6)	2 (0 to 3)
	+industry response	40 (10 to 80)	9 (-7 to 31)	14 (4 to 27)	6 (-1 to 17)	15 (7 to 26)	4 (-2 to 12)	3 (0 to 7)	2 (1 to 4)
Hispanic	*consumer behavior*	28 (2 to 63)	33 (-8 to 85)	9 (-4 to 23)	12 (-2 to 30)	2 (-4 to 10)	6 (1 to 13)	2 (-1 to 6)	0 (-2 to 3)
	+industry response	45 (16 to 83)	51 (9 to 106)	13 (1 to 28)	16 (3 to 35)	4 (-2 to 13)	8 (3 to 16)	4 (0 to 8)	1 (-1 to 4)
Other	*consumer behavior*	0 (-10 to 16)	2 (-5 to 12)	5 (1 to 11)	0 (-2 to 2)	3 (0 to 6)	2 (1 to 4)	0 (-1 to 1)	0 (-1 to 2)
	+industry response	4 (-6 to 21)	5 (-2 to 15)	6 (2 to 12)	0 (-1 to 3)	4 (1 to 7)	3 (1 to 5)	0 (-1 to 2)	1 (-1 to 2)
Advanced Prostate									
Age	*consumer behavior*	101 (13 to 214)		18 (-17 to 58)		33 (11 to 58)		15 (-4 to 38)	

	+industry response	174 (80 to 304)		37 (1 to 83)		43 (22 to 71)		24 (6 to 48)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	0	43 (-13 to 140)	0	0 (-29 to 35)	0	20 (3 to 42)	0	10 (-9 to 32)
	+industry response	0	82 (16 to 192)	0	11 (-17 to 50)	0	27 (10 to 51)	0	16 (-2 to 40)
Non-Hispanic Black	*consumer behavior*	0	2 (-31 to 51)	0	9 (-7 to 30)	0	7 (-5 to 20)	0	4 (1 to 9)
	+industry response	0	17 (-16 to 75)	0	13 (-2 to 36)	0	9 (-3 to 23)	0	6 (2 to 11)
Hispanic	*consumer behavior*	0	47 (7 to 103)	0	7 (-2 to 20)	0	4 (1 to 9)	0	0 (-1 to 3)
	+industry response	0	64 (23 to 127)	0	10 (1 to 25)	0	6 (2 to 11)	0	1 (-1 to 3)
Other	*consumer behavior*	0	1 (-4 to 12)	0	0 (-2 to 3)	0	1 (0 to 2)	0	0 (-1 to 2)
	+industry response	0	2 (-1 to 16)	0	0 (-2 to 3)	0	1 (1 to 2)	0	1 (-1 to 2)
Ovarian									
Age	*consumer behavior*	45 (-3 to 114)		13 (-14 to 54)		24 (9 to 51)		21 (8 to 46)	
	+industry response	87 (19 to 175)		25 (-4 to 75)		34 (14 to 64)		28 (15 to 56)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	21 (-15 to 89)	0	-3 (-29 to 38)	0	15 (2 to 41)	0	19 (6 to 43)	0
	+industry response	45 (-10 to 131)	0	5 (-21 to 52)	0	22 (5 to 51)	0	25 (11 to 52)	0
Non-Hispanic Black	*consumer behavior*	7 (-3 to 27)	0	3 (0 to 11)	0	5 (2 to 11)	0	1 (-1 to 4)	0
	+industry response	13 (-1 to 38)	0	5 (1 to 13)	0	7 (3 to 13)	0	1 (0 to 5)	0
Hispanic	*consumer behavior*	15 (0 to 48)	0	6 (-1 to 16)	0	1 (-2 to 6)	0	1 (-1 to 4)	0
	+industry response	25 (2 to 64)	0	8 (2 to 20)	0	2 (-1 to 8)	0	2 (0 to 5)	0
Other	*consumer behavior*	-5 (-13 to 9)	0	5 (1 to 10)	0	2 (0 to 4)	0	0 (-1 to 1)	0
	+industry response	-1 (-9 to 15)	0	5 (2 to 11)	0	2 (1 to 4)	0	0 (0 to 1)	0

Thyroid									
Age	*consumer behavior*	9 (2 to 22)		3 (-4 to 11)		6 (3 to 12)		4 (1 to 7)	
	+industry response	16 (7 to 33)		6 (0 to 16)		9 (5 to 15)		5 (3 to 9)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	0 (0 to 2)	0 (-1 to 5)	0 (-1 to 1)	-2 (-7 to 5)	0 (0 to 1)	3 (0 to 8)	1 (0 to 4)	1 (-1 to 3)
	+industry response	0 (0 to 3)	1 (0 to 9)	0 (-1 to 2)	0 (-5 to 9)	1 (0 to 2)	4 (1 to 10)	2 (1 to 4)	1 (0 to 4)
Non-Hispanic Black	*consumer behavior*	1 (0 to 5)	1 (-2 to 7)	0 (0 to 1)	0 (0 to 2)	1 (0 to 2)	0 (0 to 1)	0 (0 to 1)	0 (0 to 1)
	+industry response	2 (0 to 7)	2 (-1 to 10)	0 (0 to 2)	0 (0 to 2)	1 (0 to 2)	0 (0 to 1)	0 (0 to 1)	0 (0 to 1)
Hispanic	*consumer behavior*	3 (0 to 10)	1 (0 to 9)	1 (0 to 3)	2 (0 to 5)	0 (0 to 1)	1 (0 to 2)	0 (0 to 1)	0 (0 to 1)
	+industry response	5 (1 to 14)	2 (0 to 12)	1 (0 to 4)	2 (1 to 7)	0 (0 to 1)	1 (0 to 3)	1 (0 to 2)	0 (0 to 1)
Other	*consumer behavior*	0	0 (-1 to 3)	0 (0 to 1)	0 (-1 to 1)	0 (0 to 1)	0 (0 to 1)	0	0 (0 to 1)
	+industry response	0	0 (0 to 4)	0 (0 to 1)	0 (-1 to 2)	0 (0 to 1)	0 (0 to 1)	0	0 (0 to 1)

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.

Supplementary Table 12. Estimated health gains and costs associated with the federal menu calorie labeling on reducing cancer burdens in the US over a lifetime, one-way sensitivity analyses at 25% and 75% calorie compensation outside restaurant settings (US population=235,162,844)[1]

	Menu Calorie Labeling Policy			
	75% Compensation		25% Compensation	
	Consumer Behavior Median (2.5% to 97.5%)	Consumer Behavior + Industry Response Median (2.5% to 97.5%)	Consumer Behavior Median (2.5% to 97.5%)	Consumer Behavior + Industry Response Median (2.5% to 97.5%)
New Cancer Cases Averted, N (95% UI)				
Liver cancer	2550 (265 to 5030)	4280 (2000 to 6770)	7760 (5160 to 10500)	12800 (9790 to 16000)
Endometrial cancer	2490 (-633 to 5890)	4640 (1570 to 8070)	8890 (5500 to 12700)	15100 (11800 to 19100)
Kidney cancer	2360 (65 to 4510)	4160 (1900 to 6410)	7810 (5230 to 10000)	13000 (10400 to 15300)
Breast cancer (postmenopausal)	2060 (-616 to 5280)	3930 (1260 to 7200)	7640 (4560 to 11400)	13000 (9700 to 17200)
Pancreatic cancer	638 (51 to 1280)	1140 (536 to 1800)	2140 (1490 to 2890)	3590 (2840 to 4460)
Esophageal adenocarcinoma	598 (-239 to 1400)	1100 (262 to 1930)	2130 (1200 to 3000)	3560 (2600 to 4520)
Colorectal cancer	480 (56 to 940)	851 (423 to 1330)	1600 (1060 to 2140)	2660 (2030 to 3310)
Multiple myeloma	343 (61 to 674)	576 (281 to 950)	1050 (677 to 1480)	1730 (1240 to 2340)
Stomach cancer (cardia)	312 (-42 to 736)	533 (192 to 998)	994 (555 to 1530)	1640 (1060 to 2300)
Thyroid cancer	185 (-70 to 498)	406 (128 to 749)	851 (473 to 1310)	1470 (963 to 2100)
Gallbladder cancer	165 (70 to 274)	266 (167 to 378)	468 (348 to 602)	758 (626 to 912)
Advanced prostate cancer	162 (-28 to 360)	282 (87 to 493)	519 (304 to 768)	868 (603 to 1160)
Ovarian cancer	65 (-17 to 179)	119 (26 to 245)	228 (96 to 398)	384 (196 to 617)
Total	12700 (2430 to 24200)	22600 (12400 to 34100)	42800 (30400 to 53900)	71500 (59100 to 82800)
Cancer Deaths Prevented, N (95% UI)				
Liver cancer	2200 (199 to 4450)	3750 (1720 to 5970)	6790 (4490 to 9270)	11200 (8570 to 14100)
Breast cancer (postmenopausal)	1140 (-958 to 3640)	2420 (281 to 4990)	4980 (2540 to 7860)	8670 (6030 to 12000)
Endometrial cancer	980 (-69 to 2030)	1710 (675 to 2770)	3160 (2020 to 4450)	5270 (4120 to 6630)
Kidney cancer	939 (94 to 1820)	1630 (795 to 2520)	3020 (2080 to 3930)	4990 (4020 to 6020)
Pancreatic cancer	561 (54 to 1120)	996 (473 to 1590)	1870 (1300 to 2510)	3130 (2480 to 3890)
Esophageal adenocarcinoma	503 (-224 to 1190)	932 (203 to 1640)	1820 (1010 to 2580)	3050 (2220 to 3890)
Colorectal cancer	323 (41 to 640)	571 (280 to 910)	1080 (724 to 1440)	1800 (1390 to 2240)
Stomach cancer (cardia)	264 (-32 to 623)	446 (159 to 838)	824 (454 to 1280)	1360 (887 to 1910)
Multiple myeloma	213 (45 to 411)	350 (178 to 576)	635 (419 to 897)	1040 (757 to 1370)
Gallbladder cancer	141 (60 to 234)	226 (142 to 320)	398 (300 to 512)	644 (531 to 777)
Advanced prostate cancer	80 (-12 to 179)	135 (44 to 239)	246 (144 to 373)	410 (278 to 563)
Ovarian cancer	49 (-7 to 123)	87 (26 to 170)	162 (76 to 270)	272 (155 to 415)
Thyroid cancer	11 (1 to 24)	19 (8 to 33)	34 (21 to 53)	56 (39.9 to 81.8)
Total	7760 (1280 to 13900)	13600 (7160 to 20100)	25600 (17900 to 32300)	42500 (34600 to 49600)
Life Years Gained	34700 (5070 to 66300)	62200 (32500 to 93500)	118000 (82400 to 151000)	197000 (161000 to 232000)

QALYs Gained	51400 (9690 to 95700)	90500 (49300 to 135000)	171000 (119000 to 218000)	284000 (234000 to 334000)
Changes in Health-Related Costs, Cancer Only ($, millions)[2,3]				
Healthcare (medical) cost	-693 (-1250 to -138)	-1210 (-1770 to -660)	-2270 (-2850 to -1640)	-3760 (-4360 to -3140)
Patient time cost	-47.9 (-90.0 to -11.9)	-83.6 (-126 to -47.3)	-155 (-198 to -113)	-258 (-302 to -215)
Productivity loss	-279 (-527 to -56.6)	-490 (-743 to -271)	-929 (-1170 to -673)	-1550 (-1800 to -1290)
Policy Implementation Costs ($, millions)[2,3]				
Government cost	18.5 (14.5 to 25.1)	18.5 (14.4 to 25.5)	18.5 (14.5 to 25.1)	18.5 (14.4 to 25.5)
Administration	9.07 (8.61 to 9.56)	9.09 (8.62 to 9.55)	9.07 (8.61 to 9.56)	9.09 (8.62 to 9.55)
Monitoring	9.40 (5.45 to 16.1)	9.38 (5.30 to 16.3)	9.40 (5.45 to 16.1)	9.38 (5.30 to 16.3)
Industry cost	820 (762 to 889)	1120 (1040 to 1210)	820 (762 to 889)	1120 (1040 to 1210)
Compliance	820 (762 to 889)	823 (757 to 889)	820 (762 to 889)	823 (757 to 889)
Reformulation	-------	296 (249 to 353)	-------	296 (249 to 353)
Net Costs, Cancer Only ($, millions)[2,3,4]				
Societal perspective	-174 (-1032 to 639)	-653 (-1510 to 164)	-2520 (-3390 to -1590)	-4430 (-5310 to -3510)
Healthcare perspective	-674 (-1229 to -120)	-1190 (-1750 to -639)	-2250 (-2830 to -1620)	-3740 (-4350 to -3120)
ICER (dollars/QALY)[5]				
Societal perspective	Dominant	Dominant	Dominant	Dominant
Healthcare perspective	Dominant	Dominant	Dominant	Dominant

Abbreviations: ICER, Incremental Cost-Effectiveness Ratio; QALY, quality-adjusted life years.

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.
2. Health-related costs were inflated to 2015 US dollars using the Personal Health Care (PHC) index. Policy intervention costs were inflated to 2015 US dollars using the Consumer Price Index. Negative costs represent savings.
3. Costs are medians from 1000 simulations so may not add up to totals.
4. Net costs were calculated as policy costs minus health-related costs from reduced cancer burden. Societal perspective includes healthcare cost, patient time costs, productivity costs, and policy implementation costs; government perspective included policy costs relevant to policy implementation and program monitoring and evaluation and medical costs.
5. ICER threshold was evaluated at $150,000/QALY. Dominant represents less costly and more effective than the “no-policy intervention” scenario.

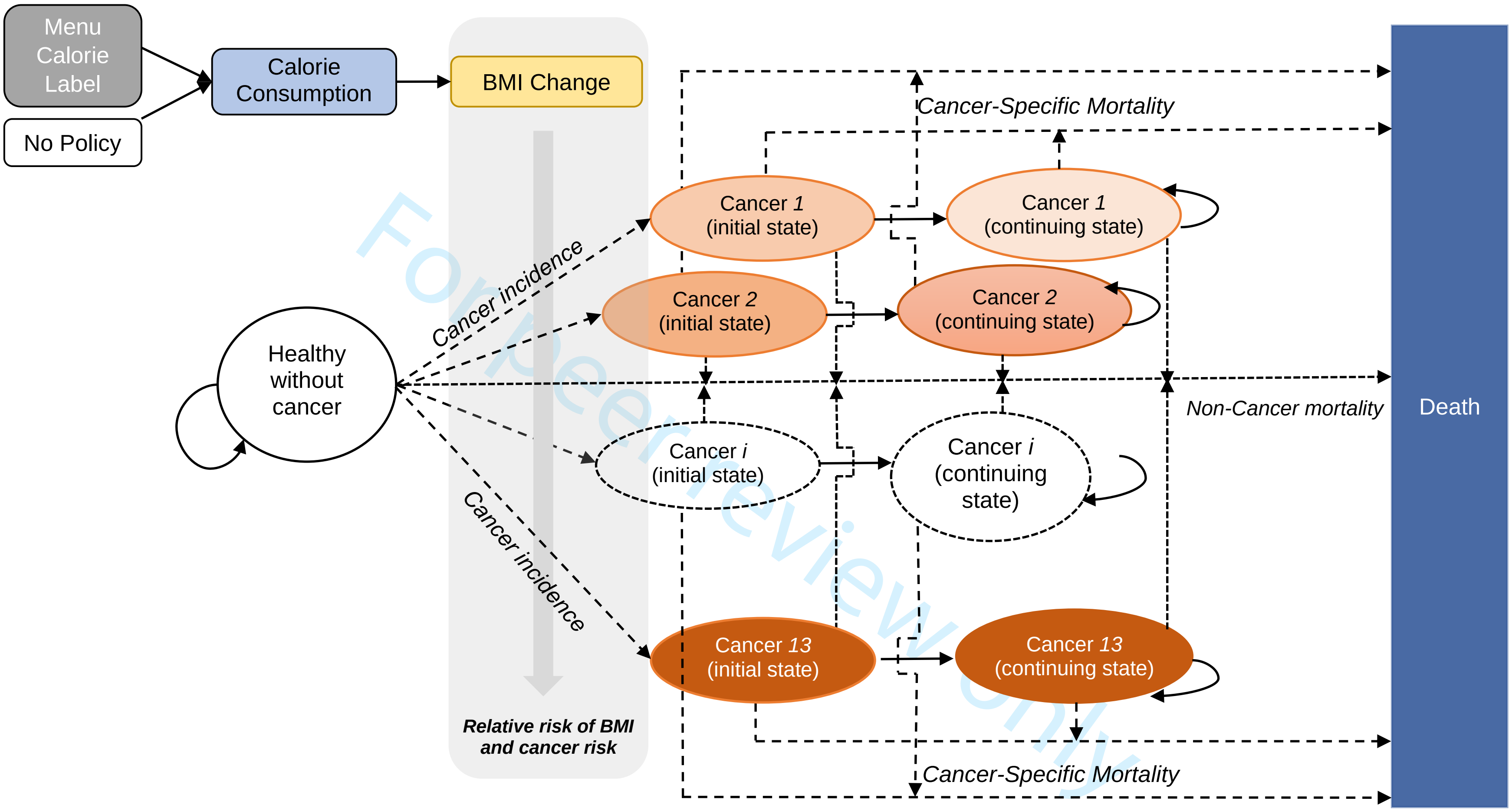
Supplementary Table 13. Estimated health gains and costs associated with the federal menu calorie labeling on reducing cancer burdens in the US over a lifetime, one-way sensitivity analysis, assuming all full-service and fast-food restaurants were covered by the policy (US population=235,162,844)[1]

	Menu Calorie Labeling Policy	
	Consumer Behavior Median (2.5% to 97.5%)	**Consumer Behavior + Industry Response** Median (2.5% to 97.5%)
New Cancer Cases Averted, N (95% UI)		
Liver cancer	7280 (4690 to 10100)	11400 (8480 to 14400)
Kidney cancer	6820 (4180 to 9460)	11100 (8470 to 13700)
Endometrial cancer	5340 (1540 to 9220)	10400 (6690 to 14300)
Breast cancer (postmenopausal)	4920 (1580 to 8420)	9380 (5960 to 13100)
Esophageal adenocarcinoma	2060 (1170 to 3060)	3260 (2310 to 4330)
Pancreatic cancer	1810 (1150 to 2600)	3000 (2290 to 3870)
Colorectal cancer	1320 (772 to 1910)	2200 (1600 to 2880)
Stomach cancer (cardia)	938 (531 to 1510)	1480 (985 to 2140)
Thyroid cancer	746 (430 to 1180)	1270 (850 to 1820)
Multiple myeloma	710 (377 to 1150)	1270 (879 to 1820)
Advanced prostate cancer	430 (208 to 681)	715 (461 to 1010)
Gallbladder cancer	329 (201 to 457)	568 (435 to 708)
Ovarian cancer	133 (20.9 to 292)	263 (109 to 468)
Total	32900 (20300 to 46000)	56400 (43700 to 69300)
Cancer Deaths Prevented, N (95% UI)		
Liver cancer	6460 (4170 to 8980)	10000 (7480 to 12800)
Breast cancer (postmenopausal)	3410 (701 to 6280)	6440 (3560 to 9750)
Kidney cancer	2620 (1610 to 3620)	4250 (3210 to 5300)
Endometrial cancer	1890 (654 to 3140)	3610 (2390 to 4900)
Esophageal adenocarcinoma	1800 (1030 to 2670)	2840 (2010 to 3750)
Pancreatic cancer	1580 (976 to 2250)	2620 (1990 to 3380)
Colorectal cancer	923 (560 to 1310)	1520 (1110 to 1970)
Stomach cancer (cardia)	785 (437 to 1270)	1240 (812 to 1790)
Multiple myeloma	431 (234 to 709)	762 (524 to 1100)
Gallbladder cancer	275 (170 to 385)	479 (366 to 601)
Advanced prostate cancer	219 (117 to 351)	353 (233 to 506)
Ovarian cancer	94 (18 to 197)	185 (91 to 317)
Thyroid cancer	27 (13 to 45)	45 (28 to 68)
Total	7760 (1280 to 13900)	34400 (26800 to 42400)
Life Years Gained	97300 (62300 to 135000)	162000 (126000 to 201000)
QALYs Gained	20500 (13100 to 28500)	230000 (178000 to 287000)
Changes in Health-Related Costs, Cancer Only ($, millions)[2,3]		

Healthcare (medical) cost	-1820 (-2500 to -1180)	-3060 (-3740 to -2400)
Patient time cost	-112 (-160 to -62.7)	-197 (-245 to -148)
Productivity loss	-692 (-976 to -401)	-1210 (-1490 to -916)
Policy Implementation Costs ($, millions)[2,3]		
Government cost	18.4 (14.7 to 25.7)	18.4 (14.7 to 25.7)
Administration	9.06 (8.56 to 9.52)	9.07 (8.60 to 9.56)
Monitoring	9.32 (5.61 to 16.5)	9.37 (5.64 to 16.6)
Industry cost	821 (764 to 888)	1120 (1040 to 1200)
Compliance	821 (764 to 888)	821 (763 to 886)
Reformulation	-------	297 (248 to 350)
Net Costs, Cancer Only ($, millions) [2,3,4]		
Societal perspective	-1780 (-2790 to -831)	-1030 (-1590 to -549)
Healthcare perspective	-1800 (-2470 to -1160)	-1670 (-2120 to -1270)
ICER (dollars/QALY)[5]		
Societal perspective	Dominant	Dominant
Healthcare perspective	Dominant	Dominant

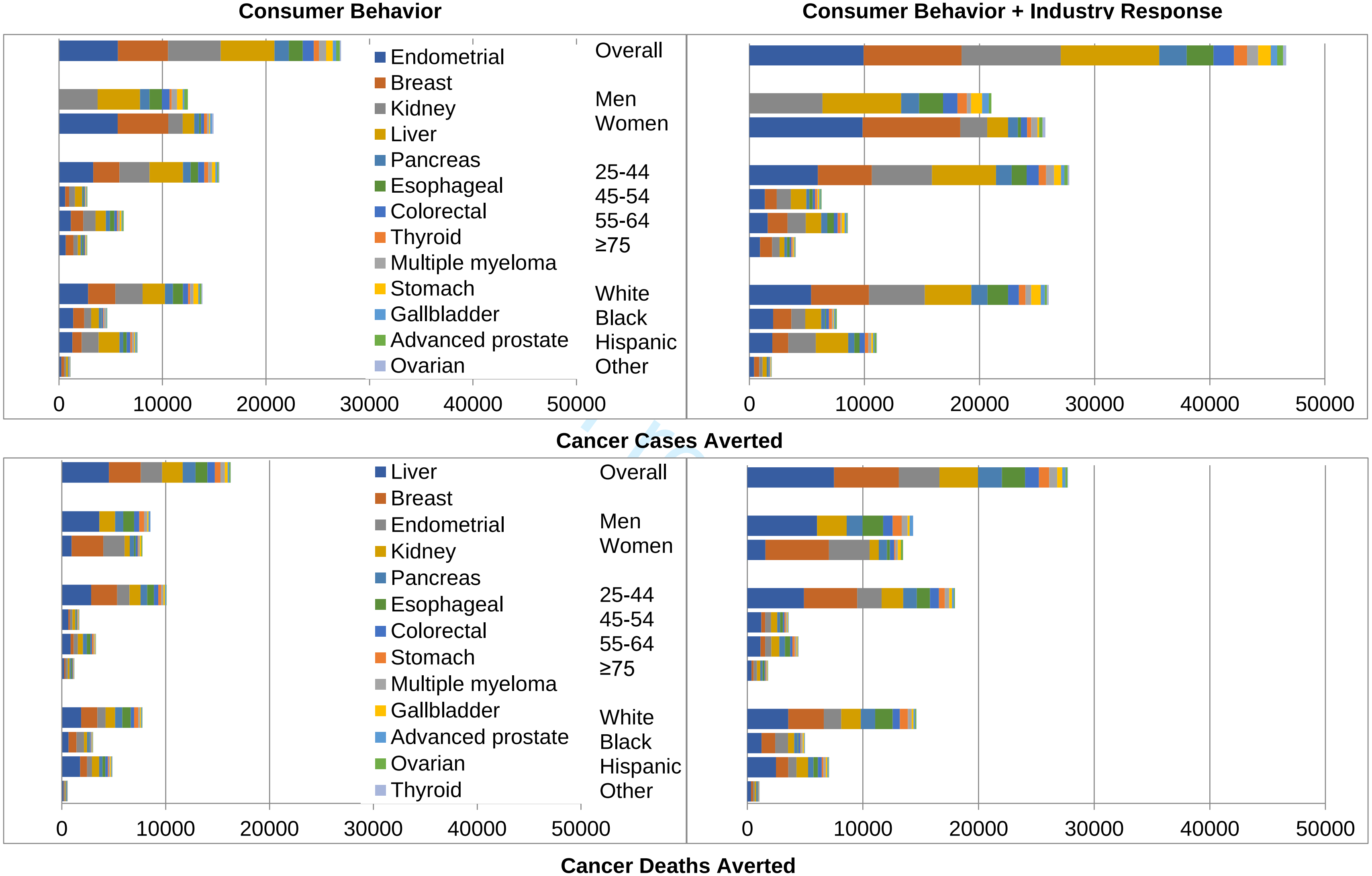
Abbreviations: ICER, Incremental Cost-Effectiveness Ratio; QALY, quality-adjusted life years.

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.
2. Health-related costs were inflated to 2015 US dollars using the Personal Health Care (PHC) index. Policy intervention costs were inflated to 2015 US dollars using the Consumer Price Index. Negative costs represent savings.
3. Costs are medians from 1000 simulations so may not add up to totals.
4. Net costs were calculated as policy costs minus health-related costs from reduced cancer burden. Societal perspective includes healthcare cost, patient time costs, productivity costs, and policy implementation costs; government perspective included policy costs relevant to policy implementation and program monitoring and evaluation and medical costs.
5. ICER threshold was evaluated at $150,000/QALY. Dominant represents less costly and more effective than the “no-policy intervention” scenario.

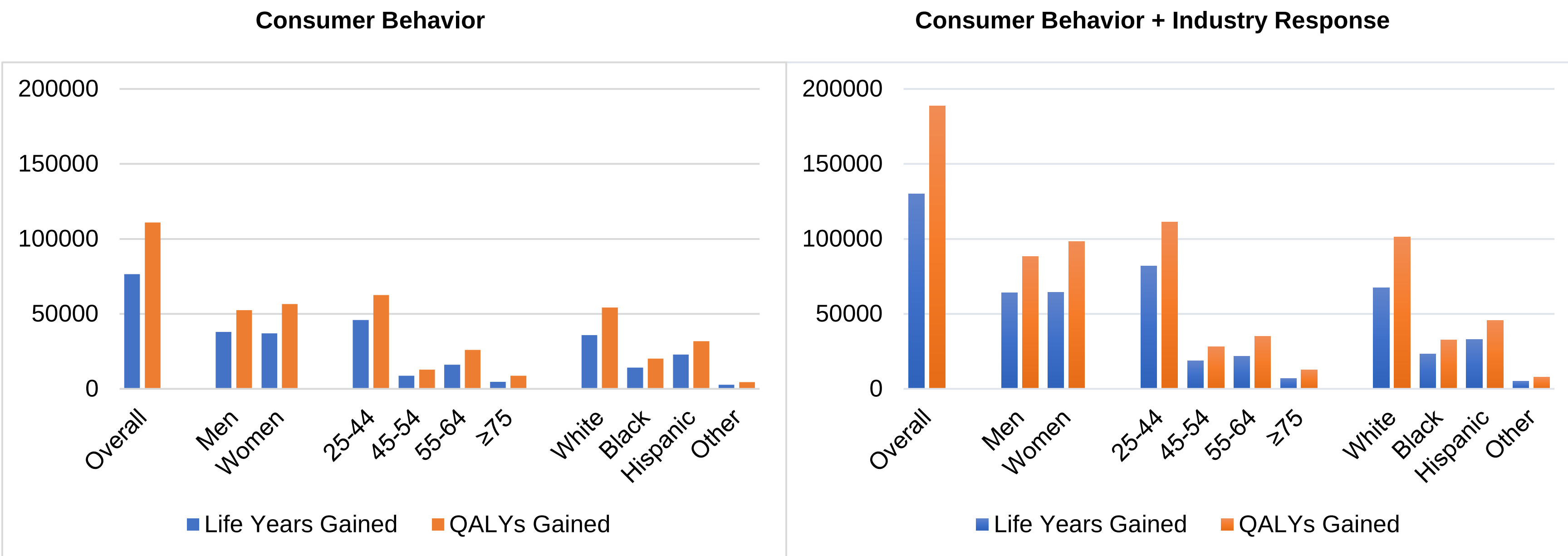


Supplementary Figure 1. Diet and Cancer Outcome Model (DiCOM)

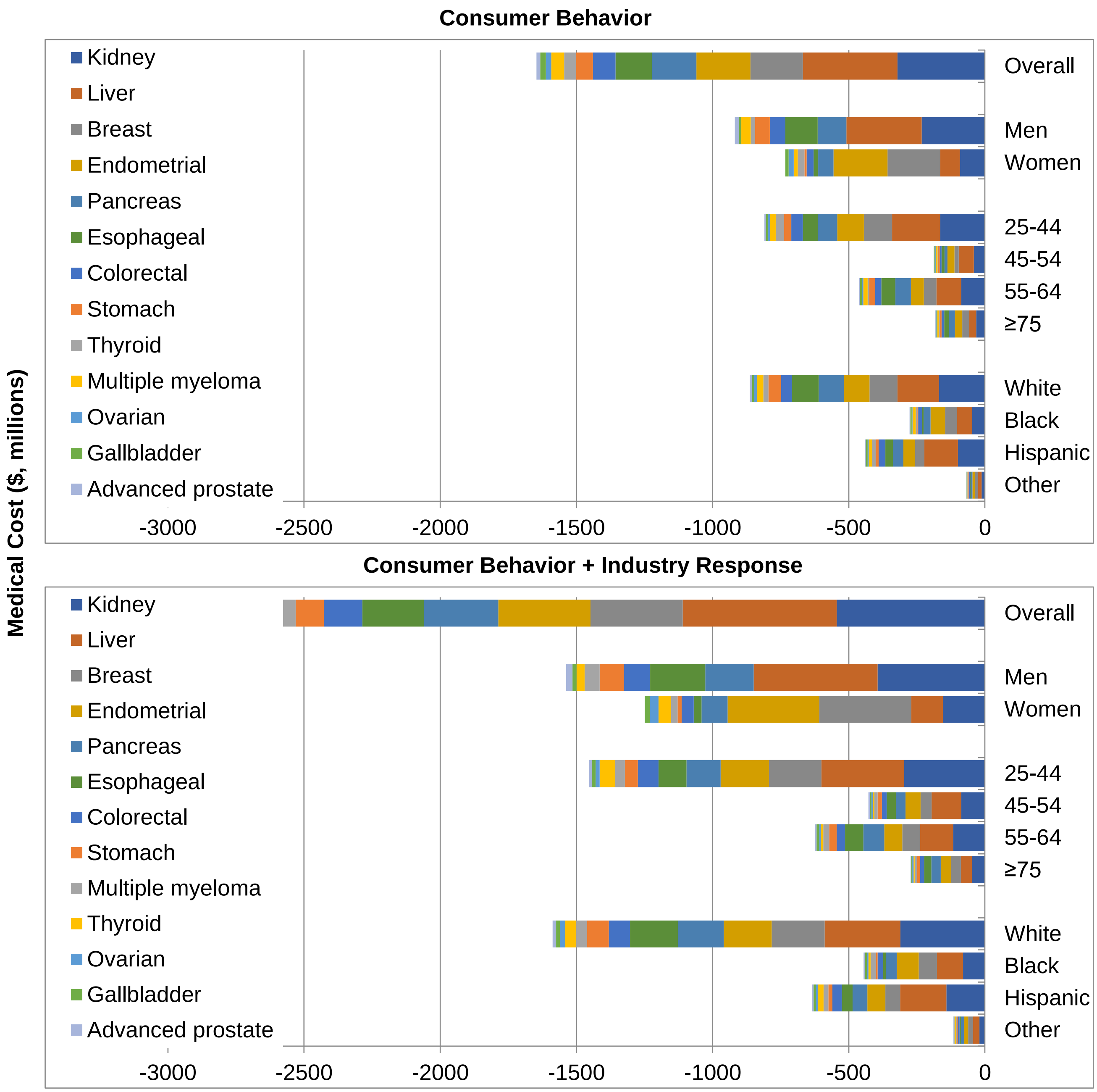
The model consists of four general health states: (a) healthy without cancer (healthy state); (b) initial cancer diagnosis (initial state) for each cancer type *i*; (c) continuing care (continuing state) for each cancer type *i*; and (d) death state. Transitions between states are based on national cancer incidence and cancer-specific mortality rates from SEER (for individual with cancer) and lifetable-based mortality rates (for individuals without cancer). The model simulates the policy impact on the number of new cases and deaths of 13 obesity-associated cancers, health-related quality of life (HRQOL), and health-related costs among U.S. adults over a lifetime by comparing a policy scenario (menu calorie label) to a non-policy scenario (status quo).



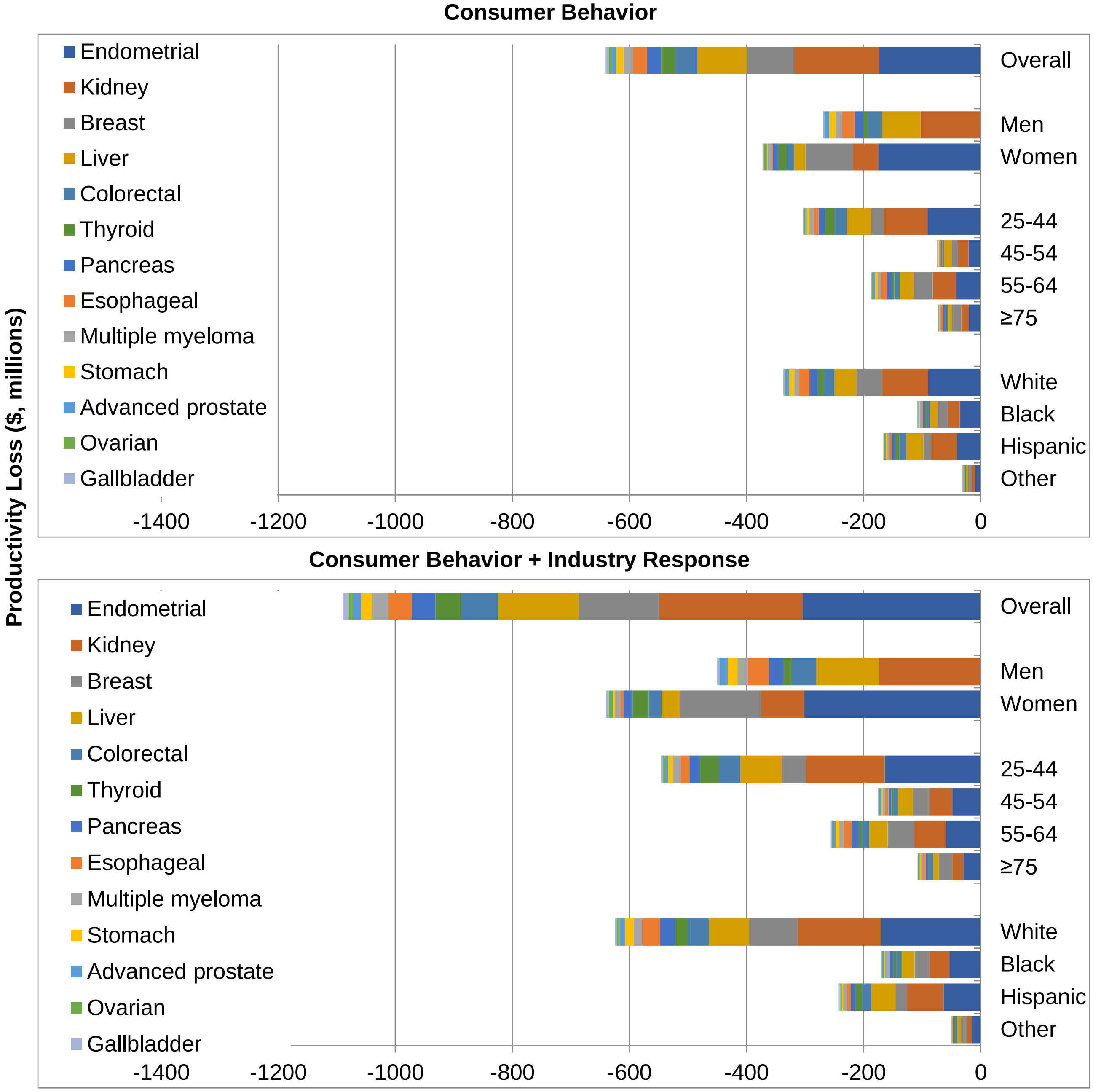
Supplementary Figure 2. Estimated reduced new cancer cases and deaths associated with the federal menu calorie labeling in the US by age, sex, race/ethnicity, and cancer type, over lifetime



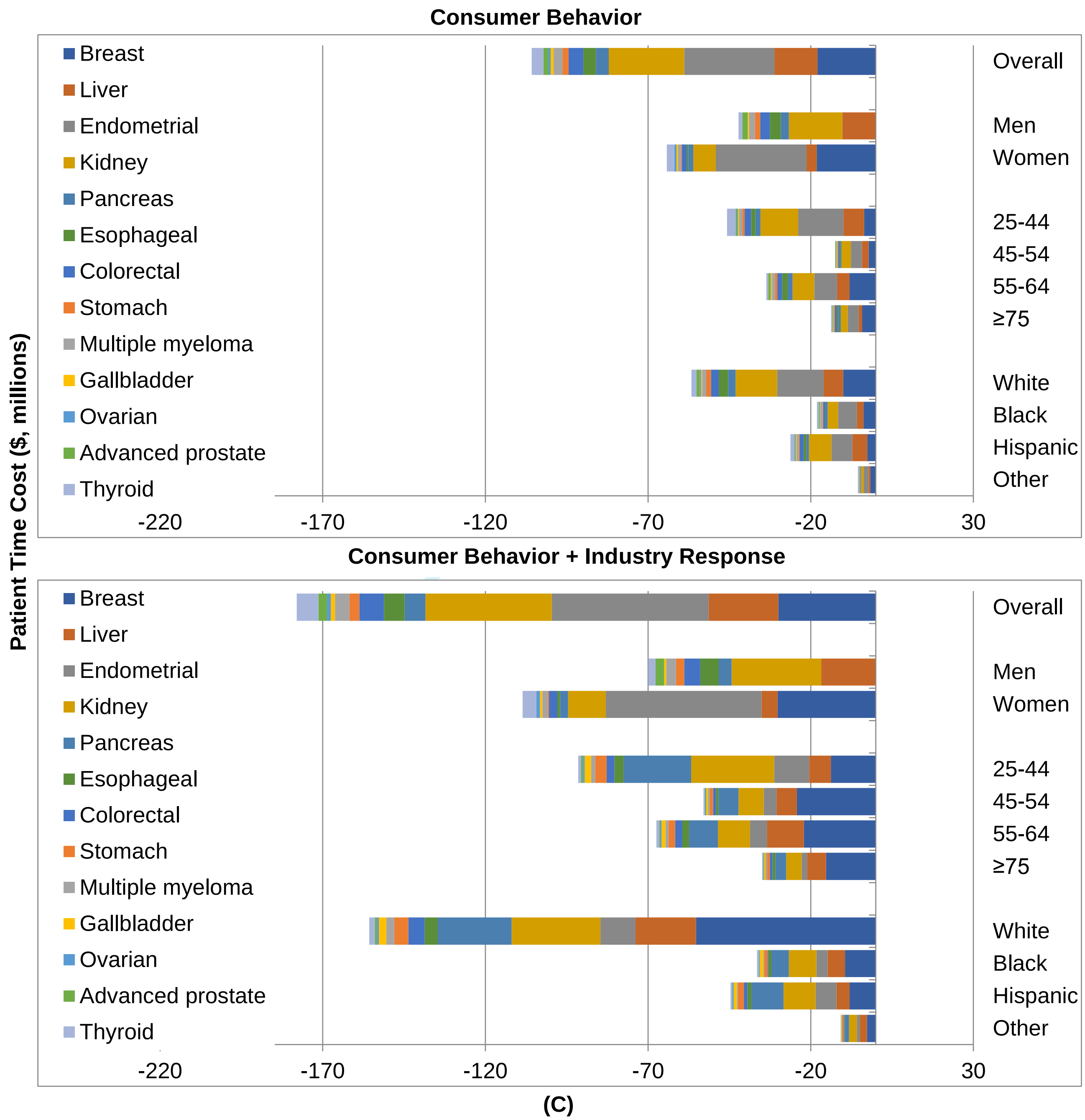
Supplementary Figure 3. Estimated life years and QALYs gained associated with the federal menu calorie labeling in the US by age, sex, and race/ethnicity, over a lifetime


Consumer Behavior
Kidney
Liver
Breast
Endometrial
Pancreas
Esophageal
Colorectal
Stomach
Thyroid
Multiple myeloma
Ovarian
Gallbladder
Advanced prostate
Overall
Men
Women
25-44
45-54
55-64
≥75
White
Black
Hispanic
Other
-3000
-2500
-2000
-1500
-1000
-500
0
Medical Cost ($, millions)
Consumer Behavior + Industry Response
Kidney
Liver
Breast
Endometrial
Pancreas
Esophageal
Colorectal
Stomach
Multiple myeloma
Thyroid
Ovarian
Gallbladder
Advanced prostate
Overall
Men
Women
25-44
45-54
55-64
≥75
White
Black
Hispanic
Other
-3000
-2500
-2000
-1500
-1000
-500
0

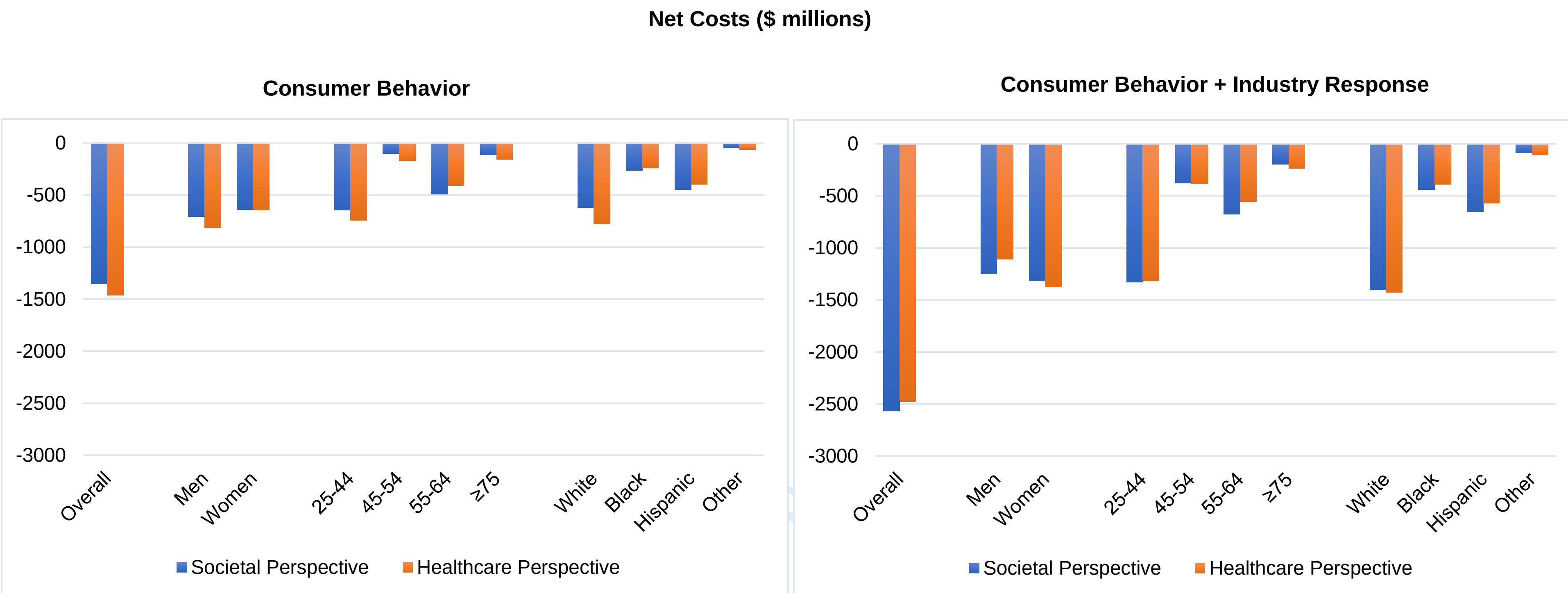
(A)


Consumer Behavior
Endometrial
Kidney
Breast
Liver
Colorectal
Thyroid
Pancreas
Esophageal
Multiple myeloma
Stomach
Advanced prostate
Ovarian
Gallbladder
Overall
Men
Women
25-44
45-54
55-64
≥75
White
Black
Hispanic
Other
-1400 -1200 -1000 -800 -600 -400 -200 0
Productivity Loss ($, millions)
Consumer Behavior + Industry Response
Endometrial
Kidney
Breast
Liver
Colorectal
Thyroid
Pancreas
Esophageal
Multiple myeloma
Stomach
Advanced prostate
Ovarian
Gallbladder
Overall
Men
Women
25-44
45-54
55-64
≥75
White
Black
Hispanic
Other
-1400 -1200 -1000 -800 -600 -400 -200 0

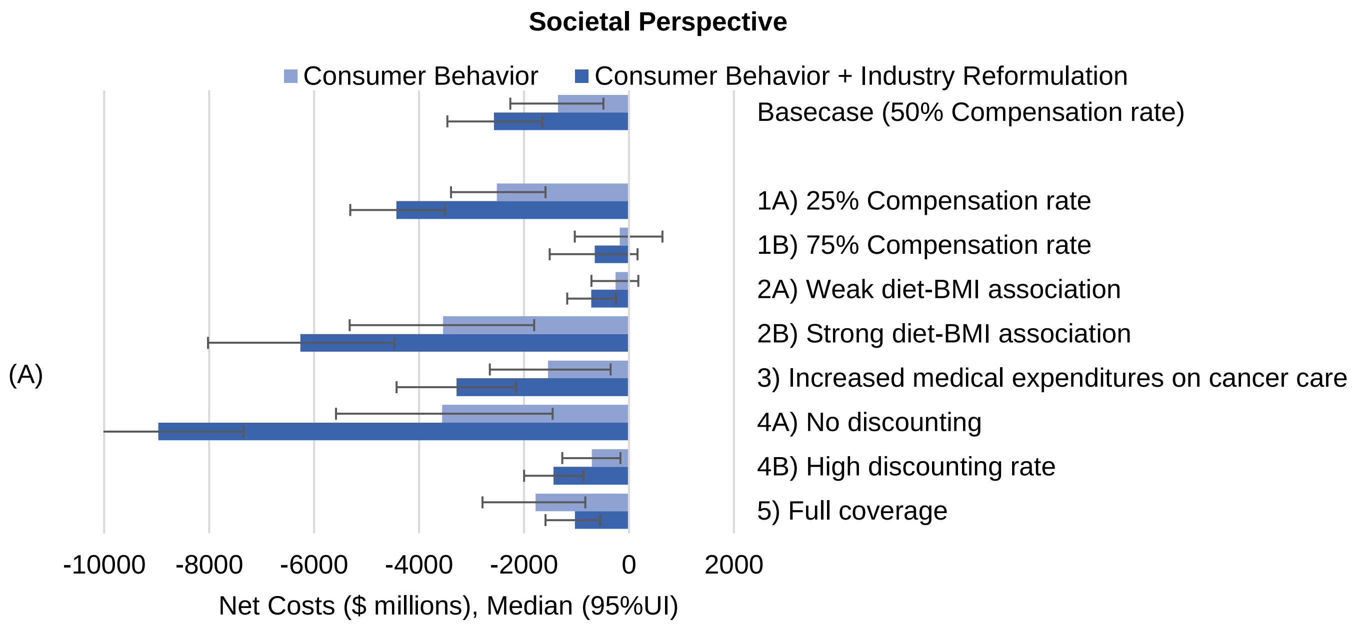
(B)

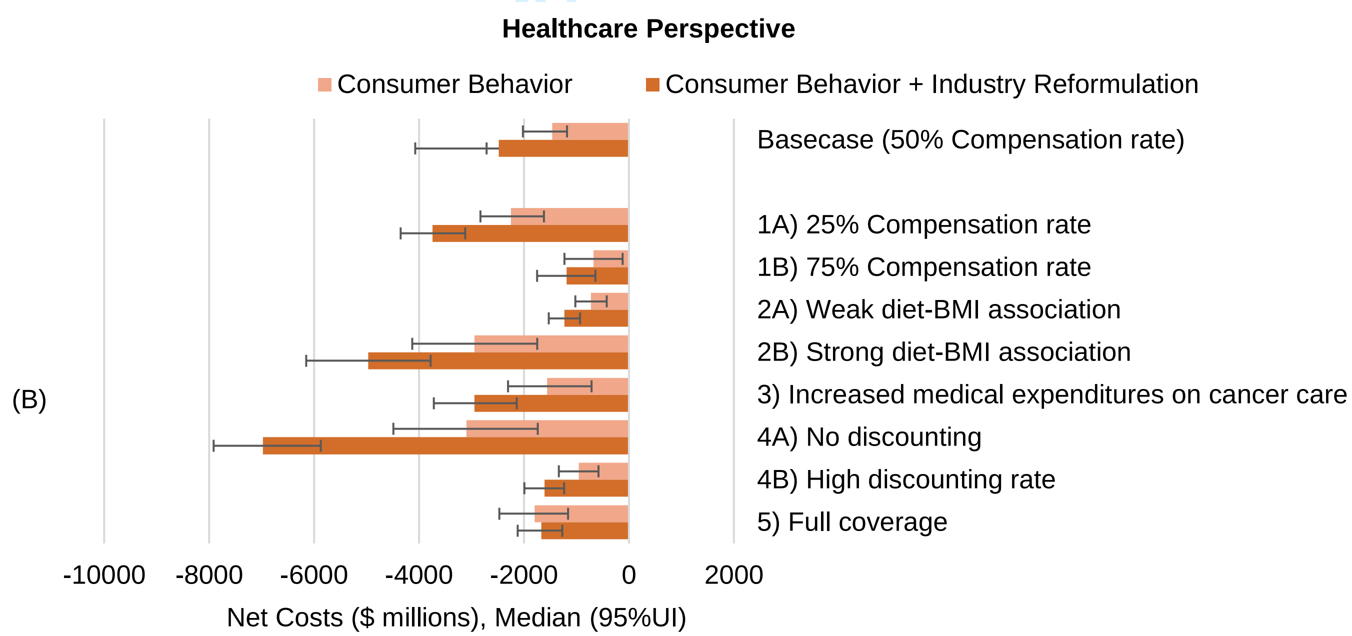


Supplementary Figure 4. Estimated changes of health-related costs associated with the federal menu calorie labeling in the US by age, sex, race/ethnicity, and cancer type, over lifetime



Supplementary Figure 5. Estimated net costs from societal and government perspectives associated with the federal menu calorie labeling policy in the US by age, sex, and race/ethnicity, over a lifetime





Supplementary Figure 6. One-Way Sensitivity Analysis of Net Costs of Menu Calorie Labeling and Obesity-Associated Cancer Rates by Varying Assumptions of Key Input Parameters From (A) Societal Perspective and (B) Healthcare Perspective

1a) assumed that only 25% of calorie reduction as a result of industry response would translate into long-term reductions in daily calories; 1b) assumed that only 75% of calorie reduction as a result of industry response would translate into long-term reductions in daily calories; 2a) weaker diet-BMI association assumed half of the base-case diet-BMI association; 2b) stronger diet-BMI association assumed two times of the base-case diet-BMI association; 3) 2% annual increase in medical expenditure on cancer care; 4a) lower discounting rate assumed 0% discounting rate; 4b) higher discounting rate assumed 5% discounting rate; and 5) assumed the coverage of the FDA's final rule increasing from 56.5% to 100% of the calories from full-service restaurants. Under base-case scenario (policy effect assumed consumer behavior: -7.3%, and industry reformulation: -5.0%; assumed that only 50% of calorie reduction as a result of industry response would translate into long-term reductions in daily calories; diet-BMI association assumed healthy-weight: 0.0015 kg/m^2 per kcal, and overweight/obese: 0.003 kg/m^2 per kcal; medical expenditure on cancer care assumed 0% annual increase; discounting rate assumed 3%; policy coverage would affect 56.5% of calories consumed at full-service restaurants and 100% of calories consumed at fast-food restaurants), the policy was cost-saving from both societal and healthcare perspectives. The policy remained cost-saving for all sensitivity analyses from the healthcare perspective and from societal perspective with additional industry reformulation. With consumer behavior alone, the policy was cost-saving under all scenarios.

Title Cost-Effectiveness Analysis of the Federal Menu Calorie Labeling and Obesity-Associated Cancer Burdens in the United States

Appendix 1. Estimate the association between menu calorie labeling policy and calorie intake from restaurant meals

To understand the effects of the federal menu calorie labeling policy, we performed a comprehensive literature search and reviewed the evidence on how the policy affected consumer behaviors and industry.

To estimate the policy effect on consumer behavior alone, we reviewed individual studies in both real-world and experimental settings as well as meta-analyses. A meta-analysis of natural experimental studies showed that menu calorie labeling was associated with a 7.3% (95% CI: 4.4% to 10.1%) reduction in calories per meal consumed/purchased.[1] This effect estimate is corresponding to an average reduction of 23.5 kcal per meal consumed by NHANES participants from 56.5% of full-service restaurants[2] and all fast-food restaurants. This estimate was consistent with evidence from a previous meta-analysis and a recent real-world study.[3, 4] A previous meta-analysis estimated that the menu calorie labeling would lead to about an 18 kcal reduction ordered per meal.[3] A recent longitudinal study used data from a large restaurant franchise in the southern U.S. and estimated that, after labeling implementation, a decrease of 60 kcal per transaction was observed in the first year, followed by an increasing trend of 0.71 kcal per transaction per week over two years.[4] These together attenuated the calorie reduction to 23 kcal per transaction by the end of the third year of the policy implementation.[5] Compared to other studies, the 7.3% calorie reduction per meal represents a more conservative estimate. It was reported in a cross-sectional study that customers at the labeled full-service restaurants purchased food with 151 fewer calories.[6] One meta-analysis of studies that evaluated energy ordered in a real-world setting showed that the calorie labeling policy would lead to a mean reduction of 77.8 in calories purchased per meal.[7] In a laboratory setting, there was a significant reduction of 115.3 kcal per meal ordered.[8] Integrating both the real-world and experimental studies, the policy was estimated to generate a significant reduction of 100.3 in calories purchased.[7] Therefore, we decided to use a reduction of calorie intake per meal by 7.3% (95% CI: 4.4% to 10.1%) as the model input given it is the most updated and conservative estimate supported by existing evidence. This policy effect on consumer behavior alone was assumed to take effect during the first year of implementation and no further reduction thereafter.

Based on the published literature, we estimated that there was a 5% reduction in calories consumed per meal from chain restaurants due to industry reformulation, the introduction of new low-calorie menu items, or the replacement of menu items high in calories with low-calorie menu options. [9-13] Bleich et al. estimated the calorie changes in chain restaurants' menu items using data from the largest chain restaurants in the U.S. [9-13] Using the estimated mean calorie per menu item from the two published studies shown in **Appendix Table 1**,[11, 12] we calculated the mean change in calories per menu item before and after the policy implementation. Given the national law was announced in 2010, using data from the trend analysis, we treated the mean calorie per menu item measured in 2008 as the baseline and found there was an 11% reduction in calories per menu item two years after the affordable care act was enacted. The change decreased to 7% in 2015, one year after the FDA announced the final rule for the industry to comply with. In the study evaluated the calorie content in current menu items, eliminated menu items, and newly introduced menu items, we estimated that there was a 1% reduction in mean per-item calories in 2013-2014 compared to that in 2012, and the reduction increased to 5% in 2015. Based on this de novo analysis, we chose a reduction in calories per meal consumed by 5% to represent a modest industry reformulation in response to the federal menu calorie labeling by chain restaurants. We assumed no industry response in the first year, then the reformulation activities would occur in the rest of the years over the model lifetime, resulting in a net reduction of 5% in calories consumed per meal.

Appendix Table 1. The policy impact of the federal menu calorie labeling on restaurant industry response

Study		Year				
		2008	**2012**	**2013**	**2014**	**2015**
Bleich, 2017[11] Calorie changes in large chain restaurants from 2008 to 2015 44 of the 100 largest chain restaurants	# of menu items (n) mean per-item calories (kcal)	6,601 368.0	9,526 329.1	10,278 330.1	10,654 337.2	11,034 340.6
	diff. (%)		2012 vs. 2008 -38.9 (-11%)			2015 vs. 2008 -27 (-7%)
Bleich, 2018[12] Higher-Calorie Menu Items Eliminated in Large Chain Restaurants 66 of the 100 largest chain restaurants	# of menu items (n) mean per-item calories (kcal)		14,705 374.4	17,219 (2013-2014) 370.9		13,920 357.4
	diff. (%)			2013-2014 vs. 2012 -3.52 (-1%)		2015 vs. 2012 -17.05 (-5%)

Appendix 2. Baseline cancer incidence and methods of cancer incidence projections for 13 types of cancers

We estimated the cancer incidence rate projections for the defined 32 demographic subgroups as inputs for the DiCOM model. We first obtained age-adjusted incidence rates from 2006 to 2015 from the United States Cancer Statistics combining data from the Surveillance, Epidemiology, and End Results (SEER) database and the Centers for Disease Control and Prevention's National Program of Cancer Registries (NPCR) database.[14]

Based on the trends from 2006 to 2015, we projected age-adjusted cancer incidence rates in the next 15 years from 2016 to2030 using the average annual percent change (AAPC) method.[15, 16] Because longer-term projections may not be valid, we chose to hold age-adjusted cancer incidence rates constant from 2030 to 2095. Specifically, the annual percent change was calculated for each cancer site in each of the 32 subgroups by fitting a regression line to the natural logarithm of the age-adjusted rates (I) in the years 2006 through 2015 (y). The equation for AAPC: $\ln(I) = \alpha + \beta y$, where α and β were coefficients to be estimated and y is the calendar year.[15, 16] We then combined the AAPC projected cancer incidence rates with the projected US population to account for the change in population age distribution over time. The projected US population in each of the 32 subgroups from 2016 to 2060 were extracted from the National Interim Projections of the US population.[17] Because projections were only available through 2060, further projections after 2060 were not considered. We further applied the cohort-period method to estimate cancer incidence in each of the 32 subgroups in the closed cohort of US adults from 2015 to 2095 as they age. Details were illustrated in **Appendix Table 2** using colon and rectum cancer incidence among non-Hispanic white females (NHWF) as an example.

Appendix Table 2. Estimating “crude” incidence after applying cohort-period method

EXAMPLE: Colon and Rectum Cancer, Non-Hispanic White Females														
Age	2015		2016				2017				2018			
	Baseline Incidence Rate	Population Size	AAPC Predicted Incidence	US Census Predicted Population Size	Cancer Cases Predicted	Age Shifted "crude" Incidence	AAPC Predicted Incidence	US Census Predicted Population Size	Cancer Cases Predicted	Age Shifted "crude" Incidence	AAPC Predicted Incidence	US Census Predicted Population Size	Cancer Cases Predicted	Age Shifted "crude" Incidence
20	8.531	30523184	8.694	1134235		10.154	8.859	1126079		11.694	9.028	1117775		13.182
21	8.531		8.694	1156761	100565		8.859	1137549			9.028	1129379		
22	8.531		8.694	1177144	102337		8.859	1159788	102748		9.028	1140620		
23	8.531		8.694	1196469	104017		8.859	1180122	104550		9.028	1162784	104976	
24	8.531		8.694	1238910	107707		8.859	1199459	106263		9.028	1183136	106813	
25	8.531		8.694	1283513	111585		8.859	1241739	110009		9.028	1202329	108546	
26	8.531		8.694	1294013	112497		8.859	1286229	113950		9.028	1244499	112353	
27	8.531		8.694	1250740	108735		8.859	1296475	114858		9.028	1288797	116352	
28	8.531		8.694	1232421	107143		8.859	1253062	111012		9.028	1298770	117252	
29	8.531		8.694	1216039	105719		8.859	1234519	109369		9.028	1255161	113315	
30	8.531		8.694	1228929	106839		8.859	1217844	107892		9.028	1236330	111615	
31	8.531		8.694	1244281	108174		8.859	1230337	108999		9.028	1219312	110079	
32	8.531		8.694	1205955	104842		8.859	1245249	110320		9.028	1231390	111169	
33	8.531		8.694	1226950	106667		8.859	1206736	106908		9.028	1246013	112489	
34	8.531		8.694	1226234	106605		8.859	1227540	108751		9.028	1207377	109001	
35	8.531		8.694	1217701	105863		8.859	1226721	108678		9.028	1228051	110868	
36	8.531		8.694	1228467	106799		8.859	1218141	107918		9.028	1227199	110791	
37	8.531		8.694	1160971	100931		8.859	1228796	108862		9.028	1218528	110008	
38	8.531		8.694	1139547	99069		8.859	1161267	102879		9.028	1229044	110958	
39	8.531		8.694	1127605	98030		8.859	1139679	100967		9.028	1161414	104852	
40	8.531		8.694	1088875	94663		8.859	1127530	99891		9.028	1139635	102886	
41	8.531		8.694	1130467	98279		8.859	1088644	96446		9.028	1127272	101770	
42	8.531		8.694	1101345	95747		8.859	1129951	100105		9.028	1088229	98245	
43	8.531		8.694	1130264	98262		8.859	1100615	97506		9.028	1129228	101946	
44	8.531		8.694	1210411	105229		8.859	1129268	100045		9.028	1099713	99282	
45	41.269	14238423	41.919	1319769	553230	43.775	42.579	1208976	514771	45.825	43.250	1128045	487878	47.459
46	41.269		41.919	1346596	564476		42.579	1317806	561110		43.250	1207332	522169	
47	41.269		41.919	1292274	541705		42.579	1344191	572344		43.250	1315541	568969	
48	41.269		41.919	1264917	530237		42.579	1289694	549140		43.250	1341533	580211	
49	41.269		41.919	1295410	543019		42.579	1262140	537408		43.250	1286923	556592	
50	41.269		41.919	1325816	555765		42.579	1292230	550220		43.250	1259139	544576	
51	41.269		41.919	1432079	600309		42.579	1322198	562980		43.250	1288813	557410	
52	41.269		41.919	1489756	624487		42.579	1427705	607904		43.250	1318321	570172	
53	41.269		41.919	1510286	633093		42.579	1484805	632216		43.250	1423107	615492	
54	41.269		41.919	1532940	642589		42.579	1504858	640755		43.250	1479608	639928	
55	59.736	15111568	58.496	1575080	921363	65.864	57.283	1526976	874691	71.195	56.094	1499151	840934	75.804
56	59.736		58.496	1579128	923731		57.283	1568482	898466		56.094	1520747	853048	
57	59.736		58.496	1554236	909170		57.283	1572018	900492		56.094	1561581	875954	
58	59.736		58.496	1566074	916095		57.283	1546788	886040		56.094	1564631	877664	
59	59.736		58.496	1559941	912507		57.283	1558015	892471		56.094	1539019	863298	
60	59.736		58.496	1509257	882859		57.283	1551289	888618		56.094	1549572	869217	
61	59.736		58.496	1507776	881993		57.283	1500225	859367		56.094	1542165	865062	
62	59.736		58.496	1469467	859583		57.283	1497943	858060		56.094	1490621	836149	
63	59.736		58.496	1428612	835685		57.283	1458963	835731		56.094	1487453	834372	
64	59.736		58.496	1384020	809600		57.283	1417465	811960		56.094	1447782	812119	
65	147.246	20639658	140.189	1344027	1884181	140.189	133.471	1372210	1831501	133.471	127.075	1405568	1786119	127.075
66	147.246		140.189	1307657	1833194		133.471	1331467	1777121		127.075	1359584	1727685	
67	147.246		140.189	1291598	1810681		133.471	1294222	1727410		127.075	1318007	1674851	
68	147.246		140.189	1292613	1812104		133.471	1277026	1704458		127.075	1279794	1626292	
69	147.246		140.189	1382868	1938632		133.471	1276471	1703717		127.075	1261379	1602891	
70	147.246		140.189	987587	1384490		133.471	1363827	1820312		127.075	1259177	1600093	
71	147.246		140.189	982267	1377032		133.471	972764	1298357		127.075	1343441	1707171	
72	147.246		140.189	972611	1363496		133.471	966021	1289357		127.075	956905	1215982	
73	147.246		140.189	1012982	1420091		133.471	954967	1274603		127.075	948632	1205469	
74	147.246		140.189	874564	1226044		133.471	992594	1324824		127.075	936077	1189515	
75	147.246		140.189	796574	1116711		133.471	855200	1141443		127.075	970797	1233635	
76	147.246		140.189	747848	1048402		133.471	777087	1037185		127.075	834495	1060430	
77	147.246		140.189	706707	990727		133.471	727604	971140		127.075	756255	961007	
78	147.246		140.189	679404	952451		133.471	685495	914936		127.075	705976	897115	
79	147.246		140.189	625026	876219		133.471	656756	876578		127.075	662851	842315	
80	147.246		140.189	595777	835215		133.471	601790	803215		127.075	632555	803816	
81	147.246		140.189	572977	803252		133.471	571026	762154		127.075	577004	733225	
82	147.246		140.189	512332	718234		133.471	546330	729192		127.075	544674	692142	
83	147.246		140.189	496976	696707		133.471	485519	648027		127.075	517986	658228	
84	147.246		140.189	475655	666817		133.471	467692	624233		127.075	457134	580901	
85	147.246		140.189	452173	633898		133.471	444106	592752		127.075	436898	555186	
86	147.246		140.189	428834	601179		133.471	418526	558610		127.075	411316	522678	
87	147.246		140.189	383933	538233		133.471	393130	524714		127.075	383961	487917	
88	147.246		140.189	356801	500196		133.471	348261	464827		127.075	356875	453497	
89	147.246		140.189	320644	449508		133.471	319862	426923		127.075	312475	397076	
90	147.246		140.189	278562	390514		133.471	283710	378670		127.075	283306	360010	
91	147.246		140.189	246568	345662		133.471	242960	324281		127.075	247721	314790	
92	147.246		140.189	209022	293026		133.471	211695	282551		127.075	208839	265381	
93	147.246		140.189	169864	238131		133.471	176399	235441		127.075	178878	227308	
94	147.246		140.189	138657	194382		133.471	140691	187782		127.075	146313	185927	
95	147.246		140.189	109277	153195		133.471	112531	150196		127.075	114362	145325	
96	147.246		140.189	80177	112399		133.471	86769	115811		127.075	89499	113730	
97	147.246		140.189	56739	79542		133.471	62172	82982		127.075	67414	85666	
98	147.246		140.189	42046	58944		133.471	42907	57268		127.075	47105	59858	
99	147.246		140.189	27405	38419		133.471	30959	41321		127.075	31659	40231	
100	147.246		140.189	49314	69133		133.471	50716	67691		127.075	52719	66992	

Appendix 3. Cancer survival for 13 types of cancers

We estimated the 5-year relative survival for the defined 32 demographic subgroups. We obtained five-year relative survival rates using the period analysis method from the United States Cancer Statistics which incorporates data from the Surveillance, Epidemiology, and End Results (SEER) database.[14] The five-year survival for 2014, which was the most recently available data at the time of analysis, was used. These rates were extracted for each cancer type and by the defined 32 demographic subgroups for each cancer type. The rates are on a scale of 0-1.

Relative survival is a net survival measure representing cancer survival in the absence of other causes of death. Relative survival is defined as the ratio of the proportion of observed survivors in a cohort of cancer patients to the proportion of expected survivors in a comparable set of cancer-free individuals.[18] Relative survival is the preferred method to estimate survival from cancer registry data.

The period analysis is a method that enhances up-to-date monitoring of survival.[19, 20] In contrast to traditional cohort analysis of survival, period analysis derives long-term survival estimates exclusively from the survival experience of patients within some recent calendar period.[19, 20] Three-year intervals were chosen which results in the years 2008-2014 is used to calculate 5-year survival. Using seven years of data to calculate 5-year survival is the standard method used by SEER and used in SEER publications.[21]

The first interval contributed to the one-year survival and used cases diagnosed in 2012-2014, the second interval contributed to the two-year survival and used cases diagnosed in 2011-2013, the third interval contributed to the three-year survival and used cases diagnosed in 2010-2012, the fourth interval contributed to the four-year survival and used cases diagnosed in 2009-2011 and the fifth interval contributed to the five-year survival and used cases diagnosed in 2008-2010.

This analysis, therefore, used 2008-2014 diagnoses to calculate for 5-year relative survival for 2014. The highlighted orange boxes represent survival contributions for each year of diagnosis and year of follow-up (**Appendix Table 3**). The annual probability of death was calculated as 1-exp[ln(5-year relative survival)/5].

Appendix Table 3. Period method for 5-year relative survival for 2014

YEARS OF DIAGNOSIS															
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1															
2															
3															
4															
5															

Appendix 4. **Methods of estimating the health-related quality of life among 13 types of cancers**

Health utility values range from 0 (dead) to 1 (perfect health and were assigned for each cancer type and by phase of care (initial, continuous, end of life), if available. We first searched databases for systematic reviews pertaining to utility weights or HRQOL measures for each cancer type of interest separately. We started with PubMed and searched Google Scholar if needed. The following search string was used for each cancer type : ("health related quality of life" OR "HRQOL" OR "quality of life" OR "QOL" OR "preference weight*" OR "utility weight*" OR "health state utilit*" OR "health utility*") AND ("cancer of interest") AND ("cancer" OR "neoplasm*") AND ("review" OR "systematic review").

When an appropriate systematic review was identified, we read the articles included in the review and determined if the paper met the following data needs. Data Extraction Hierarchy: 1) cancer type specific to the type of interest; 2) consistent in the instrument used, prefer EQ-5D whenever available; 3) US samples preferred; 4) phase of care (assume same utility weights by phase if the phase of care data were not available). If no systematic reviews were available, we searched for individual studies about the utility weights of the cancer of interest. Additionally, check how often the paper is cited to see if it is a frequently used utility weight.

Appendix 5. Methods of estimating policy implementation costs

We estimated the costs of implementing the federal menu calorie labeling for both government and industry, including government administration costs, monitoring and evaluation costs, industry compliance costs and reformulation costs, based on the FDA's budget report,[22] the Nutrition Review Project report,[23] and FDA's RIA[24] (**Appendix Table 4**).

It was estimated by FDA that approximately 298,600 establishments, organized under 2,130 chains were covered by the menu calorie labeling policy. Among the covered establishments, 115,000 (38.5%) were full-service restaurants and drinking places organized under 530 (24.9%) chains, and 116,200 (38.9%) were limited-service restaurants organized under 540 (25.4%) chains. In total, about 231,200 (77.4%) restaurants organized under 1,070 (50.2%) chains were covered by this policy.[24]

For industry compliance (#3) and reformulation costs (#4), the FDA estimated the costs by the type of establishments. Therefore, we only included the relevant costs incurred by restaurants as this approach generated more conservative estimates. In addition, the industry compliance costs consist of initial costs and recurring costs associated with new chains. In FDA's RIA, the initial costs were presented as a one-time cost, while the recurring costs associated with new chains were presented as annual costs and assumed to be incurred for 20 years starting from the 2nd year of policy implementation. According to FDA, 20 years is more appropriate for interventions that play out over long periods and whose effects deal with chronic conditions. Similarly, the reformulation costs (#4) estimated by FDA were presented as annual costs in FDA's RIA using the same assumption. We followed the same assumption and presented the annual compliance costs (#3) and annual reformulation costs (#4) incurred by restaurants in **Appendix Table 4**.

The cost of implementing the menu calorie labeling is fixed by the government. Uncertainty for the costs associated with government administration (#1) and government monitoring and evaluation (# 2) was not provided in the source materials.[22, 23] We assumed that uncertainty is 20% around these costs.

For annual costs, namely the government monitoring and evaluation costs (#2) and the recurring costs in industry compliance (part of #3), and the reformulation costs (#4), we applied a 3% discounting rate recommended by the Second Panel on cost-effectiveness in health and medicine[4] to reflect the present value of future costs of government monitoring and evaluation, industry compliance and industry reformulation. The model is a closed cohort model, so we computed the discounted present value of per-person costs and total national costs for persons alive at implementation who remained alive in each subsequent year (not for the larger total US population in each year, which also has growth from immigration and new persons reaching the threshold age). The year-specific discounting factor is estimated by 1/(1+3%)^(t-1) (t is the number of years of policy intervention, t=1, 2, 3, …, lifetime). As our model estimated the costs and health outcomes based on a closed cohort and the population size decline over time, we need to express the annual costs in proportion to the population at risk. The population at risk was estimated based on the proportion of death ($P_{dt,}$ t=1, 2, 3, …) in each year. We first obtained the proportion of people who are alive each year by calculating 1-P_{dt} (t=1, 2, 3, …). Then we multiplied the baseline population size of 235 million by the proportion of people who are alive each year (**Appendix Table 5**).

We then estimated the per-person annual cost for cost categories #2, #3 (annual part), and #4, by dividing the annual cost estimated in the second year of implementing the policy among all US populations by the population size in the second year. Specifically, for government monitoring and evaluation, the per person annual cost is estimated $503,648/233,719,989=$0.00215, the per person annual cost for industry compliance recurring component is $/233,719,989=$, and that for reformulation

is \$662,800,000 /233,719,989=\$2.83587. Taken together, to estimate the discounted annual cost of #2, #3 (annual part), and #4, we multiplied the population at risk, the per person annual cost estimated at year-2, and the year-specific discounting factor, using: discounted annual cost = population at risk x per-person annual cost x 1/(1+3%)^(t-1).

Appendix Table 4. Implementation cost estimates for the federal menu calorie labeling policy (in 2015 US dollars)

Policy Effect	Cost Category	One-time Cost*	Annual Cost*	Source	Major Elements
Consumer behavior	1. Government administration#	$9,073,620 ($7,258,896 to $10,888,344)	N/A	FDA FY 2012 Budget Report[22]	1) Costs for outreach, education, review of regulatory issues, developing training for inspectors, etc.
	2. Government monitoring and evaluation#	N/A	$503,648 ($402,918 to $604,378) (starting from 2nd year and last for a lifetime)	Nutrition Review Project report[23]	1) Monitor industry compliance 2) Evaluate the accuracy, usefulness, and health impact of the policy intervention
	3. Industry compliance	$276,632,470 ($225,552,530 to $327,205,740)	$27,648,591 ($16,756,003 to $38,649,212) (starting from 2nd year and last for a lifetime)	FDA's RIA[24] Table 4-8	1) Collecting and managing records of nutritional analysis for each standard menu item (initial cost + recurring cost associated with new chains) 2) Revising or replacing existing menus, menu boards, and providing full written nutrition information (initial cost + recurring cost associated with new chains) 3) Training employees to understand the nutrition information to help ensure compliance with the final requirements (initial cost + recurring cost associated with new chains) 4) Legal review (initial cost + recurring cost associated with new chains)
Industry response^	4. Industry reformulation	N/A	$15,059,100 ($5,791,900 to $24,124,700) (starting from 2nd year and last for a lifetime)	FDA's RIA[24] Table 4-8	1) Annually recurring costs of nutrition analysis refer to the nutrition cost that will be incurred by the covered establishments due to the introduction of a new standard or reformulated standard menu items in their menus and the cost that will be incurred by new chains entering the industry 2) Annually recurring changes to menus or menu boards will be tied to new or reformulated standard menu items. In general, these future changes to menus will be incorporated into the natural menu

					replacement cycle, so there will be no additional recurring menu update costs. However, all chain retail food establishments will need to provide additional written nutrition information for the reformulated or newly introduced menu items Average formula count, 6 new menu items, and 6 reformulated items per year FDA reformulation cost model

*Policy intervention costs were inflated to 2015 US (December) dollars using the Consumer Price Index.
Given no range of uncertainty was provided in source materials, we assumed 20% uncertainty around these costs.
^Some chains or establishments may respond to increased consumer interest in caloric content standard menu items by reformulating existing menu items or by introducing new, lower-calorie items. The change in manufacturing costs associated with reformulating these items has not been included in the cost estimation, the FDA includes the cost associated with analyzing the nutrition information of new or reformulated items.

Appendix Table 5. The population size of people who are alive each year over a lifetime (in millions)

Year	Population Size (Million)
1	235.2
2	233.7
3	232.1
4	230.4
5	228.2
⋮	⋮
67	5.832
68	4.348
69	3.157
70	2.233

Appendix 6. Annual health-related costs among cancer patients and the general population without cancer

The annual health-related costs data include: 1) medical expenditure, 2) productivity loss from missed workdays or disability, and 3) patient time cost associated with receiving care for cancer survivors by age (under 65 vs. above 65 years old) and phase of care (initial, continuing, end-year of life); 4) medical expenditure, 5) productivity loss, and 6) patient time cost for individuals without cancer by age and status of end year of life. The description of the data source and data structure were provided in **Appendix Table 6**.

We extracted the raw data for each of the costing components from the published literature.[15, 25-29] The overall assumptions for data extraction include: 1) health-related costs for breast cancer among postmenopausal females, advanced prostate cancer, esophageal adenocarcinoma, and stomach cardia cancer, by age, sex, and phase of cancer care, were the same as those for breast cancer, prostate cancer, esophagus cancer, and stomach cancer; 2) if no data available for a specific cancer type, we assumed the costs for that cancer type were the same as the estimates of costs for all-cancer sites, e.g., medical expenditure for all-cancer sites were used to replace the medical expenditures for multiple myeloma, gallbladder, liver, and thyroid cancers; 3) we extracted the costs for end-year of life due to cancer death and assumed that death due to other causes is not a competing outcome; 4) we assumed that the end-year life medical expenditure for individuals without cancer does not vary by the 32 subgroups.

If a specific costing component was not reported directly in the raw data, we calculated the cost for that component based on available data. For example, the annual productivity loss for colorectal cancer was reported as a percentage of total health-related costs.[29] We multiplied the percentage and the total health-related costs to obtain the productivity loss for colorectal cancer. We also performed data imputation for unavailable data. For instance, the annual productivity loss for all-cancer sites was

reported by time interval since cancer diagnosis (diagnosed within one year vs. diagnosed greater than one year).[25] To obtain this costing component by the defined phases of care, we calculated the weighted means which was used as the annual productivity loss for the continuous phase. We then assumed that the productivity loss in the initial phase and end-of-life phase of cancer care are 1.3 times and 4 times the mean estimates based on available data for other cancers.[15, 25] For individuals without cancer, we assumed that the end-of-life productivity loss is 4 times to the mean estimate of the productivity loss. The same rules applied to data imputation for patient time costs.

We then applied the age shifting to keep the expenditures consistent within each age group. Starting from 2021, individuals in the cohort of 55-64 years old have turned into the cohort of 65 years and older. Therefore, we assumed that starting from 2021, the health-related expenditures for individuals who were in the cohort of 55-64 years old would be the same as those for individuals who were in the cohort of 65 years and older at the beginning of the DiCOM model. Based on the same assumption, starting from 2031 and 2047, the health-related expenditures for the cohort of 45-54 years old and those for the cohort of 20-44 years old were projected to be the same as those for the cohort of 65 years and older, respectively. We followed the same rule and applied the age shifting for the health-related expenditures for individuals without cancer. All estimations and projections were performed in SAS 9.4. All health-related expenditures were inflated to 2015 US dollars using the Personal Health Care (PHC) index.

Appendix Table 6. Description of the data source of health-related expenditures

	A. Cancer Survivors		B. Individuals without Cancer	
	Data source (Excess or Total)	Category	Data source	Category
Medical expenditure	Mariotto et al. 2011, SEER-Medicare, in 2010 US dollars (Excess)	-by phase of care[1] -by age (under 65 vs. above 65 years old) -by sex	Kim et al. 2018, MEPS 2013-2014, *in vivo* analysis, in 2014 US dollars (Total)	-Medical expenditure among all US adults -by 32 subgroups stratified by age, sex, and race/ethnicity
			Hogen et al. 2001, SEER-Medicare (65+), in 2001 US dollars (Total)	-Medical expenditure in the end year of life among all US adults
Productivity loss	Zheng et al. 2016, MEPS 2008-2012, data available for colorectal, female breast, and prostate cancers, in 2012 US dollars (Total)	-by age		
	Guy et al. 2013, MEPS 2008-2010, all types of cancer, in 2010 US dollars (Total)	-by age -by time interval since cancer diagnosis (less than 1 year vs. greater than 1 year)[2]	Guy et al. 2013, MEPS 2008-2010, in 2010 US dollars (Total)	-by age
Patient time cost	Yabroff et al. 2014, MEPS 2008-2011, all types of cancer, in 2011 US dollars (Total)	-by age	Yabroff et al. 2014, MEPS 2008-2011, in 2011 US dollars (Total)	-by age

1. The definition of phases of care: 1) initial phase, defined as the first 12 months following diagnosis, 2) end-year of life phase, defined as the final 12 months of life, and 3) the continuing phase, defined as all the months between the initial phase and the end-year of life. The costs of end-year of life varied by cause of death, either cancer-specific death or death due to other causes.
2. Weighted means were calculated based on sample sizes and strata means.

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CHEERS Checklist

Items to include when reporting economic evaluations of health interventions

The **ISPOR CHEERS Task Force Report**, *Consolidated Health Economic Evaluation Reporting Standards (CHEERS)—Explanation and Elaboration: A Report of the ISPOR Health Economic Evaluations Publication Guidelines Good Reporting Practices Task Force*, provides examples and further discussion of the 24-item CHEERS Checklist and the CHEERS Statement. It may be accessed via the *Value in Health* or via the ISPOR Health Economic Evaluation Publication Guidelines – CHEERS: Good Reporting Practices webpage: http://www.ispor.org/TaskForces/EconomicPubGuidelines.asp

Section/item	Item No	Recommendation	Reported on page No/ line No
Title and abstract			
Title	1	Identify the study as an economic evaluation or use more specific terms such as "cost-effectiveness analysis", and describe the interventions compared.	Page 1/Lines 1-2
Abstract	2	Provide a structured summary of objectives, perspective, setting, methods (including study design and inputs), results (including base case and uncertainty analyses), and conclusions.	Pages 3-4/ Lines 32-59
Introduction			
Background and objectives	3	Provide an explicit statement of the broader context for the study. Present the study question and its relevance for health policy or practice decisions.	Pages 5-6/ Lines 64-92
Methods			
Target population and subgroups	4	Describe characteristics of the base case population and subgroups analysed, including why they were chosen.	Page 9/ Lines 106-113
Setting and location	5	State relevant aspects of the system(s) in which the decision(s) need(s) to be made.	Page 6/Lines 96-98
Study perspective	6	Describe the perspective of the study and relate this to the costs being evaluated.	Page 12/ Lines 189-197
Comparators	7	Describe the interventions or strategies being compared and state why they were chosen.	Pages 9-10/ Lines 125-140
Time horizon	8	State the time horizon(s) over which costs and consequences are being evaluated and say why appropriate.	Page 6/ Lines 98-99
Discount rate	9	Report the choice of discount rate(s) used for costs and outcomes and say why appropriate.	Page 12 /Line 198
Choice of health outcomes	10	Describe what outcomes were used as the measure(s) of benefit in the evaluation and their relevance for the type of analysis performed.	Page 11/ Lines 158-170
Measurement of effectiveness	11a	*Single study-based estimates:* Describe fully the design features of the single effectiveness study and why the single study was a sufficient source of clinical effectiveness data.	

	11b	*Synthesis-based estimates:* Describe fully the methods used for identification of included studies and synthesis of clinical effectiveness data.	Pages 9-11/ Lines 115-170
Measurement and valuation of preference based outcomes	12	If applicable, describe the population and methods used to elicit preferences for outcomes.	
Estimating resources and costs	13a	*Single study-based economic evaluation:* Describe approaches used to estimate resource use associated with the alternative interventions. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	
	13b	*Model-based economic evaluation:* Describe approaches and data sources used to estimate resource use associated with model health states. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	Page 11/ Lines 168-170
Currency, price date, and conversion	14	Report the dates of the estimated resource quantities and unit costs. Describe methods for adjusting estimated unit costs to the year of reported costs if necessary. Describe methods for converting costs into a common currency base and the exchange rate.	Page 12/Line 197-198
Choice of model	15	Describe and give reasons for the specific type of decision-analytical model used. Providing a figure to show model structure is strongly recommended.	Supplementary Figure 1
Assumptions	16	Describe all structural or other assumptions underpinning the decision-analytical model.	Pages 9-10/ Lines 118-120, 128-129, 135-140, 145-152
Analytical methods	17	Describe all analytical methods supporting the evaluation. This could include methods for dealing with skewed, missing, or censored data; extrapolation methods; methods for pooling data; approaches to validate or make adjustments (such as half cycle corrections) to a model; and methods for handling population heterogeneity and uncertainty.	Page 13/ Lines 210-214
Results			
Study parameters	18	Report the values, ranges, references, and, if used, probability distributions for all parameters. Report reasons or sources for distributions used to represent uncertainty where appropriate. Providing a table to show the input values is strongly recommended.	Pages 7-8/Table 1
Incremental costs and outcomes	19	For each intervention, report mean values for the main categories of estimated costs and outcomes of interest, as well as mean differences between the comparator groups. If applicable, report incremental cost-effectiveness ratios.	Pages 16-17/ Table 2
Characterising uncertainty	20a	*Single study-based economic evaluation:* Describe the effects of sampling uncertainty for the estimated incremental cost and	

		incremental effectiveness parameters, together with the impact of methodological assumptions (such as discount rate, study perspective).	
	20b	*Model-based economic evaluation:* Describe the effects on the results of uncertainty for all input parameters, and uncertainty related to the structure of the model and assumptions.	Page 21/ Lines 282-295
Characterising heterogeneity	21	If applicable, report differences in costs, outcomes, or cost-effectiveness that can be explained by variations between subgroups of patients with different baseline characteristics or other observed variability in effects that are not reducible by more information.	Pages 18-19/ Lines 267-281
Discussion			
Study findings, limitations, generalisability, and current knowledge	22	Summarise key study findings and describe how they support the conclusions reached. Discuss limitations and the generalisability of the findings and how the findings fit with current knowledge.	Pages 21-24
Other			
Source of funding	23	Describe how the study was funded and the role of the funder in the identification, design, conduct, and reporting of the analysis. Describe other non-monetary sources of support.	Page 26
Conflicts of interest	24	Describe any potential for conflict of interest of study contributors in accordance with journal policy. In the absence of a journal policy, we recommend authors comply with International Committee of Medical Journal Editors recommendations.	Pages 26-27

For consistency, the CHEERS Statement checklist format is based on the format of the CONSORT statement checklist

The **ISPOR CHEERS Task Force Report** provides examples and further discussion of the 24-item CHEERS Checklist and the CHEERS Statement. It may be accessed via the *Value in Health* link or via the ISPOR Health Economic Evaluation Publication Guidelines – CHEERS: Good Reporting Practices webpage: http://www.ispor.org/TaskForces/EconomicPubGuidelines.asp

The citation for the CHEERS Task Force Report is:
Husereau D, Drummond M, Petrou S, et al. Consolidated health economic evaluation reporting standards (CHEERS)—Explanation and elaboration: A report of the ISPOR health economic evaluations publication guidelines good reporting practices task force. Value Health 2013;16:231-50.

BMJ Open

Cost-Effectiveness Analysis of the Federal Menu Calorie Labeling and Obesity-Associated Cancer Burdens in the United States

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-063614.R1
Article Type:	Original research
Date Submitted by the Author:	11-Nov-2022
Complete List of Authors:	Du, Mengxi; Tufts University Friedman School of Nutrition Science and Policy, Griecci, Christina; Tufts University - Boston Campus, Friedman School of Nutrition and Policy Cudhea, Frederick; Tufts University Friedman School of Nutrition Science and Policy Eom, Heesun; New York Academy of Medicine, REAP Wong, John; Tufts Medical Center, Institute of Clinical Research and Health Policy Studies Wilde, Parke; Tufts University Friedman School of Nutrition Science and Policy Kim, David; Tufts Medical Center, Center for the Evaluation of Value and Risk in Health, Institute for Clinical Research and Health Policy Studies Michaud, Dominique; Tuft University School of Medicine, Wang, Y. Claire; Columbia University Mailman School of Public Health, Department of Health Policy and Management Mozaffarian, Dariush; Friedman School of Nutrition Science and Policy, Tufts University, Zhang, Fang-Fang; Tufts University Friedman School of Nutrition Science and Policy
Primary Subject Heading:	Health economics
Secondary Subject Heading:	Health policy, Public health, Nutrition and metabolism
Keywords:	Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, NUTRITION & DIETETICS, HEALTH ECONOMICS

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Cost-Effectiveness Analysis of the Federal Menu Calorie Labeling and Obesity-Associated Cancer Burdens in the United States

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Short Running Head: Cost-Effectiveness of Menu Calorie Labeling to Prevent Cancer

Word Count: 3895

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25 **Abbreviations:** AMPM, Automated Multiple Pass Method; BMI, Body Mass Index; CDC, Centers of Disease Control and Prevention; CI, Confidence Interval; DiCOM, Diet and Cancer Outcome Model; FDA, Food and Drug Administration; FNDDS, Food and Nutrient Database for Dietary Studies; MEC, Mobile Examination Center; NCHS, National Center for Health Statistics; NHANES, National Health and Nutrition Examination Survey; PSA, Probabilistic sensitivity analysis; SD, Standard Deviation; SE, Standard Error; USDA, United States Department of Agriculture; UI, Uncertainty Interval

ABSTRACT

Objective To assess the impact of menu calorie labeling on reducing obesity-associated cancer burdens in the United States (US).

Design Cost-effectiveness analysis using a Markov cohort state-transition model.

Setting Policy intervention.

Participants A modeled population of 235 million adults aged 20+ years in 2015-2016.

Interventions The impact of menu calorie labeling on reducing 13 obesity-associated cancers among US adults over a lifetime was evaluated in scenarios: (1) effects on consumer behaviors; and (2) additional effects on industry reformulation. The model integrated nationally representative demographics, calorie intake from restaurants, cancer statistics, and estimates on associations of policy with calorie intake, dietary change with BMI change, BMI with cancer rates, and policy and healthcare costs from published literature.

Main outcome measures Averted new cancer cases and cancer deaths and net costs (in 2015 US dollars) among total population and demographic subgroups. Incremental cost-effectiveness ratios from societal and healthcare perspectives were assessed and compared to the threshold of $150 000 per quality-adjusted life year (QALY) gained. Probabilistic sensitivity analyses incorporated uncertainty in input parameters and generated 95% uncertainty intervals (UIs).

Results Considering consumer behavior alone, this policy was associated with 28 000 (95% UI: 16 300-39 100) new cancer cases and 16 700 (9610-23 600) cancer deaths averted, 111 000 (64 800-158 000) QALY gained, and $1480 ($884-$2080) million saved in cancer-related medical costs among US adults. The policy was associated with net cost savings of $1460 ($864-$2060) million and $1350 ($486-$2260) million from healthcare and societal perspectives, respectively. Additional industry reformulation would substantially increase policy impact. Greater health gains and cost savings were predicted among young adults, Hispanic and non-Hispanic Black individuals.

Conclusions Study findings suggest that menu calorie labeling is associated with lower obesity-related cancer burdens and reduced healthcare costs. Policymakers may prioritize nutrition policies for cancer prevention in the US.

(Word Count: 300)

Keywords: obesity, cost-effectiveness, menu calorie labeling, cancer incidence, cancer death, medical cost

Strengths and limitations of this study

- Our study is among the first to demonstrate that the federal menu calorie labeling policy could be a cost-effective strategy to reduce obesity-related cancers in the US and potentially narrow diet-associated cancer disparities.
- This cost-effectiveness evaluation incorporated data input parameters from established resources and the evidence was robust to different policy scenarios.
- However, this modeling study does not provide a real-world evaluation of the impact of policy implementation on health and economic outcomes.
- We only modeled the impact of menu calorie labeling on calories although the policy may also result in potential changes in the nutritional quality of the restaurant meals.

INTRODUCTION

Obesity affects 1 in 3 Americans and is an established risk factor for 13 types of cancers, such as endometrial, liver, breast, prostate, and colorectal cancers.[1] Obesity-associated cancer represents 40% of all newly diagnosed cancer cases and contributes to 43.5% of total direct cancer care expenditures, estimated at $35.9 billion (US dollars) in 2015.[1-7] Rates of obesity-associated cancers are also rising disproportionately among young adults.[5 8] Substantial health and economic burdens highlight the need to prioritize cost-effective strategies to reduce obesity-associated cancers in the US.

Diet is one of the few modifiable factors for both obesity and obesity-associated cancers.[2 9] Restaurant meals account for 1 in 5 calories consumed by US adults, including 9% of calories from full-service restaurants and 12% from fast-food restaurants,[10] and therefore, can be an important target for improving population diet. Restaurant meals can have very high calories, with a mean energy of 1362 kcal/meal and 969 kcal/meal in popular meals from randomly selected full-service and fast-food restaurants, respectively.[11] Consistently, individuals who cook less frequently at home consume more daily calories than those who cook more at home.[12] Thus, reducing calories consumed from restaurant meals has the potential to reduce daily calorie intake and subsequent obesity and obesity-related cancer burdens.

To help consumers make lower-calorie choices, the Affordable Care Act mandated that all chain restaurants with 20 or more outlets post calorie information on menus and menu boards for all standard menu items.[13] The FDA published the final rules for this policy in 2016, which was subsequently implemented in 2018. A meta-analysis of 14 interventional studies including 5 randomized controlled trials (RCTs) and a recent quasi-experimental longitudinal study among 104 restaurants demonstrated that menu calorie labeling resulted in a reduction of 7.3% in caloric intake per meal and a 60 kcal (4%) reduction in calorie purchased per transaction, respectively.[14 15] Such policy can also motivate restaurant reformulation to lower calorie contents or introduce healthier food options.[16-21] Prior cost-effectiveness analyses suggest that this policy is associated with substantial health gains and is a cost-saving strategy for reducing obesity and obesity-related diseases.[22 23] It was estimated that the menu calorie labeling on fast foods was associated with a 25 kJ (6 kcal) reduction in mean daily energy intake, leading to a -0.2 kg change in mean body weight, a gain of 63 492 health-adjusted life years, and net savings of half billion (2010 Australian dollars) among Australians aged 2 years and above over their lifetime.[22] Researchers in the US have demonstrated that this policy would prevent a large number of incident cardiovascular diseases (135 781) and type 2 diabetes (99 736) and net savings of over $10 billion (2018 US dollars) among US adults over a lifetime.[22 23] However, the health and economic benefits of the policy for obesity-associated cancers have not been evaluated. This study aimed to address the knowledge gap by evaluating the cost-effectiveness of the federal menu calorie labeling and obesity-associated cancer burdens among US adults.

METHODS

Study Overview

The Diet and Cancer Outcome (DiCOM), a probabilistic cohort state-transition model,[24 25] was used to perform an economic evaluation of the menu calorie labeling and obesity-associated cancer rates among 235 million US adults aged 20 years and older (US Census), by comparing a policy scenario (menu calorie label) to status quo (no policy), over a simulated lifetime starting from 2015. The model consists of (1) four health states: healthy without cancer, initial diagnosis and treatment for 13 types of obesity-related cancers, continuous care for each of the 13 cancers, and death (from 13 cancers or other causes); (2) the annual likelihood of changes in health; and (3) the lifetime consequences of such changes on health outcomes and economic costs. (Supplementary Figure 1). The DiCOM model integrated independent parameters from different data sources, including nationally representative population demographics, dietary intake, and cancer statistics; association estimates of policy intervention with diet, diet change with body mass index (BMI), and BMI with cancer risks; and policy and health-related costs from established sources (**Table 1**). This study used de-identified datasets and was exempt from institutional review board review and follows the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) reporting guidelines.

Table 1. Key input parameters and data sources in the Dietary Cancer Outcome Model (DiCOM)

Model Input	Outcome	Estimates	Distribution	Comments	Data Source
1. Simulated population	Population	Mean consumption of calories was 332 kcal/d from full-service or fast-food restaurants (Supplementary Tables 1, 8-9)	Gamma	Stratified by age, sex, race/ethnicity; 32 subgroups	NHANES 2013-2016
2. Policy effect[1]					
a) Consumer behavior	Policy effect	7.3% (4.4%-10.1%) (Appendix 1 and Appendix Table 1)	Beta	One-time effect	Meta-analysis of labeling interventions on reducing calorie intake, Shangguan et al., 2019, American Journal of Preventative Medicine
b) Industry response	Policy effect	5% (Appendix 1 and Appendix Table 2)	Beta	Assumption: no reformulation in the 1st year of policy intervention; Restaurants will replace the high-calorie menu items with low-calorie options or reformulate the menu items in years 2 to 5 of the intervention to achieve a 5% reduction in calorie contents	Calorie changes in large chain restaurants from 2008 to 2015, Bleich et al. 2017, Prev Med; Higher-Calorie Menu Items Eliminated in Large Chain Restaurants, Bleich et al. 2018, American Journal of Preventative Medicine
3. Effect of change in calorie intake on BMI change (kg/m^2)[1]	Dietary effect	Among individuals with: BMI <25: 0.0015 per kcal BMI ≥25: 0.003 per kcal	Normal	Assumption: 55 kcal per day reduction in calorie intake would lead to 1 pound weight loss within 1 year, with no further weight loss in the future	Hall et al., 2018, JAMA; Hall et al., 2011, Lancet
4. Etiologic effect of BMI on cancer outcomes[1]	Cancer outcome	RRs ranged from 1.05 to 1.50 (Supplementary Table 2)	Lognormal	BMI change and cancer incidence	Continuous Update Project (CUP) conducted by the World Cancer Research Fund (WCRF)/American

					Institute for Cancer Research (AICR)
5. Cancer statistics[1]	Cancer incidence[3] and survival	Appendixes 2-3, Appendix Tables 2-3, and Supplementary Tables 3-4	Beta	Stratified by age, sex, and race/ethnicity	NCI's Surveillance, Epidemiology, and End Results Program (SEER) Database; CDC's National Program of Cancer Registries (NPCR) Database
6. Healthcare-related costs[1,2]	Medical expenditures, productivity loss, and patient time costs	Appendix 6, Appendix Table 6, and Supplementary Tables 6-7	Gamma	Stratified by age, and sex	NCI's Cancer Prevalence and Cost of Care Projections; Published literature
7. Policy costs[1,2]	For government and industry	Appendix 5 and Appendix Tables 4-5	Gamma	Administration and monitoring costs for government; compliance and reformulation costs for industry	FDA's budget report; Nutrition Review Project; and FDA's RIA
8. Health-related quality of life (HRQOL)[1]	For 13 types of cancers	Ranged from 0.64 to 0.86 (Appendix 4 and Supplementary Table 5)	Beta	EQ-5D[4] data from published literature by cancer type	Published literature

Abbreviations: BMI, Body Mass Index; FDA, Food and Drug Administration; NCI, National Cancer Institute; NHANES, National Health, and Nutrition Examination Survey; UK, United Kingdom.
1. Uncertainty distributions were incorporated in the probabilistic sensitivity analyses. Uncertainties in each parameter were presented in supplemental materials (Table TS3 and Tables S3-9).
2. If the source did not provide uncertainty estimates, we assumed the standard errors were 20% of the mean estimate to generate gamma distribution.
3. Time-varying input parameter, for which the model accounted the secular trends. Details were provided in the Supplements.
4. EQ-5D is a standardized instrument developed by the EuroQol Group as a measure of health-related quality of life that can be used in a wide range of health conditions and treatments.

Simulated US Population

Because FDA's final rules on menu calorie labeling were published in 2016 and implemented in 2018, considering that some restaurants have implemented this policy prior to 2016 given the law was passed in 2010, we used 2015-2016 as the baseline and assumed a closed cohort for this analysis. The projected population size of US adults aged 20+ in 2015-2016 was obtained from the US Census data.[26] We combined the 2013-2016 National Health and Nutrition Examination Survey (NHANES) to approximate the baseline and simulate the nationally representative US adult population aged 20+ years in 32 subgroups stratified by age (20-44, 45-54, 55-64, 65+), sex (men, women), and race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, Other) (Supplementary Table 1). This closed cohort of US adults was modeled from baseline through their lifetime up to 80 years or until death.

Calorie Consumption from Restaurants

Mean calorie consumption from full-service and fast-food restaurants, demographics, and prevalence of overweight or obesity were estimated using data collected from NHANES participants with at least one valid 24-hour diet recall, in every 32 strata. Following FDA's estimates,[13] we assumed that policy would affect 56.5% of calories consumed at full-service restaurants and 100% at fast-food restaurants. The National Cancer Institute method was used to estimate the usual intake distribution by statistically adjusting for within vs. between variance in dietary recalls.[27-29] The complex survey design was incorporated in all statistical analyses to ensure the representativeness of study findings to the non-institutionalized US adults.

Policy Association with Calorie Consumption

Policy association with consumer behaviors was obtained from a systematic review and meta-analysis of 13 interventional studies (5 RCTs) with 19 interventions conducted in fast-food, full-service, cafeterias, and laboratories between 2000 and 2015 that evaluated the effectiveness of menu calorie labeling on consumers' calorie consumption per meal (Appendix 1 and Appendix Table 1).[15] The study results showed a 7.3% (95% CI: 4.4%-10.1%) reduction in calories consumed per meal following calorie labeling. We assumed that the policy would have a one-time effect over one year, with no further change over time.

Policy intervention may stimulate industries to reformulate their products to lower the calorie content. Potential policy impact on industry reformulation was derived from studies of restaurant menu items following the passage and initial period of partial implementation of the final rules (Appendix Table 2). Between 2012-2014, among 66 of the 100 largest US chain restaurants, replacing higher-calorie menu items with lower-calorie items led to a 1-5% calorie reduction per menu item.[19 20] Among 44 chain restaurants with menu calorie information available in 2008, the calories per menu item fell by 7% between 2008 and 2015.[18] Based on the evidence, we chose 5% as the mid-point for the potential policy impact on industry response, which may include discontinuation of existing high-calorie menu items and/or introduction of lower-calorie menu items. We assumed that no reformulation occurs in the 1st year of policy intervention, and restaurants will replace the high-calorie menu items with low-calorie options or reformulate the menu items in years 2 to 5 of the intervention to achieve a 5% reduction in calorie content, with no change thereafter. Combining the effect on consumer behaviors with the effect on industry response, the policy would lead to a 12.3% reduction in calories consumed per meal.

In addition, we conservatively assumed that there would be some compensatory increased calorie intake outside of restaurants so that only half of all calories reduced from restaurant meals would translate into long-term reductions in daily calories (compensation rate = 50%). Therefore, the reduction in calorie consumption from fast-food or full-service restaurants among the simulated population was computed using the baseline consumption times the policy effect estimates, and then times the compensation rate.

Calorie Reduction and Obesity-Associated Cancer Risk

To estimate the relationships between calorie intake and obesity-associated cancers, we associated the multivariate-adjusted association of change in calorie intake (kcal/day) with change in BMI (kg/m^2) and the estimates of BMI and cancer risks. Based on an established energy-weight dynamic model that accounted for the long-term impacts of calorie reduction on weight and metabolic expenditure, we assumed that each 55 kcal/day calorie reduction leads to 1 pound weight loss over one year among overweight or obese adults, with no further reduction thereafter.[30 31] Because long-term observational studies suggest that weight change for an equivalent change in dietary intake is about twice as large in overweight or obese adults than normal-weight adults,[32 33] we conservatively applied half of this estimate to individuals with normal weight. For each of the 13 obesity-related cancers, the estimated change in risk for each 5 kg/m^2 change in BMI was derived from the systematic reviews and meta-analyses of multivariable-adjusted prospective cohort studies conducted by the World Cancer Research Fund/American Institute for Cancer Research Continuous Update Project and the International Agency for Research on Cancer (Supplementary Table 2).[2]

Cancer Incidence, Mortality, and Health-Related Quality of Life

Age-adjusted cancer incidences in 2015 were obtained from the National Program of Cancer Registries and the Surveillance, Epidemiology, and End Results (SEER) program. We projected the cancer incidence from 2015 to 2030 based on the 2006-2014 trend using the Average Annual Percent Change method.[34] We then combined the projected incidence rates with the projected US population from the National Interim Projections[35] to account for changes in population age distribution over time. We further applied the cohort-period method to estimate cancer incidence in the closed cohort of US adults in each of the 32 groups as they age (Appendix 2, Appendix Table 2, and Supplementary Table 3). The 5-year relative survival rates for each cancer were extracted and converted to an annual probability of death (Appendix 3, Appendix Table 3, and Supplementary Table 4).[36-38] Health-related quality of life data were obtained from publications that reported EuroQol-5 Dimension utility weights for each cancer among US patient population (Appendix 4 and Supplementary Table 5).

Policy and Health-Related Costs

Policy costs included government costs to administer, monitor, and evaluate the policy and industry costs to comply with the policy and reformulate their products (in scenario 2). Government costs were estimated from FDA's budget report and Nutrition Review Project (Appendix 5 and Appendix Tables 4-5).[39 40] Industry compliance and reformulation costs were based on the FDA's regulatory impact analysis that included initial and recurring nutrition analysis of standard menu items and menu replacement, provision of nutrition information, employee training, and legal review and accounted for restaurant size and type, reformulation type, and compliance period.[13]

Direct medical costs for cancer care were extracted from the SEER-Medicare linked database for three phases of cancer care: initial (12 months after diagnosis), continuing, and end-of-life (the last year of life) (Appendix 6, Appendix Table 6, and Supplementary Tables 6-7).[34 41] For individuals without cancer, the direct medical costs were estimated based on Medical Expenditure Panel Survey (MEPS) data and insurance claims.[25 42 43] Indirect costs including productivity loss due to disability or missed workdays and patient time costs were derived from publications using MEPS data.[44-47]

Cost-Effectiveness Analysis

Following the guidelines on cost-effectiveness in health and medicine,[48] we evaluated the policy impact by projecting the numbers of new cancer cases and cancer deaths averted and quality-adjusted life-years (QALYs) gained and cost-effectiveness from both healthcare and societal perspectives. Net costs from the healthcare perspective were assessed as the difference between government costs for implementing the policy and the direct medical costs of cancer care. Net costs from the societal perspective were assessed as the difference between total policy costs (including both government and industry costs) and health-related costs saved (including direct and indirect costs of cancer care). All costs were inflated to 2015 US dollars using the Consumer Price Index or Personal Health Care Index, with all costs and QALYs discounted at 3% annually.[48] Incremental cost-effectiveness ratios (ICERs) were calculated as net costs divided by the difference in QALYs between policy vs. no policy. ICERs falling below a willingness-to-pay threshold of $150,000 per QALY gained were considered to be cost-effective.[49 50] Cost-effectiveness analysis was further conducted among population subgroups by age, sex, and race/ethnicity to evaluate policy associations with health disparities.

One-way sensitivity analyses were performed by varying input parameters, including reducing the outside-the-restaurant calorie compensation level to 25% or increasing it to 75%, altering coverage of the FDA's final rule to all calories from full-service restaurants, reducing the diet-BMI associations to half or doubling the estimates, incorporating an estimated 2% annual increase in medical expenditures associated with cancer care, and altering annual discounting rates from 3% to 0% or 5%. We also evaluated impacts at a 10-year time horizon for stakeholders interested in shorter-term health gains and economic benefits. Probabilistic sensitivity analyses (PSAs) were conducted to incorporate uncertainty in all input parameters jointly (**Table 1**). A total of 1000 Monte Carlo simulations were performed, and 95% uncertainty intervals (UIs) were estimated based on the 2.5 and 97.5 percentiles of 1,000 simulations. All analyses were conducted using SAS (Version 9.4) and R (Version 3.3.1).

Patient and Public Involvement

This study used de-identified datasets and did not involve patients or the public in the design, conduct, reporting, or dissemination plans of our research.

RESULTS

Population Characteristics

The simulated cohort of US adults in 2015-2016 had a mean age of 47.8 years, with 65.0% being non-Hispanic white adults and 71.4% being overweight or obese (Supplementary Tables 8-9). A mean of 332 daily calories was consumed from full-service or fast-food restaurants. Higher levels were consumed among younger adults aged 20-44 years (425 kcal/day), men (388 kcal/day), non-Hispanic black (361 kcal/day), and Hispanic (367 kcal/day) adults, in comparison to other corresponding subgroups.

Health Gains

The menu calorie labeling was estimated to reduce calories consumed from restaurants by a mean of 24 kcal/day among US adults, and total daily calories by 12 kcal/day. Accounting for potential industry reformulation would reduce the mean intake by an additional 16 kcal/day, and total daily calories by 8 kcal/day.

Based on changes in consumer behavior alone, the policy was associated with a reduction of 28,000 (95% UI: 16,300-39,100) new cancer cases and 16,700 (9,610-23,600) cancer deaths, and a gain of 111,000 (64,800-158,000) QALYs among 235 million US adults over a median follow-up of 34.4 years (**Table 2 and Figure 1**). By cancer type, the greatest numbers of new cancer cases averted were cancers of endometrial (N [95% UI]: 5,700 [2,380-9,190]), liver (5,180 [2,800-7,730]), kidney (5,090 [2,670-7,730]), post-menopausal breast (4,840 [2,010-8,230]), and pancreas (1,400 [756-2,100]). The greatest numbers of prevented cancer deaths were estimated for cancers of the liver (4,530 [2,410-6,760]), post-menopausal breast (3,080 [861-5,650]),

endometrial (2,060 [957-3,220]), kidney (1,980 [1,080-2,920]), and pancreas (1,230 [661-1,830]).

Based on additional industry response, the total estimated health gains approximately doubled, preventing 47,300 (35,400-59,100) new cancer cases and 28,200 (21,100-35,300) cancer deaths, and gaining 189,000 (140,000-236,000) QALYs, with similar rankings of the types of new cancer cases and cancer deaths prevented.

Table 2. Estimated health gains and costs of the federal menu calorie labeling on reducing the obesity-related cancer burdens in the US over 10 years and a lifetime (US population=235,162,844)[1]

	Menu Calorie Labeling Policy			
	10 Years		Lifetime	
	Consumer Behavior Median (2.5% to 97.5%)	**Consumer Behavior + Industry Response** Median (2.5% to 97.5%)	**Consumer Behavior** Median (2.5% to 97.5%)	**Consumer Behavior + Industry Response** Median (2.5% to 97.5%)
New Cancer Cases Averted, N (95% UI)				
Endometrial cancer	692 (276 to 1100)	1130 (716 to 1550)	5700 (2380 to 9190)	9920 (6630 to 13600)
Liver cancer	366 (144 to 615)	626 (386 to 887)	5180 (2800 to 7730)	8550 (5960 to 11300)
Kidney cancer	584 (290 to 884)	980 (689 to 1280)	5090 (2670 to 7470)	8620 (6200 to 11000)
Breast cancer (postmenopausal)	670 (256 to 1110)	1080 (658 to 1520)	4840 (2010 to 8230)	8520 (5610 to 12200)
Pancreatic cancer	170 (83 to 257)	273 (183 to 367)	1400 (756 to 2100)	2380 (1690 to 3140)
Esophageal adenocarcinoma	179 (56 to 304)	286 (159 to 411)	1350 (485 to 2230)	2330 (1440 to 3280)
Colorectal cancer	189 (97 to 284)	319 (225 to 418)	1050 (561 to 1600)	1780 (1230 to 2370)
Multiple myeloma	75 (37 to 117)	122 (81 to 169)	690 (384 to 1090)	1150 (775 to 1630)
Stomach cancer (cardia)	54 (6 to 109)	98 (51 to 165)	647 (261 to 1140)	1090 (644 to 1660)
Thyroid cancer	105 (58 to 161)	176 (123 to 243)	516 (206 to 914)	951 (576 to 1420)
Advanced prostate cancer	66 (17 to 118)	107 (57 to 162)	339 (138 to 561)	577 (352 to 836)
Gallbladder cancer	29 (16 to 42)	46 (34 to 60)	314 (213 to 438)	512 (399 to 648)
Ovarian cancer	33 (15 to 56)	53 (33 to 78)	147 (44 to 282)	254 (110 to 420)
Total	3300 (1750 to 4720)	5230 (3870 to 6790)	28000 (16300 to 39100)	47300 (35400 to 59100)
Cancer Deaths Prevented, N (95% UI)				
Liver cancer	168 (59 to 287)	287 (174 to 410)	4530 (2410 to 6760)	7510 (5200 to 9980)
Breast cancer (postmenopausal)	68 (33 to 106)	111 (74 to 149)	3080 (862 to 5650)	5590 (3230 to 8310)
Endometrial cancer	52 (20 to 86)	87 (55 to 121)	2060 (957 to 3220)	3520 (2390 to 4700)
Kidney cancer	70 (29 to 110)	114 (74 to 154)	1980 (1080 to 2920)	3320 (2430 to 4300)
Pancreatic cancer	88 (38 to 138)	143 (93 to 195)	1230 (661 to 1830)	2080 (1480 to 2740)
Esophageal adenocarcinoma	76 (21 to 131)	122 (69 to 178)	1150 (403 to 1930)	1990 (1210 to 2820)
Colorectal cancer	34 (17 to 53)	57 (40 to 77)	706 (369 to 1080)	1200 (839 to 1600)
Stomach cancer (cardia)	22 (2 to 48)	40 (19 to 68)	541 (230 to 947)	907 (538 to 1400)
Multiple myeloma	18 (8 to 30)	29 (18 to 42)	420 (239 to 662)	691 (481 to 980)
Gallbladder cancer	13 (7 to 20)	21 (15 to 28)	267 (181 to 369)	436 (341 to 551)
Advanced prostate cancer	9 (3 to 15)	13 (7 to 19)	163 (65 to 280)	273 (163 to 404)
Ovarian cancer	8 (3 to 15)	13 (7 to 20)	107 (39 to 191)	181 (94 to 290)
Thyroid cancer	1 (1 to 2)	2 (1 to 3)	23 (11 to 38)	38 (24 to 58)
Total	654 (320 to 970)	1080 (746 to 1400)	16700 (9610 to 23600)	28200 (21100 to 35300)
Life Years Gained	678 (288 to 1040)	1120 (738 to 1490)	76400 (43400 to 109000)	130000 (96900 to 162000)
QALYs Gained	4280 (2170 to 6250)	7030 (4960 to 9090)	111000 (64800 to 158000)	189000 (140000 to 236000)

Changes in Health-Related Costs ($, millions)[2,3]				
Healthcare (medical) cost	-192 (-277 to -100)	-319 (-403 to -227)	-1480 (-2080 to -884)	-2500 (-3090 to -1900)
Patient time cost	-7.33 (-10.9 to -3.56)	-12.2 (-15.8 to -8.39)	-102 (-144 to -62.2)	-172 (-216 to -131)
Productivity loss	-48.7 (-70.1 to -24.5)	-80.4 (-102 to -56.7)	-608 (-865 to -363)	-1030 (-1290 to -780)
Policy Implementation Costs ($, millions)[2,3]				
Total	518 (493 to 548)	644 (612 to 680)	839 (780 to 908)	1140 (1060 to 1220)
Government cost	13.2 (11.4 to 15.9)	13.1 (11.4 to 15.7)	18.5 (14.5 to 25.1)	18.5 (14.4 to 25.5)
Administration	9.08 (8.59 to 9.60)	9.07 (8.64 to 9.50)	9.07 (8.61 to 9.56)	9.09 (8.62 to 9.55)
Monitoring	4.09 (2.40 to 6.74)	4.00 (2.35 to 6.63)	9.40 (5.45 to 16.1)	9.38 (5.30 to 16.3)
Industry cost	505 (480 to 535)	631 (599 to 667)	820 (762 to 889)	1120 (1040 to 1210)
Compliance	505 (480 to 535)	506 (480 to 533)	820 (762 to 889)	823 (757 to 889)
Reformulation	-------	124 (107 to 146)	-------	296 (249 to 353)
Net Costs ($, millions)[2,3,4]				
Societal perspective	270 (156 to 389)	233 (119 to 356)	-1350 (-2260 to -486)	-2570 (-3460 to -1650)
Healthcare perspective	-179 (-263 to -86.3)	-305 (-390 to -214)	-1460 (-2060 to -864)	-2480 (-3070 to -1880)
ICER (dollars/QALY)[5]				
Societal perspective	64500 (26100 to 187000)	33600 (13300 to 72400)	Dominant	Dominant
Healthcare perspective	Dominant	Dominant	Dominant	Dominant

Abbreviations: ICER, Incremental Cost-Effectiveness Ratio; QALY, quality-adjusted life years.

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.
2. Health-related costs were inflated to 2015 US dollars using the Personal Health Care (PHC) index. Policy intervention costs were inflated to 2015 US dollars using the Consumer Price Index. Negative costs represent savings.
3. Costs are medians from 1000 simulations so may not add up to totals.
4. Net costs were calculated as policy costs minus health-related costs from reduced cancer burden. The societal perspective includes healthcare costs, patient time costs, productivity costs, and policy implementation costs; the government perspective included policy costs relevant to policy implementation and program monitoring and evaluation, and medical costs.
5. ICER threshold was evaluated at $150,000/QALY. Dominant represents less costly and more effective than the “no-policy intervention” scenario.

Economic Impacts

Implementing the policy would cost the government $19 (95% UI: $15-25) million and the restaurant industry, $820 ($762-889) million in compliance costs over a lifetime (**Table 2**). The policy was associated with savings of $1480 ($884-2080) million in direct medical costs, $608 ($363-865) million in productivity loss costs, and $102 ($62-144) million in patient time costs. Potential industry reformulation would cost the restaurant industry an additional $296 ($249-353) million to implement but would also result in greater healthcare savings, including $2,500 ($1,900-3,090) million, $1,030 ($780-1,290) million and $172 ($131-216) million in reduced direct medical, productivity loss, and patient time costs, respectively.

From both the healthcare and social perspectives, implementing the menu calorie labeling policy among US adults over a lifetime would be cost-saving. With changes in consumer behavior alone, the net cost savings were estimated to be $1,460 ($864-2,060) million and $1,350 ($486-2,260) million from the healthcare and societal perspective, respectively. With additional industry response, estimated cost savings increased to $2,480 ($1,880-3,070) million from the healthcare perspective and $2,570 ($1,650-3,460) million from the societal perspective.

Policy Impacts Among Population Subgroups

Among population subgroups, the consumer response to the policy was estimated to result in greater health gains per 100,000 individuals among adults aged 20-44 years (15 new cancer cases averted) and 55-64 years (16 new cancer cases averted) than older age groups (aged 65+ years; 6 new cancer cases averted); Hispanic and non-Hispanic Black individuals than Non-Hispanic White group (22 vs. 9 and 17 vs. 9 new cancer cases averted) (**Table 3**). The numbers of cancer

deaths averted, life-years and QALYs gained, health-related costs saved, and net costs among population subgroups followed a similar pattern (Supplementary Tables 10-11 and Supplementary Figures 2-5). For instance, the policy was associated with more cancer deaths prevented per 100,000 individuals among younger adults aged 20-44 years than older adults aged 65+ years (10 vs. 3 cancer deaths averted) and Hispanic and non-Hispanic Black adults than non-Hispanic White individuals (14 vs. 5 and 11 vs. 5 cancer deaths averted). Adding potential industry reformulations resulted in larger health gains among adults aged 45-54 (128% increase in new cancer cases averted) and non-Hispanic White adults (84% increase in new cancer cases averted).

Table 3. Estimated new cancer cases and deaths prevented by the federal menu calorie labeling policy in the US by age, sex, and race/ethnicity, over a lifetime[1]

	Consumer Behavior		Consumer Behavior + Industry Response	
	N (95% UI)	Per 100,000 individuals (95% UI)	N (95% UI)	Per 100,000 individuals (95% UI)
New Cancer Cases Averted				
Age				
20-44	15700 (6170 to 25100)	15.0 (5.89 to 24.0)	28000 (18000 to 37500)	26.7 (17.2 to 35.8)
45-54	2810 (-2110 to 8030)	6.61 (-4.97 to 18.9)	6420 (1390 to 11600)	15.1 (3.27 to 27.2)
55-64	6330 (3540 to 9400)	15.7 (8.76 to 23.3)	8640 (5790 to 11800)	21.4 (14.3 to 29.1)
≥65	2740 (795 to 4650)	5.77 (1.68 to 9.80)	4060 (2070 to 5950)	8.55 (4.36 to 12.6)
Sex				
Female	15100 (6650 to 24000)	12.5 (5.51 to 19.8)	25900 (17400 to 34900)	21.4 (14.4 to 28.9)
Male	12500 (4920 to 20100)	10.9 (4.30 to 17.6)	21100 (13500 to 29100)	18.4 (11.8 to 25.4)
Race/Ethnicity				
Non-Hispanic White	14300 (4310 to 24500)	9.16 (2.77 to 15.7)	26300 (16000 to 36700)	16.9 (10.3 to 23.6)
Non-Hispanic Black	4720 (1820 to 8100)	16.6 (6.37 to 28.4)	7630 (4750 to 11100)	26.8 (16.7 to 38.9)
Hispanic	7700 (3560 to 11500)	21.5 (9.93 to 32.2)	11200 (7060 to 15300)	31.3 (19.7 to 42.6)
Other	1150 (-240 to 2440)	7.60 (-1.59 to 16.2)	1990 (652 to 3310)	13.2 (4.33 to 22.0)
Cancer Deaths Prevented				
Age				
20-44	10200 (4170 to 16400)	9.73 (3.98 to 15.7)	18100 (11700 to 24500)	17.3 (11.2 to 23.4)
45-54	1730 (-853 to 4240)	4.07 (-2.01 to 9.97)	3650 (1040 to 6240)	8.58 (2.44 to 14.7)
55-64	3320 (1760 to 4930)	8.21 (4.36 to 12.2)	4480 (2890 to 6090)	11.1 (7.15 to 15.1)
≥65	1200 (285 to 2130)	2.53 (0.60 to 4.48)	1800 (848 to 2720)	3.79 (1.79 to 5.73)
Sex				
Female	7810 (3290 to 12600)	6.47 (2.73 to 10.5)	13400 (8850 to 18500)	11.1 (7.33 to 15.3)
Male	8510 (3500 to 13900)	7.44 (3.06 to 12.1)	14400 (9300 to 20000)	12.6 (8.13 to 17.5)
Race/Ethnicity				
Non-Hispanic White	7920 (2180 to 13900)	5.08 (1.40 to 8.94)	14700 (8770 to 20900)	9.45 (5.64 to 13.5)
Non-Hispanic Black	3010 (1000 to 5370)	10.6 (3.51 to 18.8)	4990 (2950 to 7380)	17.5 (10.4 to 25.9)
Hispanic	4960 (2360 to 7560)	13.8 (6.58 to 21.1)	7190 (4480 to 9870)	20.0 (12.5 to 27.5)
Other	565 (-246 to 1350)	3.75 (-1.63 to 8.97)	1070 (273 to 1870)	7.12 (1.81 to 12.4)

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.

Sensitivity Analyses

In PSA, based on consumer responses alone, the menu calorie labeling was cost-saving over a lifetime in 93% of 1000 simulations and cost-effective (<$150,000/QALY) in the remaining 7% from the societal perspective, and was cost-saving in over 98% of 1000 simulations from the healthcare perspective. Adding the additional industry response increased the probability of cost-savings to nearly 100% of the simulations for both the societal and healthcare perspectives (**Figure 2**).

Evaluating health gains, costs, and cost-effectiveness at 10 years, the policy remained cost-saving from the healthcare perspective and was cost-effective from the societal perspective, with an ICER of $64,500 (26,100-187,000) per QALY based on consumer response alone and $33,600 (13,300-72,400) per QALY with additional industry response. The cost-effectiveness of this policy was most sensitive to varied assumptions of the diet-BMI estimates and annual discounting rates (Supplementary Tables 12-13 and Supplementary Figure 6).

DISCUSSION

This study estimated that the federal menu calorie labeling policy, based on consumer response alone, was associated with a reduction of approximately 28,000 new cancer cases and 16,700 cancer deaths among US adults over a lifetime, and net savings of $1,350 and $1,460 million from societal and healthcare perspectives, respectively. Incorporating additional modest industry responses, these health and economic gains were approximately doubled. Greater health gains were expected among younger, middle-aged subgroups, Hispanic, and non-Hispanic Black

individuals compared with other subgroups. Findings were robust to a range of probabilistic and one-way sensitivity analyses.

Our study findings supported that nutrition policies can have meaningful health and economic impacts on cancer prevention in the US. In this case, a modest change in mean calorie consumption, distributed across the population, was estimated to achieve important reductions in obesity-related cancer burdens among US adults. Using the best available estimates, our study further suggested that the federal menu calorie labeling policy is cost-effective in the short term and cost-saving in the long term in reducing obesity-associated cancer burdens. Many preventive medical screenings are cost-effective, but none of them achieve net savings. For example, among a large cohort of women born in the 1960s over a lifetime, mammography screening starting at age 45 years was estimated to have an ICER of $40 135/QALY.[51] Colonoscopy screening starting at age 45 years among U.S. adults achieved an ICER of $33 900/QALY.[52] Prostate-specific antigen screening had an ICER of $70 831 to $136 332/QALY among U.S. males beginning at 40 years of age over a lifetime.[53] In contrast, population-based nutrition interventions could be a cost-saving strategy for cancer prevention. Cost-effectiveness analyses showed that a penny-per-ounce tax on sugar-sweetened beverages would be a highly cost-effective strategy for cancer prevention among US adults, with an ICER of 13 220, the nutrition facts added sugar labeling would prevent 30 000 incident obesity-related cancer cases and 17 100 cancer deaths and be associated with a net saving of 704 million, and processed meat taxes would avert 77 000 colorectal cancer cases and 12 500 stomach cancer cases save 4.5 billion, all from the societal perspective.[24 54 55] Thus, while we shall continue the efforts of increasing the screening rates, we also need to consider population-based strategies to improve nutrition for cancer prevention in the US.

Our findings also indicated the importance of assessing potential industry response, which could nearly double health and economic benefits. The additional impacts of industry reformulation in response to nutrition-related policies have been reported in other studies focused on obesity-associated cancer, diabetes, and cardiovascular diseases.[23 55-57] Our new findings build on this recent work and highlight the importance of potential strategies to encourage industry reformulation under the federal menu calorie labeling framework to further improve the health benefits and cost-effectiveness of such policies.

In addition, our results showed that population-based nutrition policies such as menu calorie labeling can potentially narrow diet-associated cancer disparities. We found greater health gains and economic impacts among racial/ethnic minorities compared to non-Hispanic whites, likely due to higher diet-associated cancer burdens among minorities.[58] However, labeling policies may have fewer effects on food purchasing behaviors among minorities or socioeconomically disadvantaged groups. Prior studies reported that individuals with higher education and income attainment were more likely to notice and use the menu calorie labels when ordering foods in fast-food or full-service restaurants compared to socioeconomically disadvantaged groups,[59-61] and multi-racial individuals were less likely to notice and use menu calorie labels in fast food restaurants than non-Hispanic whites.[59] Previous studies also showed that literacy or numeracy could be a barrier to label use.[62 63] Thus, it is important for labeling policies to be paired with nutrition education to effectively reduce diet-associated health disparities.

Potential limitations should be considered. First, as a modeling study, our investigation does not provide the impact of real-world policy implementation on the health and economic outcomes of federal menu calorie labeling. However, conducting randomized controlled trials of national nutrition policy interventions is extremely difficult and often implausible while simulation modeling can provide complementary evidence with the flexibility to assess different policy scenarios that help inform policymaking. Second, this evaluation did not include the potential benefits of menu calorie labeling on other health outcomes such as diabetes and cardiovascular diseases. Considering such outcomes is likely to be associated with greater health gains and cost savings.[23 64 65] Third, menu calorie labeling could have a greater effect among subgroups with higher levels of income and education and non-Hispanic white adults[59-61] and thus exacerbating health disparities. Due to the lack of consistent policy effect sizes among populations with different socioeconomic statuses, we were unable to integrate this into our modeling. Forth, we only modeled the impact of menu calorie labeling on calories although the policy may also result in potential changes in the nutritional quality of the restaurant meals. The majority of current restaurant meals consumed by American adults – 70% of meals consumed from fast-food restaurants and 50% consumed from full-service restaurants – are of poor nutritional quality, and the remainder is only of intermediate nutritional quality, with very few being ideal.[10] If the policy also improves the quality of restaurant meals, the total reduction in obesity-associated cancer burdens could be greater than our current estimates.

CONCLUSIONS

Study findings suggest that menu calorie labeling is associated with lower obesity-related cancer rates and reduced costs. Policymakers may prioritize nutrition policies for cancer prevention in the US.

Ethics approval: This study used de-identified datasets and was exempt from institutional review board review.

Data sharing: Data described in the manuscript, codebook, and analytic code will be made available upon request.

Transparency Statement: The author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

Dissemination Declaration: Dissemination to the simulated population is not applicable.

Contributors: MD contributed to the data curation, formal analysis, visualization, original draft preparation, review and editing; CFG contributed to the data curation, review and editing; FFC, HE and DDK contributed to software; JBW, PW, DDK, DSM, YCW, and DM contributed to the review and editing; FFZ contributed the conceptualization, methodology, review and editing, supervision, and funding acquisition. All authors approved the final version. FFZ acts as the guarantor of the study.

Role of the funding source: This study was supported by NIH/NIMHD 1R01MD011501. The funding sources had no role in the design or conduct of the study; collection, management, analysis, or interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.

Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted work. JBW reports leadership or fiduciary role in the US Preventive Services Task Force. DK reports research funding from the National Institutes of Health, Arnold Ventures, Pharmaceutical Research and Manufacturers of America, Sarepta Therapeutics, and Janssen

Therapeutics; consulting fees from Panalgo and the American College of Physicians. DM reports research funding from the National Institutes of Health, Gates Foundation, Rockefeller Foundation, and Vail Institute for Global Research; consulting fees from Acasti Pharma, Barilla, Danone, and Motif FoodWorks; participating on scientific advisory boards of start-up companies focused on innovations for health including Beren Therapeutics Brightseed, Calibrate, DayTwo, Elysium Health, Filtricine, Foodome, HumanCo, January Inc., Perfect Day, Season, and Tiny Organics; and chapter royalties from UpToDate. All of the above is outside the submitted work. No other relationships or activities could appear to have influenced the submitted work.

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Figure 1. Estimated New Cancer Cases and Deaths Prevented by Federal Menu Calorie Labeling Policy in the US by Cancer Type over a Lifetime

Figure 2. Probabilistic Sensitivity Analyses (PSA) for Cost-Effectiveness of the Federal Menu Calorie Labeling Policy over 10 years and a Lifetime

Legend: Values are presented in cost-effectiveness planes of net costs ($millions) versus incremental quality-adjusted life years (QALYs). For each policy scenario, each colored dot represents one of the 1000 simulations, with the largest dot showing the median incremental cost-effectiveness ratio (ICER, $/QALY); and the ellipse representing the 95% UIs. Results are presented from the societal perspective and the healthcare perspective. Negative values indicate cost savings.

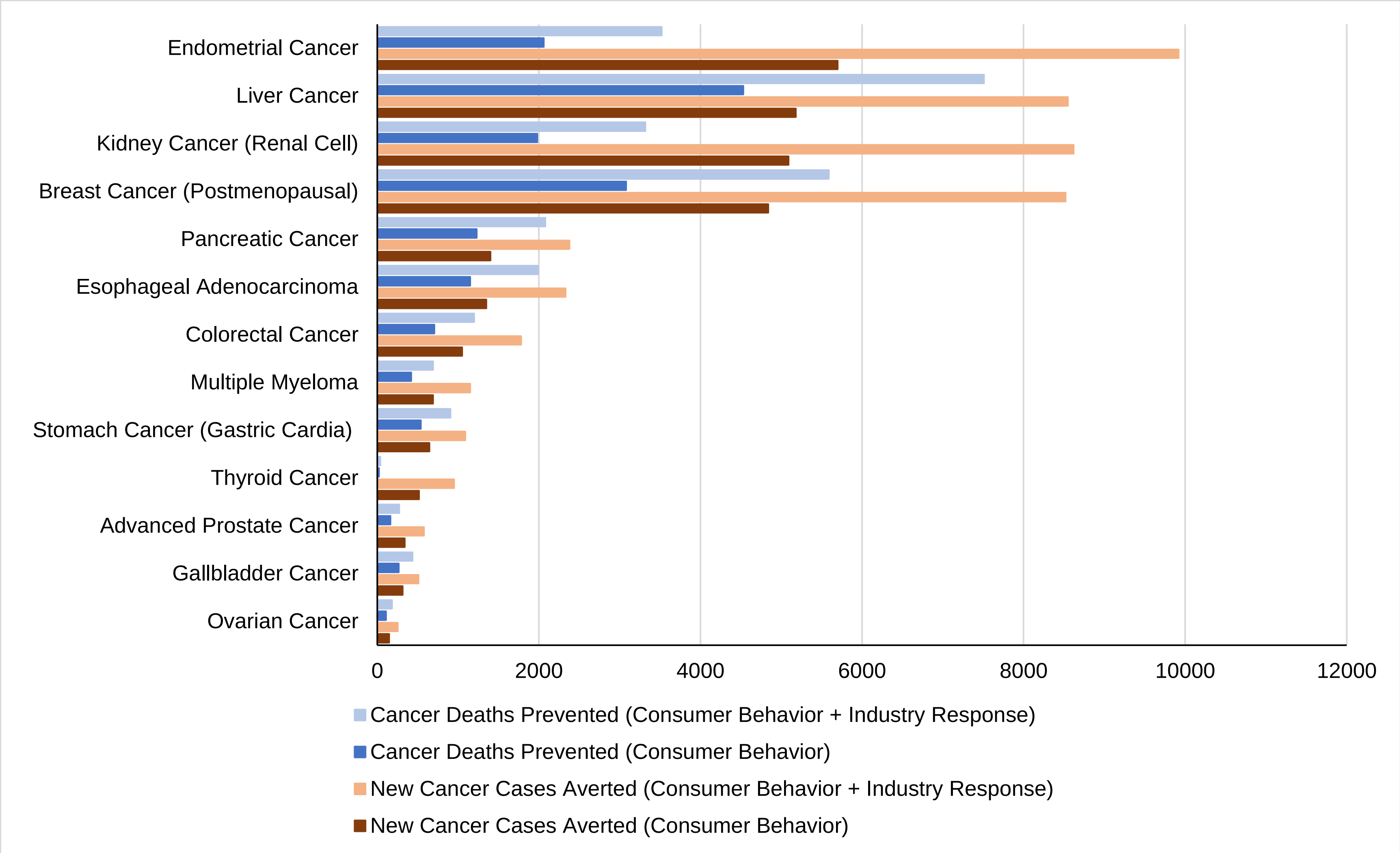
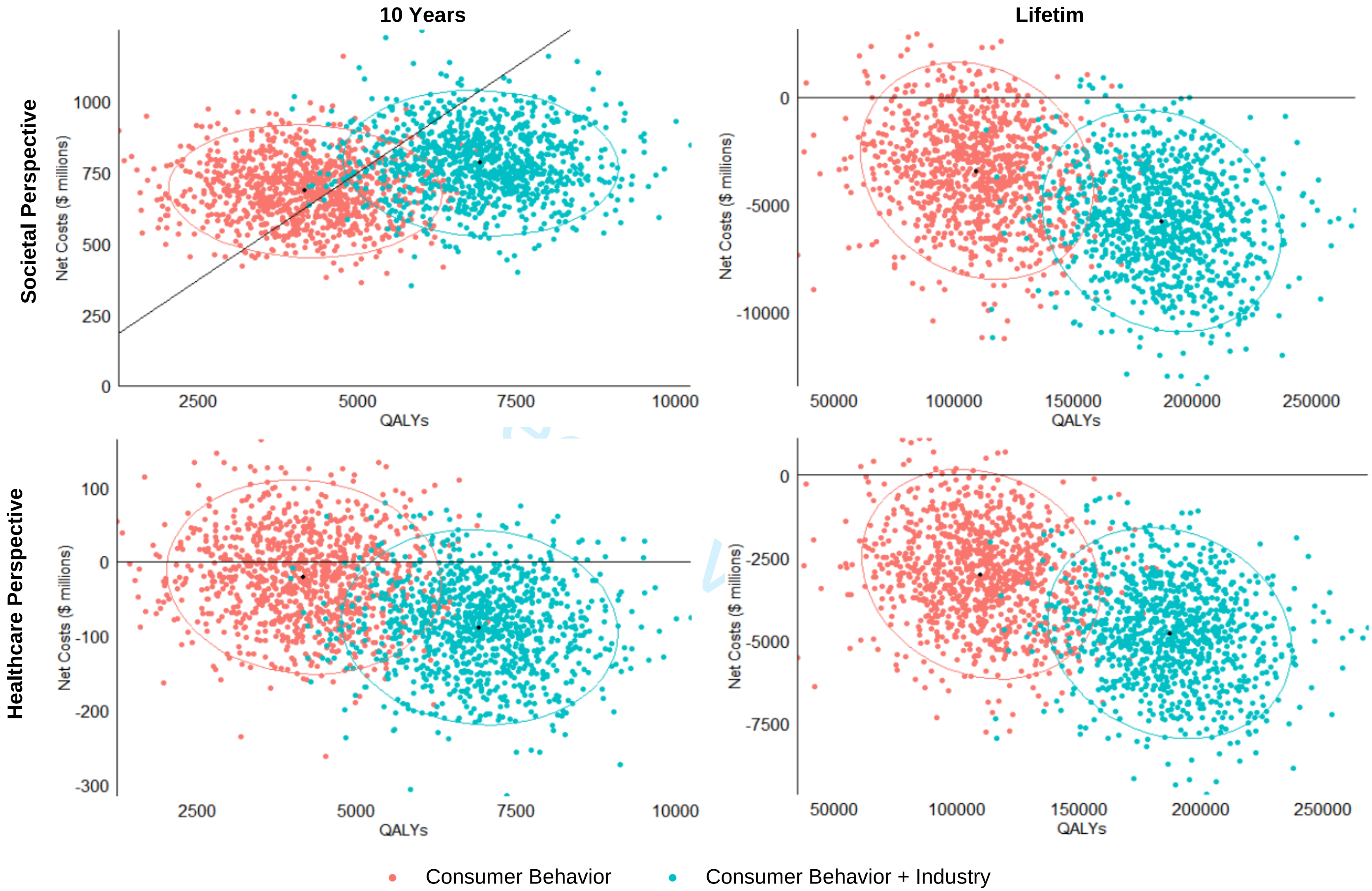


Figure 1. Estimated New Cancer Cases and Deaths Prevented by Federal Menu Calorie Labeling Policy in the US by Cancer Type over a Lifetime



Values are presented in cost-effectiveness planes of net costs ($millions) versus incremental quality-adjusted life years (QALYs). For each policy scenario, each colored dot represents one of the 1000 simulations, with the largest dot showing the median incremental cost-effectiveness ratio (ICER, $/QALY); and the ellipse representing the 95% UIs. Results are presented from the societal perspective and the healthcare perspective. Negative values indicate cost savings.

Figure 2. **Probabilistic Sensitivity Analyses (PSA) for Cost-Effectiveness of the Federal Menu Calorie Labeling Policy over 10 years and a Lifetime**

Title Cost-Effectiveness Analysis of the Federal Menu Calorie Labeling and Obesity-Associated Cancer Burdens in the United States

Appendix 1. Estimate the association between menu calorie labeling policy and calorie intake from restaurant meals

To understand the effects of the federal menu calorie labeling policy, we performed a comprehensive literature search and reviewed the evidence on how the policy affected consumer behaviors and industry.

To estimate the policy effect on consumer behavior alone, we reviewed individual studies in both real-world and experimental settings as well as meta-analyses (**Appendix Table 1)**. A meta-analysis of natural experimental studies showed that menu calorie labeling was associated with a 7.3% (95% CI: 4.4% to 10.1%) reduction in calories per meal consumed/purchased.[1] This effect estimate is corresponding to an average reduction of 23.5 kcal per meal consumed by NHANES participants from 56.5% of full-service restaurants[2] and all fast-food restaurants. This estimate was consistent with evidence from a previous meta-analysis and a recent real-world study.[3, 4] A previous meta-analysis estimated that the menu calorie labeling would lead to about an 18 kcal reduction ordered per meal.[3] A recent longitudinal study used data from a large restaurant franchise in the southern U.S. and estimated that, after labeling implementation, a decrease of 60 kcal per transaction was observed in the first year, followed by an increasing trend of 0.71 kcal per transaction per week over two years.[4] These together attenuated the calorie reduction to 23 kcal per transaction by the end of the third year of the policy implementation.[5] Compared to other studies, the 7.3% calorie reduction per meal represents a more conservative estimate. It was reported in a cross-sectional study that customers at the labeled full-service restaurants purchased food with 151 fewer calories.[6] One meta-analysis of studies that evaluated energy ordered in a real-world setting showed that the calorie labeling policy would lead to a mean reduction of 77.8 in calories purchased per meal.[7] In a laboratory setting, there was a significant reduction of 115.3 kcal per meal ordered.[8] Integrating both the real-world and experimental studies, the policy was estimated to generate a significant reduction of 100.3 in calories purchased.[7] Therefore, we decided to use a reduction of calorie intake per meal by 7.3% (95% CI: 4.4% to 10.1%) as the model input given it is the most updated and conservative estimate supported by existing evidence. This policy effect on consumer behavior alone was assumed to take effect during the first year of implementation and no further reduction thereafter.

Based on the published literature, we estimated that there was a 5% reduction in calories consumed per meal from chain restaurants due to industry reformulation, the introduction of new low-calorie menu items, or the replacement of menu items high in calories with low-calorie menu options. [9-13] Bleich et al. estimated the calorie changes in chain restaurants' menu items using data from the largest chain restaurants in the U.S. [9-13] Using the estimated mean calorie per menu item from the two published studies shown in **Appendix Table 2**,[11, 12] we calculated the mean change in calories per menu item before and after the policy implementation. Given the national law was announced in 2010, using data from the trend analysis, we treated the mean calorie per menu item measured in 2008 as the baseline and found there was an 11% reduction in calories per menu item two years after the affordable care act was enacted. The change decreased to 7% in 2015, one year after the FDA announced the final rule for the industry to comply with. In the study evaluated the calorie content in current menu items, eliminated menu items, and newly introduced menu items, we estimated that there was a 1% reduction in mean per-item calories in 2013-2014 compared to that in 2012, and the reduction increased to 5% in 2015. Based on this de novo analysis, we chose a reduction in calories per meal consumed by 5% to represent a modest industry reformulation in response to the federal menu calorie labeling by chain restaurants. We assumed no industry response in the first year, then the reformulation activities would occur in the rest of the years over the model lifetime, resulting in a net reduction of 5% in calories consumed per meal.

Appendix Table 1. Policy impact of menu calorie labeling on consumer behaviors

Study	Design	Year, country	Estimate size mean (95% CI)	Comment
Shangguan et. al., 2019[1] A Meta-Analysis of Food Labeling Effects on Consumer Diet Behaviors and Industry Practices	Meta-analysis 13 studies (5 RCTs) with 19 interventions on changes in calorie intake per meal, among children and adults	2000 to 2015, US, Canada, UK, Sweden	-7.3% (-10.1%, -4.4%) in calorie intake per meal	Corresponds to a 23.5 kcal per meal consumed by NHANES participants from 56.5% of full-service restaurants[2] and all fast-food restaurants
Petimar et. al., 2019[4] Estimating the effect of calorie menu labeling on calories purchased in a large restaurant franchise in the southern United States: quasi-experimental study	Quasi-experimental longitudinal study Transaction data from 104 restaurants of a national fast food company with three different restaurant chains located in the Louisiana, Texas, and Mississippi in the US	2015 to 2018 (pre-labeling: April 2015 to April 2017; post-labeling: April 2017 to April 2018), US	-60 (-48, -72) kcal in calorie purchased per transaction, followed by a post-implementation increasing trend of 0.71 kcal per transaction per week	Because of the post-implementation increase, the estimated reduction in calorie per transaction was 23 kcal lower than the counterfactual.
Cantu-Jungles et. al., 2017[8] A Meta-Analysis to Determine the Impact of Restaurant Menu Labeling on Calories and Nutrients (Ordered or Consumed) in U.S. Adults	Meta-analysis 14 studies that evaluated menu calorie labeling on changes in calorie chosen in laboratory and away-from-home settings, among children and adults	1996 to 2014	-115.2 (-130.87, -99.5) kcal in calorie ordered or consumed per meal in laboratory setting	N/A
Littlewood et. al., 2016[7] Menu labelling is effective in reducing energy ordered and consumed: a systematic review and meta-analysis of recent studies	Systematic review and meta-analysis 12 studies (6 RCTs) on changes in calorie consumed, ordered, or selected in both real-world and experimental settings, among children and adults	2011 to 2014, US, Canada, Australia,	-100.3 (-146.6, -54.0) kcal in calorie consumed in both settings per meal or transaction (3 studies) -77.8 (-121.6, -34.1) kcal in calorie purchased per meal or transaction in real-world setting (5 studies)	N/A
Long et. al., 2015[3] Systematic Review and Meta-analysis of the Impact of Restaurant Menu Calorie Labeling	Systematic review and meta-analysis 19 studies (11 RCTs, 8 natural experiments) on changes in calorie purchased per meal or per transaction, among children and adults	2008 to 2013, US	-18.1 (-33.6, -2.70) kcal in calorie purchased per meal or per transaction When stratifying by restaurant and non-restaurant settings (RCTs), the changes were -6.7 (-20.21, 6.81) kcal and -58.2 (-102.4, -13.9) kcal in calorie	N/A

			purchased per meal or per transaction	
Auchincloss et. al., 2013[6] Customer responses to mandatory menu labeling at full-service restaurants	Cross-sectional study 648 customer surveys and transaction receipts at 7 restaurant outlets of 1 large full-service restaurant chain (2 outlets with menu calorie labels and 5 without), among adults	2011, US	-151 kcal (-270, -33) for foods purchased from full-service restaurants (per meal)	Was included in the meta-analysis conducted by Cantu-Jungles et. al., 2017[8]

Appendix Table 2. Policy impact of menu calorie labeling on restaurant industry response

Study		Year				
		2008	**2012**	**2013**	**2014**	**2015**
Bleich et. al., 2017[11] Calorie changes in large chain restaurants from 2008 to 2015 44 of the 100 largest chain restaurants	# of menu items (n)	6,601	9,526	10,278	10,654	11,034
	mean per-item calories (kcal)	368.0	329.1	330.1	337.2	340.6
	diff. (%)		2012 vs. 2008 -38.9 (-11%)			2015 vs. 2008 -27 (-7%)
Bleich et. al., 2018[12] Higher-Calorie Menu Items Eliminated in Large Chain Restaurants 66 of the 100 largest chain restaurants	# of menu items (n)		14,705	17,219 (2013-2014)		13,920
	mean per-item calories (kcal)		374.4	370.9		357.4
	diff. (%)			2013-2014 vs. 2012 -3.52 (-1%)		2015 vs. 2012 -17.05 (-5%)

Appendix 2. Baseline cancer incidence and methods of cancer incidence projections for 13 types of cancers

We estimated the cancer incidence rate projections for the defined 32 demographic subgroups as inputs for the DiCOM model. We first obtained age-adjusted incidence rates from 2006 to 2015 from the United States Cancer Statistics combining data from the Surveillance, Epidemiology, and End Results (SEER) database and the Centers for Disease Control and Prevention's National Program of Cancer Registries (NPCR) database.[14]

Based on the trends from 2006 to 2015, we projected age-adjusted cancer incidence rates in the next 15 years from 2016 to2030 using the average annual percent change (AAPC) method.[15, 16] Because longer-term projections may not be valid, we chose to hold age-adjusted cancer incidence rates constant from 2030 to 2095. Specifically, the annual percent change was calculated for each cancer site in each of the 32 subgroups by fitting a regression line to the natural logarithm of the age-adjusted rates (I) in the years 2006 through 2015 (y). The equation for AAPC: $\ln(I) = \alpha + \beta y$, where α and β were coefficients to be estimated and y is the calendar year.[15, 16] We then combined the AAPC projected cancer incidence rates with the projected US population to account for the change in population age distribution over time. The projected US population in each of the 32 subgroups from 2016 to 2060 were extracted from the National Interim Projections of the US population.[17] Because projections were only available through 2060, further projections after 2060 were not considered. We further applied the cohort-period method to estimate cancer incidence in each of the 32 subgroups in the closed cohort of US adults from 2015 to 2095 as they age. Details were illustrated in **Appendix Table 3** using colon and rectum cancer incidence among non-Hispanic white females (NHWF) as an example.

Appendix Table 3. Estimating "crude" incidence after applying cohort-period method

EXAMPLE: Colon and Rectum Cancer, Non-Hispanic White Females														
Age	2015		2016				2017				2018			
	Baseline Incidence Rate	Population Size	AAPC Predicted Incidence	US Census Predicted Population Size	Cancer Cases Predicted	Age Shifted "crude" Incidence	AAPC Predicted Incidence	US Census Predicted Population Size	Cancer Cases Predicted	Age Shifted "crude" Incidence	AAPC Predicted Incidence	US Census Predicted Population Size	Cancer Cases Predicted	Age Shifted "crude" Incidence
20	8.531	30523184	8.694	1134235		10.154	8.859	1126079		11.694	9.028	1117775		13.182
21	8.531		8.694	1156761	100565		8.859	1137549			9.028	1129379		
22	8.531		8.694	1177144	102337		8.859	1159788	102748		9.028	1140620		
23	8.531		8.694	1196469	104017		8.859	1180122	104550		9.028	1162784	104976	
24	8.531		8.694	1238910	107707		8.859	1199459	106263		9.028	1183136	106813	
25	8.531		8.694	1283513	111585		8.859	1241739	110009		9.028	1202329	108546	
26	8.531		8.694	1294013	112497		8.859	1286229	113950		9.028	1244499	112353	
27	8.531		8.694	1250740	108735		8.859	1296475	114858		9.028	1288797	116352	
28	8.531		8.694	1232421	107143		8.859	1253062	111012		9.028	1298770	117252	
29	8.531		8.694	1216039	105719		8.859	1234519	109369		9.028	1255161	113315	
30	8.531		8.694	1228929	106839		8.859	1217844	107892		9.028	1236330	111615	
31	8.531		8.694	1244281	108174		8.859	1230337	108999		9.028	1219312	110079	
32	8.531		8.694	1205955	104842		8.859	1245249	110320		9.028	1231390	111169	
33	8.531		8.694	1226950	106667		8.859	1206736	106908		9.028	1246013	112489	
34	8.531		8.694	1226234	106605		8.859	1227540	108751		9.028	1207377	109001	
35	8.531		8.694	1217701	105863		8.859	1226721	108678		9.028	1228051	110868	
36	8.531		8.694	1228467	106799		8.859	1218141	107918		9.028	1227199	110791	
37	8.531		8.694	1160971	100931		8.859	1228796	108862		9.028	1218528	110008	
38	8.531		8.694	1139547	99069		8.859	1161267	102879		9.028	1229044	110958	
39	8.531		8.694	1127605	98030		8.859	1139679	100967		9.028	1161414	104852	
40	8.531		8.694	1088875	94663		8.859	1127530	99891		9.028	1139635	102886	
41	8.531		8.694	1130467	98279		8.859	1088644	96446		9.028	1127272	101770	
42	8.531		8.694	1101345	95747		8.859	1129951	100105		9.028	1088229	98245	
43	8.531		8.694	1130264	98262		8.859	1100615	97506		9.028	1129228	101946	
44	8.531		8.694	1210411	105229		8.859	1129268	100045		9.028	1099713	99282	
45	41.269	14238423	41.919	1319769	553230	43.775	42.579	1208976	514771	45.825	43.250	1128045	487878	47.459
46	41.269		41.919	1346596	564476		42.579	1317806	561110		43.250	1207332	522169	
47	41.269		41.919	1292274	541705		42.579	1344191	572344		43.250	1315541	568969	
48	41.269		41.919	1264917	530237		42.579	1289694	549140		43.250	1341533	580211	
49	41.269		41.919	1295410	543019		42.579	1262140	537408		43.250	1286923	556592	
50	41.269		41.919	1325816	555765		42.579	1292230	550220		43.250	1259139	544576	
51	41.269		41.919	1432079	600309		42.579	1322198	562980		43.250	1288813	557410	
52	41.269		41.919	1489756	624487		42.579	1427705	607904		43.250	1318321	570172	
53	41.269		41.919	1510286	633093		42.579	1484805	632216		43.250	1423107	615492	
54	41.269		41.919	1532940	642589		42.579	1504858	640755		43.250	1479608	639928	
55	59.736	15111568	58.496	1575080	921363	65.864	57.283	1526976	874691	71.195	56.094	1499151	840934	75.804
56	59.736		58.496	1579128	923731		57.283	1568482	898466		56.094	1520747	853048	
57	59.736		58.496	1554236	909170		57.283	1572018	900492		56.094	1561581	875954	
58	59.736		58.496	1566074	916095		57.283	1546788	886040		56.094	1564631	877664	
59	59.736		58.496	1559941	912507		57.283	1558015	892471		56.094	1539019	863298	
60	59.736		58.496	1509257	882859		57.283	1551289	888618		56.094	1549572	869217	
61	59.736		58.496	1507776	881993		57.283	1500225	859367		56.094	1542165	865062	
62	59.736		58.496	1469467	859583		57.283	1497943	858060		56.094	1490621	836149	
63	59.736		58.496	1428612	835685		57.283	1458963	835731		56.094	1487453	834372	
64	59.736		58.496	1384020	809600		57.283	1417465	811960		56.094	1447782	812119	
65	147.246	20639658	140.189	1344027	1884181	140.189	133.471	1372210	1831501	133.471	127.075	1405568	1786119	127.075
66	147.246		140.189	1307657	1833194		133.471	1331467	1777121		127.075	1359584	1727685	
67	147.246		140.189	1291598	1810681		133.471	1294222	1727410		127.075	1318007	1674851	
68	147.246		140.189	1292613	1812104		133.471	1277026	1704458		127.075	1279794	1626292	
69	147.246		140.189	1382868	1938632		133.471	1276471	1703717		127.075	1261379	1602891	
70	147.246		140.189	987587	1384490		133.471	1363827	1820312		127.075	1259177	1600093	
71	147.246		140.189	982267	1377032		133.471	972764	1298357		127.075	1343441	1707171	
72	147.246		140.189	972611	1363496		133.471	966021	1289357		127.075	956905	1215982	
73	147.246		140.189	1012982	1420091		133.471	954967	1274603		127.075	948632	1205469	
74	147.246		140.189	874564	1226044		133.471	992594	1324824		127.075	936077	1189515	
75	147.246		140.189	796574	1116711		133.471	855200	1141443		127.075	970797	1233635	
76	147.246		140.189	747848	1048402		133.471	777087	1037185		127.075	834495	1060430	
77	147.246		140.189	706707	990727		133.471	727604	971140		127.075	756255	961007	
78	147.246		140.189	679404	952451		133.471	685495	914936		127.075	705976	897115	
79	147.246		140.189	625026	876219		133.471	656756	876578		127.075	662851	842315	
80	147.246		140.189	595777	835215		133.471	601790	803215		127.075	632555	803816	
81	147.246		140.189	572977	803252		133.471	571026	762154		127.075	577004	733225	
82	147.246		140.189	512332	718234		133.471	546330	729192		127.075	544674	692142	
83	147.246		140.189	496976	696707		133.471	485519	648027		127.075	517986	658228	
84	147.246		140.189	475655	666817		133.471	467692	624233		127.075	457134	580901	
85	147.246		140.189	452173	633898		133.471	444106	592752		127.075	436898	555186	
86	147.246		140.189	428834	601179		133.471	418526	558610		127.075	411316	522678	
87	147.246		140.189	383933	538233		133.471	393130	524714		127.075	383961	487917	
88	147.246		140.189	356801	500196		133.471	348261	464827		127.075	356875	453497	
89	147.246		140.189	320644	449508		133.471	319862	426923		127.075	312475	397076	
90	147.246		140.189	278562	390514		133.471	283710	378670		127.075	283306	360010	
91	147.246		140.189	246568	345662		133.471	242960	324281		127.075	247721	314790	
92	147.246		140.189	209022	293026		133.471	211695	282551		127.075	208839	265381	
93	147.246		140.189	169864	238131		133.471	176399	235441		127.075	178878	227308	
94	147.246		140.189	138657	194382		133.471	140691	187782		127.075	146313	185927	
95	147.246		140.189	109277	153195		133.471	112531	150196		127.075	114362	145325	
96	147.246		140.189	80177	112399		133.471	86769	115811		127.075	89499	113730	
97	147.246		140.189	56739	79542		133.471	62172	82982		127.075	67414	85666	
98	147.246		140.189	42046	58944		133.471	42907	57268		127.075	47105	59858	
99	147.246		140.189	27405	38419		133.471	30959	41321		127.075	31659	40231	
100	147.246		140.189	49314	69133		133.471	50716	67691		127.075	52719	66992	

Appendix 3. Cancer survival for 13 types of cancers

We estimated the 5-year relative survival for the defined 32 demographic subgroups. We obtained five-year relative survival rates using the period analysis method from the United States Cancer Statistics which incorporates data from the Surveillance, Epidemiology, and End Results (SEER) database.[14] The five-year survival for 2014, which was the most recently available data at the time of analysis, was used. These rates were extracted for each cancer type and by the defined 32 demographic subgroups for each cancer type. The rates are on a scale of 0-1.

Relative survival is a net survival measure representing cancer survival in the absence of other causes of death. Relative survival is defined as the ratio of the proportion of observed survivors in a cohort of cancer patients to the proportion of expected survivors in a comparable set of cancer-free individuals.[18] Relative survival is the preferred method to estimate survival from cancer registry data.

The period analysis is a method that enhances up-to-date monitoring of survival.[19, 20] In contrast to traditional cohort analysis of survival, period analysis derives long-term survival estimates exclusively from the survival experience of patients within some recent calendar period.[19, 20] Three-year intervals were chosen which results in the years 2008-2014 is used to calculate 5-year survival. Using seven years of data to calculate 5-year survival is the standard method used by SEER and used in SEER publications.[21]

The first interval contributed to the one-year survival and used cases diagnosed in 2012-2014, the second interval contributed to the two-year survival and used cases diagnosed in 2011-2013, the third interval contributed to the three-year survival and used cases diagnosed in 2010-2012, the fourth interval contributed to the four-year survival and used cases diagnosed in 2009-2011 and the fifth interval contributed to the five-year survival and used cases diagnosed in 2008-2010.

This analysis, therefore, used 2008-2014 diagnoses to calculate for 5-year relative survival for 2014. The highlighted orange boxes represent survival contributions for each year of diagnosis and year of follow-up (**Appendix Table 4**). The annual probability of death was calculated as 1-exp[ln(5-year relative survival)/5].

Appendix Table 4. Period method for 5-year relative survival for 2014

YEARS OF DIAGNOSIS															
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1															
2															
3															
4															
5															

Appendix 4. **Methods of estimating the health-related quality of life among 13 types of cancers**

Health utility values range from 0 (dead) to 1 (perfect health and were assigned for each cancer type and by phase of care (initial, continuous, end of life), if available. We first searched databases for systematic reviews pertaining to utility weights or HRQOL measures for each cancer type of interest separately. We started with PubMed and searched Google Scholar if needed. The following search string was used for each cancer type : ("health related quality of life" OR "HRQOL" OR "quality of life" OR "QOL" OR "preference weight*" OR "utility weight*" OR "health state utilit*" OR "health utility*") AND ("cancer of interest") AND ("cancer" OR "neoplasm*") AND ("review" OR "systematic review").

When an appropriate systematic review was identified, we read the articles included in the review and determined if the paper met the following data needs. Data Extraction Hierarchy: 1) cancer type specific to the type of interest; 2) consistent in the instrument used, prefer EQ-5D whenever available; 3) US samples preferred; 4) phase of care (assume same utility weights by phase if the phase of care data were not available). If no systematic reviews were available, we searched for individual studies about the utility weights of the cancer of interest. Additionally, check how often the paper is cited to see if it is a frequently used utility weight.

Appendix 5. Methods of estimating policy implementation costs

We estimated the costs of implementing the federal menu calorie labeling for both government and industry, including government administration costs, monitoring and evaluation costs, industry compliance costs and reformulation costs, based on the FDA's budget report,[22] the Nutrition Review Project report,[23] and FDA's RIA[24] (**Appendix Table 5**).

It was estimated by FDA that approximately 298,600 establishments, organized under 2,130 chains were covered by the menu calorie labeling policy. Among the covered establishments, 115,000 (38.5%) were full-service restaurants and drinking places organized under 530 (24.9%) chains, and 116,200 (38.9%) were limited-service restaurants organized under 540 (25.4%) chains. In total, about 231,200 (77.4%) restaurants organized under 1,070 (50.2%) chains were covered by this policy.[24]

For industry compliance (#3) and reformulation costs (#4), the FDA estimated the costs by the type of establishments. Therefore, we only included the relevant costs incurred by restaurants as this approach generated more conservative estimates. In addition, the industry compliance costs consist of initial costs and recurring costs associated with new chains. In FDA's RIA, the initial costs were presented as a one-time cost, while the recurring costs associated with new chains were presented as annual costs and assumed to be incurred for 20 years starting from the 2nd year of policy implementation. According to FDA, 20 years is more appropriate for interventions that play out over long periods and whose effects deal with chronic conditions. Similarly, the reformulation costs (#4) estimated by FDA were presented as annual costs in FDA's RIA using the same assumption. We followed the same assumption and presented the annual compliance costs (#3) and annual reformulation costs (#4) incurred by restaurants in **Appendix Table 5**.

The cost of implementing the menu calorie labeling is fixed by the government. Uncertainty for the costs associated with government administration (#1) and government monitoring and evaluation (# 2) was not provided in the source materials.[22, 23] We assumed that uncertainty is 20% around these costs.

For annual costs, namely the government monitoring and evaluation costs (#2) and the recurring costs in industry compliance (part of #3), and the reformulation costs (#4), we applied a 3% discounting rate recommended by the Second Panel on cost-effectiveness in health and medicine[4] to reflect the present value of future costs of government monitoring and evaluation, industry compliance and industry reformulation. The model is a closed cohort model, so we computed the discounted present value of per-person costs and total national costs for persons alive at implementation who remained alive in each subsequent year (not for the larger total US population in each year, which also has growth from immigration and new persons reaching the threshold age). The year-specific discounting factor is estimated by 1/(1+3%)^(t-1) (t is the number of years of policy intervention, t=1, 2, 3, …, lifetime). As our model estimated the costs and health outcomes based on a closed cohort and the population size decline over time, we need to express the annual costs in proportion to the population at risk. The population at risk was estimated based on the proportion of death ($P_{dt,}$ t=1, 2, 3, …) in each year. We first obtained the proportion of people who are alive each year by calculating 1-P_{dt} (t=1, 2, 3, …). Then we multiplied the baseline population size of 235 million by the proportion of people who are alive each year (**Appendix Table 6**).

We then estimated the per-person annual cost for cost categories #2, #3 (annual part), and #4, by dividing the annual cost estimated in the second year of implementing the policy among all US populations by the population size in the second year. Specifically, for government monitoring and evaluation, the per person annual cost is estimated $503,648/233,719,989=$0.00215, the per person annual cost for industry compliance recurring component is $/233,719,989=$, and that for reformulation

is $662,800,000 /233,719,989=$2.83587. Taken together, to estimate the discounted annual cost of #2, #3 (annual part), and #4, we multiplied the population at risk, the per person annual cost estimated at year-2, and the year-specific discounting factor, using: discounted annual cost = population at risk x per-person annual cost x 1/(1+3%)^(t-1).

Appendix Table 5. Implementation cost estimates for the federal menu calorie labeling policy (in 2015 US dollars)

Policy Effect	Cost Category	One-time Cost*	Annual Cost*	Source	Major Elements
Consumer behavior	1. Government administration#	$9,073,620 ($7,258,896 to $10,888,344)	N/A	FDA FY 2012 Budget Report[22]	1) Costs for outreach, education, review of regulatory issues, developing training for inspectors, etc.
	2. Government monitoring and evaluation#	N/A	$503,648 ($402,918 to $604,378) (starting from 2nd year and last for a lifetime)	Nutrition Review Project report[23]	1) Monitor industry compliance 2) Evaluate the accuracy, usefulness, and health impact of the policy intervention
	3. Industry compliance	$276,632,470 ($225,552,530 to $327,205,740)	$27,648,591 ($16,756,003 to $38,649,212) (starting from 2nd year and last for a lifetime)	FDA's RIA[24] Table 4-8	1) Collecting and managing records of nutritional analysis for each standard menu item (initial cost + recurring cost associated with new chains) 2) Revising or replacing existing menus, menu boards, and providing full written nutrition information (initial cost + recurring cost associated with new chains) 3) Training employees to understand the nutrition information to help ensure compliance with the final requirements (initial cost + recurring cost associated with new chains) 4) Legal review (initial cost + recurring cost associated with new chains)
Industry response^	4. Industry reformulation	N/A	$15,059,100 ($5,791,900 to $24,124,700) (starting from 2nd year and last for a lifetime)	FDA's RIA[24] Table 4-8	1) Annually recurring costs of nutrition analysis refer to the nutrition cost that will be incurred by the covered establishments due to the introduction of a new standard or reformulated standard menu items in their menus and the cost that will be incurred by new chains entering the industry 2) Annually recurring changes to menus or menu boards will be tied to new or reformulated standard menu items. In general, these future changes to menus will be incorporated into the natural menu

					replacement cycle, so there will be no additional recurring menu update costs. However, all chain retail food establishments will need to provide additional written nutrition information for the reformulated or newly introduced menu items Average formula count, 6 new menu items, and 6 reformulated items per year FDA reformulation cost model

*Policy intervention costs were inflated to 2015 US (December) dollars using the Consumer Price Index.
Given no range of uncertainty was provided in source materials, we assumed 20% uncertainty around these costs.
^Some chains or establishments may respond to increased consumer interest in caloric content standard menu items by reformulating existing menu items or by introducing new, lower-calorie items. The change in manufacturing costs associated with reformulating these items has not been included in the cost estimation, the FDA includes the cost associated with analyzing the nutrition information of new or reformulated items.

Appendix Table 6. The population size of people who are alive each year over a lifetime (in millions)

Year	Population Size (Million)
1	235.2
2	233.7
3	232.1
4	230.4
5	228.2
⋮	⋮
67	5.832
68	4.348
69	3.157
70	2.233

Appendix 6. Annual health-related costs among cancer patients and the general population without cancer

The annual health-related costs data include: 1) medical expenditure, 2) productivity loss from missed workdays or disability, and 3) patient time cost associated with receiving care for cancer survivors by age (under 65 vs. above 65 years old) and phase of care (initial, continuing, end-year of life); 4) medical expenditure, 5) productivity loss, and 6) patient time cost for individuals without cancer by age and status of end year of life. The description of the data source and data structure were provided in **Appendix Table 7**.

We extracted the raw data for each of the costing components from the published literature.[15, 25-29] The overall assumptions for data extraction include: 1) health-related costs for breast cancer among postmenopausal females, advanced prostate cancer, esophageal adenocarcinoma, and stomach cardia cancer, by age, sex, and phase of cancer care, were the same as those for breast cancer, prostate cancer, esophagus cancer, and stomach cancer; 2) if no data available for a specific cancer type, we assumed the costs for that cancer type were the same as the estimates of costs for all-cancer sites, e.g., medical expenditure for all-cancer sites were used to replace the medical expenditures for multiple myeloma, gallbladder, liver, and thyroid cancers; 3) we extracted the costs for end-year of life due to cancer death and assumed that death due to other causes is not a competing outcome; 4) we assumed that the end-year life medical expenditure for individuals without cancer does not vary by the 32 subgroups.

If a specific costing component was not reported directly in the raw data, we calculated the cost for that component based on available data. For example, the annual productivity loss for colorectal cancer was reported as a percentage of total health-related costs.[29] We multiplied the percentage and the total health-related costs to obtain the productivity loss for colorectal cancer. We also performed data imputation for unavailable data. For instance, the annual productivity loss for all-cancer sites was

reported by time interval since cancer diagnosis (diagnosed within one year vs. diagnosed greater than one year).[25] To obtain this costing component by the defined phases of care, we calculated the weighted means which was used as the annual productivity loss for the continuous phase. We then assumed that the productivity loss in the initial phase and end-of-life phase of cancer care are 1.3 times and 4 times the mean estimates based on available data for other cancers.[15, 25] For individuals without cancer, we assumed that the end-of-life productivity loss is 4 times to the mean estimate of the productivity loss. The same rules applied to data imputation for patient time costs.

We then applied the age shifting to keep the expenditures consistent within each age group. Starting from 2021, individuals in the cohort of 55-64 years old have turned into the cohort of 65 years and older. Therefore, we assumed that starting from 2021, the health-related expenditures for individuals who were in the cohort of 55-64 years old would be the same as those for individuals who were in the cohort of 65 years and older at the beginning of the DiCOM model. Based on the same assumption, starting from 2031 and 2047, the health-related expenditures for the cohort of 45-54 years old and those for the cohort of 20-44 years old were projected to be the same as those for the cohort of 65 years and older, respectively. We followed the same rule and applied the age shifting for the health-related expenditures for individuals without cancer. All estimations and projections were performed in SAS 9.4. All health-related expenditures were inflated to 2015 US dollars using the Personal Health Care (PHC) index.

Appendix Table 7. Description of the data source of health-related expenditures

	A. Cancer Survivors		**B. Individuals without Cancer**	
	Data source (Excess or Total)	Category	Data source	Category
Medical expenditure	Mariotto et al. 2011, SEER-Medicare, in 2010 US dollars (Excess)	-by phase of care[1] -by age (under 65 vs. above 65 years old) -by sex	Kim et al. 2018, MEPS 2013-2014, *in vivo* analysis, in 2014 US dollars (Total)	-Medical expenditure among all US adults -by 32 subgroups stratified by age, sex, and race/ethnicity
			Hogen et al. 2001, SEER-Medicare (65+), in 2001 US dollars (Total)	-Medical expenditure in the end year of life among all US adults
Productivity loss	Zheng et al. 2016, MEPS 2008-2012, data available for colorectal, female breast, and prostate cancers, in 2012 US dollars (Total)	-by age		
	Guy et al. 2013, MEPS 2008-2010, all types of cancer, in 2010 US dollars (Total)	-by age -by time interval since cancer diagnosis (less than 1 year vs. greater than 1 year)[2]	Guy et al. 2013, MEPS 2008-2010, in 2010 US dollars (Total)	-by age
Patient time cost	Yabroff et al. 2014, MEPS 2008-2011, all types of cancer, in 2011 US dollars (Total)	-by age	Yabroff et al. 2014, MEPS 2008-2011, in 2011 US dollars (Total)	-by age

1. The definition of phases of care: 1) initial phase, defined as the first 12 months following diagnosis, 2) end-year of life phase, defined as the final 12 months of life, and 3) the continuing phase, defined as all the months between the initial phase and the end-year of life. The costs of end-year of life varied by cause of death, either cancer-specific death or death due to other causes.
2. Weighted means were calculated based on sample sizes and strata means.

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Supplementary Table 1. Defining population and 32 subgroups

Subgroups	Age	Sex	Race/Ethnicity
1	20-44y	Female	NHW
2	20-44y	Female	NHB
3	20-44y	Female	HISP
4	20-44y	Female	OTH
5	20-44y	Male	NHW
6	20-44y	Male	NHB
7	20-44y	Male	HISP
8	20-44y	Male	OTH
9	45-54y	Female	NHW
10	45-54y	Female	NHB
11	45-54y	Female	HISP
12	45-54y	Female	OTH
13	45-54y	Male	NHW
14	45-54y	Male	NHB
15	45-54y	Male	HISP
16	45-54y	Male	OTH
17	55-64y	Female	NHW
18	55-64y	Female	NHB
19	55-64y	Female	HISP
20	55-64y	Female	OTH
21	55-64y	Male	NHW
22	55-64y	Male	NHB
23	55-64y	Male	HISP
24	55-64y	Male	OTH
25	65+y	Female	NHW
26	65+y	Female	NHB
27	65+y	Female	HISP
28	65+y	Female	OTH
29	65+y	Male	NHW
30	65+y	Male	NHB
31	65+y	Male	HISP
32	65+y	Male	OTH

Supplementary Table 2. Relative risk estimates of etiologic relationships between body mass index (BMI) and 13 types of cancers

Cancer Type	No. of Studies	No. of Events	Source	Evidence Grading	RR (95% CI) Per 5 kg/m^2	Statistical Heterogeneity
Endometrial	26	18,717	CUP, 2013	Convincing ↑risk	1.50 (1.42-1.59)	I^2=86.2% P<0.0001
Esophageal (adenocarcinoma)	9	1,725	CUP, 2016	Convincing ↑risk	1.48 (1.35-1.62)	I^2=36.7% P=0.13
Kidney	23	15,575	CUP, 2015	Convincing ↑risk	1.30 (1.25-1.35)	I^2=38.8% P=0.03
Liver	12	14, 311	CUP, 2015	Convincing ↑risk	1.30 (1.16-1.46)	I^2=78.3% P=0.000
Gallbladder	8	6,004	CUP, 2015	Probable ↑risk	1.25 (1.15-1.37)	I^2=52.3% P=0.04
Stomach (cardia)	7	2,050	CUP, 2016	Probable ↑risk	1.23 (1.07-1.40)	I^2=55.6% P=0.04
Breast (post-menopausal)	56	80,404	CUP, 2017	Convincing ↑risk	1.12 (1.09-1.15)	I^2=75% P<0.001
Pancreas	23	9,504	CUP, 2011	Convincing ↑risk	1.10 (1.07-1.14)	I^2=19% P=0.20
Multiple myeloma	20	1,388	IARC, 2016[30]	Sufficient (IRAC) ↑risk	1.09 (1.03-1.16)	Not reported
Prostate (advanced)	24	11,149	CUP, 2014	Probable ↑risk	1.08 (1.04-1.12)	I^2=18.8% P=0.21
Thyroid	22	3,100	IARC, 2016[30]	Sufficient (IARC) ↑risk	1.06 (1.02-1.10)	Not reported
Ovary	25	15,899	CUP, 2013	Probable ↑risk	1.06 (1.02-1.11)	I^2=55.1% P=0.001
Colorectal	38	71,089	CUP, 2017	Convincing ↑risk	1.05 (1.03-1.07)	I^2=74.2% P=0.000

Supplementary Table 3. Baseline incidence rates of 13 cancers among US adults by 32 subgroups

Subgroup	Colorectal Cancer		Endometrial Cancer		Esophageal Adeno-carcinoma		Female Breast (Postmeno.)		Gallbladder Cancer		Kidney Cancer		Liver Cancer		Multiple Myeloma		Ovarian cancer		Pancreatic Cancer		Advanced Prostate Cancer		Stomach Cancer (Gastric Cardia)		Thyroid Cancer	
	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE
1	8.53	0.38	6.54	3.66	0.05	4.18	0.00	0.00	0.05	2.57	3.83	3.16	0.49	4.18	0.38	4.66	4.31	0.27	1.07	3.46	0.00	0.00	0.10	3.82	28.97	0.69
2	7.78	0.74	5.04	0.59	0.03	0.20	0.00	0.00	0.07	2.46	3.57	0.50	0.56	0.20	1.02	0.27	2.98	0.45	1.03	0.26	0.00	0.00	0.09	2.25	13.12	0.95
3	6.09	0.55	7.49	3.32	0.03	3.07	0.00	0.00	0.06	2.48	3.73	3.16	0.42	3.07	0.33	3.71	3.95	0.46	0.86	0.87	0.00	0.00	0.09	2.27	20.97	1.13
4	6.36	1.10	6.56	1.13	0.02	0.15	0.00	0.00	0.07	2.58	1.87	0.40	0.32	0.15	0.38	0.23	4.49	0.70	0.74	0.25	0.00	0.00	0.09	2.36	24.88	2.21
5	9.20	0.39	0.00	0.00	0.42	5.22	0.00	0.00	0.04	0.02	5.91	4.53	0.60	5.22	0.48	5.26	0.00	0.00	1.22	2.06	0.21	0.02	0.43	4.32	6.93	0.34
6	7.94	0.78	0.00	0.00	0.29	0.30	0.00	0.00	0.04	0.02	5.47	0.65	1.17	0.30	1.48	0.34	0.00	0.00	1.00	0.28	0.56	0.09	0.34	3.42	2.36	0.42
7	6.15	0.54	0.00	0.00	0.31	3.85	0.00	0.00	0.04	0.02	4.04	3.82	0.82	3.85	0.57	0.18	0.00	0.00	0.83	0.20	0.13	0.68	0.34	3.53	3.80	0.44
8	6.21	0.85	0.00	0.00	0.31	0.47	0.00	0.00	0.05	0.02	3.68	1.04	1.59	0.47	0.70	1.40	0.00	0.00	0.82	0.29	0.41	0.09	0.36	3.52	5.70	0.84
9	41.27	0.76	38.53	0.73	1.03	0.21	124.56	1.28	0.68	5.99	14.03	0.44	3.10	0.21	3.60	0.22	17.09	0.49	7.70	0.32	0.00	0.00	0.88	6.74	37.84	0.73
10	53.14	1.92	25.73	1.34	0.59	0.60	121.73	2.88	1.54	5.87	16.08	1.06	5.17	0.60	11.29	0.89	11.75	0.90	10.91	0.87	0.00	0.00	0.94	5.38	25.80	1.34
11	33.92	1.78	33.43	1.53	0.59	0.52	77.25	3.45	2.27	1.93	16.00	1.04	3.83	0.52	4.86	0.58	14.57	1.00	6.26	0.66	0.00	0.00	0.81	5.61	37.29	1.84
12	35.77	3.15	35.84	3.07	0.65	0.66	91.82	4.82	1.70	6.05	7.78	1.92	3.27	0.66	2.55	0.70	17.07	1.51	5.17	0.81	0.00	0.00	0.85	5.53	37.73	2.90
13	53.97	0.87	0.00	0.00	5.61	0.36	0.00	0.00	0.36	7.15	29.16	0.64	9.24	0.36	5.09	0.27	0.00	0.00	10.63	0.38	10.88	0.16	3.65	0.23	13.29	0.43
14	61.29	2.20	0.00	0.00	1.50	1.02	0.00	0.00	0.47	5.07	32.82	1.61	13.29	1.02	12.34	0.99	0.00	0.00	14.12	1.05	25.31	0.58	1.90	0.33	6.41	0.71
15	38.05	1.94	0.00	0.00	2.75	1.06	0.00	0.00	0.43	4.83	24.48	1.27	16.38	1.06	5.23	0.60	0.00	0.00	7.95	0.74	6.02	0.38	1.96	0.34	8.56	0.76
16	42.81	3.85	0.00	0.00	2.88	2.28	0.00	0.00	0.37	4.93	18.63	3.06	18.71	2.28	3.70	0.82	0.00	0.00	7.62	1.05	3.70	0.50	2.51	0.17	12.57	1.36
17	59.74	0.89	90.00	1.09	2.12	0.35	305.45	2.02	1.75	0.15	26.14	0.59	9.41	0.35	8.68	0.34	26.19	0.59	21.78	0.54	0.00	0.00	1.72	0.15	34.42	0.67
18	86.11	2.62	83.71	2.60	1.30	1.21	306.22	4.92	4.08	0.57	31.53	1.58	18.22	1.21	23.28	1.37	19.79	1.25	31.37	1.58	0.00	0.00	1.92	0.39	27.72	1.48
19	58.14	2.91	69.51	3.28	1.64	1.33	218.85	7.01	4.59	0.68	29.93	1.73	17.38	1.33	9.33	0.97	21.29	1.45	17.15	1.32	0.00	0.00	1.87	0.34	39.44	1.97
20	52.83	4.48	60.22	4.45	1.49	1.97	233.48	8.33	2.44	0.50	13.91	2.72	12.58	1.97	6.13	0.96	23.98	2.79	13.44	1.43	0.00	0.00	1.57	0.13	41.74	3.08
21	88.14	1.11	0.00	0.00	15.54	0.73	0.00	0.00	0.93	0.11	53.65	0.87	37.93	0.73	13.24	0.43	0.00	0.00	29.95	0.65	47.05	0.34	9.19	0.36	16.24	0.48
22	121.39	3.41	0.00	0.00	4.30	2.72	0.00	0.00	2.06	0.41	69.05	2.57	75.50	2.72	30.69	1.71	0.00	0.00	39.72	1.95	91.41	1.22	4.87	0.68	9.12	0.92
23	84.75	3.65	0.00	0.00	8.01	2.98	0.00	0.00	1.07	0.11	51.05	2.35	61.05	2.98	13.65	1.22	0.00	0.00	23.36	1.58	32.10	1.21	5.15	0.70	11.12	1.09
24	83.77	5.72	0.00	0.00	4.97	4.85	0.00	0.00	1.22	0.11	27.95	3.81	54.13	4.85	10.32	1.39	0.00	0.00	19.14	2.87	22.70	1.31	5.16	0.96	16.04	1.75
25	147.25	1.98	86.90	1.40	4.53	0.62	429.43	3.20	5.87	0.40	42.37	1.02	15.56	0.62	20.59	0.73	38.18	0.97	55.49	1.20	0.00	0.00	4.36	0.34	24.59	0.74
26	155.86	5.74	100.81	4.21	3.10	1.98	398.07	8.74	9.68	1.43	50.03	3.07	20.61	1.98	50.31	3.20	29.78	2.45	71.93	3.94	0.00	0.00	3.41	0.52	22.57	1.98
27	117.47	5.72	66.40	4.47	3.61	3.17	285.07	11.57	11.44	1.75	45.35	3.33	38.69	3.17	24.20	2.52	32.78	2.88	51.54	3.79	0.00	0.00	3.89	0.60	29.50	2.55
28	109.32	10.15	52.12	5.29	3.51	4.72	266.14	14.52	7.02	1.70	26.14	4.17	35.77	4.72	14.41	2.43	23.90	2.89	46.15	5.64	0.00	0.00	4.11	0.28	28.15	3.08
29	181.07	2.47	0.00	0.00	29.02	1.10	0.00	0.00	3.59	0.36	88.69	1.63	40.30	1.10	34.26	1.07	0.00	0.00	72.36	1.53	80.74	0.61	19.38	0.77	17.34	0.69
30	217.23	8.36	0.00	0.00	7.29	3.98	0.00	0.00	6.24	1.14	97.13	5.16	68.31	3.98	69.18	4.66	0.00	0.00	75.66	4.94	130.67	2.34	8.81	1.55	10.03	1.60
31	182.00	9.21	0.00	0.00	15.50	5.01	0.00	0.00	6.79	1.64	87.20	5.26	78.18	5.01	33.10	3.44	0.00	0.00	61.88	4.77	66.33	2.57	11.49	1.78	15.87	2.11
32	144.37	13.43	0.00	0.00	10.56	7.52	0.00	0.00	4.75	1.02	54.45	7.24	79.16	7.52	22.48	3.35	0.00	0.00	51.45	6.82	51.84	2.78	11.34	2.12	13.86	2.28

Supplementary Table 4. Baseline 5-year relative survival rates of 13 cancers among US adults by 32 subgroups

Subgroup	Colorectal Cancer		Endometrial Cancer		Esophageal Adeno-carcinoma		Female Breast (Postmeno.)		Gallbladder Cancer		Kidney Cancer		Liver Cancer		Multiple Myeloma		Ovarian Cancer		Pancreatic Cancer		Advanced Prostate Cancer		Stomach Cancer (Gastric Cardia)		Thyroid Cancer	
	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE
1	0.740	0.012	0.916	0.009	0.223	0.018	0.000	0.000	0.095	0.095	0.953	0.009	0.409	0.057	0.852	0.043	0.780	0.015	0.379	0.038	0.000	0.000	0.477	0.099	1.000	0.001
2	0.652	0.024	0.775	0.027	0.223	0.018	0.000	0.000	0.286	0.064	0.856	0.029	0.144	0.113	0.837	0.048	0.736	0.036	0.530	0.064	0.000	0.000	0.502	0.205	0.993	0.004
3	0.659	0.022	0.900	0.013	0.223	0.018	0.000	0.000	0.309	0.092	0.864	0.021	0.403	0.081	0.713	0.075	0.716	0.024	0.493	0.062	0.000	0.000	0.236	0.116	0.992	0.002
4	0.694	0.027	0.910	0.016	0.223	0.018	0.000	0.000	0.286	0.064	0.819	0.043	0.321	0.077	0.787	0.122	0.737	0.029	0.371	0.076	0.000	0.000	0.667	0.193	1.000	0.002
5	0.682	0.012	0.000	0.000	0.140	0.034	0.000	0.000	0.302	0.117	0.886	0.010	0.251	0.037	0.696	0.041	0.000	0.000	0.275	0.032	0.768	0.057	0.284	0.045	0.997	0.002
6	0.601	0.027	0.000	0.000	0.160	0.031	0.000	0.000	0.357	0.096	0.779	0.027	0.157	0.045	0.606	0.057	0.000	0.000	0.151	0.046	0.780	0.086	0.672	0.274	0.949	0.025
7	0.621	0.022	0.000	0.000	0.330	0.108	0.000	0.000	0.357	0.096	0.847	0.020	0.227	0.047	0.635	0.064	0.000	0.000	0.157	0.044	0.470	0.118	0.152	0.055	0.993	0.007
8	0.635	0.029	0.000	0.000	0.287	0.172	0.000	0.000	0.357	0.096	0.840	0.033	0.152	0.032	0.649	0.108	0.000	0.000	0.230	0.066	0.805	0.180	0.545	0.133	0.992	0.008
9	0.738	0.007	0.889	0.006	0.300	0.065	0.918	0.003	0.153	0.045	0.846	0.011	0.283	0.027	0.682	0.027	0.614	0.012	0.195	0.017	0.000	0.000	0.384	0.060	0.997	0.002
10	0.666	0.015	0.751	0.022	0.290	0.174	0.810	0.009	0.155	0.059	0.834	0.025	0.145	0.035	0.626	0.034	0.497	0.034	0.177	0.029	0.000	0.000	0.457	0.144	0.990	0.008
11	0.725	0.016	0.869	0.012	0.751	0.217	0.881	0.008	0.224	0.062	0.879	0.018	0.242	0.038	0.617	0.047	0.595	0.025	0.209	0.035	0.000	0.000	0.257	0.079	0.983	0.005
12	0.731	0.018	0.893	0.012	0.308	0.060	0.926	0.007	0.210	0.082	0.810	0.037	0.287	0.051	0.686	0.071	0.640	0.027	0.307	0.055	0.000	0.000	0.357	0.152	0.991	0.005
13	0.704	0.007	0.000	0.000	0.255	0.020	0.000	0.000	0.321	0.072	0.790	0.009	0.171	0.011	0.627	0.023	0.000	0.000	0.136	0.012	0.858	0.010	0.253	0.024	0.964	0.007
14	0.612	0.015	0.000	0.000	0.186	0.085	0.000	0.000	0.371	0.127	0.793	0.020	0.117	0.019	0.616	0.037	0.000	0.000	0.138	0.022	0.814	0.020	0.148	0.059	0.970	0.027
15	0.652	0.015	0.000	0.000	0.222	0.050	0.000	0.000	0.151	0.082	0.742	0.019	0.181	0.016	0.640	0.044	0.000	0.000	0.101	0.021	0.729	0.029	0.257	0.060	0.945	0.019
16	0.721	0.017	0.000	0.000	0.308	0.110	0.000	0.000	0.751	0.153	0.799	0.027	0.239	0.023	0.594	0.066	0.000	0.000	0.162	0.039	0.865	0.040	0.298	0.080	0.960	0.018
17	0.694	0.007	0.878	0.004	0.322	0.043	0.918	0.002	0.273	0.035	0.793	0.010	0.208	0.015	0.630	0.019	0.531	0.011	0.117	0.009	0.000	0.000	0.334	0.041	0.994	0.002
18	0.621	0.014	0.667	0.015	0.298	0.039	0.830	0.007	0.151	0.043	0.805	0.022	0.219	0.028	0.609	0.027	0.371	0.028	0.112	0.018	0.000	0.000	0.440	0.113	0.971	0.012
19	0.673	0.016	0.816	0.013	0.241	0.131	0.879	0.006	0.173	0.044	0.769	0.021	0.211	0.025	0.535	0.042	0.473	0.025	0.104	0.019	0.000	0.000	0.279	0.101	0.969	0.009
20	0.714	0.017	0.847	0.013	0.298	0.039	0.911	0.006	0.151	0.061	0.785	0.032	0.288	0.033	0.631	0.051	0.555	0.031	0.164	0.027	0.000	0.000	0.281	0.140	0.987	0.008
21	0.666	0.006	0.000	0.000	0.257	0.013	0.000	0.000	0.190	0.045	0.760	0.008	0.202	0.007	0.603	0.016	0.000	0.000	0.111	0.007	0.878	0.006	0.255	0.016	0.954	0.009
22	0.579	0.013	0.000	0.000	0.178	0.072	0.000	0.000	0.261	0.105	0.758	0.019	0.140	0.012	0.545	0.028	0.000	0.000	0.080	0.014	0.786	0.014	0.148	0.046	0.945	0.039
23	0.628	0.014	0.000	0.000	0.135	0.033	0.000	0.000	0.203	0.081	0.717	0.018	0.170	0.013	0.541	0.037	0.000	0.000	0.078	0.015	0.777	0.017	0.281	0.053	0.899	0.028
24	0.654	0.015	0.000	0.000	0.237	0.082	0.000	0.000	0.148	0.069	0.698	0.025	0.268	0.017	0.485	0.050	0.000	0.000	0.122	0.023	0.885	0.019	0.257	0.061	0.967	0.022
25	0.610	0.005	0.799	0.006	0.182	0.024	0.907	0.003	0.179	0.018	0.679	0.010	0.119	0.010	0.420	0.012	0.323	0.008	0.057	0.003	0.000	0.000	0.231	0.023	0.958	0.005
26	0.551	0.012	0.552	0.016	0.170	0.143	0.806	0.008	0.217	0.043	0.709	0.024	0.097	0.020	0.407	0.022	0.210	0.021	0.059	0.009	0.000	0.000	0.264	0.068	0.894	0.023
27	0.579	0.013	0.699	0.017	0.190	0.073	0.858	0.008	0.125	0.023	0.677	0.022	0.087	0.014	0.353	0.027	0.298	0.022	0.049	0.009	0.000	0.000	0.257	0.060	0.889	0.020
28	0.599	0.013	0.735	0.020	0.180	0.022	0.900	0.007	0.115	0.030	0.614	0.032	0.187	0.017	0.440	0.040	0.356	0.029	0.043	0.008	0.000	0.000	0.187	0.067	0.858	0.023
29	0.615	0.005	0.000	0.000	0.212	0.011	0.000	0.000	0.134	0.025	0.680	0.008	0.119	0.007	0.402	0.011	0.000	0.000	0.075	0.004	0.717	0.007	0.220	0.013	0.935	0.015
30	0.498	0.014	0.000	0.000	0.164	0.069	0.000	0.000	0.209	0.076	0.705	0.024	0.134	0.019	0.459	0.027	0.000	0.000	0.049	0.011	0.569	0.017	0.174	0.052	0.810	0.068
31	0.544	0.013	0.000	0.000	0.155	0.035	0.000	0.000	0.144	0.046	0.668	0.020	0.107	0.012	0.398	0.028	0.000	0.000	0.066	0.011	0.674	0.017	0.141	0.032	0.786	0.048
32	0.625	0.013	0.000	0.000	0.126	0.049	0.000	0.000	0.263	0.071	0.653	0.026	0.182	0.014	0.431	0.037	0.000	0.000	0.080	0.013	0.733	0.020	0.255	0.042	0.800	0.039

Supplementary Table 5. Health-related quality of life among US cancer patients aged 20 years or older, by cancer type and phase of care

Cancer Type	Cancer Phase	Health Related Quality of Life mean (SE)	Source
Endometrial	Overall	0.80 (0.14)	Naik et al.[31]
Esophageal Adenocarcinoma	Overall	0.69 (0.26)	Wildi et al.[32]
Kidney	Overall	0.78 (0.14)	Pickard et al.[33]
Liver	Overall	0.79 (0.19)	Naik et al.[31]
Gallbladder	Overall	0.79 (0.19)	Naik et al.[31]
Stomach (gastric cardia)	Initial: Continuous: End of Life:	0.84 (0.25) 0.86 (0.24) 0.65 (0.33)	Zhou et al.[34]
Female Breast (post-menopausal)	Initial: Continuous: End of Life:	0.78 (0.19) 0.81 (0.20) 0.64 (0.16)	Yabroff et al.[35]
Pancreas	Overall	0.65 (0.30)	Müller-Nordhorn et al.[36]
Multiple myeloma	Overall	0.79 (0.19)	Naik et al.[31]
Advanced Prostate	Initial: Continuous: End of Life:	0.78 (0.20) 0.76 (0.19) 0.59 (0.15)	Yabroff et al.[35]
Thyroid	Overall	0.85 (0.13)	Naik et al.[31]
Ovary	Overall	0.77 (0.17)	Pickard et al.[33]
Colorectal	Initial: Continuous: End of Life:	0.760 (0.19) 0.835 (0.20) 0.643 (0.26)	Färkkilä et al.[37]

Supplementary Table 6. Baseline medical costs, productivity loss, and patient time costs among US cancer patients aged 20 years or older, by cancer type

Cancer type	Sex	Age	Medical costs			Productivity loss			Patient time cost		
			Initial	Continuous	End-of-life	Initial	Continuous	End-of-life	Initial	Continuous	End-of-life
Esophageal Adenocarcinoma	Female	<65	95439	6853	156417	4884	3757	15027	650	500	2001
		≥65	79532	6853	104278	6984	5372	21489	1187	913	3652
	Male	<65	95787	6450	155612	4884	3757	15027	650	500	2001
		≥65	79822	6450	103742	6984	5372	21489	1187	913	3652
Stomach (Gastric Cardia)	Female	<65	85291	3977	155636	4884	3757	15027	650	500	2001
		≥65	71076	3977	103758	6984	5372	21489	1187	913	3652
	Male	<65	94144	4282	160695	4884	3757	15027	650	500	2001
		≥65	78453	4282	107130	6984	5372	21489	1187	913	3652
Liver	Female	<65	40173	5859	95782	4884	3757	15027	650	500	2001
		≥65	40173	5859	95782	6984	5372	21489	1187	913	3652
	Male	<65	41161	7363	97473	4884	3757	15027	650	500	2001
		≥65	41161	7363	97473	6984	5372	21489	1187	913	3652
Pancreatic	Female	<65	112154	8672	164911	4884	3757	15027	650	500	2001
		≥65	93462	8672	109941	6984	5372	21489	1187	913	3652
	Male	<65	112911	11697	169673	4884	3757	15027	650	500	2001
		≥65	94092	11697	113115	6984	5372	21489	1187	913	3652
Advanced Prostate	Male	<65	23652	3201	93363	3715	2858	11432	650	500	2001
		≥65	19710	3201	62242	6549	5038	20152	1187	913	3652
Colorectal	Female	<65	61593	3159	126778	10330	7946	31784	650	500	2001
		≥65	51327	3159	84519	7479	5753	23012	1187	913	3652

	Male	<65	62174	4595	128507	10330	7946	31784	650	500	2001
		≥65	51812	4595	85671	7479	5753	23012	1187	913	3652
Endometrial	Female	<65	32129	1535	105262	4884	3757	15027	650	500	2001
		≥65	26775	1535	70175	6984	5372	21489	1187	913	3652
Ovarian	Female	<65	98788	8296	149573	4884	3757	15027	650	500	2001
		≥65	82324	8296	99715	6984	5372	21489	1187	913	3652
Gallbladder	Female	<65	40173	5859	95782	4884	3757	15027	650	500	2001
		≥65	40173	5859	95782	6984	5372	21489	1187	913	3652
	Male	<65	41161	7363	97473	4884	3757	15027	650	500	2001
		≥65	41161	7363	97473	6984	5372	21489	1187	913	3652
Kidney (Renal Cell)	Female	<65	46077	6255	110765	4884	3757	15027	650	500	2001
		≥65	38397	6255	73843	6984	5372	21489	1187	913	3652
	Male	<65	46048	6018	117123	4884	3757	15027	650	500	2001
		≥65	38374	6018	78082	6984	5372	21489	1187	913	3652
Breast (Postmenopausal)	Female	<65	27693	2207	94284	5985	4604	18416	650	500	2001
		≥65	23078	2207	62856	4752	3655	14620	1187	913	3652
Thyroid	Female	<65	40173	5859	95782	4884	3757	15027	650	500	2001
		≥65	40173	5859	95782	6984	5372	21489	1187	913	3652
	Male	<65	41161	7363	97473	4884	3757	15027	650	500	2001
		≥65	41161	7363	97473	6984	5372	21489	1187	913	3652
Multiple Myeloma	Female	<65	40173	5859	95782	4884	3757	15027	650	500	2001
		≥65	40173	5859	95782	6984	5372	21489	1187	913	3652

Male	<65	41161	7363	97473	4884	3757	15027	650	500	2001
	≥65	41161	7363	97473	6984	5372	21489	1187	913	3652

Supplementary Table 7. Baseline medical costs, productivity loss, and patient time cost among general population aged 20 years or older in the US, by 32 subgroups

Age group, years	Sex	Race/ethnicity	Medical costs: Annual general costs	Medical costs: End-of-life costs	Productivity loss: Annual general costs	Productivity loss: End-of-life costs	Patient time cost: Annual general costs	Patient time cost: End-of-life costs
20-44	Female	NHW	4020	40000	2040	8160	226	904
		NHB	3100	40000	2040	8160	226	904
		Hispanic	2355	40000	2040	8160	226	904
		Other	2617	40000	2040	8160	226	904
	Male	NHW	2022	40000	2040	8160	226	904
		NHB	2279	40000	2040	8160	226	904
		Hispanic	1145	40000	2040	8160	226	904
		Other	1803	40000	2040	8160	226	904
							226	904
45-54	Female	NHW	5371	40000	2040	8160	226	904
		NHB	5712	40000	2040	8160	226	904
		Hispanic	3196	40000	2040	8160	226	904
		Other	4082	40000	2040	8160	226	904
	Male	NHW	3812	40000	2040	8160	226	904
		NHB	3639	40000	2040	8160	226	904
		Hispanic	3612	40000	2040	8160	226	904
		Other	2560	40000	2040	8160	226	904
							226	904
55-64	Female	NHW	7300	40000	2040	8160	226	904
		NHB	5479	40000	2040	8160	226	904
		Hispanic	4607	40000	2040	8160	226	904
		Other	3951	40000	2040	8160	226	904
	Male	NHW	6519	40000	2040	8160	226	904
		NHB	6455	40000	2040	8160	226	904
		Hispanic	5077	40000	2040	8160	226	904
		Other	6320	40000	2040	8160	226	904
≥65	Female	NHW	8997	40000	4409	8160	607	904
		NHB	9585	40000	4409	8160	607	904
		Hispanic	8847	40000	4409	8160	607	904
		Other	8625	40000	4409	8160	607	904
	Male	NHW	9334	40000	4409	8160	607	904
		NHB	7367	40000	4409	8160	607	904
		Hispanic	5640	40000	4409	8160	607	904
		Other	7461	40000	4409	8160	607	904

Supplementary Table 8. Characteristics of US adults aged 20 years or older participated in the NHANES, 2013-2016

Characteristics	(N=10064)	Calorie Consumption, kcal/day
Age, years	47.8 ± 0.41	
Age groups, years, N (%)		
20-44	4319 (44.5)	425 ± 4.38
25-54	1704 (18.3)	315 ± 5.39
55-64	1725 (17.3)	271 ± 4.90
≥65	2316 (19.9)	192 ± 3.83
Sex, N (%)		
Male	4829 (48.3)	388 ± 4.53
Female	5235 (51.7)	279 ± 4.04
Race/ethnicity, N (%)		
Non-Hispanic White	3944 (65.0)	320 ± 4.76
Non-Hispanic Black	2069 (11.2)	361 ± 6.55
Hispanic	2668 (14.9)	367 ± 4.44
Other	1383 (8.90)	325 ± 8.12
Education, N (%)		
Less than high school graduate	2178 (14.2)	311 ± 5.14
High school graduate	2249 (21.6)	332 ± 5.72
Some college	3070 (33.1)	341 ± 4.92
College graduate	2562 (31.0)	332 ± 7.10
Family income to poverty ratio, N (%)		
<1.30	3862 (28.3)	325 ± 4.87
1.30-1.84	2842 (26.7)	333 ± 4.55
1.85-2.99	1725 (20.4)	344 ± 6.73
≥3.00	1635 (24.5)	328 ± 7.01
Body mass index (BMI), kg/m^2	29.3 ± 0.16	
Weight status, N (%)		
Underweight (BMI<18.5)	145 (1.36)	341 ± 17.5
Normal weight (BMI=18.5-24.9)	2671 (27.2)	327 ± 4.81
Overweight/Obese (BMI≥25)	7163 (71.4)	334 ± 4.01

Supplementary Table 9. Consumption of calories from full-service and fast-food restaurants among US adults participated in 2013-2016 NHANES by 32 subgroups

Age group, years	**Sex**	**Race/ethnicity**	**Baseline consumption**, kcal/day (mean ± SE)
20-44	Female	NHW	357 ± 6.47
		NHB	397 ± 8.98
		Hispanic	364 ± 6.77
		Other	334 ± 11.3
	Male	NHW	485 ± 9.00
		NHB	508 ± 12.3
		Hispanic	500 ± 13.7
		Other	466 ± 14.1
45-54	Female	NHW	270 ± 9.38
		NHB	266 ± 7.85
		Hispanic	265 ± 9.11
		Other	228 ± 14.6
	Male	NHW	374 ± 11.3
		NHB	388 ± 17.4
		Hispanic	355 ± 15.0
		Other	338 ± 20.2
55-64	Female	NHW	231 ± 5.25
		NHB	249 ± 9.58
		Hispanic	234 ± 7.99
		Other	216 ± 10.2
	Male	NHW	315 ± 9.55
		NHB	314 ± 18.3
		Hispanic	307 ± 9.90
		Other	298 ± 11.1
≥65	Female	NHW	164 ± 4.71
		NHB	156 ± 6.07
		Hispanic	158 ± 5.27
		Other	137 ± 5.43
	Male	NHW	235 ± 7.43
		NHB	220 ± 7.07
		Hispanic	218 ± 8.07

Other	198 ± 20.0

Supplementary Table 10. Estimated new cancer cases averted by the federal menu calorie labeling in the US by age, sex, race/ethnicity, and cancer type, over lifetime (U.S. population=235,162,844)[1]

Cancer Type	Policy Scenario	20-44 y Female	20-44 y Male	45-54 y Female	45-54 y Male	55-64 y Female	55-64 y Male	65 + y Female	65 + y Male
Endometrial									
Age	*consumer behavior*	3300 (696 to 6090)		591 (-990 to 2160)		1140 (433 to 1940)		656 (107 to 1190)	
	+industry response	5960 (3360 to 8890)		1340 (-208 to 2980)		1600 (928 to 2430)		926 (396 to 1460)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	1630 (-711 to 4080)	0	-136 (-1590 to 1430)	0	757 (140 to 1500)	0	572 (38 to 1070)	0
	+industry response	3080 (829 to 5780)	0	369 (-1100 to 1950)	0	1110 (463 to 1830)	0	780 (245 to 1290)	0
Non-Hispanic Black	*consumer behavior*	763 (-157 to 1710)	0	258 (-23 to 543)	0	283 (73 to 528)	0	47 (-43 to 150)	0
	+industry response	1240 (316 to 2200)	0	372 (93 to 668)	0	355 (146 to 604)	0	77 (-13 to 176)	0
Hispanic	*consumer behavior*	910 (74 to 1790)	0	290 (-48 to 596)	0	42 (-83 to 185)	0	43 (-16 to 102)	0
	+industry response	1460 (580 to 2340)	0	399 (66 to 703)	0	89 (-35 to 233)	0	64 (5 to 122)	0
Other	*consumer behavior*	19 (-312 to 402)	0	165 (41 to 319)	0	54 (3 to 109)	0	-6 (-26 to 14)	0
	+industry response	150 (-174 to 546)	0	191 (68 to 344)	0	68 (18 to 124)	0	0 (-21 to 21)	0
Breast (Postmenopausal)									
Age	*consumer behavior*	2530 (263 to 5040)		373 (-1070 to 1950)		1210 (480 to 2130)		742 (137 to 1380)	
	+industry response	4670 (2330 to 7350)		1040 (-390 to 2680)		1710 (1010 to 2640)		1040 (433 to 1700)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	1370 (-659 to 3750)	0	-224 (-1570 to 1210)	0	832 (170 to 1670)	0	660 (57 to 1280)	0
	+industry response	2660 (490 to 5220)	0	234 (-1130 to 1770)	0	1200 (535 to 2040)	0	902 (291 to 1570)	0
Non-Hispanic Black	*consumer behavior*	567 (-110 to 1300)	0	182 (-34 to 431)	0	267 (89 to 487)	0	43 (-40 to 136)	0

	+industry response	912 (240 to 1680)	0	271 (55 to 536)	0	329 (149 to 554)	0	71 (-13 to 166)	0
Hispanic	*consumer behavior*	581 (44 to 1200)	0	231 (-14 to 474)	0	32.9 (-72 to 154)	0	42 (-12 to 100)	0
	+industry response	934 (368 to 1600)	0	312 (71 to 563)	0	76 (-34 to 198)	0	61 (6 to 123)	0
Other	*consumer behavior*	1 (-310 to 384)	0	182 (40 to 353)	0	74 (9 to 148)	0	-7 (-35 to 22)	0
	+industry response	128 (-187 to 541)	0	210 (71 to 386)	0	94 (29 to 170)	0	1 (-27 to 31)	0
Kidney (Renal Cell)									
Age	*consumer behavior*	2930 (864 to 5040)		581 (-364 to 1540)		1180 (526 to 1810)		428 (28 to 805)	
	+industry response	5240 (3110 to 7390)		1230 (244 to 2210)		1590 (941 to 2250)		651 (248 to 1030)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	338 (-137 to 844)	1040 (-536 to 2790)	-42 (-332 to 273)	53 (-791 to 884)	172 (34 to 339)	677 (88 to 1240)	147 (18 to 280)	192 (-170 to 536)
	+industry response	646 (173 to 1180)	2020 (410 to 3750)	58 (-236 to 383)	379 (-452 to 1250)	251 (109 to 420)	898 (326 to 1470)	199 (72 to 335)	320 (-35 to 661)
Non-Hispanic Black	*consumer behavior*	170 (-35 to 384)	88 (-454 to 620)	60 (-5 to 128)	136 (-96 to 410)	79 (26 to 139)	85 (-81 to 258)	13 (-12 to 40)	44 (9 to 79)
	+industry response	280 (69 to 502)	343 (-202 to 898)	87 (22 to 157)	203 (-30 to 475)	97 (43 to 157)	119 (-45 to 295)	21 (-4 to 48)	56 (22 to 90)
Hispanic	*consumer behavior*	267 (21 to 527)	895 (-21 to 1920)	92 (-4 to 184)	230 (-25 to 503)	14 (-27 to 60)	94 (8 to 196)	15 (-6 to 36)	9 (-29 to 50)
	+industry response	425 (166 to 697)	1290 (371 to 2320)	123 (27 to 218)	305 (49 to 570)	29 (-12 to 76)	127 (41 to 232)	22 (2 to 44)	21 (-17 to 63)
Other	*consumer behavior*	5 (-47 to 66)	75 (-103 to 274)	34 (12 to 59)	3 (-64 to 77)	13 (2 to 25)	33 (10 to 58)	-1 (-6 to 4)	8 (-18 to 37)
	+industry response	27 (-26 to 89)	147 (-29 to 347)	38 (17 to 64)	17 (-52 to 91)	16 (5 to 28)	41 (19 to 67)	1 (-4 to 6)	11 (-15 to 40)
Liver									
Age	*consumer behavior*	3210 (1000 to 5540)		701 (-200 to 1760)		1000 (477 to 1580)		275 (17 to 551)	
	+industry response	5560 (3130 to 8130)		1340 (397 to 2480)		1340 (804 to 1950)		432 (174 to 719)	
Race/Ethnicity									

Non-Hispanic White	consumer behavior	170 (-125 to 597)	1150 (-258 to 3130)	18 (-168 to 236)	-82 (-844 to 807)	113 (36 to 227)	520 (108 to 1020)	75 (6 to 155)	116 (-110 to 365)
	+industry response	367 (53 to 855)	2120 (498 to 4300)	78 (-105 to 319)	215 (-537 to 1150)	159 (77 to 280)	668 (287 to 1220)	100 (35 to 189)	198 (-26 to 454)
Non-Hispanic Black	consumer behavior	143 (-27 to 346)	85 (-678 to 1050)	53 (2 to 120)	213 (-146 to 705)	51 (14 to 100)	118 (-112 to 393)	7 (-7 to 26)	37 (-4 to 88)
	+industry response	231 (53 to 458)	429 (-312 to 1460)	74 (24 to 147)	306 (-41 to 823)	63 (28 to 115)	163 (-58 to 447)	12 (-2 to 32)	52 (11 to 107)
Hispanic	consumer behavior	239 (19 to 570)	1150 (93 to 2490)	99 (3 to 215)	321 (15 to 703)	14 (-30 to 72)	113 (19 to 233)	17 (-5 to 41)	8 (-33 to 54)
	+industry response	384 (132 to 756)	1600 (529 to 3050)	132 (36 to 257)	409 (106 to 820)	31 (-13 to 90)	150 (55 to 276)	25 (3 to 50)	20 (-19 to 70)
Other	consumer behavior	2 (-56 to 82)	99 (-125 to 379)	38 (9 to 77)	-1 (-101 to 125)	15 (0 to 34)	38 (5 to 76)	0 (-8 to 7)	9 (-28 to 53)
	+industry response	26 (-32 to 108)	183 (-31 to 483)	43 (15 to 85)	18 (-80 to 152)	19 (5 to 40)	48 (17 to 91)	2 (-5 to 10)	14 (-23 to 59)
Pancreatic									
Age	consumer behavior	764 (262 to 1340)		81.6 (-186 to 388)		404 (193 to 651)		148 (21 to 286)	
	+industry response	1350 (820 to 1990)		269 (4 to 595)		540 (327 to 793)		227 (96 to 370)	
Race/Ethnicity									
Non-Hispanic White	consumer behavior	121 (-44 to 367)	247 (-120 to 768)	-48 (-159 to 87)	-16 (-246 to 245)	87 (26 to 175)	218 (48 to 432)	63 (3 to 131)	58 (-54 to 189)
	+industry response	229 (50 to 493)	490 (99 to 1060)	-11 (-124 to 134)	73 (-154 to 363)	122 (56 to 218)	283 (115 to 507)	87 (27 to 163)	98 (-12 to 238)
Non-Hispanic Black	consumer behavior	60 (-10 to 158)	18 (-80 to 128)	24 (-1 to 54)	30 (-20 to 87)	32 (9 to 63)	19 (-16 to 62)	5 (-6 to 19)	10 (2 to 19)
	+industry response	98 (21 to 207)	64 (-36 to 184)	34 (9 to 67)	44 (-4 to 102)	39 (17 to 72)	27 (-9 to 70)	9 (-2 to 23)	13 (5 to 23)
Hispanic	consumer behavior	68 (5 to 150)	194 (13 to 422)	26 (-4 to 60)	46 (-5 to 105)	4 (-11 to 22)	18 (-3 to 44)	6 (-2 to 14)	2 (-8 to 12)
	+industry response	108 (40 to 201)	273 (92 to 518)	36 (7 to 70)	63 (11 to 124)	10 (-5 to 28)	26 (6 to 53)	8 (0 to 18)	5 (-5 to 15)
Other	consumer behavior	-2 (-27 to 30)	18 (-29 to 72)	17 (4 to 33)	0 (-20 to 23)	8 (1 to 16)	10 (3 to 19)	0 (-4 to 3)	2 (-6 to 13)
	+industry response	9 (-17 to 43)	36 (-9 to 94)	19 (7 to 36)	4 (-16 to 28)	10 (3 to 18)	13 (5 to 22)	1 (-3 to 5)	4 (-5 to 14)

Esophageal Adenocarcinoma									
Age	*consumer behavior*	715 (43 to 1480)		92 (-296 to 501)		419 (136 to 719)		128 (-60 to 309)	
	+industry response	1300 (602 to 2100)		293 (-102 to 708)		556 (270 to 858)		206 (20 to 390)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	45 (-25 to 125)	406 (-228 to 1100)	-9 (-55 to 41)	26 (-368 to 419)	30 (7 to 58)	345 (64 to 630)	27 (5 to 50)	92 (-88 to 263)
	+industry response	91 (17 to 179)	815 (174 to 1560)	7 (-40 to 60)	179 (-210 to 578)	43 (20 to 73)	449 (174 to 739)	35 (14 to 59)	155 (-17 to 330)
Non-Hispanic Black	*consumer behavior*	10 (-2 to 22)	10 (-28 to 50)	3 (-1 to 8)	11 (-7 to 32)	5 (2 to 9)	67 (-7 to 22)	1 (-1 to 3)	4 (0 to 7)
	+industry response	16 (4 to 29)	28 (-11 to 69)	5 (1 to 9)	16 (-2 to 37)	6 (3 to 11)	9 (-4 to 25)	1 (0 to 3)	5 (2 to 8)
Hispanic	*consumer behavior*	28 (2 to 57)	196 (-2 to 414)	9 (-1 to 20)	46 (-7 to 112)	2 (-3 to 8)	24 (3 to 47)	2 (-1 to 4)	2 (-7 to 12)
	+industry response	44 (17 to 76)	280 (80 to 504)	13 (2 to 24)	63 (7 to 130)	3 (-1 to 10)	32 (11 to 56)	3 (0 to 5)	4 (-4 to 15)
Other	*consumer behavior*	-1 (-10 to 11)	10 (-16 to 41)	6 (1 to 11)	0 (-12 to 13)	2 (0 to 5)	7 (2 to 12)	0 (-1 to 1)	2 (-4 to 8)
	+industry response	3 (-6 to 15)	21 (-6 to 52)	75 (2 to 12)	2 (-10 to 15)	3 (1 to 6)	8 (4 to 13)	0 (-1 to 1)	2 (-3 to 9)
Colorectal									
Age	*consumer behavior*	584 (183 to 1090)		79 (-90 to 289)		251 (126 to 412)		117 (19 to 224)	
	+industry response	1050 (605 to 1610)		201 (23 to 426)		341 (209 to 514)		175 (81 to 289)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	67 (-51 to 261)	169 (-107 to 569)	-35 (-106 to 64)	-17 (-151 to 163)	52 (11 to 111)	126 (21 to 262)	55 (11 to 115)	44 (-36 to 129)
	+industry response	144 (-2 to 382)	358 (40 to 790)	-12 (-80 to 97)	38 (-99 to 233)	75 (30 to 146)	168 (62 to 313)	73 (28 to 138)	70 (-7 to 162)
Non-Hispanic Black	*consumer behavior*	31 (-9 to 88)	38 (-48 to 144)	11 (-1 to 29)	26 (-13 to 79)	19 (7 to 36)	14 (-17 to 49)	3 (-4 to 12)	8 (1 to 17)
	+industry response	53 (9 to 119)	78 (-8 to 203)	17 (4 to 36)	36 (-2 to 91)	23 (11 to 41)	20 (-9 to 56)	6 (-1 to 15)	11 (3 to 21)
Hispanic	*consumer behavior*	45 (2 to 113)	185 (25 to 409)	20 (1 to 43)	57 (9 to 114)	3 (-7 to 16)	21 (2 to 44)	4 (-1 to 11)	1 (-8 to 11)

		+industry response	73 (18 to 155)	256 (84 to 504)	26 (8 to 51)	70 (23 to 129)	6 (-3 to 20)	28 (10 to 53)	6 (1 to 13)	4 (-5 to 14)
	Other	*consumer behavior*	-2 (-21 to 26)	20 (-31 to 89)	7 (-1 to 19)	1 (-20 to 26)	4 (0 to 11)	8 (1 to 16)	-1 (-3 to 2)	3 (-6 to 13)
		+industry response	6 (-13 to 36)	41 (-9 to 115)	9 (1 to 21)	5 (-15 to 31)	6 (1 to 12)	10 (4 to 19)	0 (-2 to 3)	4 (-5 to 14)
Thyroid										
Age		*consumer behavior*	374 (114 to 751)		10 (-69 to 125)		84 (44 to 144)		34 (7 to 68)	
		+industry response	683 (349 to 1130)		67 (-17 to 200)		117 (70 to 187)		52 (22 to 91)	
Race/Ethnicity										
	Non-Hispanic White	*consumer behavior*	96 (-59 to 382)	52 (-59 to 273)	-28 (-85 to 56)	-15 (-64 to 58)	21 (1 to 62)	28 (1 to 73)	20 (2 to 47)	8 (-9 to 31)
		+industry response	205 (-15 to 563)	131 (-26 to 395)	-8 (-63 to 92)	3 (-43 to 85)	33 (5 to 80)	40 (12 to 90)	28 (9 to 58)	14 (-3 to 40)
	Non-Hispanic Black	*consumer behavior*	29 (-10 to 113)	7 (-10 to 36)	8 (-1 to 24)	3 (-3 to 12)	12 (6 to 22)	2 (-2 to 8)	1 (-2 to 5)	1 (0 to 2)
		+industry response	52 (-1 to 153)	16 (-4 to 50)	12 (2 to 30)	5 (-1 to 15)	14 (8 to 26)	3 (-1 to 10)	2 (0 to 7)	2 (1 to 3)
	Hispanic	*consumer behavior*	68 (1 to 201)	59 (6 to 151)	15 (-5 to 39)	13 (2 to 30)	2 (-4 to 12)	4 (0 to 9)	2 (-1 to 6)	0 (-1 to 3)
		+industry response	113 (22 to 276)	84 (26 to 189)	21 (2 to 48)	16 (6 to 35)	4 (-2 to 15)	5 (2 to 12)	3 (0 to 8)	1 (-1 to 3)
	Other	*consumer behavior*	-4 (-38 to 59)	13 (-13 to 56)	6 (-4 to 20)	1 (-7 to 12)	5 (2 to 10)	5 (3 to 8)	-1 (-2 to 1)	0 (-2 to 3)
		+industry response	12 (-25 to 82)	23 (-2 to 70)	8 (-1 to 23)	3 (-5 to 14)	6 (3 to 11)	6 (4 to 9)	0 (-2 to 2)	1 (-1 to 4)
Multiple Myeloma										
Age		*consumer behavior*	370 (113 to 743)		78 (-46 to 242)		181 (85 to 308)		63 (7 to 128)	
		+industry response	653 (327 to 1120)		164 (29 to 357)		243 (142 to 385)		97 (41 to 169)	
Race/Ethnicity										
	Non-Hispanic White	*consumer behavior*	27 (-34 to 138)	102 (-61 to 375)	-14 (-50 to 50)	-4 (-96 to 139)	24 (3 to 67)	96 (25 to 204)	20 (1 to 52)	23 (-23 to 83)
		+industry response	64 (-22 to 204)	207 (0 to 544)	-1 (-38 to 74)	29 (-60 to 199)	36 (9 to 87)	125 (52 to 246)	28 (8 to 65)	39 (-5 to 111)

Non-Hispanic Black	consumer behavior	39 (-9 to 135)	22 (-63 to 178)	14 (-1 to 43)	27 (-15 to 95)	19 (4 to 45)	11 (-22 to 60)	4 (-4 to 17)	10 (2 to 22)
	+industry response	66 (1 to 183)	65 (-30 to 242)	22 (4 to 55)	38 (-3 to 113)	24 (9 to 54)	18 (-13 to 71)	6 (-1 to 20)	13 (5 to 26)
Hispanic	consumer behavior	26 (0 to 79)	111 (12 to 277)	7 (-5 to 24)	25 (-3 to 68)	2 (-4 to 11)	15 (3 to 32)	2 (-1 to 7)	0 (-5 to 7)
	+industry response	43 (6 to 110)	154 (50 to 340)	10 (0 to 30)	33 (6 to 82)	4 (-2 to 15)	19 (8 to 39)	3 (0 to 9)	1 (-3 to 9)
Other	consumer behavior	0 (-7 to 11)	8 (-11 to 41)	7 (3 to 12)	0 (-10 to 12)	1 (1 to 4)	4 (1 to 9)	-0 (-1 to 1)	1 (-3 to 6)
	+industry response	2 (-4 to 16)	16 (-3 to 53)	8 (4 to 13)	1 (-8 to 15)	2 (0 to 5)	5 (2 to 11)	0 (-1 to 1)	1 (-2 to 6)
Stomach (Gastric Cardia)									
Age	consumer behavior	338 (49 to 803)		58 (-99 to 264)		182 (70 to 347)		54 (-19 to 149)	
	+industry response	607 (241 to 1140)		141 (-20 to 378)		240 (129 to 420)		86 (15 to 190)	
Race/Ethnicity									
Non-Hispanic White	consumer behavior	18 (-19 to 77)	208 (-55 to 648)	-9 (-31 to 25)	24 (-128 to 233)	15 (4 to 37)	145 (35 to 304)	14 (3 to 28)	34 (-36 to 124)
	+industry response	43 (-6 to 117)	380 (51 to 886)	-1 (-24 to 38)	86 (-67 to 322)	22 (9 to 47)	187 (77 to 364)	18 (8 to 35)	58 (-9 to 160)
Non-Hispanic Black	consumer behavior	7 (-2 to 21)	6 (-19 to 44)	2 (0 to 6)	7 (-5 to 24)	3 (1 to 7)	3 (-6 to 15)	0 (0 to 2)	3 (1 to 5)
	+industry response	12 (2 to 28)	19 (-8 to 62)	3 (1 to 7)	10 (-2 to 29)	4 (2 to 8)	5 (-4 to 17)	1 (0 to 2)	3 (2 to 6)
Hispanic	consumer behavior	15 (1 to 39)	63 (-7 to 170)	5 (0 to 13)	16 (-4 to 45)	1 (-2 to 5)	7 (0 to 18)	1 (0 to 3)	1 (-3 to 5)
	+industry response	24 (6 to 52)	95 (21 to 214)	7 (2 to 16)	22 (3 to 54)	2 (-1 to 6)	10 (3 to 23)	1 (0 to 3)	2 (-2 to 7)
Other	consumer behavior	-1 (-7 to 10)	5 (-14 to 34)	5 (2 to 9)	0 (-8 to 12)	1 (0 to 3)	4 (1 to 9)	0 (-1 to 1)	1 (-3 to 6)
	+industry response	2 (-5 to 14)	12 (-7 to 46)	6 (3 to 10)	2 (-6 to 15)	2 (0 to 4)	5 (2 to 10)	0 (-1 to 1)	2 (-2 to 7)
Gallbladder									
Age	consumer behavior	161 (67 to 263)		51 (8 to 100)		76 (47 to 109)		29 (11 to 51)	
	+industry response	282 (181 to 396)		86 (43 to 138)		101 (73 to 137)		44 (25 to 66)	

Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	24 (-10 to 71)	19 (-13 to 61)	0 (-25 to 30)	1.97 (-17 to 24)	19 (5 to 38)	23 (6 to 42)	16 (3 to 31)	6 (-5 to 17)
	+industry response	47 (10 to 99)	39 (5 to 88)	9 (-16 to 42)	9 (-10 to 34)	27 (12 to 48)	29 (13 to 50)	21 (8 to 37)	9 (-1 to 21)
Non-Hispanic Black	*consumer behavior*	27 (-6 to 70)	2 (-17 to 26)	11 (0 to 24)	6 (-4 to 18)	14 (4 to 26)	4 (-4 to 12)	2 (-2 to 7)	2 (0 to 4)
	+industry response	45 (11 to 93)	11 (-8 to 38)	15 (4 to 29)	9 (-1 to 21)	17 (8 to 30)	5 (-2 to 14)	4 (-1 to 9)	3 (1 to 5)
Hispanic	*consumer behavior*	32 (2 to 73)	42 (-10 to 106)	10 (-4 to 26)	14 (-2 to 34)	3 (-5 to 11)	7 (1 to 15)	3 (-1 to 7)	0 (-3 to 4)
	+industry response	53 (19 to 96)	65 (11 to 130)	15 (1 to 31)	19 (3 to 39)	5 (-2 to 14)	9 (3 to 18)	4 (1 to 9)	1 (-2 to 5)
Other	*consumer behavior*	0 (-11 to 18)	3 (-6 to 15)	6 (1 to 13)	0 (-4 to 5)	3 (0 to 7)	3 (1 to 5)	0 (-1 to 1)	1 (-1 to 3)
	+industry response	5 (-7 to 24)	7 (-2 to 19)	7 (2 to 14)	1 (-3 to 6)	4 (1 to 8)	3 (1 to 5)	0 (-1 to 2)	1 (-1 to 3)
Advanced Prostate									
Age	*consumer behavior*	163 (9 to 360)		37 (-54 to 146)		106 (33 to 194)		35 (-14 to 91)	
	+industry response	300 (130 to 507)		85 (-6 to 203)		142 (67 to 240)		56 (9 to 119)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	0	86 (-24 to 267)	0	-1 (-80 to 98)	0	75 (9 to 162)	0	24 (-23 to 80)
	+industry response	0	162 (32 to 350)	0	30 (-48 to 144)	0	100 (36 to 199)	0	40 (-5 to 102)
Non-Hispanic Black	*consumer behavior*	0	3 (-61 to 97)	0	21 (-17 to 69)	0	16 (-13 to 51)	0	8 (2 to 17)
	+industry response	0	34 (-33 to 145)	0	31 (-5 to 83)	0	22 (-7 to 57)	0	11 (4 to 20)
Hispanic	*consumer behavior*	0	59 (8 to 133)	0	13 (-3 to 37)	0	9 (2 to 20)	0	1 (-3 to 5)
	+industry response	0	82 (28 to 163)	0	18 (1 to 44)	0	12 (5 to 23)	0	2 (-2 to 7)
Other	*consumer behavior*	0	3 (-10 to 21)	0	0 (-7 to 8)	0	4 (2 to 8)	0	1 (-3 to 5)
	+industry response	0	8 (-5 to 28)	0	1 (-5 to 9)	0	5 (3 to 9)	0	2 (-2 to 6)

Ovarian									
Age	*consumer behavior*	66 (-10 to 180)		16 (-20 to 75)		31 (11 to 69)		28 (11 to 61)	
	+industry response	129 (16 to 277)		33 (-6 to 102)		45 (17 to 87)		37 (19 to 75)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	34 (-25 to 147)	0	-4 (-38 to 54)	0	20 (2 to 55)	0	25 (8 to 57)	0
	+industry response	71 (-23 to 220)	0	7 (-30 to 72)	0	30 (6 to 71)	0	32 (15 to 70)	0
Non-Hispanic Black	*consumer behavior*	11 (-5 to 41)	0	4 (0 to 13)	0	6 (3 to 13)	0	1 (-1 to 5)	0
	+industry response	19 (-3 to 56)	0	6 (0 to 17)	0	8 (4 to 16)	0	2 (0 to 6)	0
Hispanic	*consumer behavior*	21 (-2 to 67)	0	8 (-1 to 21)	0	1 (-3 to 8)	0	1 (-1 to 5)	0
	+industry response	34 (1 to 91)	0	11 (3 to 26)	0	3 (-1 to 10)	0	2 (0 to 6)	0
Other	*consumer behavior*	-8 (-19 to 13)	0	6 (2 to 13)	0	2 (1 to 5)	0	0 (-1 to 1)	0
	+industry response	-3 (-15 to 21)	0	7 (3 to 14)	0	3 (1 to 6)	0	0 (-1 to 2)	0

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.

Supplementary Table 11. Estimated cancer deaths reduced by the federal menu calorie labeling in the US by age, sex, race/ethnicity, and cancer type, over a lifetime (U.S. population=235,162,844)[1]

Cancer Type	Policy Scenario	20-44 y		45-54 y		55-64 y		65 + y	
		Female	Male	Female	Male	Female	Male	Female	Male
Breast (Postmenopausal)									
Age	*consumer behavior*	2490 (260 to 4980)		151 (-204 to 521)		285 (129 to 479)		126 (30 to 227)	
	+industry response	4610 (2290 to 7240)		336 (-26 to 725)		396 (237 to 598)		178 (82 to 284)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	1350 (-652 to 3690)	0	-55 (-373 to 278)	0	165 (33 to 327)	0	103 (10 to 204)	0
	+industry response	2620 (480 to 5150)	0	54 (-264 to 419)	0	238 (105 to 401)	0	139 (47 to 244)	0
Non-Hispanic Black	*consumer behavior*	560 (-109 to 1280)	0	85 (-11 to 200)	0	95 (32 to 173)	0	13 (-12 to 40)	0
	+industry response	901 (238 to 1660)	0	126 (26 to 247)	0	117 (53 to 196)	0	21 (-4 to 49)	0
Hispanic	*consumer behavior*	572 (45 to 1180)	0	76 (-7 to 163)	0	9 (-21 to 44)	0	10 (-3 to 24)	0
	+industry response	922 (364 to 1570)	0	104 (21 to 193)	0	21 (-9 to 57)	0	15 (2 to 30)	0
Other	*consumer behavior*	0 (-306 to 378)	0	39 (9 to 76)	0	15 (2 to 31)	0	-1 (-6 to 3)	0
	+industry response	125 (-185 to 532)	0	45 (16 to 84)	0	19 (6 to 35)	0	0 (-5 to 5)	0
Liver									
Age	*consumer behavior*	2840 (897 to 4890)		628 (-181 to 1570)		852 (411 to 1340)		227 (18 to 455)	
	+industry response	4900 (2760 to 7190)		1200 (345 to 2210)		1140 (689 to 1650)		357 (146 to 587)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	139 (-108 to 504)	1040 (-237 to 2780)	15 (-147 to 207)	-70 (-749 to 722)	98 (31 to 196)	440 (93 to 858)	63 (6 to 130)	97 (-88 to 297)
	+industry response	310 (42 to 719)	1900 (449 to 3830)	67 (-93 to 276)	199 (-478 to 1040)	137 (67 to 240)	565 (241 to 1020)	85 (30 to 159)	161 (-18 to 369)

Non-Hispanic Black	*consumer behavior*	134 (-25 to 317)	72 (-601 to 932)	49 (3 to 110)	193 (-133 to 632)	43 (12 to 85)	100 (-95 to 336)	6 (-6 to 22)	29 (-4 to 69)
	+industry response	214 (51 to 425)	382 (-273 to 1280)	68 (23 to 133)	276 (-37 to 729)	54 (24 to 97)	139 (-49 to 377)	10 (-2 to 27)	41 (8 to 83)
Hispanic	*consumer behavior*	199 (17 to 473)	1020 (88 to 2210)	87 (2 to 189)	285 (13 to 630)	12 (-26 to 62)	99 (18 to 201)	15 (-4 to 35)	6 (-28 to 46)
	+industry response	316 (111 to 623)	1430 (482 to 2690)	116 (31 to 223)	365 (94 to 729)	26 (-11 to 78)	131 (48 to 242)	21 (3 to 43)	17 (-15 to 59)
Other	*consumer behavior*	2 (-47 to 68)	90 (-110 to 339)	32 (7 to 65)	-2 (-88 to 108)	12 (0 to 28)	30 (4 to 61)	0 (-6 to 6)	7 (-22 to 42)
	+industry response	22 (-28 to 93)	168 (-26 to 434)	36 (13 to 71)	15 (-70 to 130)	16 (4 to 32)	39 (14 to 74)	1 (-4 to 8)	11 (-18 to 46)
Endometrial									
Age	*consumer behavior*	1190 (309 to 2140)		251 (-248 to 785)		394 (177 to 659)		213 (51 to 378)	
	+industry response	2100 (1200 to 3110)		512 (26 to 1060)		548 (325 to 817)		302 (139 to 472)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	440 (-210 to 1170)	0	-42 (-511 to 440)	0	206 (36 to 399)	0	173 (13 to 319)	0
	+industry response	858 (218 to 1620)	0	114 (-351 to 606)	0	298 (127 to 491)	0	234 (76 to 388)	0
Non-Hispanic Black	*consumer behavior*	412 (-90 to 937)	0	139 (-9 to 293)	0	157 (42 to 295)	0	26 (-24 to 83)	0
	+industry response	666 (177 to 1210)	0	201 (51 to 361)	0	195 (81 to 338)	0	42 (-8 to 97)	0
Hispanic	*consumer behavior*	315 (22 to 645)	0	105 (-22 to 222)	0	16 (-33 to 70)	0	19 (-7 to 44)	0
	+industry response	505 (197 to 854)	0	144 (21 to 261)	0	34 (-14 to 89)	0	28 (3 to 54)	0
Other	*consumer behavior*	8 (-99 to 139)	0	51 (13 to 99)	0	17 (1 to 36)	0	-3 (-10 to 5)	0
	+industry response	50 (-56 to 187)	0	58 (21 to 107)	0	22 (6 to 41)	0	0 (-8 to 7)	0
Kidney (Renal Cell)									
Age	*consumer behavior*	1050 (284 to 1830)		263 (-153 to 695)		506 (225 to 778)		182 (20 to 338)	
	+industry response	1880 (1100 to 2680)		539 (106 to 977)		679 (402 to 954)		276 (112 to 429)	
Race/Ethnicity									

Non-Hispanic White	*consumer behavior*	57 (-23 to 159)	332 (-183 to 922)	-16 (-128 to 106)	26 (-351 to 396)	72 (14 to 138)	287 (42 to 525)	66 (9 to 124)	81 (-68 to 219)
	+industry response	111 (27 to 224)	663 (123 to 1280)	22 (-90 to 146)	168 (-199 to 552)	105 (46 to 171)	378 (138 to 623)	89 (33 to 148)	133 (-12 to 272)
Non-Hispanic Black	*consumer behavior*	67 (-16 to 162)	48 (-225 to 326)	24 (-2 to 53)	59 (-40 to 171)	30 (10 to 56)	35 (-32 to 106)	5 (-5 to 16)	16 (3 to 28)
	+industry response	113 (25 to 218)	174 (-96 to 461)	34 (9 to 64)	87 (-14 to 199)	37 (17 to 63)	49 (-17 to 121)	8 (-2 to 20)	20 (7 to 33)
Hispanic	*consumer behavior*	111 (9 to 229)	367 (0 to 792)	30 (-3 to 62)	118 (-15 to 261)	6 (-13 to 29)	47 (5 to 98)	7 (-2 to 17)	4 (-12 to 23)
	+industry response	177 (67 to 305)	522 (168 to 968)	40 (8 to 74)	157 (23 to 303)	13 (-5 to 36)	64 (22 to 116)	11 (1 to 21)	9 (-7 to 28)
Other	*consumer behavior*	3 (-23 to 34)	33 (-40 to 122)	15 (5 to 28)	0 (-28 to 33)	5 (1 to 11)	16 (5 to 29)	-1 (-3 to 2)	4 (-8 to 17)
	+industry response	13 (-12 to 45)	63 (-10 to 156)	17 (7 to 30)	6 (-22 to 39)	6 (2 to 12)	20 (9 to 33)	0 (-2 to 3)	5 (-6 to 18)
Pancreatic									
Age	*consumer behavior*	656 (220 to 1160)		74 (-166 to 350)		362 (175 to 581)		131 (20 to 250)	
	+industry response	1160 (707 to 1730)		243 (1 to 535)		483 (293 to 708)		199 (87 to 321)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	101 (-40 to 310)	213 (-100 to 659)	-44 (-143 to 78)	-13 (-216 to 221)	79 (24 to 158)	193 (44 to 384)	56 (3 to 117)	50 (-45 to 162)
	+industry response	196 (42 to 425)	420 (85 to 911)	-10 (-111 to 120)	67 (-140 to 326)	111 (51 to 198)	250 (102 to 448)	78 (25 to 146)	84 (-10 to 203)
Non-Hispanic Black	*consumer behavior*	48 (-7 to 125)	16 (-72 to 117)	22 (-1 to 49)	27 (-18 to 78)	29 (8 to 57)	18 (-15 to 56)	5 (-5 to 17)	9 (1 to 17)
	+industry response	78 (18 to 162)	57 (-33 to 164)	31 (9 to 62)	39 (-3 to 91)	36 (15 to 65)	24 (-8 to 63)	8 (-1 to 20)	12 (4 to 19)
Hispanic	*consumer behavior*	55 (5 to 118)	175 (13 to 374)	24 (-4 to 53)	42 (-5 to 97)	4 (-10 to 20)	16 (-2 to 40)	5 (-2 to 13)	1 (-7 to 10)
	+industry response	88 (33 to 158)	245 (83 to 462)	32 (6 to 63)	57 (10 to 113)	9 (-5 to 25)	23 (5 to 48)	8 (1 to 16)	4 (-4 to 13)
Other	*consumer behavior*	-2 (-23 to 25)	16 (-23 to 63)	14 (3 to 27)	0 (-18 to 20)	7 (1 to 14)	9 (3 to 17)	0 (-3 to 3)	2 (-5 to 11)
	+industry response	7 (-14 to 36)	32 (-7 to 82)	16 (6 to 30)	3 (-14 to 24)	9 (2 to 16)	11 (5 to 19)	1 (-2 to 4)	3 (-4 to 12)

Esophageal Adenocarcinoma									
Age	*consumer behavior*	631 (33 to 1320)		78 (-255 to 423)		348 (113 to 584)		101 (-42 to 239)	
	+industry response	1150 (520 to 1870)		246 (-96 to 601)		457 (225 to 699)		161 (19 to 302)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	40 (-23 to 112)	366 (-206 to 1000)	-8 (-47 to 36)	24 (-314 to 359)	24 (6 to 47)	283 (55 to 516)	22 (4 to 41)	71 (-65 to 202)
	+industry response	81 (15 to 160)	732 (157 to 1400)	5 (-34 to 51)	152 (-176 to 495)	35 (16 to 59)	366 (142 to 602)	28 (11 to 48)	119 (-13 to 253)
Non-Hispanic Black	*consumer behavior*	9 (-1 to 20)	9 (-25 to 45)	3 (0 to 7)	10 (-6 to 28)	4 (1 to 8)	6 (-6 to 18)	1 (-1 to 2)	3 (0 to 5)
	+industry response	14 (3 to 26)	25 (-10 to 62)	4 (1 to 8)	14 (-2 to 33)	5 (2 to 9)	8 (-3 to 21)	1 (0 to 3)	4 (1 to 6)
Hispanic	*consumer behavior*	25 (2 to 52)	164 (2 to 354)	3 (-1 to 13)	40 (-7 to 99)	1 (-3 to 7)	21 (3 to 42)	1 (-1 to 4)	1 (-6 to 10)
	+industry response	40 (15 to 68)	235 (70 to 425)	5 (0 to 16)	55 (6 to 114)	3 (-1 to 8)	28 (10 to 50)	2 (0 to 4)	4 (-4 to 12)
Other	*consumer behavior*	-1 (-9 to 10)	9 (-14 to 35)	5 (1 to 9)	-1 (-10 to 10)	2 (0 to 4)	6 (2 to 10)	0 (-1 to 1)	1 (-3 to 7)
	+industry response	3 (-6 to 14)	18 (-5 to 46)	6 (2 to 10)	1 (-8 to 12)	2 (1 to 5)	7 (3 to 11)	0 (-1 to 1)	2 (-3 to 7)
Colorectal									
Age	*consumer behavior*	430 (139 to 779)		56 (-48 to 184)		150 (77 to 241)		63 (13 to 119)	
	+industry response	764 (450 to 1160)		133 (23 to 268)		203 (126 to 304)		95 (46 to 153)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	49 (-36 to 181)	119 (-75 to 391)	-21 (-65 to 40)	-10 (-89 to 97)	32 (7 to 67)	72 (11 to 150)	31 (6 to 63)	22 (-17 to 64)
	+industry response	106 (4 to 261)	248 (28 to 545)	-6 (-49 to 59)	24 (-60 to 140)	46 (20 to 85)	96 (36 to 176)	41 (16 to 76)	35 (-3 to 81)
Non-Hispanic Black	*consumer behavior*	26 (-7 to 70)	27 (-36 to 104)	8 (0 to 21)	18 (-9 to 53)	13 (4 to 24)	9 (-10 to 31)	2 (-2 to 7)	5 (0 to 10)
	+industry response	44 (9 to 94)	58 (-7 to 145)	12 (4 to 26)	25.1 (-1 to 61)	15 (7 to 27)	13 (-6 to 36)	3 (-1 to 9)	6 (2 to 12)
Hispanic	*consumer behavior*	36 (2 to 88)	136 (21 to 300)	13 (0 to 27)	37 (5 to 74)	2 (-4 to 10)	13 (2 to 28)	2 (-1 to 7)	1 (-5 to 6)

		+industry response	58 (17 to 120)	188 (65 to 366)	16 (5 to 32)	45 (14 to 84)	4 (-2 to 13)	18 (6 to 33)	4 (0 to 8)	2 (-3 to 8)
	Other	*consumer behavior*	-1 (-15 to 20)	16 (-21 to 65)	5 (-1 to 11)	0 (-12 to 15)	2 (0 to 6)	5 (1 to 9)	0 (-2 to 1)	1 (-3 to 6)
		+industry response	5 (-9 to 27)	30 (-5 to 83)	6 (1 to 13)	2 (-9 to 17)	3 (1 to 7)	6 (2 to 11)	0 (-1 to 2)	2 (-2 to 7)
Stomach (Gastric Cardia)										
Age		*consumer behavior*	286 (45 to 672)		50 (-84 to 224)		149 (58 to 282)		42 (-14 to 113)	
		+industry response	513 (196 to 965)		120 (-14 to 321)		196 (105 to 342)		67 (13 to 145)	
Race/Ethnicity										
	Non-Hispanic White	*consumer behavior*	14 (-16 to 63)	178 (-46 to 545)	-7 (-26 to 20)	21 (-109 to 194)	13 (4 to 30)	118 (29 to 248)	11 (3 to 22)	27 (-26 to 95)
		+industry response	34 (-5 to 95)	322 (43 to 766)	-1 (-19 to 30)	74 (-58 to 270)	18 (7 to 38)	152 (63 to 296)	14 (6 to 27)	45 (-6 to 121)
	Non-Hispanic Black	*consumer behavior*	5 (-1 to 17)	2 (-11 to 29)	2 (0 to 5)	6 (-5 to 22)	2 (1 to 5)	3 (-5 to 13)	0 (0 to 1)	2 (1 to 4)
		+industry response	9 (2 to 22)	7 (-5 to 43)	2 (1 to 6)	9 (-2 to 26)	3 (2 to 6)	4 (-3 to 15)	1 (0 to 2)	3 (1 to 5)
	Hispanic	*consumer behavior*	13 (1 to 35)	57 (-6 to 154)	5 (0 to 12)	14 (-3 to 38)	1 (-1 to 4)	6 (0 to 15)	1 (0 to 2)	0 (-2 to 4)
		+industry response	22 (5 to 47)	86 (20 to 194)	6 (2 to 14)	19 (3 to 46)	1 (-1 to 5)	8 (2 to 19)	1 (0 to 3)	1 (-1 to 6)
	Other	*consumer behavior*	-1 (-5 to 7)	4 (-9 to 25)	4 (2 to 8)	0 (-7 to 10)	1 (0 to 3)	3 (1 to 7)	0 (-1 to 1)	1 (-2 to 5)
		+industry response	1 (-3 to 9)	9 (-4 to 34)	4 (2 to 8)	2 (-5 to 12)	1 (0 to 3)	4 (2 to 8)	0 (0 to 1)	1 (-2 to 5)
Multiple Myeloma										
Age		*consumer behavior*	220 (65 to 441)		51 (-29 to 150)		112 (54 to 186)		42 (6 to 84)	
		+industry response	380 (202 to 657)		105 (20 to 215)		151 (89 to 232)		63 (27 to 111)	
Race/Ethnicity										
	Non-Hispanic White	*consumer behavior*	11 (-13 to 52)	59 (-34 to 221)	-8 (-32 to 31)	-3 (-59 to 83)	15 (2 to 41)	58 (15 to 123)	14 (1 to 35)	15 (-14 to 54)

	+industry response	26 (-7 to 81)	122 (1 to 321)	-1 (-23 to 45)	19 (-37 to 123)	22 (6 to 53)	75 (32 to 147)	19 (6 to 44)	26 (-3 to 71)
Non-Hispanic Black	*consumer behavior*	17 (-4 to 63)	14 (-40 to 115)	10 (0 to 29)	17 (-10 to 59)	12 (3 to 28)	7 (-14 to 38)	2 (-3 to 11)	6 (1 to 12)
	+industry response	29 (1 to 83)	44 (-20 to 159)	15 (3 to 37)	24 (-1 to 70)	15 (6 to 34)	11 (-8 to 45)	4 (-1 to 13)	7 (3 to 15)
Hispanic	*consumer behavior*	16 (0 to 51)	72 (9 to 193)	5 (-3 to 17)	15 (-2 to 42)	1 (-3 to 8)	10 (2 to 22)	2 (-1 to 5)	0 (-3 to 5)
	+industry response	28 (5 to 71)	100 (31 to 244)	7 (0 to 21)	21 (4 to 51)	3 (-1 to 10)	13 (5 to 26)	3 (0 to 6)	1 (-2 to 6)
Other	*consumer behavior*	0 (-3 to 6)	5 (-7 to 27)	4 (2 to 7)	0 (-6 to 7)	1 (0 to 2)	3 (1 to 6)	0 (-1 to 1)	1 (-2 to 4)
	+industry response	1 (-2 to 8)	10 (-2 to 36)	4 (2 to 8)	1 (-5 to 9)	1 (0 to 3)	4 (2 to 7)	0 (-1 to 1)	1 (-1 to 4)
Gallbladder									
Age	*consumer behavior*	136 (58 to 229)		44 (7 to 86)		65 (40 to 93)		24 (9 to 41)	
	+industry response	239 (153 to 341)		74 (36 to 119)		86 (61 to 117)		36 (20 to 53)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	22 (-10 to 64)	15 (-10 to 52)	0 (-23 to 27)	2 (-14 to 19)	16 (4 to 32)	19 (6 to 36)	13 (2 to 25)	5 (-4 to 14)
	+industry response	43 (9 to 90)	32 (4 to 72)	8 (-15 to 37)	8 (-8 to 27)	23 (10 to 40)	24 (11 to 42)	17 (6 to 30)	8 (-1 to 18)
Non-Hispanic Black	*consumer behavior*	24 (-5 to 61)	2 (-14 to 21)	10 (0 to 21)	4 (-3 to 14)	12 (4 to 23)	3 (-3 to 10)	2 (-2 to 6)	2 (0 to 3)
	+industry response	40 (10 to 80)	9 (-7 to 31)	14 (4 to 27)	6 (-1 to 17)	15 (7 to 26)	4 (-2 to 12)	3 (0 to 7)	2 (1 to 4)
Hispanic	*consumer behavior*	28 (2 to 63)	33 (-8 to 85)	9 (-4 to 23)	12 (-2 to 30)	2 (-4 to 10)	6 (1 to 13)	2 (-1 to 6)	0 (-2 to 3)
	+industry response	45 (16 to 83)	51 (9 to 106)	13 (1 to 28)	16 (3 to 35)	4 (-2 to 13)	8 (3 to 16)	4 (0 to 8)	1 (-1 to 4)
Other	*consumer behavior*	0 (-10 to 16)	2 (-5 to 12)	5 (1 to 11)	0 (-2 to 2)	3 (0 to 6)	2 (1 to 4)	0 (-1 to 1)	0 (-1 to 2)
	+industry response	4 (-6 to 21)	5 (-2 to 15)	6 (2 to 12)	0 (-1 to 3)	4 (1 to 7)	3 (1 to 5)	0 (-1 to 2)	1 (-1 to 2)
Advanced Prostate									
Age	*consumer behavior*	101 (13 to 214)		18 (-17 to 58)		33 (11 to 58)		15 (-4 to 38)	

	+industry response	174 (80 to 304)		37 (1 to 83)		43 (22 to 71)		24 (6 to 48)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	0	43 (-13 to 140)	0	0 (-29 to 35)	0	20 (3 to 42)	0	10 (-9 to 32)
	+industry response	0	82 (16 to 192)	0	11 (-17 to 50)	0	27 (10 to 51)	0	16 (-2 to 40)
Non-Hispanic Black	*consumer behavior*	0	2 (-31 to 51)	0	9 (-7 to 30)	0	7 (-5 to 20)	0	4 (1 to 9)
	+industry response	0	17 (-16 to 75)	0	13 (-2 to 36)	0	9 (-3 to 23)	0	6 (2 to 11)
Hispanic	*consumer behavior*	0	47 (7 to 103)	0	7 (-2 to 20)	0	4 (1 to 9)	0	0 (-1 to 3)
	+industry response	0	64 (23 to 127)	0	10 (1 to 25)	0	6 (2 to 11)	0	1 (-1 to 3)
Other	*consumer behavior*	0	1 (-4 to 12)	0	0 (-2 to 3)	0	1 (0 to 2)	0	0 (-1 to 2)
	+industry response	0	2 (-1 to 16)	0	0 (-2 to 3)	0	1 (1 to 2)	0	1 (-1 to 2)
Ovarian									
Age	*consumer behavior*	45 (-3 to 114)		13 (-14 to 54)		24 (9 to 51)		21 (8 to 46)	
	+industry response	87 (19 to 175)		25 (-4 to 75)		34 (14 to 64)		28 (15 to 56)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	21 (-15 to 89)	0	-3 (-29 to 38)	0	15 (2 to 41)	0	19 (6 to 43)	0
	+industry response	45 (-10 to 131)	0	5 (-21 to 52)	0	22 (5 to 51)	0	25 (11 to 52)	0
Non-Hispanic Black	*consumer behavior*	7 (-3 to 27)	0	3 (0 to 11)	0	5 (2 to 11)	0	1 (-1 to 4)	0
	+industry response	13 (-1 to 38)	0	5 (1 to 13)	0	7 (3 to 13)	0	1 (0 to 5)	0
Hispanic	*consumer behavior*	15 (0 to 48)	0	6 (-1 to 16)	0	1 (-2 to 6)	0	1 (-1 to 4)	0
	+industry response	25 (2 to 64)	0	8 (2 to 20)	0	2 (-1 to 8)	0	2 (0 to 5)	0
Other	*consumer behavior*	-5 (-13 to 9)	0	5 (1 to 10)	0	2 (0 to 4)	0	0 (-1 to 1)	0
	+industry response	-1 (-9 to 15)	0	5 (2 to 11)	0	2 (1 to 4)	0	0 (0 to 1)	0

Thyroid									
Age	*consumer behavior*	9 (2 to 22)		3 (-4 to 11)		6 (3 to 12)		4 (1 to 7)	
	+industry response	16 (7 to 33)		6 (0 to 16)		9 (5 to 15)		5 (3 to 9)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	0 (0 to 2)	0 (-1 to 5)	0 (-1 to 1)	-2 (-7 to 5)	0 (0 to 1)	3 (0 to 8)	1 (0 to 4)	1 (-1 to 3)
	+industry response	0 (0 to 3)	1 (0 to 9)	0 (-1 to 2)	0 (-5 to 9)	1 (0 to 2)	4 (1 to 10)	2 (1 to 4)	1 (0 to 4)
Non-Hispanic Black	*consumer behavior*	1 (0 to 5)	1 (-2 to 7)	0 (0 to 1)	0 (0 to 2)	1 (0 to 2)	0 (0 to 1)	0 (0 to 1)	0 (0 to 1)
	+industry response	2 (0 to 7)	2 (-1 to 10)	0 (0 to 2)	0 (0 to 2)	1 (0 to 2)	0 (0 to 1)	0 (0 to 1)	0 (0 to 1)
Hispanic	*consumer behavior*	3 (0 to 10)	1 (0 to 9)	1 (0 to 3)	2 (0 to 5)	0 (0 to 1)	1 (0 to 2)	0 (0 to 1)	0 (0 to 1)
	+industry response	5 (1 to 14)	2 (0 to 12)	1 (0 to 4)	2 (1 to 7)	0 (0 to 1)	1 (0 to 3)	1 (0 to 2)	0 (0 to 1)
Other	*consumer behavior*	0	0 (-1 to 3)	0 (0 to 1)	0 (-1 to 1)	0 (0 to 1)	0 (0 to 1)	0	0 (0 to 1)
	+industry response	0	0 (0 to 4)	0 (0 to 1)	0 (-1 to 2)	0 (0 to 1)	0 (0 to 1)	0	0 (0 to 1)

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.

Supplementary Table 12. Estimated health gains and costs associated with the federal menu calorie labeling on reducing cancer burdens in the US over a lifetime, one-way sensitivity analyses at 25% and 75% calorie compensation outside restaurant settings (US population=235,162,844)[1]

	Menu Calorie Labeling Policy			
	75% Compensation		**25% Compensation**	
	Consumer Behavior Median (2.5% to 97.5%)	**Consumer Behavior + Industry Response** Median (2.5% to 97.5%)	**Consumer Behavior** Median (2.5% to 97.5%)	**Consumer Behavior + Industry Response** Median (2.5% to 97.5%)
New Cancer Cases Averted, N (95% UI)				
Liver cancer	2550 (265 to 5030)	4280 (2000 to 6770)	7760 (5160 to 10500)	12800 (9790 to 16000)
Endometrial cancer	2490 (-633 to 5890)	4640 (1570 to 8070)	8890 (5500 to 12700)	15100 (11800 to 19100)
Kidney cancer	2360 (65 to 4510)	4160 (1900 to 6410)	7810 (5230 to 10000)	13000 (10400 to 15300)
Breast cancer (postmenopausal)	2060 (-616 to 5280)	3930 (1260 to 7200)	7640 (4560 to 11400)	13000 (9700 to 17200)
Pancreatic cancer	638 (51 to 1280)	1140 (536 to 1800)	2140 (1490 to 2890)	3590 (2840 to 4460)
Esophageal adenocarcinoma	598 (-239 to 1400)	1100 (262 to 1930)	2130 (1200 to 3000)	3560 (2600 to 4520)
Colorectal cancer	480 (56 to 940)	851 (423 to 1330)	1600 (1060 to 2140)	2660 (2030 to 3310)
Multiple myeloma	343 (61 to 674)	576 (281 to 950)	1050 (677 to 1480)	1730 (1240 to 2340)
Stomach cancer (cardia)	312 (-42 to 736)	533 (192 to 998)	994 (555 to 1530)	1640 (1060 to 2300)
Thyroid cancer	185 (-70 to 498)	406 (128 to 749)	851 (473 to 1310)	1470 (963 to 2100)
Gallbladder cancer	165 (70 to 274)	266 (167 to 378)	468 (348 to 602)	758 (626 to 912)
Advanced prostate cancer	162 (-28 to 360)	282 (87 to 493)	519 (304 to 768)	868 (603 to 1160)
Ovarian cancer	65 (-17 to 179)	119 (26 to 245)	228 (96 to 398)	384 (196 to 617)
Total	12700 (2430 to 24200)	22600 (12400 to 34100)	42800 (30400 to 53900)	71500 (59100 to 82800)
Cancer Deaths Prevented, N (95% UI)				
Liver cancer	2200 (199 to 4450)	3750 (1720 to 5970)	6790 (4490 to 9270)	11200 (8570 to 14100)
Breast cancer (postmenopausal)	1140 (-958 to 3640)	2420 (281 to 4990)	4980 (2540 to 7860)	8670 (6030 to 12000)
Endometrial cancer	980 (-69 to 2030)	1710 (675 to 2770)	3160 (2020 to 4450)	5270 (4120 to 6630)
Kidney cancer	939 (94 to 1820)	1630 (795 to 2520)	3020 (2080 to 3930)	4990 (4020 to 6020)
Pancreatic cancer	561 (54 to 1120)	996 (473 to 1590)	1870 (1300 to 2510)	3130 (2480 to 3890)
Esophageal adenocarcinoma	503 (-224 to 1190)	932 (203 to 1640)	1820 (1010 to 2580)	3050 (2220 to 3890)
Colorectal cancer	323 (41 to 640)	571 (280 to 910)	1080 (724 to 1440)	1800 (1390 to 2240)
Stomach cancer (cardia)	264 (-32 to 623)	446 (159 to 838)	824 (454 to 1280)	1360 (887 to 1910)
Multiple myeloma	213 (45 to 411)	350 (178 to 576)	635 (419 to 897)	1040 (757 to 1370)
Gallbladder cancer	141 (60 to 234)	226 (142 to 320)	398 (300 to 512)	644 (531 to 777)
Advanced prostate cancer	80 (-12 to 179)	135 (44 to 239)	246 (144 to 373)	410 (278 to 563)
Ovarian cancer	49 (-7 to 123)	87 (26 to 170)	162 (76 to 270)	272 (155 to 415)
Thyroid cancer	11 (1 to 24)	19 (8 to 33)	34 (21 to 53)	56 (39.9 to 81.8)
Total	7760 (1280 to 13900)	13600 (7160 to 20100)	25600 (17900 to 32300)	42500 (34600 to 49600)
Life Years Gained	34700 (5070 to 66300)	62200 (32500 to 93500)	118000 (82400 to 151000)	197000 (161000 to 232000)

QALYs Gained	51400 (9690 to 95700)	90500 (49300 to 135000)	171000 (119000 to 218000)	284000 (234000 to 334000)
Changes in Health-Related Costs, Cancer Only ($, millions)[2,3]				
Healthcare (medical) cost	-693 (-1250 to -138)	-1210 (-1770 to -660)	-2270 (-2850 to -1640)	-3760 (-4360 to -3140)
Patient time cost	-47.9 (-90.0 to -11.9)	-83.6 (-126 to -47.3)	-155 (-198 to -113)	-258 (-302 to -215)
Productivity loss	-279 (-527 to -56.6)	-490 (-743 to -271)	-929 (-1170 to -673)	-1550 (-1800 to -1290)
Policy Implementation Costs ($, millions)[2,3]				
Government cost	18.5 (14.5 to 25.1)	18.5 (14.4 to 25.5)	18.5 (14.5 to 25.1)	18.5 (14.4 to 25.5)
Administration	9.07 (8.61 to 9.56)	9.09 (8.62 to 9.55)	9.07 (8.61 to 9.56)	9.09 (8.62 to 9.55)
Monitoring	9.40 (5.45 to 16.1)	9.38 (5.30 to 16.3)	9.40 (5.45 to 16.1)	9.38 (5.30 to 16.3)
Industry cost	820 (762 to 889)	1120 (1040 to 1210)	820 (762 to 889)	1120 (1040 to 1210)
Compliance	820 (762 to 889)	823 (757 to 889)	820 (762 to 889)	823 (757 to 889)
Reformulation	-------	296 (249 to 353)	-------	296 (249 to 353)
Net Costs, Cancer Only ($, millions) [2,3,4]				
Societal perspective	-174 (-1032 to 639)	-653 (-1510 to 164)	-2520 (-3390 to -1590)	-4430 (-5310 to -3510)
Healthcare perspective	-674 (-1229 to -120)	-1190 (-1750 to -639)	-2250 (-2830 to -1620)	-3740 (-4350 to -3120)
ICER (dollars/QALY)[5]				
Societal perspective	Dominant	Dominant	Dominant	Dominant
Healthcare perspective	Dominant	Dominant	Dominant	Dominant

Abbreviations: ICER, Incremental Cost-Effectiveness Ratio; QALY, quality-adjusted life years.

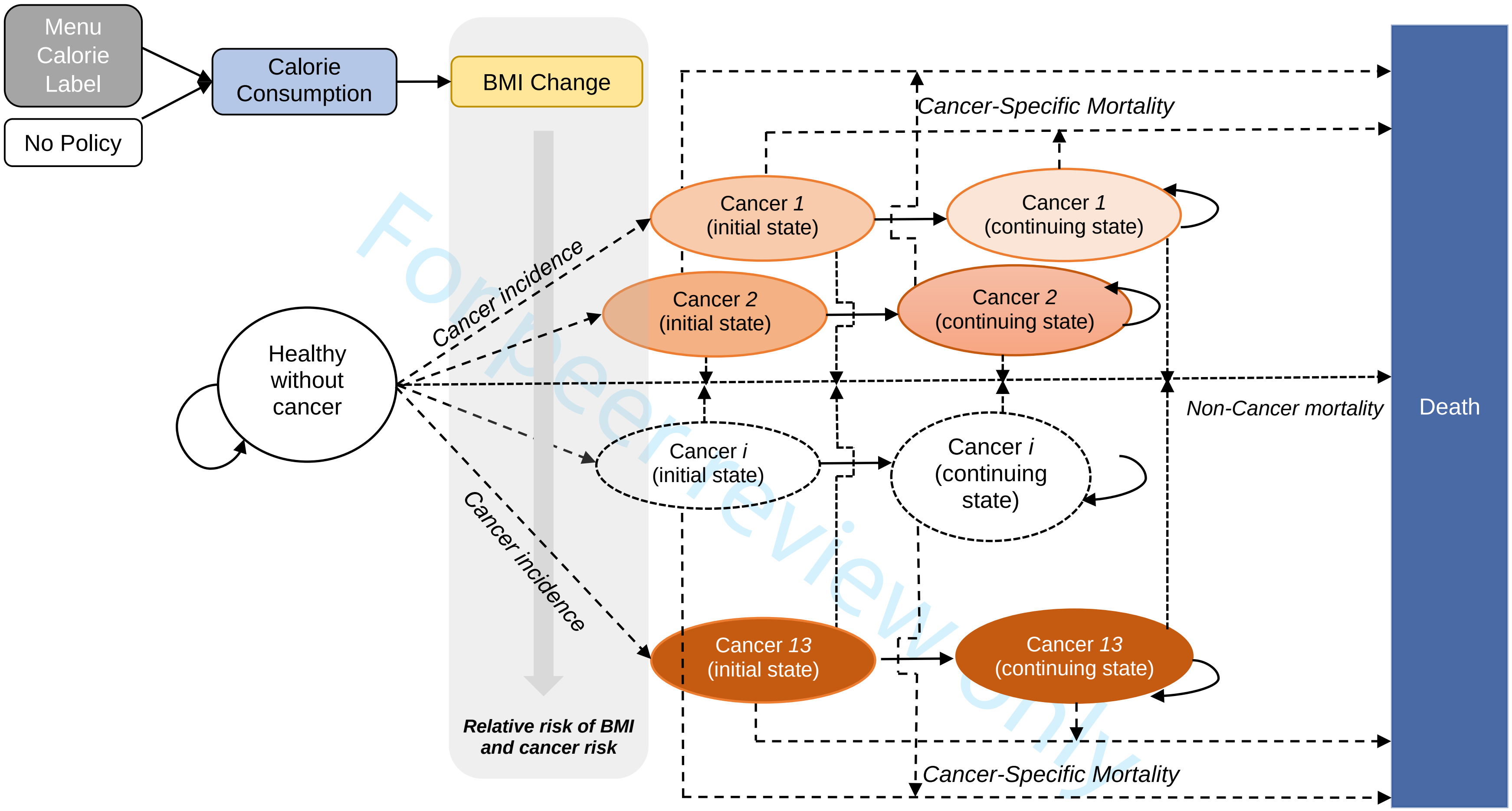
1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.
2. Health-related costs were inflated to 2015 US dollars using the Personal Health Care (PHC) index. Policy intervention costs were inflated to 2015 US dollars using the Consumer Price Index. Negative costs represent savings.
3. Costs are medians from 1000 simulations so may not add up to totals.
4. Net costs were calculated as policy costs minus health-related costs from reduced cancer burden. Societal perspective includes healthcare cost, patient time costs, productivity costs, and policy implementation costs; government perspective included policy costs relevant to policy implementation and program monitoring and evaluation and medical costs.
5. ICER threshold was evaluated at $150,000/QALY. Dominant represents less costly and more effective than the “no-policy intervention” scenario.

Supplementary Table 13. Estimated health gains and costs associated with the federal menu calorie labeling on reducing cancer burdens in the US over a lifetime, one-way sensitivity analysis, assuming all full-service and fast-food restaurants were covered by the policy (US population=235,162,844)[1]

	Menu Calorie Labeling Policy	
	Consumer Behavior Median (2.5% to 97.5%)	**Consumer Behavior + Industry Response** Median (2.5% to 97.5%)
New Cancer Cases Averted, N (95% UI)		
Liver cancer	7280 (4690 to 10100)	11400 (8480 to 14400)
Kidney cancer	6820 (4180 to 9460)	11100 (8470 to 13700)
Endometrial cancer	5340 (1540 to 9220)	10400 (6690 to 14300)
Breast cancer (postmenopausal)	4920 (1580 to 8420)	9380 (5960 to 13100)
Esophageal adenocarcinoma	2060 (1170 to 3060)	3260 (2310 to 4330)
Pancreatic cancer	1810 (1150 to 2600)	3000 (2290 to 3870)
Colorectal cancer	1320 (772 to 1910)	2200 (1600 to 2880)
Stomach cancer (cardia)	938 (531 to 1510)	1480 (985 to 2140)
Thyroid cancer	746 (430 to 1180)	1270 (850 to 1820)
Multiple myeloma	710 (377 to 1150)	1270 (879 to 1820)
Advanced prostate cancer	430 (208 to 681)	715 (461 to 1010)
Gallbladder cancer	329 (201 to 457)	568 (435 to 708)
Ovarian cancer	133 (20.9 to 292)	263 (109 to 468)
Total	32900 (20300 to 46000)	56400 (43700 to 69300)
Cancer Deaths Prevented, N (95% UI)		
Liver cancer	6460 (4170 to 8980)	10000 (7480 to 12800)
Breast cancer (postmenopausal)	3410 (701 to 6280)	6440 (3560 to 9750)
Kidney cancer	2620 (1610 to 3620)	4250 (3210 to 5300)
Endometrial cancer	1890 (654 to 3140)	3610 (2390 to 4900)
Esophageal adenocarcinoma	1800 (1030 to 2670)	2840 (2010 to 3750)
Pancreatic cancer	1580 (976 to 2250)	2620 (1990 to 3380)
Colorectal cancer	923 (560 to 1310)	1520 (1110 to 1970)
Stomach cancer (cardia)	785 (437 to 1270)	1240 (812 to 1790)
Multiple myeloma	431 (234 to 709)	762 (524 to 1100)
Gallbladder cancer	275 (170 to 385)	479 (366 to 601)
Advanced prostate cancer	219 (117 to 351)	353 (233 to 506)
Ovarian cancer	94 (18 to 197)	185 (91 to 317)
Thyroid cancer	27 (13 to 45)	45 (28 to 68)
Total	7760 (1280 to 13900)	34400 (26800 to 42400)
Life Years Gained	97300 (62300 to 135000)	162000 (126000 to 201000)
QALYs Gained	20500 (13100 to 28500)	230000 (178000 to 287000)
Changes in Health-Related Costs, Cancer Only ($, millions)[2,3]		

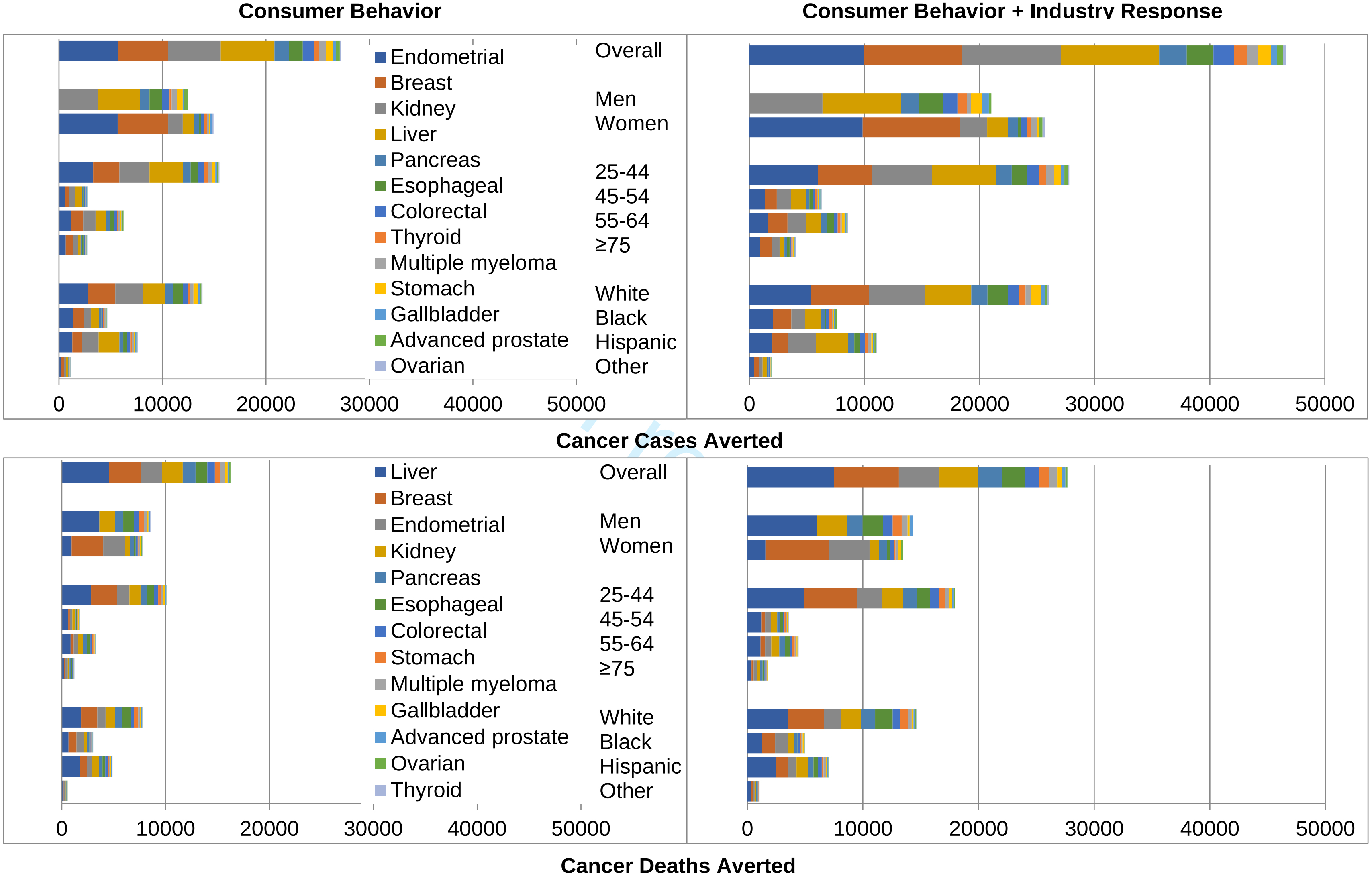
Healthcare (medical) cost	-1820 (-2500 to -1180)	-3060 (-3740 to -2400)
Patient time cost	-112 (-160 to -62.7)	-197 (-245 to -148)
Productivity loss	-692 (-976 to -401)	-1210 (-1490 to -916)
Policy Implementation Costs ($, millions)[2,3]		
Government cost	18.4 (14.7 to 25.7)	18.4 (14.7 to 25.7)
Administration	9.06 (8.56 to 9.52)	9.07 (8.60 to 9.56)
Monitoring	9.32 (5.61 to 16.5)	9.37 (5.64 to 16.6)
Industry cost	821 (764 to 888)	1120 (1040 to 1200)
Compliance	821 (764 to 888)	821 (763 to 886)
Reformulation	-------	297 (248 to 350)
Net Costs, Cancer Only ($, millions) [2,3,4]		
Societal perspective	-1780 (-2790 to -831)	-1030 (-1590 to -549)
Healthcare perspective	-1800 (-2470 to -1160)	-1670 (-2120 to -1270)
ICER (dollars/QALY)[5]		
Societal perspective	Dominant	Dominant
Healthcare perspective	Dominant	Dominant

Abbreviations: ICER, Incremental Cost-Effectiveness Ratio; QALY, quality-adjusted life years.
1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.
2. Health-related costs were inflated to 2015 US dollars using the Personal Health Care (PHC) index. Policy intervention costs were inflated to 2015 US dollars using the Consumer Price Index. Negative costs represent savings.
3. Costs are medians from 1000 simulations so may not add up to totals.
4. Net costs were calculated as policy costs minus health-related costs from reduced cancer burden. Societal perspective includes healthcare cost, patient time costs, productivity costs, and policy implementation costs; government perspective included policy costs relevant to policy implementation and program monitoring and evaluation and medical costs.
5. ICER threshold was evaluated at $150,000/QALY. Dominant represents less costly and more effective than the “no-policy intervention” scenario.

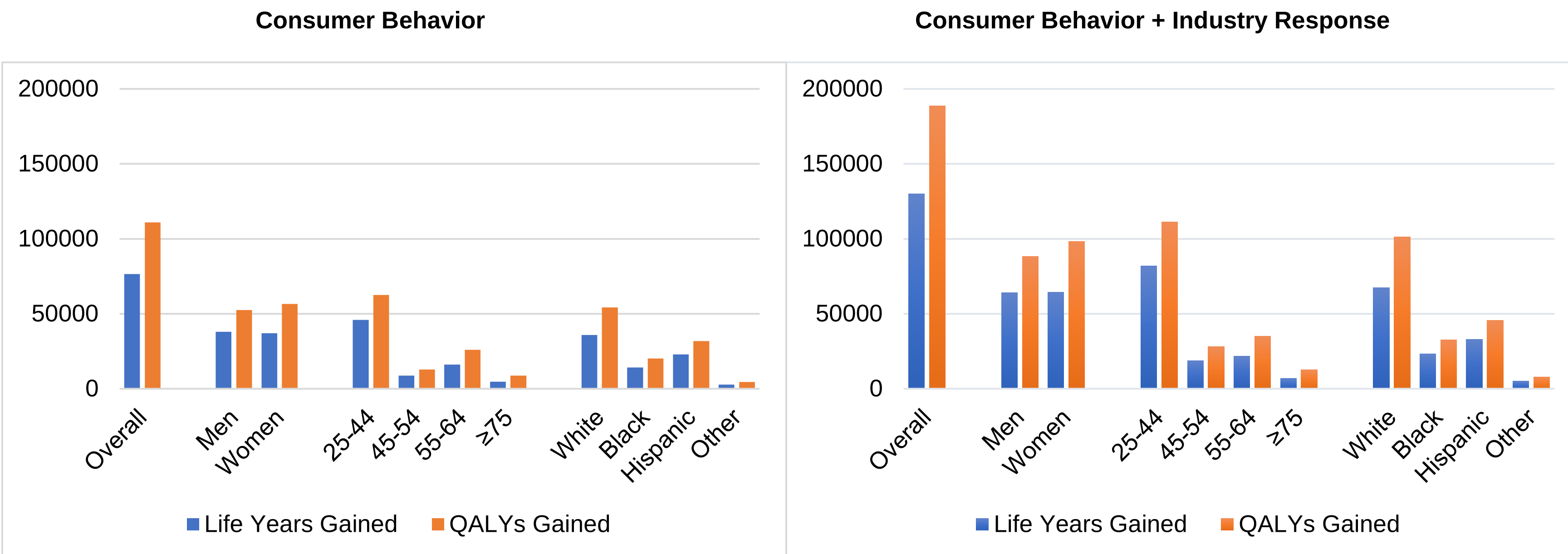


Supplementary Figure 1. Diet and Cancer Outcome Model (DiCOM)

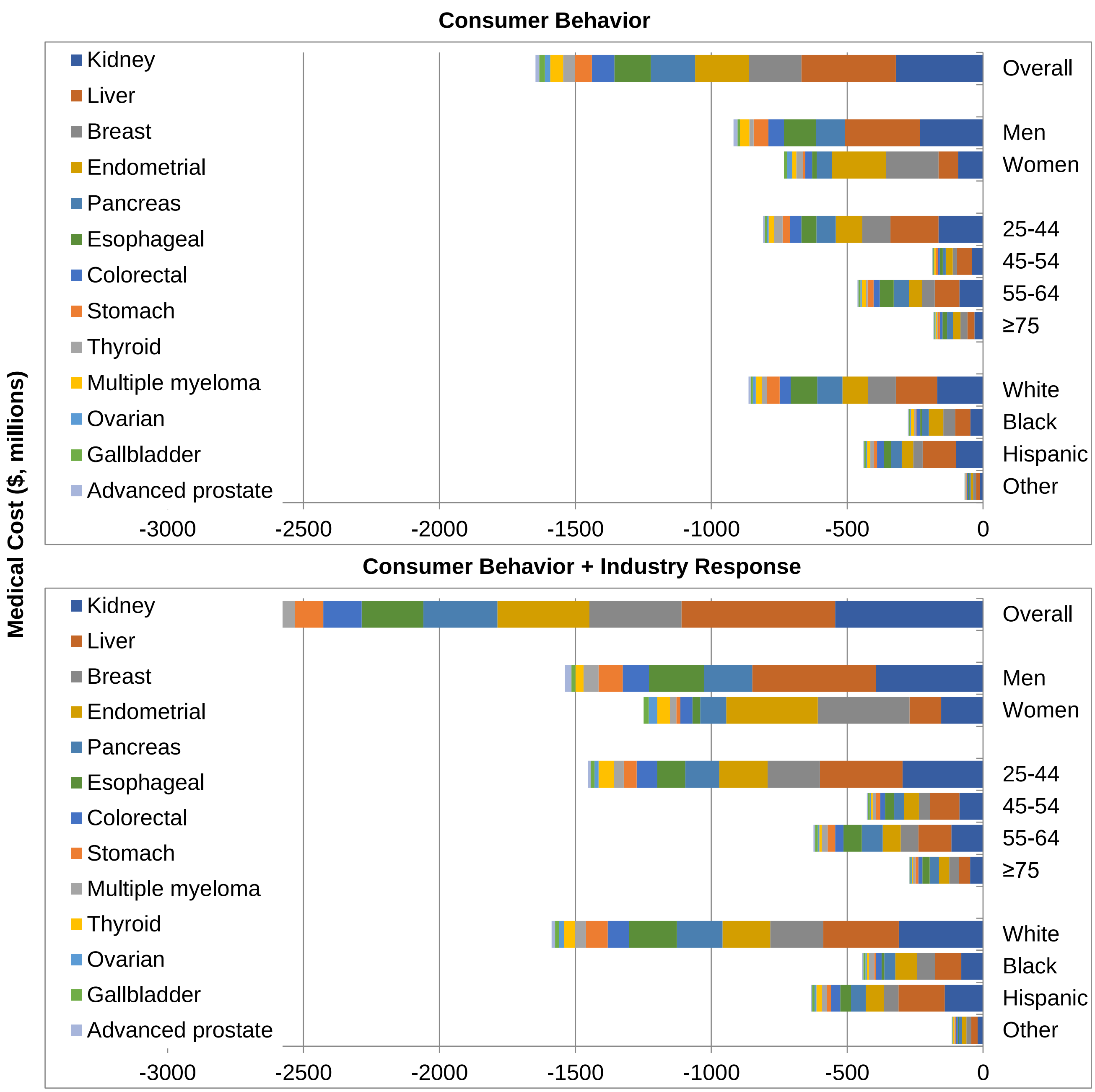
The model consists of four general health states: (a) healthy without cancer (healthy state); (b) initial cancer diagnosis (initial state) for each cancer type *i*; (c) continuing care (continuing state) for each cancer type *i*; and (d) death state. Transitions between states are based on national cancer incidence and cancer-specific mortality rates from SEER (for individual with cancer) and lifetable-based mortality rates (for individuals without cancer). The model simulates the policy impact on the number of new cases and deaths of 13 obesity-associated cancers, health-related quality of life (HRQOL), and health-related costs among U.S. adults over a lifetime by comparing a policy scenario (menu calorie label) to a non-policy scenario (status quo).



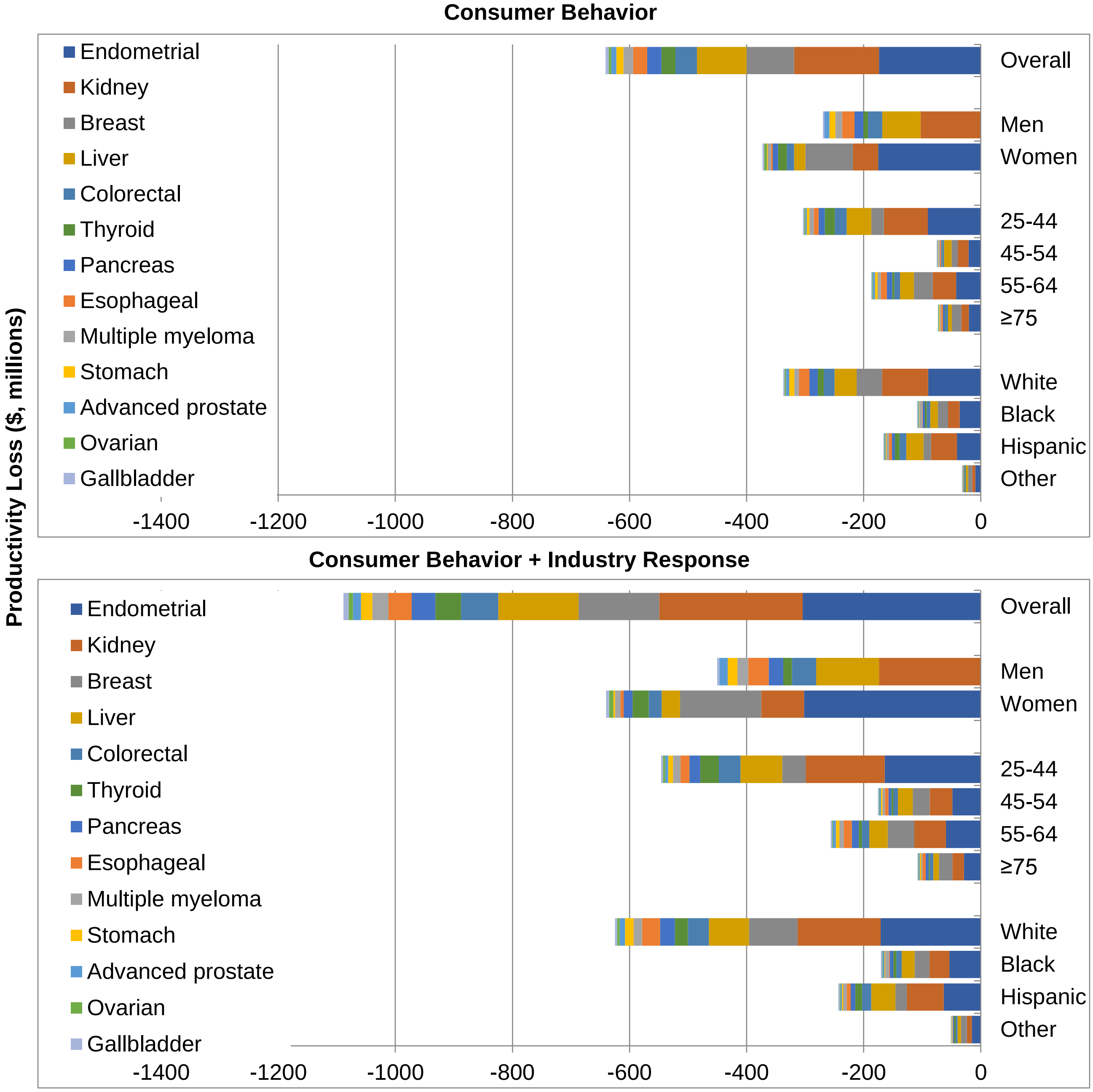
Supplementary Figure 2. Estimated reduced new cancer cases and deaths associated with the federal menu calorie labeling in the US by age, sex, race/ethnicity, and cancer type, over lifetime



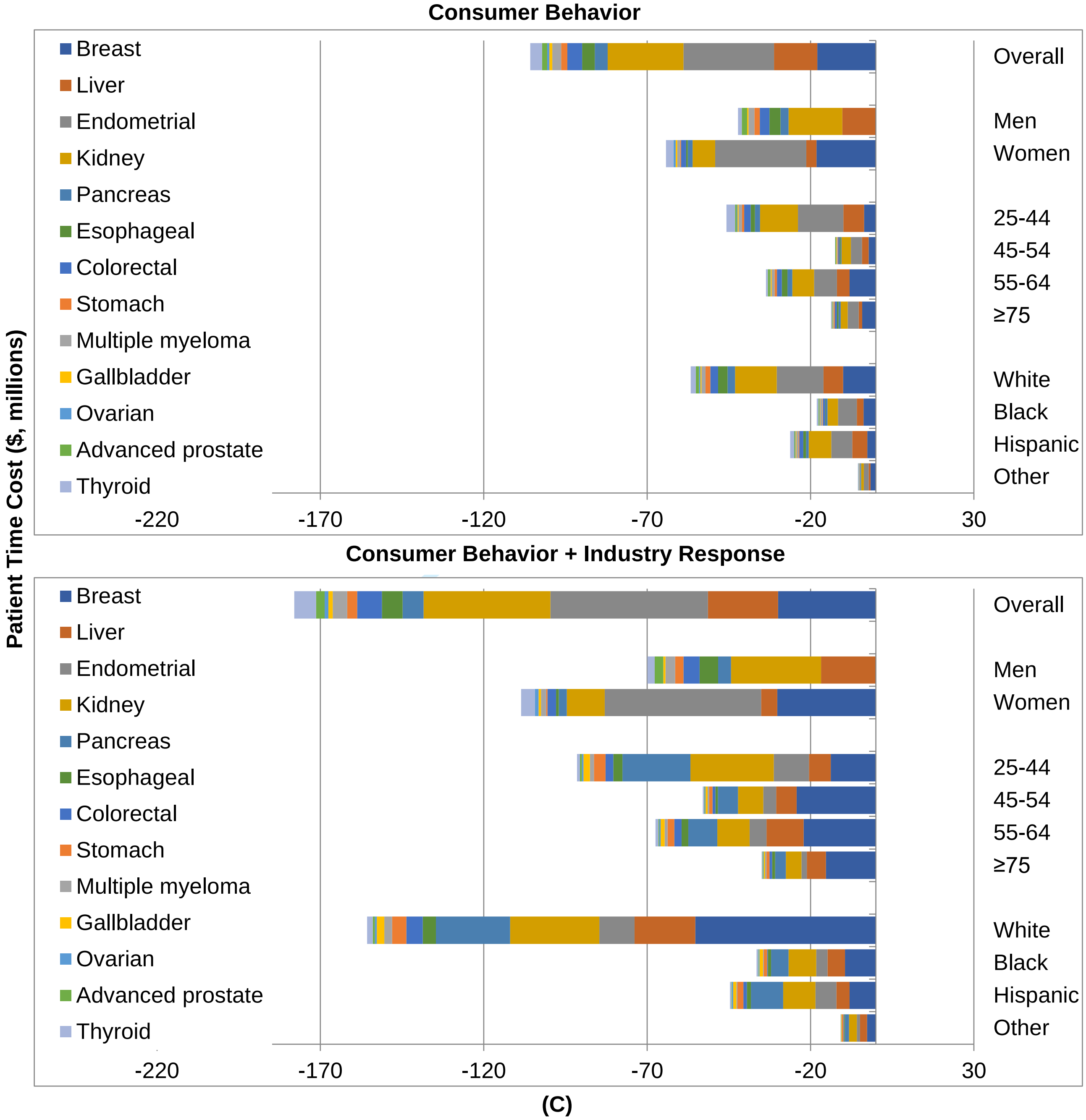
Supplementary Figure 3. Estimated life years and QALYs gained associated with the federal menu calorie labeling in the US by age, sex, and race/ethnicity, over a lifetime


Consumer Behavior
Kidney
Liver
Breast
Endometrial
Pancreas
Esophageal
Colorectal
Stomach
Thyroid
Multiple myeloma
Ovarian
Gallbladder
Advanced prostate
Overall
Men
Women
25-44
45-54
55-64
≥75
White
Black
Hispanic
Other
-3000
-2500
-2000
-1500
-1000
-500
0
Medical Cost ($, millions)
Consumer Behavior + Industry Response
Kidney
Liver
Breast
Endometrial
Pancreas
Esophageal
Colorectal
Stomach
Multiple myeloma
Thyroid
Ovarian
Gallbladder
Advanced prostate
Overall
Men
Women
25-44
45-54
55-64
≥75
White
Black
Hispanic
Other
-3000
-2500
-2000
-1500
-1000
-500
0

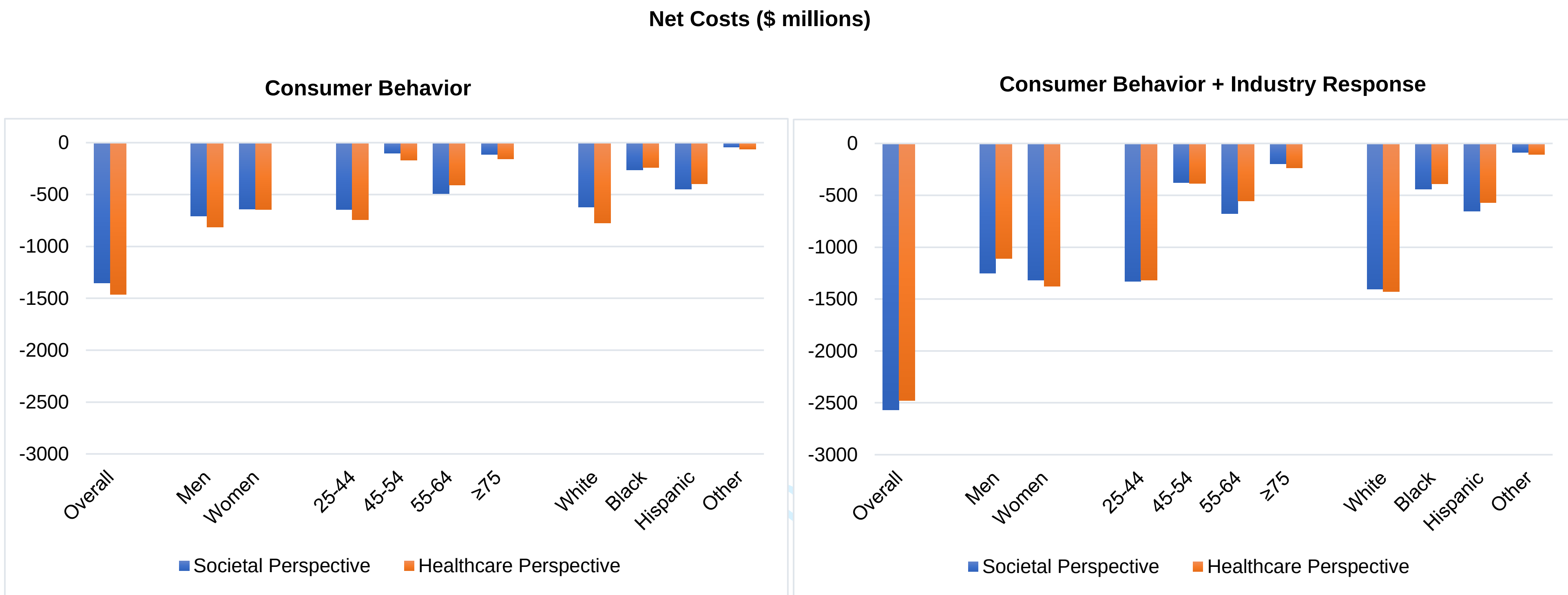
(A)


Consumer Behavior
Endometrial
Kidney
Breast
Liver
Colorectal
Thyroid
Pancreas
Esophageal
Multiple myeloma
Stomach
Advanced prostate
Ovarian
Gallbladder
Overall
Men
Women
25-44
45-54
55-64
≥75
White
Black
Hispanic
Other
-1400
-1200
-1000
-800
-600
-400
-200
0
Productivity Loss ($, millions)
Consumer Behavior + Industry Response
Endometrial
Kidney
Breast
Liver
Colorectal
Thyroid
Pancreas
Esophageal
Multiple myeloma
Stomach
Advanced prostate
Ovarian
Gallbladder
Overall
Men
Women
25-44
45-54
55-64
≥75
White
Black
Hispanic
Other
-1400
-1200
-1000
-800
-600
-400
-200
0

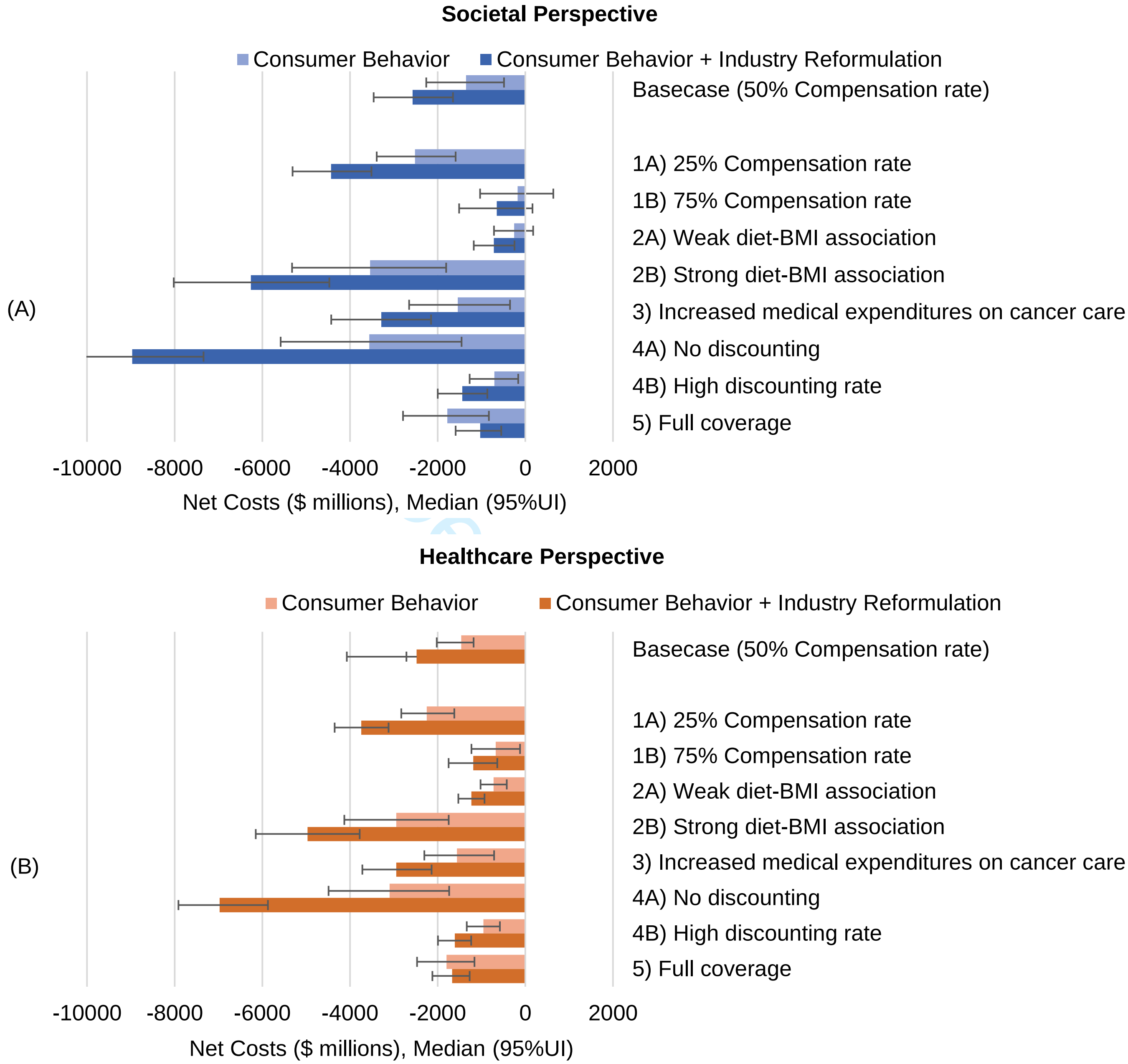
(B)



Supplementary Figure 4. Estimated changes of health-related costs associated with the federal menu calorie labeling in the US by age, sex, race/ethnicity, and cancer type, over lifetime



Supplementary Figure 5. Estimated net costs from societal and government perspectives associated with the federal menu calorie labeling policy in the US by age, sex, and race/ethnicity, over a lifetime



Supplementary Figure 6. One-Way Sensitivity Analysis of Net Costs of Menu Calorie Labeling and Obesity-Associated Cancer Rates by Varying Assumptions of Key Input Parameters From (A) Societal Perspective and (B) Healthcare Perspective

1a) assumed that only 25% of calorie reduction as a result of industry response would translate into long-term reductions in daily calories; 1b) assumed that only 75% of calorie reduction as a result of industry response would translate into long-term reductions in daily calories; 2a) weaker diet-BMI association assumed half of the base-case diet-BMI association; 2b) stronger diet-BMI association assumed two times of the base-case diet-BMI association; 3) 2% annual increase in medical expenditure on cancer care; 4a) lower discounting rate assumed 0% discounting rate; 4b) higher discounting rate assumed 5% discounting rate; and 5) assumed the coverage of the FDA's final rule increasing from 56.5% to 100% of the calories from full-service restaurants. Under base-case scenario (policy effect assumed consumer behavior: -7.3%, and industry reformulation: -5.0%; assumed that only 50% of calorie reduction as a result of industry response would translate into long-term reductions in daily calories; diet-BMI association assumed healthy-weight: 0.0015 kg/m^2 per kcal, and overweight/obese: 0.003 kg/m^2 per kcal; medical expenditure on cancer care assumed 0% annual increase; discounting rate assumed 3%; policy coverage would affect 56.5% of calories consumed at full-service restaurants and 100% of calories consumed at fast-food restaurants), the policy was cost-saving from both societal and healthcare perspectives. The policy remained cost-saving for all sensitivity analyses from the healthcare perspective and from societal perspective with additional industry reformulation. With consumer behavior alone, the policy was cost-saving under all scenarios.

CHEERS Checklist

Items to include when reporting economic evaluations of health interventions

The **ISPOR CHEERS Task Force Report**, *Consolidated Health Economic Evaluation Reporting Standards (CHEERS)—Explanation and Elaboration: A Report of the ISPOR Health Economic Evaluations Publication Guidelines Good Reporting Practices Task Force*, provides examples and further discussion of the 24-item CHEERS Checklist and the CHEERS Statement. It may be accessed via the *Value in Health* or via the ISPOR Health Economic Evaluation Publication Guidelines – CHEERS: Good Reporting Practices webpage: http://www.ispor.org/TaskForces/EconomicPubGuidelines.asp

Section/item	Item No	Recommendation	Reported on page No/ line No
Title and abstract			
Title	1	Identify the study as an economic evaluation or use more specific terms such as "cost-effectiveness analysis", and describe the interventions compared.	Page 1/Lines 1-2
Abstract	2	Provide a structured summary of objectives, perspective, setting, methods (including study design and inputs), results (including base case and uncertainty analyses), and conclusions.	Pages 3-4/ Lines 32-59
Introduction			
Background and objectives	3	Provide an explicit statement of the broader context for the study. Present the study question and its relevance for health policy or practice decisions.	Pages 5-6/ Lines 64-92
Methods			
Target population and subgroups	4	Describe characteristics of the base case population and subgroups analysed, including why they were chosen.	Page 9/ Lines 106-113
Setting and location	5	State relevant aspects of the system(s) in which the decision(s) need(s) to be made.	Page 6/Lines 96-98
Study perspective	6	Describe the perspective of the study and relate this to the costs being evaluated.	Page 12/ Lines 189-197
Comparators	7	Describe the interventions or strategies being compared and state why they were chosen.	Pages 9-10/ Lines 125-140
Time horizon	8	State the time horizon(s) over which costs and consequences are being evaluated and say why appropriate.	Page 6/ Lines 98-99
Discount rate	9	Report the choice of discount rate(s) used for costs and outcomes and say why appropriate.	Page 12 /Line 198
Choice of health outcomes	10	Describe what outcomes were used as the measure(s) of benefit in the evaluation and their relevance for the type of analysis performed.	Page 11/ Lines 158-170
Measurement of effectiveness	11a	*Single study-based estimates:* Describe fully the design features of the single effectiveness study and why the single study was a sufficient source of clinical effectiveness data.	

	11b	*Synthesis-based estimates:* Describe fully the methods used for identification of included studies and synthesis of clinical effectiveness data.	Pages 9-11/ Lines 115-170
Measurement and valuation of preference based outcomes	12	If applicable, describe the population and methods used to elicit preferences for outcomes.	
Estimating resources and costs	13a	*Single study-based economic evaluation:* Describe approaches used to estimate resource use associated with the alternative interventions. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	
	13b	*Model-based economic evaluation:* Describe approaches and data sources used to estimate resource use associated with model health states. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	Page 11/ Lines 168-170
Currency, price date, and conversion	14	Report the dates of the estimated resource quantities and unit costs. Describe methods for adjusting estimated unit costs to the year of reported costs if necessary. Describe methods for converting costs into a common currency base and the exchange rate.	Page 12/Line 197-198
Choice of model	15	Describe and give reasons for the specific type of decision-analytical model used. Providing a figure to show model structure is strongly recommended.	Supplementary Figure 1
Assumptions	16	Describe all structural or other assumptions underpinning the decision-analytical model.	Pages 9-10/ Lines 118-120, 128-129, 135-140, 145-152
Analytical methods	17	Describe all analytical methods supporting the evaluation. This could include methods for dealing with skewed, missing, or censored data; extrapolation methods; methods for pooling data; approaches to validate or make adjustments (such as half cycle corrections) to a model; and methods for handling population heterogeneity and uncertainty.	Page 13/ Lines 210-214
Results			
Study parameters	18	Report the values, ranges, references, and, if used, probability distributions for all parameters. Report reasons or sources for distributions used to represent uncertainty where appropriate. Providing a table to show the input values is strongly recommended.	Pages 7-8/Table 1
Incremental costs and outcomes	19	For each intervention, report mean values for the main categories of estimated costs and outcomes of interest, as well as mean differences between the comparator groups. If applicable, report incremental cost-effectiveness ratios.	Pages 16-17/ Table 2
Characterising uncertainty	20a	*Single study-based economic evaluation:* Describe the effects of sampling uncertainty for the estimated incremental cost and	

		incremental effectiveness parameters, together with the impact of methodological assumptions (such as discount rate, study perspective).	
	20b	*Model-based economic evaluation:* Describe the effects on the results of uncertainty for all input parameters, and uncertainty related to the structure of the model and assumptions.	Page 21/ Lines 282-295
Characterising heterogeneity	21	If applicable, report differences in costs, outcomes, or cost-effectiveness that can be explained by variations between subgroups of patients with different baseline characteristics or other observed variability in effects that are not reducible by more information.	Pages 18-19/ Lines 267-281
Discussion			
Study findings, limitations, generalisability, and current knowledge	22	Summarise key study findings and describe how they support the conclusions reached. Discuss limitations and the generalisability of the findings and how the findings fit with current knowledge.	Pages 21-24
Other			
Source of funding	23	Describe how the study was funded and the role of the funder in the identification, design, conduct, and reporting of the analysis. Describe other non-monetary sources of support.	Page 26
Conflicts of interest	24	Describe any potential for conflict of interest of study contributors in accordance with journal policy. In the absence of a journal policy, we recommend authors comply with International Committee of Medical Journal Editors recommendations.	Pages 26-27

For consistency, the CHEERS Statement checklist format is based on the format of the CONSORT statement checklist

The **ISPOR CHEERS Task Force Report** provides examples and further discussion of the 24-item CHEERS Checklist and the CHEERS Statement. It may be accessed via the *Value in Health* link or via the ISPOR Health Economic Evaluation Publication Guidelines – CHEERS: Good Reporting Practices webpage: http://www.ispor.org/TaskForces/EconomicPubGuidelines.asp

The citation for the CHEERS Task Force Report is:
Husereau D, Drummond M, Petrou S, et al. Consolidated health economic evaluation reporting standards (CHEERS)—Explanation and elaboration: A report of the ISPOR health economic evaluations publication guidelines good reporting practices task force. Value Health 2013;16:231-50.

BMJ Open

What is the cost-effectiveness of menu calorie labeling on reducing obesity-associated cancer burdens: an economic evaluation of a federal policy intervention among 235 million adults in the United States

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-063614.R2
Article Type:	Original research
Date Submitted by the Author:	12-Dec-2022
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Primary Subject Heading:	Health economics
Secondary Subject Heading:	Health policy, Public health, Nutrition and metabolism
Keywords:	Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, NUTRITION & DIETETICS, HEALTH ECONOMICS

What is the cost-effectiveness of menu calorie labeling on reducing obesity-associated cancer burdens: an economic evaluation of a federal policy intervention among 235 million adults in the United States

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Short Running Head: Cost-Effectiveness of Menu Calorie Labeling to Prevent Cancer

Word Count: 3895

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Abbreviations: AMPM, Automated Multiple Pass Method; BMI, Body Mass Index; CDC, Centers of Disease Control and Prevention; CI, Confidence Interval; DiCOM, Diet and Cancer Outcome Model; FDA, Food and Drug Administration; FNDDS, Food and Nutrient Database for Dietary Studies; MEC, Mobile Examination Center; NCHS, National Center for Health Statistics; NHANES, National Health and Nutrition Examination Survey; PSA, Probabilistic sensitivity analysis; SD, Standard Deviation; SE, Standard Error; USDA, United States Department of Agriculture; UI, Uncertainty Interval

ABSTRACT

Objective To assess the impact of menu calorie labeling on reducing obesity-associated cancer burdens in the United States (US).

Design Cost-effectiveness analysis using a Markov cohort state-transition model.

Setting Policy intervention.

Participants A modeled population of 235 million adults aged 20+ years in 2015-2016.

Interventions The impact of menu calorie labeling on reducing 13 obesity-associated cancers among US adults over a lifetime was evaluated in scenarios: (1) effects on consumer behaviors; and (2) additional effects on industry reformulation. The model integrated nationally representative demographics, calorie intake from restaurants, cancer statistics, and estimates on associations of policy with calorie intake, dietary change with BMI change, BMI with cancer rates, and policy and healthcare costs from published literature.

Main outcome measures Averted new cancer cases and cancer deaths and net costs (in 2015 US dollars) among total population and demographic subgroups. Incremental cost-effectiveness ratios from societal and healthcare perspectives were assessed and compared to the threshold of $150 000 per quality-adjusted life year (QALY) gained. Probabilistic sensitivity analyses incorporated uncertainty in input parameters and generated 95% uncertainty intervals (UIs).

Results Considering consumer behavior alone, this policy was associated with 28 000 (95% UI: 16 300-39 100) new cancer cases and 16 700 (9610-23 600) cancer deaths averted, 111 000 (64 800-158 000) QALY gained, and $1480 ($884-$2080) million saved in cancer-related medical costs among US adults. The policy was associated with net cost savings of $1460 ($864-$2060) million and $1350 ($486-$2260) million from healthcare and societal perspectives, respectively. Additional industry reformulation would substantially increase policy impact. Greater health gains and cost savings were predicted among young adults, Hispanic and non-Hispanic Black individuals.

Conclusions Study findings suggest that menu calorie labeling is associated with lower obesity-related cancer burdens and reduced healthcare costs. Policymakers may prioritize nutrition policies for cancer prevention in the US.

(Word Count: 300)

Keywords: obesity, cost-effectiveness, menu calorie labeling, cancer incidence, cancer death, medical cost

Strengths and limitations of this study

- Our study populated a Markov cohort state-transition model among 32 subgroups based on the nationally representative distributions of age, sex, and race/ethnicity and demonstrated that the federal menu calorie labeling could be a cost-effective strategy to reduce obesity-related cancers in the US and potentially narrow diet-associated cancer disparities.
- This cost-effectiveness evaluation incorporated data input parameters from established resources and the evidence was robust to different policy scenarios.
- However, given the nature of modeling research, this study does not provide a real-world evaluation of the impact of policy implementation on health and economic outcomes.
- We only modeled the impact of menu calorie labeling on calories although the policy may also result in potential changes in the nutritional quality of the restaurant meals.

INTRODUCTION

Obesity affects 1 in 3 Americans and is an established risk factor for 13 types of cancers, such as endometrial, liver, breast, prostate, and colorectal cancers.[1] Obesity-associated cancer represents 40% of all newly diagnosed cancer cases and contributes to 43.5% of total direct cancer care expenditures, estimated at $35.9 billion (US dollars) in 2015.[1-7] Rates of obesity-associated cancers are also rising disproportionately among young adults.[5 8] Substantial health and economic burdens highlight the need to prioritize cost-effective strategies to reduce obesity-associated cancers in the US.

Diet is one of the few modifiable factors for both obesity and obesity-associated cancers.[2 9] Restaurant meals account for 1 in 5 calories consumed by US adults, including 9% of calories from full-service restaurants and 12% from fast-food restaurants,[10] and therefore, can be an important target for improving population diet. Restaurant meals can have very high calories, with a mean energy of 1362 kcal/meal and 969 kcal/meal in popular meals from randomly selected full-service and fast-food restaurants, respectively.[11] Consistently, individuals who cook less frequently at home consume more daily calories than those who cook more at home.[12] Thus, reducing calories consumed from restaurant meals has the potential to reduce daily calorie intake and subsequent obesity and obesity-related cancer burdens.

To help consumers make lower-calorie choices, the Affordable Care Act mandated that all chain restaurants with 20 or more outlets post calorie information on menus and menu boards for all standard menu items.[13] The FDA published the final rules for this policy in 2016, which was subsequently implemented in 2018. A meta-analysis of 14 interventional studies including 5 randomized controlled trials (RCTs) and a recent quasi-experimental longitudinal study among 104 restaurants demonstrated that menu calorie labeling resulted in a reduction of 7.3% in caloric intake per meal and a 60 kcal (4%) reduction in calorie purchased per transaction, respectively.[14 15] Such policy can also motivate restaurant reformulation to lower calorie contents or introduce healthier food options.[16-21] Prior cost-effectiveness analyses suggest that this policy is associated with substantial health gains and is a cost-saving strategy for reducing obesity and obesity-related diseases.[22 23] It was estimated that the menu calorie labeling on fast foods was associated with a 25 kJ (6 kcal) reduction in mean daily energy intake, leading to a -0.2 kg change in mean body weight, a gain of 63 492 health-adjusted life years, and net savings of half billion (2010 Australian dollars) among Australians aged 2 years and above over their lifetime.[22] Researchers in the US have demonstrated that this policy would prevent a large number of incident cardiovascular diseases (135 781) and type 2 diabetes (99 736) and net savings of over $10 billion (2018 US dollars) among US adults over a lifetime.[22 23] However, the health and economic benefits of the policy for obesity-associated cancers have not been evaluated. This study aimed to address the knowledge gap by evaluating the cost-effectiveness of the federal menu calorie labeling and obesity-associated cancer burdens among US adults.

METHODS

Study Overview

The Diet and Cancer Outcome (DiCOM), a probabilistic cohort state-transition model,[24 25] was used to perform an economic evaluation of the menu calorie labeling and obesity-associated cancer rates among 235 million US adults aged 20 years and older (US Census), by comparing a policy scenario (menu calorie label) to status quo (no policy), over a simulated lifetime starting

123 from 2015. The model consists of (1) four health states: healthy without cancer, initial diagnosis and treatment for 13 types of obesity-related cancers, continuous care for each of the 13 cancers, and death (from 13 cancers or other causes); (2) the annual likelihood of changes in health; and (3) the lifetime consequences of such changes on health outcomes and economic costs. (Supplementary Figure 1). The DiCOM model integrated independent parameters from different data sources, including nationally representative population demographics, dietary intake, and cancer statistics; association estimates of policy intervention with diet, diet change with body mass index (BMI), and BMI with cancer risks; and policy and health-related costs from established sources (**Table 1**). This study used de-identified datasets and was exempt from institutional review board review and follows the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) reporting guidelines.

Table 1. Key input parameters and data sources in the Dietary Cancer Outcome Model (DiCOM)

Model Input	Outcome	Estimates	Distribution	Comments	Data Source
1. Simulated population	Population	Mean consumption of calories was 332 kcal/d from full-service or fast-food restaurants (Supplementary Tables 1, 8-9)	Gamma	Stratified by age, sex, race/ethnicity; 32 subgroups	NHANES 2013-2016
2. Policy effect[1]					
a) Consumer behavior	Policy effect	7.3% (4.4%-10.1%) (Appendix 1 and Appendix Table 1)	Beta	One-time effect	Meta-analysis of labeling interventions on reducing calorie intake, Shangguan et al., 2019, American Journal of Preventative Medicine
b) Industry response	Policy effect	5% (Appendix 1 and Appendix Table 2)	Beta	Assumption: no reformulation in the 1st year of policy intervention; Restaurants will replace the high-calorie menu items with low-calorie options or reformulate the menu items in years 2 to 5 of the intervention to achieve a 5% reduction in calorie contents	Calorie changes in large chain restaurants from 2008 to 2015, Bleich et al. 2017, Prev Med; Higher-Calorie Menu Items Eliminated in Large Chain Restaurants, Bleich et al. 2018, American Journal of Preventative Medicine
3. Effect of change in calorie intake on BMI change (kg/m^2)[1]	Dietary effect	Among individuals with: BMI <25: 0.0015 per kcal BMI ≥25: 0.003 per kcal	Normal	Assumption: 55 kcal per day reduction in calorie intake would lead to 1 pound weight loss within 1 year, with no further weight loss in the future	Hall et al., 2018, JAMA; Hall et al., 2011, Lancet

4. Etiologic effect of BMI on cancer outcomes[1]	Cancer outcome	RRs ranged from 1.05 to 1.50 (Supplementary Table 2)	Lognormal	BMI change and cancer incidence	Continuous Update Project (CUP) conducted by the World Cancer Research Fund (WCRF)/American Institute for Cancer Research (AICR)
5. Cancer statistics[1]	Cancer incidence[3] and survival	Appendixes 2-3, Appendix Tables 2-3, and Supplementary Tables 3-4	Beta	Stratified by age, sex, and race/ethnicity	NCI's Surveillance, Epidemiology, and End Results Program (SEER) Database; CDC's National Program of Cancer Registries (NPCR) Database
6. Healthcare-related costs[1,2]	Medical expenditures, productivity loss, and patient time costs	Appendix 6, Appendix Table 6, and Supplementary Tables 6-7	Gamma	Stratified by age, and sex	NCI's Cancer Prevalence and Cost of Care Projections; Published literature
7. Policy costs[1,2]	For government and industry	Appendix 5 and Appendix Tables 4-5	Gamma	Administration and monitoring costs for government; compliance and reformulation costs for industry	FDA's budget report; Nutrition Review Project; and FDA's RIA
8. Health-related quality of life (HRQOL)[1]	For 13 types of cancers	Ranged from 0.64 to 0.86 (Appendix 4 and Supplementary Table 5)	Beta	EQ-5D[4] data from published literature by cancer type	Published literature

Abbreviations: BMI, Body Mass Index; FDA, Food and Drug Administration; NCI, National Cancer Institute; NHANES, National Health, and Nutrition Examination Survey; UK, United Kingdom.
1. Uncertainty distributions were incorporated in the probabilistic sensitivity analyses. Uncertainties in each parameter were presented in supplemental materials (Table TS3 and Tables S3-9).
2. If the source did not provide uncertainty estimates, we assumed the standard errors were 20% of the mean estimate to generate gamma distribution.
3. Time-varying input parameter, for which the model accounted the secular trends. Details were provided in the Supplements.
4. EQ-5D is a standardized instrument developed by the EuroQol Group as a measure of health-related quality of life that can be used in a wide range of health conditions and treatments.

Simulated US Population

Because FDA's final rules on menu calorie labeling were published in 2016 and implemented in 2018, considering that some restaurants have implemented this policy prior to 2016 given the law was passed in 2010, we used 2015-2016 as the baseline and assumed a closed cohort for this analysis. The projected population size of US adults aged 20+ in 2015-2016 was obtained from the US Census data.[26] We combined the 2013-2016 National Health and Nutrition Examination Survey (NHANES) to approximate the baseline and simulate the nationally representative US adult population aged 20+ years in 32 subgroups stratified by age (20-44, 45-54, 55-64, 65+), sex (men, women), and race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, Other) (Supplementary Table 1). This closed cohort of US adults was modeled from baseline through their lifetime up to 80 years or until death.

Calorie Consumption from Restaurants

Mean calorie consumption from full-service and fast-food restaurants, demographics, and prevalence of overweight or obesity were estimated using data collected from NHANES participants with at least one valid 24-hour diet recall, in every 32 strata. Following FDA's estimates,[13] we assumed that policy would affect 56.5% of calories consumed at full-service restaurants and 100% at fast-food restaurants. The National Cancer Institute method was used to estimate the usual intake distribution by statistically adjusting for within vs. between variance in dietary recalls.[27-29] The complex survey design was incorporated in all statistical analyses to ensure the representativeness of study findings to the non-institutionalized US adults.

Policy Association with Calorie Consumption

Policy association with consumer behaviors was obtained from a systematic review and meta-analysis of 13 interventional studies (5 RCTs) with 19 interventions conducted in fast-food, full-service, cafeterias, and laboratories between 2000 and 2015 that evaluated the effectiveness of menu calorie labeling on consumers' calorie consumption per meal (Appendix 1 and Appendix Table 1).[15] The study results showed a 7.3% (95% CI: 4.4%-10.1%) reduction in calories consumed per meal following calorie labeling. We assumed that the policy would have a one-time effect over one year, with no further change over time.

Policy intervention may stimulate industries to reformulate their products to lower the calorie content. Potential policy impact on industry reformulation was derived from studies of restaurant menu items following the passage and initial period of partial implementation of the final rules (Appendix Table 2). Between 2012-2014, among 66 of the 100 largest US chain restaurants, replacing higher-calorie menu items with lower-calorie items led to a 1-5% calorie reduction per menu item.[19 20] Among 44 chain restaurants with menu calorie information available in 2008, the calories per menu item fell by 7% between 2008 and 2015.[18] Based on the evidence, we chose 5% as the mid-point for the potential policy impact on industry response, which may include discontinuation of existing high-calorie menu items and/or introduction of lower-calorie menu items. We assumed that no reformulation occurs in the 1st year of policy intervention, and restaurants will replace the high-calorie menu items with low-calorie options or reformulate the menu items in years 2 to 5 of the intervention to achieve a 5% reduction in calorie content, with no change thereafter. Combining the effect on consumer behaviors with the effect on industry response, the policy would lead to a 12.3% reduction in calories consumed per meal.

In addition, we conservatively assumed that there would be some compensatory increased calorie intake outside of restaurants so that only half of all calories reduced from restaurant meals would translate into long-term reductions in daily calories (compensation rate = 50%). Therefore, the reduction in calorie consumption from fast-food or full-service restaurants among the simulated population was computed using the baseline consumption times the policy effect estimates, and then times the compensation rate.

Calorie Reduction and Obesity-Associated Cancer Risk

To estimate the relationships between calorie intake and obesity-associated cancers, we associated the multivariate-adjusted association of change in calorie intake (kcal/day) with change in BMI (kg/m^2) and the estimates of BMI and cancer risks. Based on an established energy-weight dynamic model that accounted for the long-term impacts of calorie reduction on weight and metabolic expenditure, we assumed that each 55 kcal/day calorie reduction leads to 1 pound weight loss over one year among overweight or obese adults, with no further reduction thereafter.[30 31] Because long-term observational studies suggest that weight change for an equivalent change in dietary intake is about twice as large in overweight or obese adults than normal-weight adults,[32 33] we conservatively applied half of this estimate to individuals with normal weight. For each of the 13 obesity-related cancers, the estimated change in risk for each 5 kg/m^2 change in BMI was derived from the systematic reviews and meta-analyses of multivariable-adjusted prospective cohort studies conducted by the World Cancer Research Fund/American Institute for Cancer Research Continuous Update Project and the International Agency for Research on Cancer (Supplementary Table 2).[2]

Cancer Incidence, Mortality, and Health-Related Quality of Life

Age-adjusted cancer incidences in 2015 were obtained from the National Program of Cancer Registries and the Surveillance, Epidemiology, and End Results (SEER) program. We projected the cancer incidence from 2015 to 2030 based on the 2006-2014 trend using the Average Annual Percent Change method.[34] We then combined the projected incidence rates with the projected US population from the National Interim Projections[35] to account for changes in population age distribution over time. We further applied the cohort-period method to estimate cancer incidence in the closed cohort of US adults in each of the 32 groups as they age (Appendix 2, Appendix Table 2, and Supplementary Table 3). The 5-year relative survival rates for each cancer were extracted and converted to an annual probability of death (Appendix 3, Appendix Table 3, and Supplementary Table 4).[36-38] Health-related quality of life data were obtained from publications that reported EuroQol-5 Dimension utility weights for each cancer among US patient population (Appendix 4 and Supplementary Table 5).

Policy and Health-Related Costs

Policy costs included government costs to administer, monitor, and evaluate the policy and industry costs to comply with the policy and reformulate their products (in scenario 2). Government costs were estimated from FDA's budget report and Nutrition Review Project (Appendix 5 and Appendix Tables 4-5).[39,40] Industry compliance and reformulation costs were based on the FDA's regulatory impact analysis that included initial and recurring nutrition analysis of standard menu items and menu replacement, provision of nutrition information, employee training, and legal review and accounted for restaurant size and type, reformulation type, and compliance period.[13]

Direct medical costs for cancer care were extracted from the SEER-Medicare linked database for three phases of cancer care: initial (12 months after diagnosis), continuing, and end-of-life (the last year of life) (Appendix 6, Appendix Table 6, and Supplementary Tables 6-7).[34 41] For individuals without cancer, the direct medical costs were estimated based on Medical Expenditure Panel Survey (MEPS) data and insurance claims.[25 42 43] Indirect costs including productivity loss due to disability or missed workdays and patient time costs were derived from publications using MEPS data.[44-47]

Cost-Effectiveness Analysis

Following the guidelines on cost-effectiveness in health and medicine,[48] we evaluated the policy impact by projecting the numbers of new cancer cases and cancer deaths averted and quality-adjusted life-years (QALYs) gained and cost-effectiveness from both healthcare and societal perspectives. Net costs from the healthcare perspective were assessed as the difference between government costs for implementing the policy and the direct medical costs of cancer care. Net costs from the societal perspective were assessed as the difference between total policy costs (including both government and industry costs) and health-related costs saved (including direct and indirect costs of cancer care). All costs were inflated to 2015 US dollars using the Consumer Price Index or Personal Health Care Index, with all costs and QALYs discounted at 3% annually.[48] Incremental cost-effectiveness ratios (ICERs) were calculated as net costs divided by the difference in QALYs between policy vs. no policy. ICERs falling below a willingness-to-pay threshold of $150,000 per QALY gained were considered to be cost-effective.[49 50] Cost-effectiveness analysis was further conducted among population subgroups by age, sex, and race/ethnicity to evaluate policy associations with health disparities.

One-way sensitivity analyses were performed by varying input parameters, including reducing the outside-the-restaurant calorie compensation level to 25% or increasing it to 75%, altering coverage of the FDA's final rule to all calories from full-service restaurants, reducing the diet-BMI associations to half or doubling the estimates, incorporating an estimated 2% annual increase in medical expenditures associated with cancer care, and altering annual discounting rates from 3% to 0% or 5%. We also evaluated impacts at a 10-year time horizon for stakeholders interested in shorter-term health gains and economic benefits. Probabilistic sensitivity analyses (PSAs) were conducted to incorporate uncertainty in all input parameters jointly (**Table 1**). A total of 1000 Monte Carlo simulations were performed, and 95% uncertainty intervals (UIs) were estimated based on the 2.5 and 97.5 percentiles of 1,000 simulations. All analyses were conducted using SAS (Version 9.4) and R (Version 3.3.1).

Patient and Public Involvement

This study used de-identified datasets and did not involve patients or the public in the design, conduct, reporting, or dissemination plans of our research.

RESULTS

Population Characteristics

The simulated cohort of US adults in 2015-2016 had a mean age of 47.8 years, with 65.0% being non-Hispanic white adults and 71.4% being overweight or obese (Supplementary Tables 8-9). A mean of 332 daily calories was consumed from full-service or fast-food restaurants. Higher levels were consumed among younger adults aged 20-44 years (425 kcal/day), men (388 kcal/day), non-Hispanic black (361 kcal/day), and Hispanic (367 kcal/day) adults, in comparison to other corresponding subgroups.

Health Gains

The menu calorie labeling was estimated to reduce calories consumed from restaurants by a mean of 24 kcal/day among US adults, and total daily calories by 12 kcal/day. Accounting for potential industry reformulation would reduce the mean intake by an additional 16 kcal/day, and total daily calories by 8 kcal/day.

Based on changes in consumer behavior alone, the policy was associated with a reduction of 28,000 (95% UI: 16,300-39,100) new cancer cases and 16,700 (9,610-23,600) cancer deaths, and a gain of 111,000 (64,800-158,000) QALYs among 235 million US adults over a median follow-up of 34.4 years (**Table 2 and Figure 1**). By cancer type, the greatest numbers of new cancer cases averted were cancers of endometrial (N [95% UI]: 5,700 [2,380-9,190]), liver (5,180 [2,800-7,730]), kidney (5,090 [2,670-7,730]), post-menopausal breast (4,840 [2,010-8,230]), and pancreas (1,400 [756-2,100]). The greatest numbers of prevented cancer deaths were estimated for cancers of the liver (4,530 [2,410-6,760]), post-menopausal breast (3,080 [861-5,650]),

endometrial (2,060 [957-3,220]), kidney (1,980 [1,080-2,920]), and pancreas (1,230 [661-1,830]).

Based on additional industry response, the total estimated health gains approximately doubled, preventing 47,300 (35,400-59,100) new cancer cases and 28,200 (21,100-35,300) cancer deaths, and gaining 189,000 (140,000-236,000) QALYs, with similar rankings of the types of new cancer cases and cancer deaths prevented.

Table 2. Estimated health gains and costs of the federal menu calorie labeling on reducing the obesity-related cancer burdens in the US over 10 years and a lifetime (US population=235,162,844)[1]

	Menu Calorie Labeling Policy			
	10 Years		Lifetime	
	Consumer Behavior Median (2.5% to 97.5%)	**Consumer Behavior + Industry Response** Median (2.5% to 97.5%)	**Consumer Behavior** Median (2.5% to 97.5%)	**Consumer Behavior + Industry Response** Median (2.5% to 97.5%)
New Cancer Cases Averted, N (95% UI)				
Endometrial cancer	692 (276 to 1100)	1130 (716 to 1550)	5700 (2380 to 9190)	9920 (6630 to 13600)
Liver cancer	366 (144 to 615)	626 (386 to 887)	5180 (2800 to 7730)	8550 (5960 to 11300)
Kidney cancer	584 (290 to 884)	980 (689 to 1280)	5090 (2670 to 7470)	8620 (6200 to 11000)
Breast cancer (postmenopausal)	670 (256 to 1110)	1080 (658 to 1520)	4840 (2010 to 8230)	8520 (5610 to 12200)
Pancreatic cancer	170 (83 to 257)	273 (183 to 367)	1400 (756 to 2100)	2380 (1690 to 3140)
Esophageal adenocarcinoma	179 (56 to 304)	286 (159 to 411)	1350 (485 to 2230)	2330 (1440 to 3280)
Colorectal cancer	189 (97 to 284)	319 (225 to 418)	1050 (561 to 1600)	1780 (1230 to 2370)
Multiple myeloma	75 (37 to 117)	122 (81 to 169)	690 (384 to 1090)	1150 (775 to 1630)
Stomach cancer (cardia)	54 (6 to 109)	98 (51 to 165)	647 (261 to 1140)	1090 (644 to 1660)
Thyroid cancer	105 (58 to 161)	176 (123 to 243)	516 (206 to 914)	951 (576 to 1420)
Advanced prostate cancer	66 (17 to 118)	107 (57 to 162)	339 (138 to 561)	577 (352 to 836)
Gallbladder cancer	29 (16 to 42)	46 (34 to 60)	314 (213 to 438)	512 (399 to 648)
Ovarian cancer	33 (15 to 56)	53 (33 to 78)	147 (44 to 282)	254 (110 to 420)
Total	3300 (1750 to 4720)	5230 (3870 to 6790)	28000 (16300 to 39100)	47300 (35400 to 59100)
Cancer Deaths Prevented, N (95% UI)				
Liver cancer	168 (59 to 287)	287 (174 to 410)	4530 (2410 to 6760)	7510 (5200 to 9980)
Breast cancer (postmenopausal)	68 (33 to 106)	111 (74 to 149)	3080 (862 to 5650)	5590 (3230 to 8310)
Endometrial cancer	52 (20 to 86)	87 (55 to 121)	2060 (957 to 3220)	3520 (2390 to 4700)
Kidney cancer	70 (29 to 110)	114 (74 to 154)	1980 (1080 to 2920)	3320 (2430 to 4300)
Pancreatic cancer	88 (38 to 138)	143 (93 to 195)	1230 (661 to 1830)	2080 (1480 to 2740)
Esophageal adenocarcinoma	76 (21 to 131)	122 (69 to 178)	1150 (403 to 1930)	1990 (1210 to 2820)
Colorectal cancer	34 (17 to 53)	57 (40 to 77)	706 (369 to 1080)	1200 (839 to 1600)
Stomach cancer (cardia)	22 (2 to 48)	40 (19 to 68)	541 (230 to 947)	907 (538 to 1400)
Multiple myeloma	18 (8 to 30)	29 (18 to 42)	420 (239 to 662)	691 (481 to 980)
Gallbladder cancer	13 (7 to 20)	21 (15 to 28)	267 (181 to 369)	436 (341 to 551)
Advanced prostate cancer	9 (3 to 15)	13 (7 to 19)	163 (65 to 280)	273 (163 to 404)
Ovarian cancer	8 (3 to 15)	13 (7 to 20)	107 (39 to 191)	181 (94 to 290)
Thyroid cancer	1 (1 to 2)	2 (1 to 3)	23 (11 to 38)	38 (24 to 58)
Total	654 (320 to 970)	1080 (746 to 1400)	16700 (9610 to 23600)	28200 (21100 to 35300)

Life Years Gained	678 (288 to 1040)	1120 (738 to 1490)		76400 (43400 to 109000)	130000 (96900 to 162000)
QALYs Gained	4280 (2170 to 6250)	7030 (4960 to 9090)		111000 (64800 to 158000)	189000 (140000 to 236000)
Changes in Health-Related Costs ($, millions)[2,3]					
Healthcare (medical) cost	-192 (-277 to -100)	-319 (-403 to -227)		-1480 (-2080 to -884)	-2500 (-3090 to -1900)
Patient time cost	-7.33 (-10.9 to -3.56)	-12.2 (-15.8 to -8.39)		-102 (-144 to -62.2)	-172 (-216 to -131)
Productivity loss	-48.7 (-70.1 to -24.5)	-80.4 (-102 to -56.7)		-608 (-865 to -363)	-1030 (-1290 to -780)
Policy Implementation Costs ($, millions)[2,3]					
Total	518 (493 to 548)	644 (612 to 680)		839 (780 to 908)	1140 (1060 to 1220)
Government cost	13.2 (11.4 to 15.9)	13.1 (11.4 to 15.7)		18.5 (14.5 to 25.1)	18.5 (14.4 to 25.5)
Administration	9.08 (8.59 to 9.60)	9.07 (8.64 to 9.50)		9.07 (8.61 to 9.56)	9.09 (8.62 to 9.55)
Monitoring	4.09 (2.40 to 6.74)	4.00 (2.35 to 6.63)		9.40 (5.45 to 16.1)	9.38 (5.30 to 16.3)
Industry cost	505 (480 to 535)	631 (599 to 667)		820 (762 to 889)	1120 (1040 to 1210)
Compliance	505 (480 to 535)	506 (480 to 533)		820 (762 to 889)	823 (757 to 889)
Reformulation	-------	124 (107 to 146)		-------	296 (249 to 353)
Net Costs ($, millions)[2,3,4]					
Societal perspective	270 (156 to 389)	233 (119 to 356)		-1350 (-2260 to -486)	-2570 (-3460 to -1650)
Healthcare perspective	-179 (-263 to -86.3)	-305 (-390 to -214)		-1460 (-2060 to -864)	-2480 (-3070 to -1880)
ICER (dollars/QALY)[5]					
Societal perspective	64500 (26100 to 187000)	33600 (13300 to 72400)		Dominant	Dominant
Healthcare perspective	Dominant	Dominant		Dominant	Dominant

Abbreviations: ICER, Incremental Cost-Effectiveness Ratio; QALY, quality-adjusted life years.

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.
2. Health-related costs were inflated to 2015 US dollars using the Personal Health Care (PHC) index. Policy intervention costs were inflated to 2015 US dollars using the Consumer Price Index. Negative costs represent savings.
3. Costs are medians from 1000 simulations so may not add up to totals.
4. Net costs were calculated as policy costs minus health-related costs from reduced cancer burden. The societal perspective includes healthcare costs, patient time costs, productivity costs, and policy implementation costs; the government perspective included policy costs relevant to policy implementation and program monitoring and evaluation, and medical costs.
5. ICER threshold was evaluated at $150,000/QALY. Dominant represents less costly and more effective than the "no-policy intervention" scenario.

Economic Impacts

Implementing the policy would cost the government $19 (95% UI: $15-25) million and the restaurant industry, $820 ($762-889) million in compliance costs over a lifetime (**Table 2**). The policy was associated with savings of $1480 ($884-2080) million in direct medical costs, $608 ($363-865) million in productivity loss costs, and $102 ($62-144) million in patient time costs. Potential industry reformulation would cost the restaurant industry an additional $296 ($249-353) million to implement but would also result in greater healthcare savings, including $2,500 ($1,900-3,090) million, $1,030 ($780-1,290) million and $172 ($131-216) million in reduced direct medical, productivity loss, and patient time costs, respectively.

From both the healthcare and social perspectives, implementing the menu calorie labeling policy among US adults over a lifetime would be cost-saving. With changes in consumer behavior alone, the net cost savings were estimated to be $1,460 ($864-2,060) million and $1,350 ($486-2,260) million from the healthcare and societal perspective, respectively. With additional industry response, estimated cost savings increased to $2,480 ($1,880-3,070) million from the healthcare perspective and $2,570 ($1,650-3,460) million from the societal perspective.

Policy Impacts Among Population Subgroups

Among population subgroups, the consumer response to the policy was estimated to result in greater health gains per 100,000 individuals among adults aged 20-44 years (15 new cancer cases averted) and 55-64 years (16 new cancer cases averted) than older age groups (aged 65+ years; 6 new cancer cases averted); Hispanic and non-Hispanic Black individuals than Non-Hispanic White group (22 vs. 9 and 17 vs. 9 new cancer cases averted) (**Table 3**). The numbers of cancer

deaths averted, life-years and QALYs gained, health-related costs saved, and net costs among population subgroups followed a similar pattern (Supplementary Tables 10-11 and Supplementary Figures 2-5). For instance, the policy was associated with more cancer deaths prevented per 100,000 individuals among younger adults aged 20-44 years than older adults aged 65+ years (10 vs. 3 cancer deaths averted) and Hispanic and non-Hispanic Black adults than non-Hispanic White individuals (14 vs. 5 and 11 vs. 5 cancer deaths averted). Adding potential industry reformulations resulted in larger health gains among adults aged 45-54 (128% increase in new cancer cases averted) and non-Hispanic White adults (84% increase in new cancer cases averted).

Table 3. Estimated new cancer cases and deaths prevented by the federal menu calorie labeling policy in the US by age, sex, and race/ethnicity, over a lifetime[1]

	Consumer Behavior		Consumer Behavior + Industry Response	
	N (95% UI)	Per 100,000 individuals (95% UI)	N (95% UI)	Per 100,000 individuals (95% UI)
New Cancer Cases Averted				
Age				
20-44	15700 (6170 to 25100)	15.0 (5.89 to 24.0)	28000 (18000 to 37500)	26.7 (17.2 to 35.8)
45-54	2810 (-2110 to 8030)	6.61 (-4.97 to 18.9)	6420 (1390 to 11600)	15.1 (3.27 to 27.2)
55-64	6330 (3540 to 9400)	15.7 (8.76 to 23.3)	8640 (5790 to 11800)	21.4 (14.3 to 29.1)
≥65	2740 (795 to 4650)	5.77 (1.68 to 9.80)	4060 (2070 to 5950)	8.55 (4.36 to 12.6)
Sex				
Female	15100 (6650 to 24000)	12.5 (5.51 to 19.8)	25900 (17400 to 34900)	21.4 (14.4 to 28.9)
Male	12500 (4920 to 20100)	10.9 (4.30 to 17.6)	21100 (13500 to 29100)	18.4 (11.8 to 25.4)
Race/Ethnicity				
Non-Hispanic White	14300 (4310 to 24500)	9.16 (2.77 to 15.7)	26300 (16000 to 36700)	16.9 (10.3 to 23.6)
Non-Hispanic Black	4720 (1820 to 8100)	16.6 (6.37 to 28.4)	7630 (4750 to 11100)	26.8 (16.7 to 38.9)
Hispanic	7700 (3560 to 11500)	21.5 (9.93 to 32.2)	11200 (7060 to 15300)	31.3 (19.7 to 42.6)
Other	1150 (-240 to 2440)	7.60 (-1.59 to 16.2)	1990 (652 to 3310)	13.2 (4.33 to 22.0)
Cancer Deaths Prevented				
Age				
20-44	10200 (4170 to 16400)	9.73 (3.98 to 15.7)	18100 (11700 to 24500)	17.3 (11.2 to 23.4)
45-54	1730 (-853 to 4240)	4.07 (-2.01 to 9.97)	3650 (1040 to 6240)	8.58 (2.44 to 14.7)
55-64	3320 (1760 to 4930)	8.21 (4.36 to 12.2)	4480 (2890 to 6090)	11.1 (7.15 to 15.1)
≥65	1200 (285 to 2130)	2.53 (0.60 to 4.48)	1800 (848 to 2720)	3.79 (1.79 to 5.73)
Sex				
Female	7810 (3290 to 12600)	6.47 (2.73 to 10.5)	13400 (8850 to 18500)	11.1 (7.33 to 15.3)
Male	8510 (3500 to 13900)	7.44 (3.06 to 12.1)	14400 (9300 to 20000)	12.6 (8.13 to 17.5)
Race/Ethnicity				
Non-Hispanic White	7920 (2180 to 13900)	5.08 (1.40 to 8.94)	14700 (8770 to 20900)	9.45 (5.64 to 13.5)
Non-Hispanic Black	3010 (1000 to 5370)	10.6 (3.51 to 18.8)	4990 (2950 to 7380)	17.5 (10.4 to 25.9)
Hispanic	4960 (2360 to 7560)	13.8 (6.58 to 21.1)	7190 (4480 to 9870)	20.0 (12.5 to 27.5)
Other	565 (-246 to 1350)	3.75 (-1.63 to 8.97)	1070 (273 to 1870)	7.12 (1.81 to 12.4)

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.

Sensitivity Analyses

In PSA, based on consumer responses alone, the menu calorie labeling was cost-saving over a lifetime in 93% of 1000 simulations and cost-effective (<$150,000/QALY) in the remaining 7% from the societal perspective, and was cost-saving in over 98% of 1000 simulations from the healthcare perspective. Adding the additional industry response increased the probability of cost-savings to nearly 100% of the simulations for both the societal and healthcare perspectives (**Figure 2**).

Evaluating health gains, costs, and cost-effectiveness at 10 years, the policy remained cost-saving from the healthcare perspective and was cost-effective from the societal perspective, with an ICER of $64,500 (26,100-187,000) per QALY based on consumer response alone and $33,600 (13,300-72,400) per QALY with additional industry response. The cost-effectiveness of this policy was most sensitive to varied assumptions of the diet-BMI estimates and annual discounting rates (Supplementary Tables 12-13 and Supplementary Figure 6).

DISCUSSION

This study estimated that the federal menu calorie labeling policy, based on consumer response alone, was associated with a reduction of approximately 28,000 new cancer cases and 16,700 cancer deaths among US adults over a lifetime, and net savings of $1,350 and $1,460 million from societal and healthcare perspectives, respectively. Incorporating additional modest industry responses, these health and economic gains were approximately doubled. Greater health gains were expected among younger, middle-aged subgroups, Hispanic, and non-Hispanic Black

individuals compared with other subgroups. Findings were robust to a range of probabilistic and one-way sensitivity analyses.

Our study findings supported that nutrition policies can have meaningful health and economic impacts on cancer prevention in the US. In this case, a modest change in mean calorie consumption, distributed across the population, was estimated to achieve important reductions in obesity-related cancer burdens among US adults. Using the best available estimates, our study further suggested that the federal menu calorie labeling policy is cost-effective in the short term and cost-saving in the long term in reducing obesity-associated cancer burdens. Many preventive medical screenings are cost-effective, but none of them achieve net savings. For example, among a large cohort of women born in the 1960s over a lifetime, mammography screening starting at age 45 years was estimated to have an ICER of $40 135/QALY.[51] Colonoscopy screening starting at age 45 years among U.S. adults achieved an ICER of $33 900/QALY.[52] Prostate-specific antigen screening had an ICER of $70 831 to $136 332/QALY among U.S. males beginning at 40 years of age over a lifetime.[53] In contrast, population-based nutrition interventions could be a cost-saving strategy for cancer prevention. Cost-effectiveness analyses showed that a penny-per-ounce tax on sugar-sweetened beverages would be a highly cost-effective strategy for cancer prevention among US adults, with an ICER of 13 220, the nutrition facts added sugar labeling would prevent 30 000 incident obesity-related cancer cases and 17 100 cancer deaths and be associated with a net saving of 704 million, and processed meat taxes would avert 77 000 colorectal cancer cases and 12 500 stomach cancer cases save 4.5 billion, all from the societal perspective.[24 54 55] Thus, while we shall continue the efforts of increasing the screening rates, we also need to consider population-based strategies to improve nutrition for cancer prevention in the US.

Our findings also indicated the importance of assessing potential industry response, which could nearly double health and economic benefits. The additional impacts of industry reformulation in response to nutrition-related policies have been reported in other studies focused on obesity-associated cancer, diabetes, and cardiovascular diseases.[23 55-57] Our new findings build on this recent work and highlight the importance of potential strategies to encourage industry reformulation under the federal menu calorie labeling framework to further improve the health benefits and cost-effectiveness of such policies.

In addition, our results showed that population-based nutrition policies such as menu calorie labeling can potentially narrow diet-associated cancer disparities. We found greater health gains and economic impacts among racial/ethnic minorities compared to non-Hispanic whites, likely due to higher diet-associated cancer burdens among minorities.[58] However, labeling policies may have fewer effects on food purchasing behaviors among minorities or socioeconomically disadvantaged groups. Prior studies reported that individuals with higher education and income attainment were more likely to notice and use the menu calorie labels when ordering foods in fast-food or full-service restaurants compared to socioeconomically disadvantaged groups,[59-61] and multi-racial individuals were less likely to notice and use menu calorie labels in fast food restaurants than non-Hispanic whites.[59] Previous studies also showed that literacy or numeracy could be a barrier to label use.[62 63] Thus, it is important for labeling policies to be paired with nutrition education to effectively reduce diet-associated health disparities.

Potential limitations should be considered. First, as a modeling study, our investigation does not provide the impact of real-world policy implementation on the health and economic outcomes of federal menu calorie labeling. However, conducting randomized controlled trials of national nutrition policy interventions is extremely difficult and often implausible while simulation modeling can provide complementary evidence with the flexibility to assess different policy scenarios that help inform policymaking. Second, this evaluation did not include the potential benefits of menu calorie labeling on other health outcomes such as diabetes and cardiovascular diseases. Considering such outcomes is likely to be associated with greater health gains and cost savings.[23 64 65] Third, menu calorie labeling could have a greater effect among subgroups with higher levels of income and education and non-Hispanic white adults[59-61] and thus exacerbating health disparities. Due to the lack of consistent policy effect sizes among populations with different socioeconomic statuses, we were unable to integrate this into our modeling. Forth, we only modeled the impact of menu calorie labeling on calories although the policy may also result in potential changes in the nutritional quality of the restaurant meals. The majority of current restaurant meals consumed by American adults – 70% of meals consumed from fast-food restaurants and 50% consumed from full-service restaurants – are of poor nutritional quality, and the remainder is only of intermediate nutritional quality, with very few being ideal.[10] If the policy also improves the quality of restaurant meals, the total reduction in obesity-associated cancer burdens could be greater than our current estimates.

CONCLUSIONS

417 Study findings suggest that menu calorie labeling is associated with lower obesity-related cancer
418 rates and reduced costs. Policymakers may prioritize nutrition policies for cancer prevention in
419 the US.

Ethics approval: This study used de-identified datasets and was exempt from institutional review board review.

Data sharing: Data described in the manuscript, codebook, and analytic code will be made available upon request.

Transparency Statement: The author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

Dissemination Declaration: Dissemination to the simulated population is not applicable.

Contributors: MD contributed to the data curation, formal analysis, visualization, original draft preparation, review and editing; CFG contributed to the data curation, review and editing; FFC, HE and DDK contributed to software; JBW, PW, DDK, DSM, YCW, and DM contributed to the review and editing; FFZ contributed the conceptualization, methodology, review and editing, supervision, and funding acquisition. All authors approved the final version. FFZ acts as the guarantor of the study.

Role of the funding source: This study was supported by NIH/NIMHD 1R01MD011501. The funding sources had no role in the design or conduct of the study; collection, management, analysis, or interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.

Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted work. JBW reports leadership or fiduciary role in the US Preventive Services Task Force. DK reports research funding from the National Institutes of Health, Arnold Ventures, Pharmaceutical Research and Manufacturers of America, Sarepta Therapeutics, and Janssen

Therapeutics; consulting fees from Panalgo and the American College of Physicians. DM reports research funding from the National Institutes of Health, Gates Foundation, Rockefeller Foundation, and Vail Institute for Global Research; consulting fees from Acasti Pharma, Barilla, Danone, and Motif FoodWorks; participating on scientific advisory boards of start-up companies focused on innovations for health including Beren Therapeutics Brightseed, Calibrate, DayTwo, Elysium Health, Filtricine, Foodome, HumanCo, January Inc., Perfect Day, Season, and Tiny Organics; and chapter royalties from UpToDate. All of the above is outside the submitted work. No other relationships or activities could appear to have influenced the submitted work.

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Figure 1. Estimated New Cancer Cases and Deaths Prevented by Federal Menu Calorie Labeling Policy in the US by Cancer Type over a Lifetime

Figure 2. Probabilistic Sensitivity Analyses (PSA) for Cost-Effectiveness of the Federal Menu Calorie Labeling Policy over 10 years and a Lifetime

Legend: Values are presented in cost-effectiveness planes of net costs ($millions) versus incremental quality-adjusted life years (QALYs). For each policy scenario, each colored dot represents one of the 1000 simulations, with the largest dot showing the median incremental cost-effectiveness ratio (ICER, $/QALY); and the ellipse representing the 95% UIs. Results are presented from the societal perspective and the healthcare perspective. Negative values indicate cost savings.

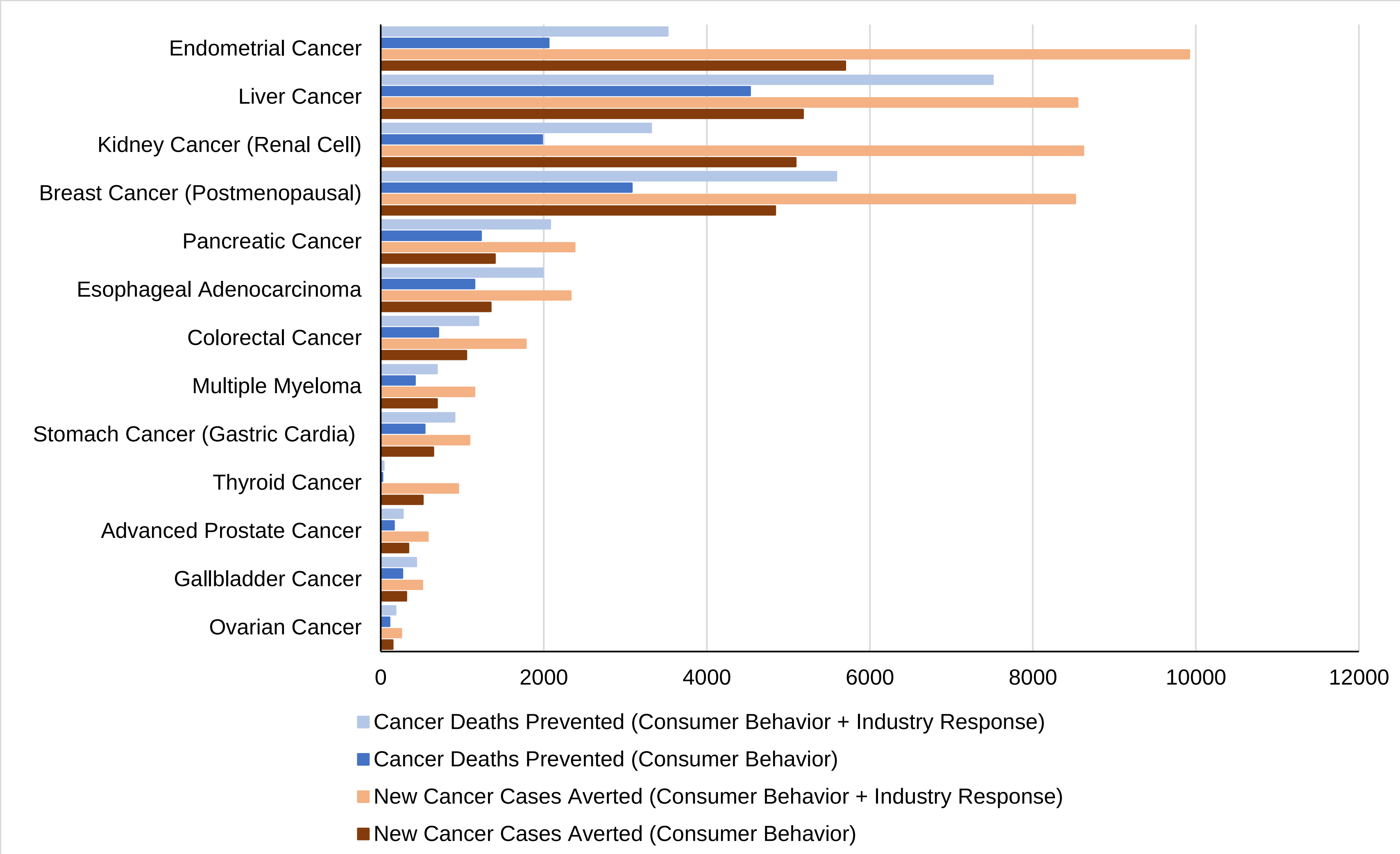
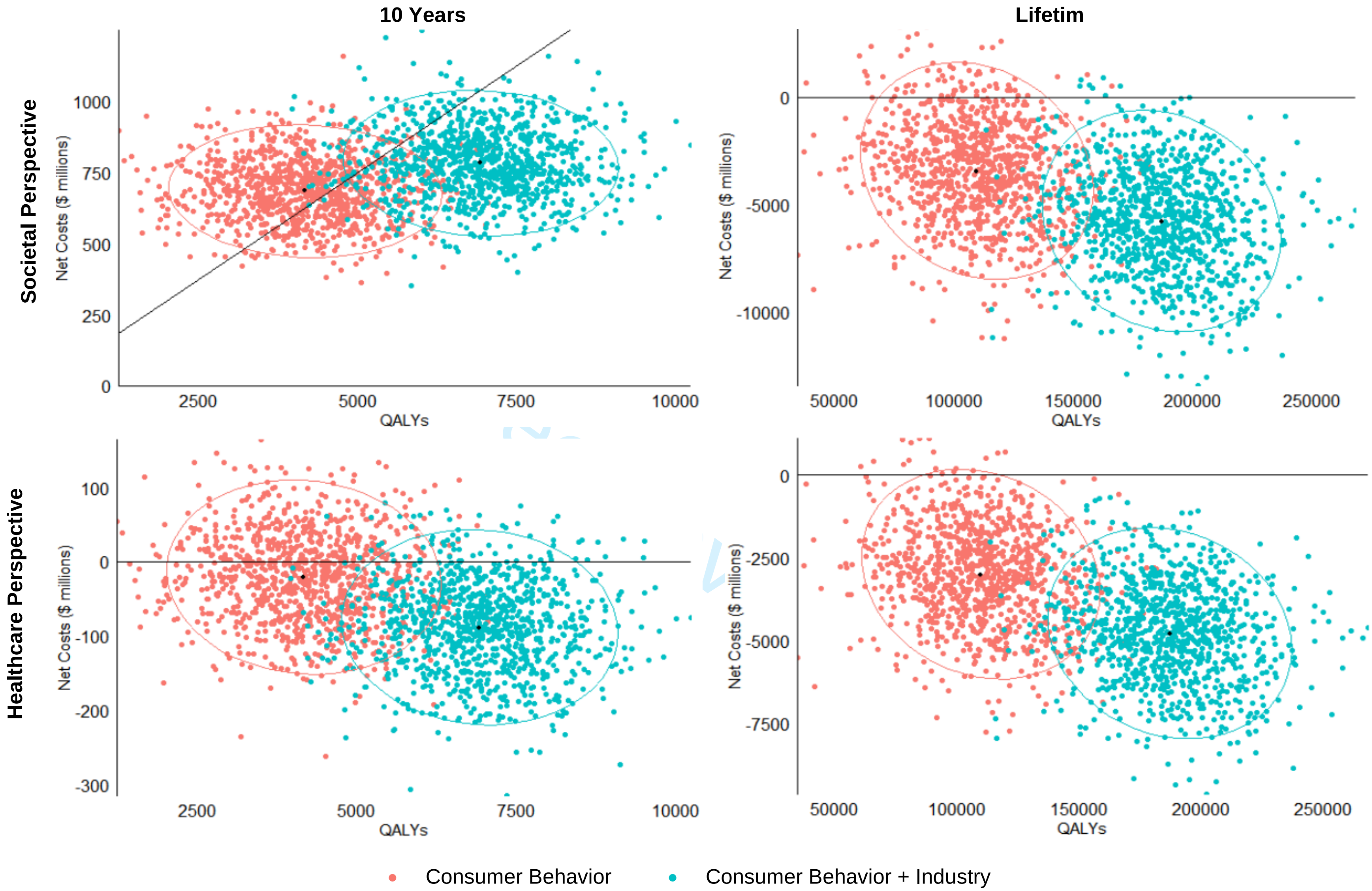


Figure 1. Estimated New Cancer Cases and Deaths Prevented by Federal Menu Calorie Labeling Policy in the US by Cancer Type over a Lifetime



Values are presented in cost-effectiveness planes of net costs ($millions) versus incremental quality-adjusted life years (QALYs). For each policy scenario, each colored dot represents one of the 1000 simulations, with the largest dot showing the median incremental cost-effectiveness ratio (ICER, $/QALY); and the ellipse representing the 95% UIs. Results are presented from the societal perspective and the healthcare perspective. Negative values indicate cost savings.

Figure 2. Probabilistic Sensitivity Analyses (PSA) for Cost-Effectiveness of the Federal Menu Calorie Labeling Policy over 10 years and a Lifetime

Title Cost-Effectiveness Analysis of the Federal Menu Calorie Labeling and Obesity-Associated Cancer Burdens in the United States

Appendix 1. Estimate the association between menu calorie labeling policy and calorie intake from restaurant meals

To understand the effects of the federal menu calorie labeling policy, we performed a comprehensive literature search and reviewed the evidence on how the policy affected consumer behaviors and industry.

To estimate the policy effect on consumer behavior alone, we reviewed individual studies in both real-world and experimental settings as well as meta-analyses (**Appendix Table 1)**. A meta-analysis of natural experimental studies showed that menu calorie labeling was associated with a 7.3% (95% CI: 4.4% to 10.1%) reduction in calories per meal consumed/purchased.[1] This effect estimate is corresponding to an average reduction of 23.5 kcal per meal consumed by NHANES participants from 56.5% of full-service restaurants[2] and all fast-food restaurants. This estimate was consistent with evidence from a previous meta-analysis and a recent real-world study.[3, 4] A previous meta-analysis estimated that the menu calorie labeling would lead to about an 18 kcal reduction ordered per meal.[3] A recent longitudinal study used data from a large restaurant franchise in the southern U.S. and estimated that, after labeling implementation, a decrease of 60 kcal per transaction was observed in the first year, followed by an increasing trend of 0.71 kcal per transaction per week over two years.[4] These together attenuated the calorie reduction to 23 kcal per transaction by the end of the third year of the policy implementation.[5] Compared to other studies, the 7.3% calorie reduction per meal represents a more conservative estimate. It was reported in a cross-sectional study that customers at the labeled full-service restaurants purchased food with 151 fewer calories.[6] One meta-analysis of studies that evaluated energy ordered in a real-world setting showed that the calorie labeling policy would lead to a mean reduction of 77.8 in calories purchased per meal.[7] In a laboratory setting, there was a significant reduction of 115.3 kcal per meal ordered.[8] Integrating both the real-world and experimental studies, the policy was estimated to generate a significant reduction of 100.3 in calories purchased.[7] Therefore, we decided to use a reduction of calorie intake per meal by 7.3% (95% CI: 4.4% to 10.1%) as the model input given it is the most updated and conservative estimate supported by existing evidence. This policy effect on consumer behavior alone was assumed to take effect during the first year of implementation and no further reduction thereafter.

Based on the published literature, we estimated that there was a 5% reduction in calories consumed per meal from chain restaurants due to industry reformulation, the introduction of new low-calorie menu items, or the replacement of menu items high in calories with low-calorie menu options. [9-13] Bleich et al. estimated the calorie changes in chain restaurants' menu items using data from the largest chain restaurants in the U.S. [9-13] Using the estimated mean calorie per menu item from the two published studies shown in **Appendix Table 2**,[11, 12] we calculated the mean change in calories per menu item before and after the policy implementation. Given the national law was announced in 2010, using data from the trend analysis, we treated the mean calorie per menu item measured in 2008 as the baseline and found there was an 11% reduction in calories per menu item two years after the affordable care act was enacted. The change decreased to 7% in 2015, one year after the FDA announced the final rule for the industry to comply with. In the study evaluated the calorie content in current menu items, eliminated menu items, and newly introduced menu items, we estimated that there was a 1% reduction in mean per-item calories in 2013-2014 compared to that in 2012, and the reduction increased to 5% in 2015. Based on this de novo analysis, we chose a reduction in calories per meal consumed by 5% to represent a modest industry reformulation in response to the federal menu calorie labeling by chain restaurants. We assumed no industry response in the first year, then the reformulation activities would occur in the rest of the years over the model lifetime, resulting in a net reduction of 5% in calories consumed per meal.

Appendix Table 1. Policy impact of menu calorie labeling on consumer behaviors

Study	Design	Year, country	Estimate size mean (95% CI)	Comment
Shangguan et. al., 2019[1] A Meta-Analysis of Food Labeling Effects on Consumer Diet Behaviors and Industry Practices	Meta-analysis 13 studies (5 RCTs) with 19 interventions on changes in calorie intake per meal, among children and adults	2000 to 2015, US, Canada, UK, Sweden	-7.3% (-10.1%, -4.4%) in calorie intake per meal	Corresponds to a 23.5 kcal per meal consumed by NHANES participants from 56.5% of full-service restaurants[2] and all fast-food restaurants
Petimar et. al., 2019[4] Estimating the effect of calorie menu labeling on calories purchased in a large restaurant franchise in the southern United States: quasi-experimental study	Quasi-experimental longitudinal study Transaction data from 104 restaurants of a national fast food company with three different restaurant chains located in the Louisiana, Texas, and Mississippi in the US	2015 to 2018 (pre-labeling: April 2015 to April 2017; post-labeling: April 2017 to April 2018), US	-60 (-48, -72) kcal in calorie purchased per transaction, followed by a post-implementation increasing trend of 0.71 kcal per transaction per week	Because of the post-implementation increase, the estimated reduction in calorie per transaction was 23 kcal lower than the counterfactual.
Cantu-Jungles et. al., 2017[8] A Meta-Analysis to Determine the Impact of Restaurant Menu Labeling on Calories and Nutrients (Ordered or Consumed) in U.S. Adults	Meta-analysis 14 studies that evaluated menu calorie labeling on changes in calorie chosen in laboratory and away-from-home settings, among children and adults	1996 to 2014	-115.2 (-130.87, -99.5) kcal in calorie ordered or consumed per meal in laboratory setting	N/A
Littlewood et. al., 2016[7] Menu labelling is effective in reducing energy ordered and consumed: a systematic review and meta-analysis of recent studies	Systematic review and meta-analysis 12 studies (6 RCTs) on changes in calorie consumed, ordered, or selected in both real-world and experimental settings, among children and adults	2011 to 2014, US, Canada, Australia,	-100.3 (-146.6, -54.0) kcal in calorie consumed in both settings per meal or transaction (3 studies) -77.8 (-121.6, -34.1) kcal in calorie purchased per meal or transaction in real-world setting (5 studies)	N/A
Long et. al., 2015[3] Systematic Review and Meta-analysis of the Impact of Restaurant Menu Calorie Labeling	Systematic review and meta-analysis 19 studies (11 RCTs, 8 natural experiments) on changes in calorie purchased per meal or per transaction, among children and adults	2008 to 2013, US	-18.1 (-33.6, -2.70) kcal in calorie purchased per meal or per transaction When stratifying by restaurant and non-restaurant settings (RCTs), the changes were -6.7 (-20.21, 6.81) kcal and -58.2 (-102.4, -13.9) kcal in calorie	N/A

			purchased per meal or per transaction	
Auchincloss et. al., 2013[6] Customer responses to mandatory menu labeling at full-service restaurants	Cross-sectional study 648 customer surveys and transaction receipts at 7 restaurant outlets of 1 large full-service restaurant chain (2 outlets with menu calorie labels and 5 without), among adults	2011, US	-151 kcal (-270, -33) for foods purchased from full-service restaurants (per meal)	Was included in the meta-analysis conducted by Cantu-Jungles et. al., 2017[8]

Appendix Table 2. Policy impact of menu calorie labeling on restaurant industry response

Study		**Year**				
		2008	**2012**	**2013**	**2014**	**2015**
Bleich et. al., 2017[11] Calorie changes in large chain restaurants from 2008 to 2015 44 of the 100 largest chain restaurants	# of menu items (n) mean per-item calories (kcal)	6,601 368.0	9,526 329.1	10,278 330.1	10,654 337.2	11,034 340.6
	diff. (%)		2012 vs. 2008 -38.9 (-11%)			2015 vs. 2008 -27 (-7%)
Bleich et. al., 2018[12] Higher-Calorie Menu Items Eliminated in Large Chain Restaurants 66 of the 100 largest chain restaurants	# of menu items (n) mean per-item calories (kcal)		14,705 374.4	17,219 (2013-2014) 370.9		13,920 357.4
	diff. (%)			2013-2014 vs. 2012 -3.52 (-1%)		2015 vs. 2012 -17.05 (-5%)

Appendix 2. Baseline cancer incidence and methods of cancer incidence projections for 13 types of cancers

We estimated the cancer incidence rate projections for the defined 32 demographic subgroups as inputs for the DiCOM model. We first obtained age-adjusted incidence rates from 2006 to 2015 from the United States Cancer Statistics combining data from the Surveillance, Epidemiology, and End Results (SEER) database and the Centers for Disease Control and Prevention's National Program of Cancer Registries (NPCR) database.[14]

Based on the trends from 2006 to 2015, we projected age-adjusted cancer incidence rates in the next 15 years from 2016 to2030 using the average annual percent change (AAPC) method.[15, 16] Because longer-term projections may not be valid, we chose to hold age-adjusted cancer incidence rates constant from 2030 to 2095. Specifically, the annual percent change was calculated for each cancer site in each of the 32 subgroups by fitting a regression line to the natural logarithm of the age-adjusted rates (I) in the years 2006 through 2015 (y). The equation for AAPC: $\ln(I) = \alpha + \beta y$, where α and β were coefficients to be estimated and y is the calendar year.[15, 16] We then combined the AAPC projected cancer incidence rates with the projected US population to account for the change in population age distribution over time. The projected US population in each of the 32 subgroups from 2016 to 2060 were extracted from the National Interim Projections of the US population.[17] Because projections were only available through 2060, further projections after 2060 were not considered. We further applied the cohort-period method to estimate cancer incidence in each of the 32 subgroups in the closed cohort of US adults from 2015 to 2095 as they age. Details were illustrated in **Appendix Table 3** using colon and rectum cancer incidence among non-Hispanic white females (NHWF) as an example.

Appendix Table 3. Estimating “crude” incidence after applying cohort-period method

EXAMPLE: Colon and Rectum Cancer, Non-Hispanic White Females

Age	2015		2016				2017				2018			
	Baseline Incidence Rate	Population Size	AAPC Predicted Incidence	US Census Predicted Population Size	Cancer Cases Predicted	Age Shifted "crude" Incidence	AAPC Predicted Incidence	US Census Predicted Population Size	Cancer Cases Predicted	Age Shifted "crude" Incidence	AAPC Predicted Incidence	US Census Predicted Population Size	Cancer Cases Predicted	Age Shifted "crude" Incidence
20	8.531	30523184	8.694	1134235		10.154	8.859	1126079		11.694	9.028	1117775		13.182
21	8.531		8.694	1156761	100565		8.859	1137549			9.028	1129379		
22	8.531		8.694	1177144	102337		8.859	1159788	102748		9.028	1140620		
23	8.531		8.694	1196469	104017		8.859	1180122	104550		9.028	1162784	104976	
24	8.531		8.694	1238910	107707		8.859	1199459	106263		9.028	1183136	106813	
25	8.531		8.694	1283513	111585		8.859	1241739	110009		9.028	1202329	108546	
26	8.531		8.694	1294013	112497		8.859	1286229	113950		9.028	1244499	112353	
27	8.531		8.694	1250740	108735		8.859	1296475	114858		9.028	1288797	116352	
28	8.531		8.694	1232421	107143		8.859	1253062	111012		9.028	1298770	117252	
29	8.531		8.694	1216039	105719		8.859	1234519	109369		9.028	1255161	113315	
30	8.531		8.694	1228929	106839		8.859	1217844	107892		9.028	1236330	111615	
31	8.531		8.694	1244281	108174		8.859	1230337	108999		9.028	1219312	110079	
32	8.531		8.694	1205955	104842		8.859	1245249	110320		9.028	1231390	111169	
33	8.531		8.694	1226950	106667		8.859	1206736	106908		9.028	1246013	112489	
34	8.531		8.694	1226234	106605		8.859	1227540	108751		9.028	1207377	109001	
35	8.531		8.694	1217701	105863		8.859	1226721	108678		9.028	1228051	110868	
36	8.531		8.694	1228467	106799		8.859	1218141	107918		9.028	1227199	110791	
37	8.531		8.694	1160971	100931		8.859	1228796	108862		9.028	1218528	110008	
38	8.531		8.694	1139547	99069		8.859	1161267	102879		9.028	1229044	110958	
39	8.531		8.694	1127605	98030		8.859	1139679	100967		9.028	1161414	104852	
40	8.531		8.694	1088875	94663		8.859	1127530	99891		9.028	1139635	102886	
41	8.531		8.694	1130467	98279		8.859	1088644	96446		9.028	1127272	101770	
42	8.531		8.694	1101345	95747		8.859	1129951	100105		9.028	1088229	98245	
43	8.531		8.694	1130264	98262		8.859	1100615	97506		9.028	1129228	101946	
44	8.531		8.694	1210411	105229		8.859	1129268	100045		9.028	1099713	99282	
45	41.269	14238423	41.919	1319769	553230	43.775	42.579	1208976	514771	45.825	43.250	1128045	487878	47.459
46	41.269		41.919	1346596	564476		42.579	1317806	561110		43.250	1207332	522169	
47	41.269		41.919	1292274	541705		42.579	1344191	572344		43.250	1315541	568969	
48	41.269		41.919	1264917	530237		42.579	1289694	549140		43.250	1341533	580211	
49	41.269		41.919	1295410	543019		42.579	1262140	537408		43.250	1286923	556592	
50	41.269		41.919	1325816	555765		42.579	1292230	550220		43.250	1259139	544576	
51	41.269		41.919	1432079	600309		42.579	1322198	562980		43.250	1288813	557410	
52	41.269		41.919	1489756	624487		42.579	1427705	607904		43.250	1318321	570172	
53	41.269		41.919	1510286	633093		42.579	1484805	632216		43.250	1423107	615492	
54	41.269		41.919	1532940	642589		42.579	1504858	640755		43.250	1479608	639928	
55	59.736	15111568	58.496	1575080	921363	65.864	57.283	1526976	874691	71.195	56.094	1499151	840934	75.804
56	59.736		58.496	1579128	923731		57.283	1568482	898466		56.094	1520747	853048	
57	59.736		58.496	1554236	909170		57.283	1572018	900492		56.094	1561581	875954	
58	59.736		58.496	1566074	916095		57.283	1546788	886040		56.094	1564631	877664	
59	59.736		58.496	1559941	912507		57.283	1558015	892471		56.094	1539019	863298	
60	59.736		58.496	1509257	882859		57.283	1551289	888618		56.094	1549572	869217	
61	59.736		58.496	1507776	881993		57.283	1500225	859367		56.094	1542165	865062	
62	59.736		58.496	1469467	859583		57.283	1497943	858060		56.094	1490621	836149	
63	59.736		58.496	1428612	835685		57.283	1458963	835731		56.094	1487453	834372	
64	59.736		58.496	1384020	809600		57.283	1417465	811960		56.094	1447782	812119	
65	147.246	20639658	140.189	1344027	1884181	140.189	133.471	1372210	1831501	133.471	127.075	1405568	1786119	127.075
66	147.246		140.189	1307657	1833194		133.471	1331467	1777121		127.075	1359584	1727685	
67	147.246		140.189	1291598	1810681		133.471	1294222	1727410		127.075	1318007	1674851	
68	147.246		140.189	1292613	1812104		133.471	1277026	1704458		127.075	1279794	1626292	
69	147.246		140.189	1382868	1938632		133.471	1276471	1703717		127.075	1261379	1602891	
70	147.246		140.189	987587	1384490		133.471	1363827	1820312		127.075	1259177	1600093	
71	147.246		140.189	982267	1377032		133.471	972764	1298357		127.075	1343441	1707171	
72	147.246		140.189	972611	1363496		133.471	966021	1289357		127.075	956905	1215982	
73	147.246		140.189	1012982	1420091		133.471	954967	1274603		127.075	948632	1205469	
74	147.246		140.189	874564	1226044		133.471	992594	1324824		127.075	936077	1189515	
75	147.246		140.189	796574	1116711		133.471	855200	1141443		127.075	970797	1233635	
76	147.246		140.189	747848	1048402		133.471	777087	1037185		127.075	834495	1060430	
77	147.246		140.189	706707	990727		133.471	727604	971140		127.075	756255	961007	
78	147.246		140.189	679404	952451		133.471	685495	914936		127.075	705976	897115	
79	147.246		140.189	625026	876219		133.471	656756	876578		127.075	662851	842315	
80	147.246		140.189	595777	835215		133.471	601790	803215		127.075	632555	803816	
81	147.246		140.189	572977	803252		133.471	571026	762154		127.075	577004	733225	
82	147.246		140.189	512332	718234		133.471	546330	729192		127.075	544674	692142	
83	147.246		140.189	496976	696707		133.471	485519	648027		127.075	517986	658228	
84	147.246		140.189	475655	666817		133.471	467692	624233		127.075	457134	580901	
85	147.246		140.189	452173	633898		133.471	444106	592752		127.075	436898	555186	
86	147.246		140.189	428834	601179		133.471	418526	558610		127.075	411316	522678	
87	147.246		140.189	383933	538233		133.471	393130	524714		127.075	383961	487917	
88	147.246		140.189	356801	500196		133.471	348261	464827		127.075	356875	453497	
89	147.246		140.189	320644	449508		133.471	319862	426923		127.075	312475	397076	
90	147.246		140.189	278562	390514		133.471	283710	378670		127.075	283306	360010	
91	147.246		140.189	246568	345662		133.471	242960	324281		127.075	247721	314790	
92	147.246		140.189	209022	293026		133.471	211695	282551		127.075	208839	265381	
93	147.246		140.189	169864	238131		133.471	176399	235441		127.075	178878	227308	
94	147.246		140.189	138657	194382		133.471	140691	187782		127.075	146313	185927	
95	147.246		140.189	109277	153195		133.471	112531	150196		127.075	114362	145325	
96	147.246		140.189	80177	112399		133.471	86769	115811		127.075	89499	113730	
97	147.246		140.189	56739	79542		133.471	62172	82982		127.075	67414	85666	
98	147.246		140.189	42046	58944		133.471	42907	57268		127.075	47105	59858	
99	147.246		140.189	27405	38419		133.471	30959	41321		127.075	31659	40231	
100	147.246		140.189	49314	69133		133.471	50716	67691		127.075	52719	66992	

Appendix 3. Cancer survival for 13 types of cancers

We estimated the 5-year relative survival for the defined 32 demographic subgroups. We obtained five-year relative survival rates using the period analysis method from the United States Cancer Statistics which incorporates data from the Surveillance, Epidemiology, and End Results (SEER) database.[14] The five-year survival for 2014, which was the most recently available data at the time of analysis, was used. These rates were extracted for each cancer type and by the defined 32 demographic subgroups for each cancer type. The rates are on a scale of 0-1.

Relative survival is a net survival measure representing cancer survival in the absence of other causes of death. Relative survival is defined as the ratio of the proportion of observed survivors in a cohort of cancer patients to the proportion of expected survivors in a comparable set of cancer-free individuals.[18] Relative survival is the preferred method to estimate survival from cancer registry data.

The period analysis is a method that enhances up-to-date monitoring of survival.[19, 20] In contrast to traditional cohort analysis of survival, period analysis derives long-term survival estimates exclusively from the survival experience of patients within some recent calendar period.[19, 20] Three-year intervals were chosen which results in the years 2008-2014 is used to calculate 5-year survival. Using seven years of data to calculate 5-year survival is the standard method used by SEER and used in SEER publications.[21]

The first interval contributed to the one-year survival and used cases diagnosed in 2012-2014, the second interval contributed to the two-year survival and used cases diagnosed in 2011-2013, the third interval contributed to the three-year survival and used cases diagnosed in 2010-2012, the fourth interval contributed to the four-year survival and used cases diagnosed in 2009-2011 and the fifth interval contributed to the five-year survival and used cases diagnosed in 2008-2010.

This analysis, therefore, used 2008-2014 diagnoses to calculate for 5-year relative survival for 2014. The highlighted orange boxes represent survival contributions for each year of diagnosis and year of follow-up (**Appendix Table 4**). The annual probability of death was calculated as 1-exp[ln(5-year relative survival)/5].

Appendix Table 4. Period method for 5-year relative survival for 2014

YEARS OF DIAGNOSIS															
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1															
2															
3															
4															
5															

Appendix 4. Methods of estimating the health-related quality of life among 13 types of cancers

Health utility values range from 0 (dead) to 1 (perfect health and were assigned for each cancer type and by phase of care (initial, continuous, end of life), if available. We first searched databases for systematic reviews pertaining to utility weights or HRQOL measures for each cancer type of interest separately. We started with PubMed and searched Google Scholar if needed. The following search string was used for each cancer type : ("health related quality of life" OR "HRQOL" OR "quality of life" OR "QOL" OR "preference weight*" OR “utility weight*” OR “health state utilit*” OR “health utility*”) AND (“cancer of interest”) AND ("cancer" OR “neoplasm*”) AND ("review" OR “systematic review”).

When an appropriate systematic review was identified, we read the articles included in the review and determined if the paper met the following data needs. Data Extraction Hierarchy: 1) cancer type specific to the type of interest; 2) consistent in the instrument used, prefer EQ-5D whenever available; 3) US samples preferred; 4) phase of care (assume same utility weights by phase if the phase of care data were not available). If no systematic reviews were available, we searched for individual studies about the utility weights of the cancer of interest. Additionally, check how often the paper is cited to see if it is a frequently used utility weight.

Appendix 5. Methods of estimating policy implementation costs

We estimated the costs of implementing the federal menu calorie labeling for both government and industry, including government administration costs, monitoring and evaluation costs, industry compliance costs and reformulation costs, based on the FDA's budget report,[22] the Nutrition Review Project report,[23] and FDA's RIA[24] (**Appendix Table 5**).

It was estimated by FDA that approximately 298,600 establishments, organized under 2,130 chains were covered by the menu calorie labeling policy. Among the covered establishments, 115,000 (38.5%) were full-service restaurants and drinking places organized under 530 (24.9%) chains, and 116,200 (38.9%) were limited-service restaurants organized under 540 (25.4%) chains. In total, about 231,200 (77.4%) restaurants organized under 1,070 (50.2%) chains were covered by this policy.[24]

For industry compliance (#3) and reformulation costs (#4), the FDA estimated the costs by the type of establishments. Therefore, we only included the relevant costs incurred by restaurants as this approach generated more conservative estimates. In addition, the industry compliance costs consist of initial costs and recurring costs associated with new chains. In FDA's RIA, the initial costs were presented as a one-time cost, while the recurring costs associated with new chains were presented as annual costs and assumed to be incurred for 20 years starting from the 2nd year of policy implementation. According to FDA, 20 years is more appropriate for interventions that play out over long periods and whose effects deal with chronic conditions. Similarly, the reformulation costs (#4) estimated by FDA were presented as annual costs in FDA's RIA using the same assumption. We followed the same assumption and presented the annual compliance costs (#3) and annual reformulation costs (#4) incurred by restaurants in **Appendix Table 5**.

The cost of implementing the menu calorie labeling is fixed by the government. Uncertainty for the costs associated with government administration (#1) and government monitoring and evaluation (# 2) was not provided in the source materials.[22, 23] We assumed that uncertainty is 20% around these costs.

For annual costs, namely the government monitoring and evaluation costs (#2) and the recurring costs in industry compliance (part of #3), and the reformulation costs (#4), we applied a 3% discounting rate recommended by the Second Panel on cost-effectiveness in health and medicine[4] to reflect the present value of future costs of government monitoring and evaluation, industry compliance and industry reformulation. The model is a closed cohort model, so we computed the discounted present value of per-person costs and total national costs for persons alive at implementation who remained alive in each subsequent year (not for the larger total US population in each year, which also has growth from immigration and new persons reaching the threshold age). The year-specific discounting factor is estimated by 1/(1+3%)^(t-1) (t is the number of years of policy intervention, t=1, 2, 3, …, lifetime). As our model estimated the costs and health outcomes based on a closed cohort and the population size decline over time, we need to express the annual costs in proportion to the population at risk. The population at risk was estimated based on the proportion of death (P_{dt}, t=1, 2, 3, …) in each year. We first obtained the proportion of people who are alive each year by calculating 1-P_{dt} (t=1, 2, 3, …). Then we multiplied the baseline population size of 235 million by the proportion of people who are alive each year (**Appendix Table 6**).

We then estimated the per-person annual cost for cost categories #2, #3 (annual part), and #4, by dividing the annual cost estimated in the second year of implementing the policy among all US populations by the population size in the second year. Specifically, for government monitoring and evaluation, the per person annual cost is estimated $503,648/233,719,989=$0.00215, the per person annual cost for industry compliance recurring component is $/233,719,989=$, and that for reformulation

is \$662,800,000 /233,719,989=\$2.83587. Taken together, to estimate the discounted annual cost of #2, #3 (annual part), and #4, we multiplied the population at risk, the per person annual cost estimated at year-2, and the year-specific discounting factor, using: discounted annual cost = population at risk x per-person annual cost x 1/(1+3%)^(t-1).

Appendix Table 5. Implementation cost estimates for the federal menu calorie labeling policy (in 2015 US dollars)

Policy Effect	Cost Category	One-time Cost*	Annual Cost*	Source	Major Elements
Consumer behavior	1. Government administration#	$9,073,620 ($7,258,896 to $10,888,344)	N/A	FDA FY 2012 Budget Report[22]	1) Costs for outreach, education, review of regulatory issues, developing training for inspectors, etc.
	2. Government monitoring and evaluation#	N/A	$503,648 ($402,918 to $604,378) (starting from 2nd year and last for a lifetime)	Nutrition Review Project report[23]	1) Monitor industry compliance 2) Evaluate the accuracy, usefulness, and health impact of the policy intervention
	3. Industry compliance	$276,632,470 ($225,552,530 to $327,205,740)	$27,648,591 ($16,756,003 to $38,649,212) (starting from 2nd year and last for a lifetime)	FDA's RIA[24] Table 4-8	1) Collecting and managing records of nutritional analysis for each standard menu item (initial cost + recurring cost associated with new chains) 2) Revising or replacing existing menus, menu boards, and providing full written nutrition information (initial cost + recurring cost associated with new chains) 3) Training employees to understand the nutrition information to help ensure compliance with the final requirements (initial cost + recurring cost associated with new chains) 4) Legal review (initial cost + recurring cost associated with new chains)
Industry response^	4. Industry reformulation	N/A	$15,059,100 ($5,791,900 to $24,124,700) (starting from 2nd year and last for a lifetime)	FDA's RIA[24] Table 4-8	1) Annually recurring costs of nutrition analysis refer to the nutrition cost that will be incurred by the covered establishments due to the introduction of a new standard or reformulated standard menu items in their menus and the cost that will be incurred by new chains entering the industry 2) Annually recurring changes to menus or menu boards will be tied to new or reformulated standard menu items. In general, these future changes to menus will be incorporated into the natural menu

					replacement cycle, so there will be no additional recurring menu update costs. However, all chain retail food establishments will need to provide additional written nutrition information for the reformulated or newly introduced menu items Average formula count, 6 new menu items, and 6 reformulated items per year FDA reformulation cost model

*Policy intervention costs were inflated to 2015 US (December) dollars using the Consumer Price Index.
Given no range of uncertainty was provided in source materials, we assumed 20% uncertainty around these costs.
^Some chains or establishments may respond to increased consumer interest in caloric content standard menu items by reformulating existing menu items or by introducing new, lower-calorie items. The change in manufacturing costs associated with reformulating these items has not been included in the cost estimation, the FDA includes the cost associated with analyzing the nutrition information of new or reformulated items.

Appendix Table 6. The population size of people who are alive each year over a lifetime (in millions)

Year	Population Size (Million)
1	235.2
2	233.7
3	232.1
4	230.4
5	228.2
⋮	⋮
67	5.832
68	4.348
69	3.157
70	2.233

Appendix 6. Annual health-related costs among cancer patients and the general population without cancer

The annual health-related costs data include: 1) medical expenditure, 2) productivity loss from missed workdays or disability, and 3) patient time cost associated with receiving care for cancer survivors by age (under 65 vs. above 65 years old) and phase of care (initial, continuing, end-year of life); 4) medical expenditure, 5) productivity loss, and 6) patient time cost for individuals without cancer by age and status of end year of life. The description of the data source and data structure were provided in **Appendix Table 7**.

We extracted the raw data for each of the costing components from the published literature.[15, 25-29] The overall assumptions for data extraction include: 1) health-related costs for breast cancer among postmenopausal females, advanced prostate cancer, esophageal adenocarcinoma, and stomach cardia cancer, by age, sex, and phase of cancer care, were the same as those for breast cancer, prostate cancer, esophagus cancer, and stomach cancer; 2) if no data available for a specific cancer type, we assumed the costs for that cancer type were the same as the estimates of costs for all-cancer sites, e.g., medical expenditure for all-cancer sites were used to replace the medical expenditures for multiple myeloma, gallbladder, liver, and thyroid cancers; 3) we extracted the costs for end-year of life due to cancer death and assumed that death due to other causes is not a competing outcome; 4) we assumed that the end-year life medical expenditure for individuals without cancer does not vary by the 32 subgroups.

If a specific costing component was not reported directly in the raw data, we calculated the cost for that component based on available data. For example, the annual productivity loss for colorectal cancer was reported as a percentage of total health-related costs.[29] We multiplied the percentage and the total health-related costs to obtain the productivity loss for colorectal cancer. We also performed data imputation for unavailable data. For instance, the annual productivity loss for all-cancer sites was

reported by time interval since cancer diagnosis (diagnosed within one year vs. diagnosed greater than one year).[25] To obtain this costing component by the defined phases of care, we calculated the weighted means which was used as the annual productivity loss for the continuous phase. We then assumed that the productivity loss in the initial phase and end-of-life phase of cancer care are 1.3 times and 4 times the mean estimates based on available data for other cancers.[15, 25] For individuals without cancer, we assumed that the end-of-life productivity loss is 4 times to the mean estimate of the productivity loss. The same rules applied to data imputation for patient time costs.

We then applied the age shifting to keep the expenditures consistent within each age group. Starting from 2021, individuals in the cohort of 55-64 years old have turned into the cohort of 65 years and older. Therefore, we assumed that starting from 2021, the health-related expenditures for individuals who were in the cohort of 55-64 years old would be the same as those for individuals who were in the cohort of 65 years and older at the beginning of the DiCOM model. Based on the same assumption, starting from 2031 and 2047, the health-related expenditures for the cohort of 45-54 years old and those for the cohort of 20-44 years old were projected to be the same as those for the cohort of 65 years and older, respectively. We followed the same rule and applied the age shifting for the health-related expenditures for individuals without cancer. All estimations and projections were performed in SAS 9.4. All health-related expenditures were inflated to 2015 US dollars using the Personal Health Care (PHC) index.

Appendix Table 7. Description of the data source of health-related expenditures

	A. Cancer Survivors		B. Individuals without Cancer	
	Data source (Excess or Total)	Category	Data source	Category
Medical expenditure	Mariotto et al. 2011, SEER-Medicare, in 2010 US dollars (Excess)	-by phase of care[1] -by age (under 65 vs. above 65 years old) -by sex	Kim et al. 2018, MEPS 2013-2014, *in vivo* analysis, in 2014 US dollars (Total)	-Medical expenditure among all US adults -by 32 subgroups stratified by age, sex, and race/ethnicity
			Hogen et al. 2001, SEER-Medicare (65+), in 2001 US dollars (Total)	-Medical expenditure in the end year of life among all US adults
Productivity loss	Zheng et al. 2016, MEPS 2008-2012, data available for colorectal, female breast, and prostate cancers, in 2012 US dollars (Total)	-by age		
	Guy et al. 2013, MEPS 2008-2010, all types of cancer, in 2010 US dollars (Total)	-by age -by time interval since cancer diagnosis (less than 1 year vs. greater than 1 year)[2]	Guy et al. 2013, MEPS 2008-2010, in 2010 US dollars (Total)	-by age
Patient time cost	Yabroff et al. 2014, MEPS 2008-2011, all types of cancer, in 2011 US dollars (Total)	-by age	Yabroff et al. 2014, MEPS 2008-2011, in 2011 US dollars (Total)	-by age

1. The definition of phases of care: 1) initial phase, defined as the first 12 months following diagnosis, 2) end-year of life phase, defined as the final 12 months of life, and 3) the continuing phase, defined as all the months between the initial phase and the end-year of life. The costs of end-year of life varied by cause of death, either cancer-specific death or death due to other causes.
2. Weighted means were calculated based on sample sizes and strata means.

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Supplementary Table 1. Defining population and 32 subgroups

Subgroups	Age	Sex	Race/Ethnicity
1	20-44y	Female	NHW
2	20-44y	Female	NHB
3	20-44y	Female	HISP
4	20-44y	Female	OTH
5	20-44y	Male	NHW
6	20-44y	Male	NHB
7	20-44y	Male	HISP
8	20-44y	Male	OTH
9	45-54y	Female	NHW
10	45-54y	Female	NHB
11	45-54y	Female	HISP
12	45-54y	Female	OTH
13	45-54y	Male	NHW
14	45-54y	Male	NHB
15	45-54y	Male	HISP
16	45-54y	Male	OTH
17	55-64y	Female	NHW
18	55-64y	Female	NHB
19	55-64y	Female	HISP
20	55-64y	Female	OTH
21	55-64y	Male	NHW
22	55-64y	Male	NHB
23	55-64y	Male	HISP
24	55-64y	Male	OTH
25	65+y	Female	NHW
26	65+y	Female	NHB
27	65+y	Female	HISP
28	65+y	Female	OTH
29	65+y	Male	NHW
30	65+y	Male	NHB
31	65+y	Male	HISP
32	65+y	Male	OTH

Supplementary Table 2. Relative risk estimates of etiologic relationships between body mass index (BMI) and 13 types of cancers

Cancer Type	No. of Studies	No. of Events	Source	Evidence Grading	RR (95% CI) Per 5 kg/m^2	Statistical Heterogeneity
Endometrial	26	18,717	CUP, 2013	Convincing ↑risk	1.50 (1.42-1.59)	I^2=86.2% P<0.0001
Esophageal (adenocarcinoma)	9	1,725	CUP, 2016	Convincing ↑risk	1.48 (1.35-1.62)	I^2=36.7% P=0.13
Kidney	23	15,575	CUP, 2015	Convincing ↑risk	1.30 (1.25-1.35)	I^2=38.8% P=0.03
Liver	12	14, 311	CUP, 2015	Convincing ↑risk	1.30 (1.16-1.46)	I^2=78.3% P=0.000
Gallbladder	8	6,004	CUP, 2015	Probable ↑risk	1.25 (1.15-1.37)	I^2=52.3% P=0.04
Stomach (cardia)	7	2,050	CUP, 2016	Probable ↑risk	1.23 (1.07-1.40)	I^2=55.6% P=0.04
Breast (post-menopausal)	56	80,404	CUP, 2017	Convincing ↑risk	1.12 (1.09-1.15)	I^2=75% P<0.001
Pancreas	23	9,504	CUP, 2011	Convincing ↑risk	1.10 (1.07-1.14)	I^2=19% P=0.20
Multiple myeloma	20	1,388	IARC, 2016[30]	Sufficient (IRAC) ↑risk	1.09 (1.03-1.16)	Not reported
Prostate (advanced)	24	11,149	CUP, 2014	Probable ↑risk	1.08 (1.04-1.12)	I^2=18.8% P=0.21
Thyroid	22	3,100	IARC, 2016[30]	Sufficient (IARC) ↑risk	1.06 (1.02-1.10)	Not reported
Ovary	25	15,899	CUP, 2013	Probable ↑risk	1.06 (1.02-1.11)	I^2=55.1% P=0.001
Colorectal	38	71,089	CUP, 2017	Convincing ↑risk	1.05 (1.03-1.07)	I^2=74.2% P=0.000

Supplementary Table 3. Baseline incidence rates of 13 cancers among US adults by 32 subgroups

Subgroup	Colorectal Cancer		Endometrial Cancer		Esophageal Adeno-carcinoma		Female Breast (Postmeno.)		Gallbladder Cancer		Kidney Cancer		Liver Cancer		Multiple Myeloma		Ovarian cancer		Pancreatic Cancer		Advanced Prostate Cancer		Stomach Cancer (Gastric Cardia)		Thyroid Cancer	
	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE
1	8.53	0.38	6.54	3.66	0.05	4.18	0.00	0.00	0.05	2.57	3.83	3.16	0.49	4.18	0.38	4.66	4.31	0.27	107	3.46	0.00	0.00	0.10	3.82	28.97	0.69
2	7.78	0.74	5.04	0.59	0.03	0.20	0.00	0.00	0.07	2.46	3.57	0.50	0.56	0.20	102	0.27	2.98	0.45	103	0.26	0.00	0.00	0.09	2.25	13.12	0.95
3	6.09	0.55	7.49	3.32	0.03	3.07	0.00	0.00	0.06	2.48	3.73	3.16	0.42	3.07	0.33	3.71	3.95	0.46	0.86	0.87	0.00	0.00	0.09	2.27	20.97	113
4	6.36	110	6.56	113	0.02	0.15	0.00	0.00	0.07	2.58	187	0.40	0.32	0.15	0.38	0.23	4.49	0.70	0.74	0.25	0.00	0.00	0.09	2.36	24.88	2.21
5	9.20	0.39	0.00	0.00	0.42	5.22	0.00	0.00	0.04	0.02	5.91	4.53	0.60	5.22	0.48	5.26	0.00	0.00	122	2.06	0.21	0.02	0.43	4.32	6.93	0.34
6	7.94	0.78	0.00	0.00	0.29	0.30	0.00	0.00	0.04	0.02	5.47	0.65	117	0.30	148	0.34	0.00	0.00	100	0.28	0.56	0.09	0.34	3.42	2.36	0.42
7	6.15	0.54	0.00	0.00	0.31	3.85	0.00	0.00	0.04	0.02	4.04	3.82	0.82	3.85	0.57	0.18	0.00	0.00	0.83	0.20	0.13	0.68	0.34	3.53	3.80	0.44
8	6.21	0.85	0.00	0.00	0.31	0.47	0.00	0.00	0.05	0.02	3.68	104	159	0.47	0.70	140	0.00	0.00	0.82	0.29	0.41	0.09	0.36	3.52	5.70	0.84
9	4127	0.76	38.53	0.73	103	0.21	124.56	128	0.68	5.99	14.03	0.44	3.10	0.21	3.60	0.22	17.09	0.49	7.70	0.32	0.00	0.00	0.88	6.74	37.84	0.73
10	53.14	192	25.73	134	0.59	0.60	12173	2.88	154	5.87	16.08	106	5.17	0.60	1129	0.89	1175	0.90	10.91	0.87	0.00	0.00	0.94	5.38	25.80	134
11	33.92	178	33.43	153	0.59	0.52	77.25	3.45	2.27	193	16.00	104	3.83	0.52	4.86	0.58	14.57	100	6.26	0.66	0.00	0.00	0.81	5.61	37.29	184
12	35.77	3.15	35.84	3.07	0.65	0.66	9182	4.82	170	6.05	7.78	192	3.27	0.66	2.55	0.70	17.07	151	5.17	0.81	0.00	0.00	0.85	5.53	37.73	2.90
13	53.97	0.87	0.00	0.00	5.61	0.36	0.00	0.00	0.36	7.15	29.16	0.64	9.24	0.36	5.09	0.27	0.00	0.00	10.63	0.38	10.88	0.16	3.65	0.23	13.29	0.43
14	6129	2.20	0.00	0.00	150	102	0.00	0.00	0.47	5.07	32.82	161	13.29	102	12.34	0.99	0.00	0.00	14.12	105	25.31	0.58	190	0.33	6.41	0.71
15	38.05	194	0.00	0.00	2.75	106	0.00	0.00	0.43	4.83	24.48	127	16.38	106	5.23	0.60	0.00	0.00	7.95	0.74	6.02	0.38	196	0.34	8.56	0.76
16	42.81	3.85	0.00	0.00	2.88	2.28	0.00	0.00	0.37	4.93	18.63	3.06	18.71	2.28	3.70	0.82	0.00	0.00	7.62	105	3.70	0.50	2.51	0.17	12.57	136
17	59.74	0.89	90.00	109	2.12	0.35	305.45	2.02	175	0.15	26.14	0.59	9.41	0.35	8.68	0.34	26.19	0.59	2178	0.54	0.00	0.00	172	0.15	34.42	0.67
18	86.11	2.62	83.71	2.60	130	121	306.22	4.92	4.08	0.57	3153	158	18.22	121	23.28	137	19.79	125	3137	158	0.00	0.00	192	0.39	27.72	148
19	58.14	2.91	69.51	3.28	164	133	218.85	7.01	4.59	0.68	29.93	173	17.38	133	9.33	0.97	2129	145	17.15	132	0.00	0.00	187	0.34	39.44	197
20	52.83	4.48	60.22	4.45	149	197	233.48	8.33	2.44	0.50	13.91	2.72	12.58	197	6.13	0.96	23.98	2.79	13.44	143	0.00	0.00	157	0.13	4174	3.08
21	88.14	111	0.00	0.00	15.54	0.73	0.00	0.00	0.93	0.11	53.65	0.87	37.93	0.73	13.24	0.43	0.00	0.00	29.95	0.65	47.05	0.34	9.19	0.36	16.24	0.48
22	12139	3.41	0.00	0.00	4.30	2.72	0.00	0.00	2.06	0.41	69.05	2.57	75.50	2.72	30.69	171	0.00	0.00	39.72	195	9141	122	4.87	0.68	9.12	0.92
23	84.75	3.65	0.00	0.00	8.01	2.98	0.00	0.00	107	0.11	5105	2.35	6105	2.98	13.65	122	0.00	0.00	23.36	158	32.10	121	5.15	0.70	11.12	109
24	83.77	5.72	0.00	0.00	4.97	4.85	0.00	0.00	122	0.11	27.95	3.81	54.13	4.85	10.32	139	0.00	0.00	19.14	2.87	22.70	131	5.16	0.96	16.04	175
25	147.25	198	86.90	140	4.53	0.62	429.43	3.20	5.87	0.40	42.37	102	15.56	0.62	20.59	0.73	38.18	0.97	55.49	120	0.00	0.00	4.36	0.34	24.59	0.74
26	155.86	5.74	100.81	4.21	3.10	198	398.07	8.74	9.68	143	50.03	3.07	20.61	198	50.31	3.20	29.78	2.45	7193	3.94	0.00	0.00	3.41	0.52	22.57	198
27	117.47	5.72	66.40	4.47	3.61	3.17	285.07	11.57	11.44	175	45.35	3.33	38.69	3.17	24.20	2.52	32.78	2.88	5154	3.79	0.00	0.00	3.89	0.60	29.50	2.55
28	109.32	10.15	52.12	5.29	3.51	4.72	266.14	14.52	7.02	170	26.14	4.17	35.77	4.72	14.41	2.43	23.90	2.89	46.15	5.64	0.00	0.00	4.11	0.28	28.15	3.08
29	18107	2.47	0.00	0.00	29.02	110	0.00	0.00	3.59	0.36	88.69	163	40.30	110	34.26	107	0.00	0.00	72.36	153	80.74	0.61	19.38	0.77	17.34	0.69
30	217.23	8.36	0.00	0.00	7.29	3.98	0.00	0.00	6.24	114	97.13	5.16	68.31	3.98	69.18	4.66	0.00	0.00	75.66	4.94	130.67	2.34	8.81	155	10.03	160
31	182.00	9.21	0.00	0.00	15.50	5.01	0.00	0.00	6.79	164	87.20	5.26	78.18	5.01	33.10	3.44	0.00	0.00	6188	4.77	66.33	2.57	11.49	178	15.87	2.11
32	144.37	13.43	0.00	0.00	10.56	7.52	0.00	0.00	4.75	102	54.45	7.24	79.16	7.52	22.48	3.35	0.00	0.00	5145	6.82	5184	2.78	11.34	2.12	13.86	2.28

Supplementary Table 4. Baseline 5-year relative survival rates of 13 cancers among US adults by 32 subgroups

Subgroup	Colorectal Cancer		Endometrial Cancer		Esophageal Adeno-carcinoma		Female Breast (Postmeno.)		Gallbladder Cancer		Kidney Cancer		Liver Cancer		Multiple Myeloma		Ovarian Cancer		Pancreatic Cancer		Advanced Prostate Cancer		Stomach Cancer (Gastric Cardia)		Thyroid Cancer	
	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE	Rate	SE
1	0.740	0.012	0.916	0.009	0.223	0.018	0.000	0.000	0.095	0.095	0.953	0.009	0.409	0.057	0.852	0.043	0.780	0.015	0.379	0.038	0.000	0.000	0.477	0.099	1.000	0.001
2	0.652	0.024	0.775	0.027	0.223	0.018	0.000	0.000	0.286	0.064	0.856	0.029	0.144	0.113	0.837	0.048	0.736	0.036	0.530	0.064	0.000	0.000	0.502	0.205	0.993	0.004
3	0.659	0.022	0.900	0.013	0.223	0.018	0.000	0.000	0.309	0.092	0.864	0.021	0.403	0.081	0.713	0.075	0.716	0.024	0.493	0.062	0.000	0.000	0.236	0.116	0.992	0.002
4	0.694	0.027	0.910	0.016	0.223	0.018	0.000	0.000	0.286	0.064	0.819	0.043	0.321	0.077	0.787	0.122	0.737	0.029	0.371	0.076	0.000	0.000	0.667	0.193	1.000	0.002
5	0.682	0.012	0.000	0.000	0.140	0.034	0.000	0.000	0.302	0.117	0.886	0.010	0.251	0.037	0.696	0.041	0.000	0.000	0.275	0.032	0.768	0.057	0.284	0.045	0.997	0.002
6	0.601	0.027	0.000	0.000	0.160	0.031	0.000	0.000	0.357	0.096	0.779	0.027	0.157	0.045	0.606	0.057	0.000	0.000	0.151	0.046	0.780	0.086	0.672	0.274	0.949	0.025
7	0.621	0.022	0.000	0.000	0.330	0.108	0.000	0.000	0.357	0.096	0.847	0.020	0.227	0.047	0.635	0.064	0.000	0.000	0.157	0.044	0.470	0.118	0.152	0.055	0.993	0.007
8	0.635	0.029	0.000	0.000	0.287	0.172	0.000	0.000	0.357	0.096	0.840	0.033	0.152	0.032	0.649	0.108	0.000	0.000	0.230	0.066	0.805	0.180	0.545	0.133	0.992	0.008
9	0.738	0.007	0.889	0.006	0.300	0.065	0.918	0.003	0.153	0.045	0.846	0.011	0.283	0.027	0.682	0.027	0.614	0.012	0.195	0.017	0.000	0.000	0.384	0.060	0.997	0.002
10	0.666	0.015	0.751	0.022	0.290	0.174	0.810	0.009	0.155	0.059	0.834	0.025	0.145	0.035	0.626	0.034	0.497	0.034	0.177	0.029	0.000	0.000	0.457	0.144	0.990	0.008
11	0.725	0.016	0.869	0.012	0.751	0.217	0.881	0.008	0.224	0.062	0.879	0.018	0.242	0.038	0.617	0.047	0.595	0.025	0.209	0.035	0.000	0.000	0.257	0.079	0.983	0.005
12	0.731	0.018	0.893	0.012	0.308	0.060	0.926	0.007	0.210	0.082	0.810	0.037	0.287	0.051	0.686	0.071	0.640	0.027	0.307	0.055	0.000	0.000	0.357	0.152	0.991	0.005
13	0.704	0.007	0.000	0.000	0.255	0.020	0.000	0.000	0.321	0.072	0.790	0.009	0.171	0.011	0.627	0.023	0.000	0.000	0.136	0.012	0.858	0.010	0.253	0.024	0.964	0.007
14	0.612	0.015	0.000	0.000	0.186	0.085	0.000	0.000	0.371	0.127	0.793	0.020	0.117	0.019	0.616	0.037	0.000	0.000	0.138	0.022	0.814	0.020	0.148	0.059	0.970	0.027
15	0.652	0.015	0.000	0.000	0.222	0.050	0.000	0.000	0.151	0.082	0.742	0.019	0.181	0.016	0.640	0.044	0.000	0.000	0.101	0.021	0.729	0.029	0.257	0.060	0.945	0.019
16	0.721	0.017	0.000	0.000	0.308	0.110	0.000	0.000	0.751	0.153	0.799	0.027	0.239	0.023	0.594	0.066	0.000	0.000	0.162	0.039	0.865	0.040	0.298	0.080	0.960	0.018
17	0.694	0.007	0.878	0.004	0.322	0.043	0.918	0.002	0.273	0.035	0.793	0.010	0.208	0.015	0.630	0.019	0.531	0.011	0.117	0.009	0.000	0.000	0.334	0.041	0.994	0.002
18	0.621	0.014	0.667	0.015	0.298	0.039	0.830	0.007	0.151	0.043	0.805	0.022	0.219	0.028	0.609	0.027	0.371	0.028	0.112	0.018	0.000	0.000	0.440	0.113	0.971	0.012
19	0.673	0.016	0.816	0.013	0.241	0.131	0.879	0.006	0.173	0.044	0.769	0.021	0.211	0.025	0.535	0.042	0.473	0.025	0.104	0.019	0.000	0.000	0.279	0.101	0.969	0.009
20	0.714	0.017	0.847	0.013	0.298	0.039	0.911	0.006	0.151	0.061	0.785	0.032	0.288	0.033	0.631	0.051	0.555	0.031	0.164	0.027	0.000	0.000	0.281	0.140	0.987	0.008
21	0.666	0.006	0.000	0.000	0.257	0.013	0.000	0.000	0.190	0.045	0.760	0.008	0.202	0.007	0.603	0.016	0.000	0.000	0.111	0.007	0.878	0.006	0.255	0.016	0.954	0.009
22	0.579	0.013	0.000	0.000	0.178	0.072	0.000	0.000	0.261	0.105	0.758	0.019	0.140	0.012	0.545	0.028	0.000	0.000	0.080	0.014	0.786	0.014	0.148	0.046	0.945	0.039
23	0.628	0.014	0.000	0.000	0.135	0.033	0.000	0.000	0.203	0.081	0.717	0.018	0.170	0.013	0.541	0.037	0.000	0.000	0.078	0.015	0.777	0.017	0.281	0.053	0.899	0.028
24	0.654	0.015	0.000	0.000	0.237	0.082	0.000	0.000	0.148	0.069	0.698	0.025	0.268	0.017	0.485	0.050	0.000	0.000	0.122	0.023	0.885	0.019	0.257	0.061	0.967	0.022
25	0.610	0.005	0.799	0.006	0.182	0.024	0.907	0.003	0.179	0.018	0.679	0.010	0.119	0.010	0.420	0.012	0.323	0.008	0.057	0.003	0.000	0.000	0.231	0.023	0.958	0.005
26	0.551	0.012	0.552	0.016	0.170	0.143	0.806	0.008	0.217	0.043	0.709	0.024	0.097	0.020	0.407	0.022	0.210	0.021	0.059	0.009	0.000	0.000	0.264	0.068	0.894	0.023
27	0.579	0.013	0.699	0.017	0.190	0.073	0.858	0.008	0.125	0.023	0.677	0.022	0.087	0.014	0.353	0.027	0.298	0.022	0.049	0.009	0.000	0.000	0.257	0.060	0.889	0.020
28	0.599	0.013	0.735	0.020	0.180	0.022	0.900	0.007	0.115	0.030	0.614	0.032	0.187	0.017	0.440	0.040	0.356	0.029	0.043	0.008	0.000	0.000	0.187	0.067	0.858	0.023
29	0.615	0.005	0.000	0.000	0.212	0.011	0.000	0.000	0.134	0.025	0.680	0.008	0.119	0.007	0.402	0.011	0.000	0.000	0.075	0.004	0.717	0.007	0.220	0.013	0.935	0.015
30	0.498	0.014	0.000	0.000	0.164	0.069	0.000	0.000	0.209	0.076	0.705	0.024	0.134	0.019	0.459	0.027	0.000	0.000	0.049	0.011	0.569	0.017	0.174	0.052	0.810	0.068
31	0.544	0.013	0.000	0.000	0.155	0.035	0.000	0.000	0.144	0.046	0.668	0.020	0.107	0.012	0.398	0.028	0.000	0.000	0.066	0.011	0.674	0.017	0.141	0.032	0.786	0.048
32	0.625	0.013	0.000	0.000	0.126	0.049	0.000	0.000	0.263	0.071	0.653	0.026	0.182	0.014	0.431	0.037	0.000	0.000	0.080	0.013	0.733	0.020	0.255	0.042	0.800	0.039

Supplementary Table 5. Health-related quality of life among US cancer patients aged 20 years or older, by cancer type and phase of care

Cancer Type	Cancer Phase	Health Related Quality of Life mean (SE)	Source
Endometrial	Overall	0.80 (0.14)	Naik et al.[31]
Esophageal Adenocarcinoma	Overall	0.69 (0.26)	Wildi et al.[32]
Kidney	Overall	0.78 (0.14)	Pickard et al.[33]
Liver	Overall	0.79 (0.19)	Naik et al.[31]
Gallbladder	Overall	0.79 (0.19)	Naik et al.[31]
Stomach (gastric cardia)	Initial: Continuous: End of Life:	0.84 (0.25) 0.86 (0.24) 0.65 (0.33)	Zhou et al.[34]
Female Breast (post-menopausal)	Initial: Continuous: End of Life:	0.78 (0.19) 0.81 (0.20) 0.64 (0.16)	Yabroff et al.[35]
Pancreas	Overall	0.65 (0.30)	Müller-Nordhorn et al.[36]
Multiple myeloma	Overall	0.79 (0.19)	Naik et al.[31]
Advanced Prostate	Initial: Continuous: End of Life:	0.78 (0.20) 0.76 (0.19) 0.59 (0.15)	Yabroff et al.[35]
Thyroid	Overall	0.85 (0.13)	Naik et al.[31]
Ovary	Overall	0.77 (0.17)	Pickard et al.[33]
Colorectal	Initial: Continuous: End of Life:	0.760 (0.19) 0.835 (0.20) 0.643 (0.26)	Färkkilä et al.[37]

Supplementary Table 6. Baseline medical costs, productivity loss, and patient time costs among US cancer patients aged 20 years or older, by cancer type

Cancer type	Sex	Age	Medical costs			Productivity loss			Patient time cost		
			Initial	Continuous	End-of-life	Initial	Continuous	End-of-life	Initial	Continuous	End-of-life
Esophageal Adenocarcinoma	Female	<65	95439	6853	156417	4884	3757	15027	650	500	2001
		≥65	79532	6853	104278	6984	5372	21489	1187	913	3652
	Male	<65	95787	6450	155612	4884	3757	15027	650	500	2001
		≥65	79822	6450	103742	6984	5372	21489	1187	913	3652
Stomach (Gastric Cardia)	Female	<65	85291	3977	155636	4884	3757	15027	650	500	2001
		≥65	71076	3977	103758	6984	5372	21489	1187	913	3652
	Male	<65	94144	4282	160695	4884	3757	15027	650	500	2001
		≥65	78453	4282	107130	6984	5372	21489	1187	913	3652
Liver	Female	<65	40173	5859	95782	4884	3757	15027	650	500	2001
		≥65	40173	5859	95782	6984	5372	21489	1187	913	3652
	Male	<65	41161	7363	97473	4884	3757	15027	650	500	2001
		≥65	41161	7363	97473	6984	5372	21489	1187	913	3652
Pancreatic	Female	<65	112154	8672	164911	4884	3757	15027	650	500	2001
		≥65	93462	8672	109941	6984	5372	21489	1187	913	3652
	Male	<65	112911	11697	169673	4884	3757	15027	650	500	2001
		≥65	94092	11697	113115	6984	5372	21489	1187	913	3652
Advanced Prostate	Male	<65	23652	3201	93363	3715	2858	11432	650	500	2001
		≥65	19710	3201	62242	6549	5038	20152	1187	913	3652
Colorectal	Female	<65	61593	3159	126778	10330	7946	31784	650	500	2001
		≥65	51327	3159	84519	7479	5753	23012	1187	913	3652

	Male	<65	62174	4595	128507	10330	7946	31784	650	500	2001
		≥65	51812	4595	85671	7479	5753	23012	1187	913	3652
Endometrial	Female	<65	32129	1535	105262	4884	3757	15027	650	500	2001
		≥65	26775	1535	70175	6984	5372	21489	1187	913	3652
Ovarian	Female	<65	98788	8296	149573	4884	3757	15027	650	500	2001
		≥65	82324	8296	99715	6984	5372	21489	1187	913	3652
Gallbladder	Female	<65	40173	5859	95782	4884	3757	15027	650	500	2001
		≥65	40173	5859	95782	6984	5372	21489	1187	913	3652
	Male	<65	41161	7363	97473	4884	3757	15027	650	500	2001
		≥65	41161	7363	97473	6984	5372	21489	1187	913	3652
Kidney (Renal Cell)	Female	<65	46077	6255	110765	4884	3757	15027	650	500	2001
		≥65	38397	6255	73843	6984	5372	21489	1187	913	3652
	Male	<65	46048	6018	117123	4884	3757	15027	650	500	2001
		≥65	38374	6018	78082	6984	5372	21489	1187	913	3652
Breast (Postmenopausal)	Female	<65	27693	2207	94284	5985	4604	18416	650	500	2001
		≥65	23078	2207	62856	4752	3655	14620	1187	913	3652
Thyroid	Female	<65	40173	5859	95782	4884	3757	15027	650	500	2001
		≥65	40173	5859	95782	6984	5372	21489	1187	913	3652
	Male	<65	41161	7363	97473	4884	3757	15027	650	500	2001
		≥65	41161	7363	97473	6984	5372	21489	1187	913	3652
Multiple Myeloma	Female	<65	40173	5859	95782	4884	3757	15027	650	500	2001
		≥65	40173	5859	95782	6984	5372	21489	1187	913	3652

Male	<65	41161	7363	97473	4884	3757	15027	650	500	2001
	≥65	41161	7363	97473	6984	5372	21489	1187	913	3652

Supplementary Table 7. Baseline medical costs, productivity loss, and patient time cost among general population aged 20 years or older in the US, by 32 subgroups

Age group, years	Sex	Race/ethnicity	Medical costs		Productivity loss		Patient time cost	
			Annual general costs	End-of-life costs	Annual general costs	End-of-life costs	Annual general costs	End-of-life costs
20-44	Female	NHW	4020	40000	2040	8160	226	904
		NHB	3100	40000	2040	8160	226	904
		Hispanic	2355	40000	2040	8160	226	904
		Other	2617	40000	2040	8160	226	904
	Male	NHW	2022	40000	2040	8160	226	904
		NHB	2279	40000	2040	8160	226	904
		Hispanic	1145	40000	2040	8160	226	904
		Other	1803	40000	2040	8160	226	904
							226	904
45-54	Female	NHW	5371	40000	2040	8160	226	904
		NHB	5712	40000	2040	8160	226	904
		Hispanic	3196	40000	2040	8160	226	904
		Other	4082	40000	2040	8160	226	904
	Male	NHW	3812	40000	2040	8160	226	904
		NHB	3639	40000	2040	8160	226	904
		Hispanic	3612	40000	2040	8160	226	904
		Other	2560	40000	2040	8160	226	904
							226	904
55-64	Female	NHW	7300	40000	2040	8160	226	904
		NHB	5479	40000	2040	8160	226	904
		Hispanic	4607	40000	2040	8160	226	904
		Other	3951	40000	2040	8160	226	904
	Male	NHW	6519	40000	2040	8160	226	904
		NHB	6455	40000	2040	8160	226	904
		Hispanic	5077	40000	2040	8160	226	904
		Other	6320	40000	2040	8160	226	904
≥65	Female	NHW	8997	40000	4409	8160	607	904
		NHB	9585	40000	4409	8160	607	904
		Hispanic	8847	40000	4409	8160	607	904
		Other	8625	40000	4409	8160	607	904
	Male	NHW	9334	40000	4409	8160	607	904
		NHB	7367	40000	4409	8160	607	904
		Hispanic	5640	40000	4409	8160	607	904
		Other	7461	40000	4409	8160	607	904

Supplementary Table 8. Characteristics of US adults aged 20 years or older participated in the NHANES, 2013-2016

Characteristics	(N=10064)	**Calorie Consumption**, kcal/day
Age, years	47.8 ± 0.41	
Age groups, years, N (%)		
20-44	4319 (44.5)	425 ± 4.38
25-54	1704 (18.3)	315 ± 5.39
55-64	1725 (17.3)	271 ± 4.90
≥65	2316 (19.9)	192 ± 3.83
Sex, N (%)		
Male	4829 (48.3)	388 ± 4.53
Female	5235 (51.7)	279 ± 4.04
Race/ethnicity, N (%)		
Non-Hispanic White	3944 (65.0)	320 ± 4.76
Non-Hispanic Black	2069 (11.2)	361 ± 6.55
Hispanic	2668 (14.9)	367 ± 4.44
Other	1383 (8.90)	325 ± 8.12
Education, N (%)		
Less than high school graduate	2178 (14.2)	311 ± 5.14
High school graduate	2249 (21.6)	332 ± 5.72
Some college	3070 (33.1)	341 ± 4.92
College graduate	2562 (31.0)	332 ± 7.10
Family income to poverty ratio, N (%)		
<1.30	3862 (28.3)	325 ± 4.87
1.30-1.84	2842 (26.7)	333 ± 4.55
1.85-2.99	1725 (20.4)	344 ± 6.73
≥3.00	1635 (24.5)	328 ± 7.01
Body mass index (BMI), kg/m^2	29.3 ± 0.16	
Weight status, N (%)		
Underweight (BMI<18.5)	145 (1.36)	341 ± 17.5
Normal weight (BMI=18.5-24.9)	2671 (27.2)	327 ± 4.81
Overweight/Obese (BMI≥25)	7163 (71.4)	334 ± 4.01

Supplementary Table 9. Consumption of calories from full-service and fast-food restaurants among US adults participated in 2013-2016 NHANES by 32 subgroups

Age group, years	**Sex**	**Race/ethnicity**	**Baseline consumption**, kcal/day (mean ± SE)
20-44	Female	NHW	357 ± 6.47
		NHB	397 ± 8.98
		Hispanic	364 ± 6.77
		Other	334 ± 11.3
	Male	NHW	485 ± 9.00
		NHB	508 ± 12.3
		Hispanic	500 ± 13.7
		Other	466 ± 14.1
45-54	Female	NHW	270 ± 9.38
		NHB	266 ± 7.85
		Hispanic	265 ± 9.11
		Other	228 ± 14.6
	Male	NHW	374 ± 11.3
		NHB	388 ± 17.4
		Hispanic	355 ± 15.0
		Other	338 ± 20.2
55-64	Female	NHW	231 ± 5.25
		NHB	249 ± 9.58
		Hispanic	234 ± 7.99
		Other	216 ± 10.2
	Male	NHW	315 ± 9.55
		NHB	314 ± 18.3
		Hispanic	307 ± 9.90
		Other	298 ± 11.1
≥65	Female	NHW	164 ± 4.71
		NHB	156 ± 6.07
		Hispanic	158 ± 5.27
		Other	137 ± 5.43
	Male	NHW	235 ± 7.43
		NHB	220 ± 7.07
		Hispanic	218 ± 8.07

	Other	198 ± 20.0

Supplementary Table 10. Estimated new cancer cases averted by the federal menu calorie labeling in the US by age, sex, race/ethnicity, and cancer type, over lifetime (U.S. population=235,162,844)[1]

Cancer Type	Policy Scenario	20-44 y Female	20-44 y Male	45-54 y Female	45-54 y Male	55-64 y Female	55-64 y Male	65 + y Female	65 + y Male
Endometrial									
Age	*consumer behavior*	3300 (696 to 6090)		591 (-990 to 2160)		1140 (433 to 1940)		656 (107 to 1190)	
	+industry response	5960 (3360 to 8890)		1340 (-208 to 2980)		1600 (928 to 2430)		926 (396 to 1460)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	1630 (-711 to 4080)	0	-136 (-1590 to 1430)	0	757 (140 to 1500)	0	572 (38 to 1070)	0
	+industry response	3080 (829 to 5780)	0	369 (-1100 to 1950)	0	1110 (463 to 1830)	0	780 (245 to 1290)	0
Non-Hispanic Black	*consumer behavior*	763 (-157 to 1710)	0	258 (-23 to 543)	0	283 (73 to 528)	0	47 (-43 to 150)	0
	+industry response	1240 (316 to 2200)	0	372 (93 to 668)	0	355 (146 to 604)	0	77 (-13 to 176)	0
Hispanic	*consumer behavior*	910 (74 to 1790)	0	290 (-48 to 596)	0	42 (-83 to 185)	0	43 (-16 to 102)	0
	+industry response	1460 (580 to 2340)	0	399 (66 to 703)	0	89 (-35 to 233)	0	64 (5 to 122)	0
Other	*consumer behavior*	19 (-312 to 402)	0	165 (41 to 319)	0	54 (3 to 109)	0	-6 (-26 to 14)	0
	+industry response	150 (-174 to 546)	0	191 (68 to 344)	0	68 (18 to 124)	0	0 (-21 to 21)	0
Breast (Postmenopausal)									
Age	*consumer behavior*	2530 (263 to 5040)		373 (-1070 to 1950)		1210 (480 to 2130)		742 (137 to 1380)	
	+industry response	4670 (2330 to 7350)		1040 (-390 to 2680)		1710 (1010 to 2640)		1040 (433 to 1700)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	1370 (-659 to 3750)	0	-224 (-1570 to 1210)	0	832 (170 to 1670)	0	660 (57 to 1280)	0
	+industry response	2660 (490 to 5220)	0	234 (-1130 to 1770)	0	1200 (535 to 2040)	0	902 (291 to 1570)	0
Non-Hispanic Black	*consumer behavior*	567 (-110 to 1300)	0	182 (-34 to 431)	0	267 (89 to 487)	0	43 (-40 to 136)	0

	+industry response	912 (240 to 1680)	0	271 (55 to 536)	0	329 (149 to 554)	0	71 (-13 to 166)	0
Hispanic	*consumer behavior*	581 (44 to 1200)	0	231 (-14 to 474)	0	32.9 (-72 to 154)	0	42 (-12 to 100)	0
	+industry response	934 (368 to 1600)	0	312 (71 to 563)	0	76 (-34 to 198)	0	61 (6 to 123)	0
Other	*consumer behavior*	1 (-310 to 384)	0	182 (40 to 353)	0	74 (9 to 148)	0	-7 (-35 to 22)	0
	+industry response	128 (-187 to 541)	0	210 (71 to 386)	0	94 (29 to 170)	0	1 (-27 to 31)	0
Kidney (Renal Cell)									
Age	*consumer behavior*	2930 (864 to 5040)		581 (-364 to 1540)		1180 (526 to 1810)		428 (28 to 805)	
	+industry response	5240 (3110 to 7390)		1230 (244 to 2210)		1590 (941 to 2250)		651 (248 to 1030)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	338 (-137 to 844)	1040 (-536 to 2790)	-42 (-332 to 273)	53 (-791 to 884)	172 (34 to 339)	677 (88 to 1240)	147 (18 to 280)	192 (-170 to 536)
	+industry response	646 (173 to 1180)	2020 (410 to 3750)	58 (-236 to 383)	379 (-452 to 1250)	251 (109 to 420)	898 (326 to 1470)	199 (72 to 335)	320 (-35 to 661)
Non-Hispanic Black	*consumer behavior*	170 (-35 to 384)	88 (-454 to 620)	60 (-5 to 128)	136 (-96 to 410)	79 (26 to 139)	85 (-81 to 258)	13 (-12 to 40)	44 (9 to 79)
	+industry response	280 (69 to 502)	343 (-202 to 898)	87 (22 to 157)	203 (-30 to 475)	97 (43 to 157)	119 (-45 to 295)	21 (-4 to 48)	56 (22 to 90)
Hispanic	*consumer behavior*	267 (21 to 527)	895 (-21 to 1920)	92 (-4 to 184)	230 (-25 to 503)	14 (-27 to 60)	94 (8 to 196)	15 (-6 to 36)	9 (-29 to 50)
	+industry response	425 (166 to 697)	1290 (371 to 2320)	123 (27 to 218)	305 (49 to 570)	29 (-12 to 76)	127 (41 to 232)	22 (2 to 44)	21 (-17 to 63)
Other	*consumer behavior*	5 (-47 to 66)	75 (-103 to 274)	34 (12 to 59)	3 (-64 to 77)	13 (2 to 25)	33 (10 to 58)	-1 (-6 to 4)	8 (-18 to 37)
	+industry response	27 (-26 to 89)	147 (-29 to 347)	38 (17 to 64)	17 (-52 to 91)	16 (5 to 28)	41 (19 to 67)	1 (-4 to 6)	11 (-15 to 40)
Liver									
Age	*consumer behavior*	3210 (1000 to 5540)		701 (-200 to 1760)		1000 (477 to 1580)		275 (17 to 551)	
	+industry response	5560 (3130 to 8130)		1340 (397 to 2480)		1340 (804 to 1950)		432 (174 to 719)	
Race/Ethnicity									

Non-Hispanic White	*consumer behavior*	170 (-125 to 597)	1150 (-258 to 3130)	18 (-168 to 236)	-82 (-844 to 807)	113 (36 to 227)	520 (108 to 1020)	75 (6 to 155)	116 (-110 to 365)
	+industry response	367 (53 to 855)	2120 (498 to 4300)	78 (-105 to 319)	215 (-537 to 1150)	159 (77 to 280)	668 (287 to 1220)	100 (35 to 189)	198 (-26 to 454)
Non-Hispanic Black	*consumer behavior*	143 (-27 to 346)	85 (-678 to 1050)	53 (2 to 120)	213 (-146 to 705)	51 (14 to 100)	118 (-112 to 393)	7 (-7 to 26)	37 (-4 to 88)
	+industry response	231 (53 to 458)	429 (-312 to 1460)	74 (24 to 147)	306 (-41 to 823)	63 (28 to 115)	163 (-58 to 447)	12 (-2 to 32)	52 (11 to 107)
Hispanic	*consumer behavior*	239 (19 to 570)	1150 (93 to 2490)	99 (3 to 215)	321 (15 to 703)	14 (-30 to 72)	113 (19 to 233)	17 (-5 to 41)	8 (-33 to 54)
	+industry response	384 (132 to 756)	1600 (529 to 3050)	132 (36 to 257)	409 (106 to 820)	31 (-13 to 90)	150 (55 to 276)	25 (3 to 50)	20 (-19 to 70)
Other	*consumer behavior*	2 (-56 to 82)	99 (-125 to 379)	38 (9 to 77)	-1 (-101 to 125)	15 (0 to 34)	38 (5 to 76)	0 (-8 to 7)	9 (-28 to 53)
	+industry response	26 (-32 to 108)	183 (-31 to 483)	43 (15 to 85)	18 (-80 to 152)	19 (5 to 40)	48 (17 to 91)	2 (-5 to 10)	14 (-23 to 59)
Pancreatic									
Age	*consumer behavior*	764 (262 to 1340)		81.6 (-186 to 388)		404 (193 to 651)		148 (21 to 286)	
	+industry response	1350 (820 to 1990)		269 (4 to 595)		540 (327 to 793)		227 (96 to 370)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	121 (-44 to 367)	247 (-120 to 768)	-48 (-159 to 87)	-16 (-246 to 245)	87 (26 to 175)	218 (48 to 432)	63 (3 to 131)	58 (-54 to 189)
	+industry response	229 (50 to 493)	490 (99 to 1060)	-11 (-124 to 134)	73 (-154 to 363)	122 (56 to 218)	283 (115 to 507)	87 (27 to 163)	98 (-12 to 238)
Non-Hispanic Black	*consumer behavior*	60 (-10 to 158)	18 (-80 to 128)	24 (-1 to 54)	30 (-20 to 87)	32 (9 to 63)	19 (-16 to 62)	5 (-6 to 19)	10 (2 to 19)
	+industry response	98 (21 to 207)	64 (-36 to 184)	34 (9 to 67)	44 (-4 to 102)	39 (17 to 72)	27 (-9 to 70)	9 (-2 to 23)	13 (5 to 23)
Hispanic	*consumer behavior*	68 (5 to 150)	194 (13 to 422)	26 (-4 to 60)	46 (-5 to 105)	4 (-11 to 22)	18 (-3 to 44)	6 (-2 to 14)	2 (-8 to 12)
	+industry response	108 (40 to 201)	273 (92 to 518)	36 (7 to 70)	63 (11 to 124)	10 (-5 to 28)	26 (6 to 53)	8 (0 to 18)	5 (-5 to 15)
Other	*consumer behavior*	-2 (-27 to 30)	18 (-29 to 72)	17 (4 to 33)	0 (-20 to 23)	8 (1 to 16)	10 (3 to 19)	0 (-4 to 3)	2 (-6 to 13)
	+industry response	9 (-17 to 43)	36 (-9 to 94)	19 (7 to 36)	4 (-16 to 28)	10 (3 to 18)	13 (5 to 22)	1 (-3 to 5)	4 (-5 to 14)

Esophageal Adenocarcinoma									
Age	*consumer behavior*	715 (43 to 1480)		92 (-296 to 501)		419 (136 to 719)		128 (-60 to 309)	
	+industry response	1300 (602 to 2100)		293 (-102 to 708)		556 (270 to 858)		206 (20 to 390)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	45 (-25 to 125)	406 (-228 to 1100)	-9 (-55 to 41)	26 (-368 to 419)	30 (7 to 58)	345 (64 to 630)	27 (5 to 50)	92 (-88 to 263)
	+industry response	91 (17 to 179)	815 (174 to 1560)	7 (-40 to 60)	179 (-210 to 578)	43 (20 to 73)	449 (174 to 739)	35 (14 to 59)	155 (-17 to 330)
Non-Hispanic Black	*consumer behavior*	10 (-2 to 22)	10 (-28 to 50)	3 (-1 to 8)	11 (-7 to 32)	5 (2 to 9)	67 (-7 to 22)	1 (-1 to 3)	4 (0 to 7)
	+industry response	16 (4 to 29)	28 (-11 to 69)	5 (1 to 9)	16 (-2 to 37)	6 (3 to 11)	9 (-4 to 25)	1 (0 to 3)	5 (2 to 8)
Hispanic	*consumer behavior*	28 (2 to 57)	196 (-2 to 414)	9 (-1 to 20)	46 (-7 to 112)	2 (-3 to 8)	24 (3 to 47)	2 (-1 to 4)	2 (-7 to 12)
	+industry response	44 (17 to 76)	280 (80 to 504)	13 (2 to 24)	63 (7 to 130)	3 (-1 to 10)	32 (11 to 56)	3 (0 to 5)	4 (-4 to 15)
Other	*consumer behavior*	-1 (-10 to 11)	10 (-16 to 41)	6 (1 to 11)	0 (-12 to 13)	2 (0 to 5)	7 (2 to 12)	0 (-1 to 1)	2 (-4 to 8)
	+industry response	3 (-6 to 15)	21 (-6 to 52)	75 (2 to 12)	2 (-10 to 15)	3 (1 to 6)	8 (4 to 13)	0 (-1 to 1)	2 (-3 to 9)
Colorectal									
Age	*consumer behavior*	584 (183 to 1090)		79 (-90 to 289)		251 (126 to 412)		117 (19 to 224)	
	+industry response	1050 (605 to 1610)		201 (23 to 426)		341 (209 to 514)		175 (81 to 289)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	67 (-51 to 261)	169 (-107 to 569)	-35 (-106 to 64)	-17 (-151 to 163)	52 (11 to 111)	126 (21 to 262)	55 (11 to 115)	44 (-36 to 129)
	+industry response	144 (-2 to 382)	358 (40 to 790)	-12 (-80 to 97)	38 (-99 to 233)	75 (30 to 146)	168 (62 to 313)	73 (28 to 138)	70 (-7 to 162)
Non-Hispanic Black	*consumer behavior*	31 (-9 to 88)	38 (-48 to 144)	11 (-1 to 29)	26 (-13 to 79)	19 (7 to 36)	14 (-17 to 49)	3 (-4 to 12)	8 (1 to 17)
	+industry response	53 (9 to 119)	78 (-8 to 203)	17 (4 to 36)	36 (-2 to 91)	23 (11 to 41)	20 (-9 to 56)	6 (-1 to 15)	11 (3 to 21)
Hispanic	*consumer behavior*	45 (2 to 113)	185 (25 to 409)	20 (1 to 43)	57 (9 to 114)	3 (-7 to 16)	21 (2 to 44)	4 (-1 to 11)	1 (-8 to 11)

		+industry response	73 (18 to 155)	256 (84 to 504)	26 (8 to 51)	70 (23 to 129)	6 (-3 to 20)	28 (10 to 53)	6 (1 to 13)	4 (-5 to 14)
	Other	*consumer behavior*	-2 (-21 to 26)	20 (-31 to 89)	7 (-1 to 19)	1 (-20 to 26)	4 (0 to 11)	8 (1 to 16)	-1 (-3 to 2)	3 (-6 to 13)
		+industry response	6 (-13 to 36)	41 (-9 to 115)	9 (1 to 21)	5 (-15 to 31)	6 (1 to 12)	10 (4 to 19)	0 (-2 to 3)	4 (-5 to 14)
Thyroid										
Age		*consumer behavior*	374 (114 to 751)		10 (-69 to 125)		84 (44 to 144)		34 (7 to 68)	
		+industry response	683 (349 to 1130)		67 (-17 to 200)		117 (70 to 187)		52 (22 to 91)	
Race/Ethnicity										
	Non-Hispanic White	*consumer behavior*	96 (-59 to 382)	52 (-59 to 273)	-28 (-85 to 56)	-15 (-64 to 58)	21 (1 to 62)	28 (1 to 73)	20 (2 to 47)	8 (-9 to 31)
		+industry response	205 (-15 to 563)	131 (-26 to 395)	-8 (-63 to 92)	3 (-43 to 85)	33 (5 to 80)	40 (12 to 90)	28 (9 to 58)	14 (-3 to 40)
	Non-Hispanic Black	*consumer behavior*	29 (-10 to 113)	7 (-10 to 36)	8 (-1 to 24)	3 (-3 to 12)	12 (6 to 22)	2 (-2 to 8)	1 (-2 to 5)	1 (0 to 2)
		+industry response	52 (-1 to 153)	16 (-4 to 50)	12 (2 to 30)	5 (-1 to 15)	14 (8 to 26)	3 (-1 to 10)	2 (0 to 7)	2 (1 to 3)
	Hispanic	*consumer behavior*	68 (1 to 201)	59 (6 to 151)	15 (-5 to 39)	13 (2 to 30)	2 (-4 to 12)	4 (0 to 9)	2 (-1 to 6)	0 (-1 to 3)
		+industry response	113 (22 to 276)	84 (26 to 189)	21 (2 to 48)	16 (6 to 35)	4 (-2 to 15)	5 (2 to 12)	3 (0 to 8)	1 (-1 to 3)
	Other	*consumer behavior*	-4 (-38 to 59)	13 (-13 to 56)	6 (-4 to 20)	1 (-7 to 12)	5 (2 to 10)	5 (3 to 8)	-1 (-2 to 1)	0 (-2 to 3)
		+industry response	12 (-25 to 82)	23 (-2 to 70)	8 (-1 to 23)	3 (-5 to 14)	6 (3 to 11)	6 (4 to 9)	0 (-2 to 2)	1 (-1 to 4)
Multiple Myeloma										
Age		*consumer behavior*	370 (113 to 743)		78 (-46 to 242)		181 (85 to 308)		63 (7 to 128)	
		+industry response	653 (327 to 1120)		164 (29 to 357)		243 (142 to 385)		97 (41 to 169)	
Race/Ethnicity										
	Non-Hispanic White	*consumer behavior*	27 (-34 to 138)	102 (-61 to 375)	-14 (-50 to 50)	-4 (-96 to 139)	24 (3 to 67)	96 (25 to 204)	20 (1 to 52)	23 (-23 to 83)
		+industry response	64 (-22 to 204)	207 (0 to 544)	-1 (-38 to 74)	29 (-60 to 199)	36 (9 to 87)	125 (52 to 246)	28 (8 to 65)	39 (-5 to 111)

Non-Hispanic Black	*consumer behavior*	39 (-9 to 135)	22 (-63 to 178)	14 (-1 to 43)	27 (-15 to 95)	19 (4 to 45)	11 (-22 to 60)	4 (-4 to 17)	10 (2 to 22)
	+industry response	66 (1 to 183)	65 (-30 to 242)	22 (4 to 55)	38 (-3 to 113)	24 (9 to 54)	18 (-13 to 71)	6 (-1 to 20)	13 (5 to 26)
Hispanic	*consumer behavior*	26 (0 to 79)	111 (12 to 277)	7 (-5 to 24)	25 (-3 to 68)	2 (-4 to 11)	15 (3 to 32)	2 (-1 to 7)	0 (-5 to 7)
	+industry response	43 (6 to 110)	154 (50 to 340)	10 (0 to 30)	33 (6 to 82)	4 (-2 to 15)	19 (8 to 39)	3 (0 to 9)	1 (-3 to 9)
Other	*consumer behavior*	0 (-7 to 11)	8 (-11 to 41)	7 (3 to 12)	0 (-10 to 12)	1 (1 to 4)	4 (1 to 9)	-0 (-1 to 1)	1 (-3 to 6)
	+industry response	2 (-4 to 16)	16 (-3 to 53)	8 (4 to 13)	1 (-8 to 15)	2 (0 to 5)	5 (2 to 11)	0 (-1 to 1)	1 (-2 to 6)
Stomach (Gastric Cardia)									
Age	*consumer behavior*	338 (49 to 803)		58 (-99 to 264)		182 (70 to 347)		54 (-19 to 149)	
	+industry response	607 (241 to 1140)		141 (-20 to 378)		240 (129 to 420)		86 (15 to 190)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	18 (-19 to 77)	208 (-55 to 648)	-9 (-31 to 25)	24 (-128 to 233)	15 (4 to 37)	145 (35 to 304)	14 (3 to 28)	34 (-36 to 124)
	+industry response	43 (-6 to 117)	380 (51 to 886)	-1 (-24 to 38)	86 (-67 to 322)	22 (9 to 47)	187 (77 to 364)	18 (8 to 35)	58 (-9 to 160)
Non-Hispanic Black	*consumer behavior*	7 (-2 to 21)	6 (-19 to 44)	2 (0 to 6)	7 (-5 to 24)	3 (1 to 7)	3 (-6 to 15)	0 (0 to 2)	3 (1 to 5)
	+industry response	12 (2 to 28)	19 (-8 to 62)	3 (1 to 7)	10 (-2 to 29)	4 (2 to 8)	5 (-4 to 17)	1 (0 to 2)	3 (2 to 6)
Hispanic	*consumer behavior*	15 (1 to 39)	63 (-7 to 170)	5 (0 to 13)	16 (-4 to 45)	1 (-2 to 5)	7 (0 to 18)	1 (0 to 3)	1 (-3 to 5)
	+industry response	24 (6 to 52)	95 (21 to 214)	7 (2 to 16)	22 (3 to 54)	2 (-1 to 6)	10 (3 to 23)	1 (0 to 3)	2 (-2 to 7)
Other	*consumer behavior*	-1 (-7 to 10)	5 (-14 to 34)	5 (2 to 9)	0 (-8 to 12)	1 (0 to 3)	4 (1 to 9)	0 (-1 to 1)	1 (-3 to 6)
	+industry response	2 (-5 to 14)	12 (-7 to 46)	6 (3 to 10)	2 (-6 to 15)	2 (0 to 4)	5 (2 to 10)	0 (-1 to 1)	2 (-2 to 7)
Gallbladder									
Age	*consumer behavior*	161 (67 to 263)		51 (8 to 100)		76 (47 to 109)		29 (11 to 51)	
	+industry response	282 (181 to 396)		86 (43 to 138)		101 (73 to 137)		44 (25 to 66)	

Race/Ethnicity										
	Non-Hispanic White	*consumer behavior*	24 (-10 to 71)	19 (-13 to 61)	0 (-25 to 30)	1.97 (-17 to 24)	19 (5 to 38)	23 (6 to 42)	16 (3 to 31)	6 (-5 to 17)
		+industry response	47 (10 to 99)	39 (5 to 88)	9 (-16 to 42)	9 (-10 to 34)	27 (12 to 48)	29 (13 to 50)	21 (8 to 37)	9 (-1 to 21)
	Non-Hispanic Black	*consumer behavior*	27 (-6 to 70)	2 (-17 to 26)	11 (0 to 24)	6 (-4 to 18)	14 (4 to 26)	4 (-4 to 12)	2 (-2 to 7)	2 (0 to 4)
		+industry response	45 (11 to 93)	11 (-8 to 38)	15 (4 to 29)	9 (-1 to 21)	17 (8 to 30)	5 (-2 to 14)	4 (-1 to 9)	3 (1 to 5)
	Hispanic	*consumer behavior*	32 (2 to 73)	42 (-10 to 106)	10 (-4 to 26)	14 (-2 to 34)	3 (-5 to 11)	7 (1 to 15)	3 (-1 to 7)	0 (-3 to 4)
		+industry response	53 (19 to 96)	65 (11 to 130)	15 (1 to 31)	19 (3 to 39)	5 (-2 to 14)	9 (3 to 18)	4 (1 to 9)	1 (-2 to 5)
	Other	*consumer behavior*	0 (-11 to 18)	3 (-6 to 15)	6 (1 to 13)	0 (-4 to 5)	3 (0 to 7)	3 (1 to 5)	0 (-1 to 1)	1 (-1 to 3)
		+industry response	5 (-7 to 24)	7 (-2 to 19)	7 (2 to 14)	1 (-3 to 6)	4 (1 to 8)	3 (1 to 5)	0 (-1 to 2)	1 (-1 to 3)
Advanced Prostate										
Age		*consumer behavior*	163 (9 to 360)		37 (-54 to 146)		106 (33 to 194)		35 (-14 to 91)	
		+industry response	300 (130 to 507)		85 (-6 to 203)		142 (67 to 240)		56 (9 to 119)	
Race/Ethnicity										
	Non-Hispanic White	*consumer behavior*	0	86 (-24 to 267)	0	-1 (-80 to 98)	0	75 (9 to 162)	0	24 (-23 to 80)
		+industry response	0	162 (32 to 350)	0	30 (-48 to 144)	0	100 (36 to 199)	0	40 (-5 to 102)
	Non-Hispanic Black	*consumer behavior*	0	3 (-61 to 97)	0	21 (-17 to 69)	0	16 (-13 to 51)	0	8 (2 to 17)
		+industry response	0	34 (-33 to 145)	0	31 (-5 to 83)	0	22 (-7 to 57)	0	11 (4 to 20)
	Hispanic	*consumer behavior*	0	59 (8 to 133)	0	13 (-3 to 37)	0	9 (2 to 20)	0	1 (-3 to 5)
		+industry response	0	82 (28 to 163)	0	18 (1 to 44)	0	12 (5 to 23)	0	2 (-2 to 7)
	Other	*consumer behavior*	0	3 (-10 to 21)	0	0 (-7 to 8)	0	4 (2 to 8)	0	1 (-3 to 5)
		+industry response	0	8 (-5 to 28)	0	1 (-5 to 9)	0	5 (3 to 9)	0	2 (-2 to 6)

Ovarian									
Age	*consumer behavior*	66 (-10 to 180)		16 (-20 to 75)		31 (11 to 69)		28 (11 to 61)	
	+industry response	129 (16 to 277)		33 (-6 to 102)		45 (17 to 87)		37 (19 to 75)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	34 (-25 to 147)	0	-4 (-38 to 54)	0	20 (2 to 55)	0	25 (8 to 57)	0
	+industry response	71 (-23 to 220)	0	7 (-30 to 72)	0	30 (6 to 71)	0	32 (15 to 70)	0
Non-Hispanic Black	*consumer behavior*	11 (-5 to 41)	0	4 (0 to 13)	0	6 (3 to 13)	0	1 (-1 to 5)	0
	+industry response	19 (-3 to 56)	0	6 (0 to 17)	0	8 (4 to 16)	0	2 (0 to 6)	0
Hispanic	*consumer behavior*	21 (-2 to 67)	0	8 (-1 to 21)	0	1 (-3 to 8)	0	1 (-1 to 5)	0
	+industry response	34 (1 to 91)	0	11 (3 to 26)	0	3 (-1 to 10)	0	2 (0 to 6)	0
Other	*consumer behavior*	-8 (-19 to 13)	0	6 (2 to 13)	0	2 (1 to 5)	0	0 (-1 to 1)	0
	+industry response	-3 (-15 to 21)	0	7 (3 to 14)	0	3 (1 to 6)	0	0 (-1 to 2)	0

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.

Supplementary Table 11. Estimated cancer deaths reduced by the federal menu calorie labeling in the US by age, sex, race/ethnicity, and cancer type, over a lifetime (U.S. population=235,162,844)[1]

Cancer Type	Policy Scenario	20-44 y Female	20-44 y Male	45-54 y Female	45-54 y Male	55-64 y Female	55-64 y Male	65 + y Female	65 + y Male
Breast (Postmenopausal)									
Age	*consumer behavior*	2490 (260 to 4980)		151 (-204 to 521)		285 (129 to 479)		126 (30 to 227)	
	+industry response	4610 (2290 to 7240)		336 (-26 to 725)		396 (237 to 598)		178 (82 to 284)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	1350 (-652 to 3690)	0	-55 (-373 to 278)	0	165 (33 to 327)	0	103 (10 to 204)	0
	+industry response	2620 (480 to 5150)	0	54 (-264 to 419)	0	238 (105 to 401)	0	139 (47 to 244)	0
Non-Hispanic Black	*consumer behavior*	560 (-109 to 1280)	0	85 (-11 to 200)	0	95 (32 to 173)	0	13 (-12 to 40)	0
	+industry response	901 (238 to 1660)	0	126 (26 to 247)	0	117 (53 to 196)	0	21 (-4 to 49)	0
Hispanic	*consumer behavior*	572 (45 to 1180)	0	76 (-7 to 163)	0	9 (-21 to 44)	0	10 (-3 to 24)	0
	+industry response	922 (364 to 1570)	0	104 (21 to 193)	0	21 (-9 to 57)	0	15 (2 to 30)	0
Other	*consumer behavior*	0 (-306 to 378)	0	39 (9 to 76)	0	15 (2 to 31)	0	-1 (-6 to 3)	0
	+industry response	125 (-185 to 532)	0	45 (16 to 84)	0	19 (6 to 35)	0	0 (-5 to 5)	0
Liver									
Age	*consumer behavior*	2840 (897 to 4890)		628 (-181 to 1570)		852 (411 to 1340)		227 (18 to 455)	
	+industry response	4900 (2760 to 7190)		1200 (345 to 2210)		1140 (689 to 1650)		357 (146 to 587)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	139 (-108 to 504)	1040 (-237 to 2780)	15 (-147 to 207)	-70 (-749 to 722)	98 (31 to 196)	440 (93 to 858)	63 (6 to 130)	97 (-88 to 297)
	+industry response	310 (42 to 719)	1900 (449 to 3830)	67 (-93 to 276)	199 (-478 to 1040)	137 (67 to 240)	565 (241 to 1020)	85 (30 to 159)	161 (-18 to 369)

Non-Hispanic Black	*consumer behavior*	134 (-25 to 317)	72 (-601 to 932)	49 (3 to 110)	193 (-133 to 632)	43 (12 to 85)	100 (-95 to 336)	6 (-6 to 22)	29 (-4 to 69)
	+industry response	214 (51 to 425)	382 (-273 to 1280)	68 (23 to 133)	276 (-37 to 729)	54 (24 to 97)	139 (-49 to 377)	10 (-2 to 27)	41 (8 to 83)
Hispanic	*consumer behavior*	199 (17 to 473)	1020 (88 to 2210)	87 (2 to 189)	285 (13 to 630)	12 (-26 to 62)	99 (18 to 201)	15 (-4 to 35)	6 (-28 to 46)
	+industry response	316 (111 to 623)	1430 (482 to 2690)	116 (31 to 223)	365 (94 to 729)	26 (-11 to 78)	131 (48 to 242)	21 (3 to 43)	17 (-15 to 59)
Other	*consumer behavior*	2 (-47 to 68)	90 (-110 to 339)	32 (7 to 65)	-2 (-88 to 108)	12 (0 to 28)	30 (4 to 61)	0 (-6 to 6)	7 (-22 to 42)
	+industry response	22 (-28 to 93)	168 (-26 to 434)	36 (13 to 71)	15 (-70 to 130)	16 (4 to 32)	39 (14 to 74)	1 (-4 to 8)	11 (-18 to 46)
Endometrial									
Age	*consumer behavior*	1190 (309 to 2140)		251 (-248 to 785)		394 (177 to 659)		213 (51 to 378)	
	+industry response	2100 (1200 to 3110)		512 (26 to 1060)		548 (325 to 817)		302 (139 to 472)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	440 (-210 to 1170)	0	-42 (-511 to 440)	0	206 (36 to 399)	0	173 (13 to 319)	0
	+industry response	858 (218 to 1620)	0	114 (-351 to 606)	0	298 (127 to 491)	0	234 (76 to 388)	0
Non-Hispanic Black	*consumer behavior*	412 (-90 to 937)	0	139 (-9 to 293)	0	157 (42 to 295)	0	26 (-24 to 83)	0
	+industry response	666 (177 to 1210)	0	201 (51 to 361)	0	195 (81 to 338)	0	42 (-8 to 97)	0
Hispanic	*consumer behavior*	315 (22 to 645)	0	105 (-22 to 222)	0	16 (-33 to 70)	0	19 (-7 to 44)	0
	+industry response	505 (197 to 854)	0	144 (21 to 261)	0	34 (-14 to 89)	0	28 (3 to 54)	0
Other	*consumer behavior*	8 (-99 to 139)	0	51 (13 to 99)	0	17 (1 to 36)	0	-3 (-10 to 5)	0
	+industry response	50 (-56 to 187)	0	58 (21 to 107)	0	22 (6 to 41)	0	0 (-8 to 7)	0
Kidney (Renal Cell)									
Age	*consumer behavior*	1050 (284 to 1830)		263 (-153 to 695)		506 (225 to 778)		182 (20 to 338)	
	+industry response	1880 (1100 to 2680)		539 (106 to 977)		679 (402 to 954)		276 (112 to 429)	
Race/Ethnicity									

Non-Hispanic White	*consumer behavior*	57 (-23 to 159)	332 (-183 to 922)	-16 (-128 to 106)	26 (-351 to 396)	72 (14 to 138)	287 (42 to 525)	66 (9 to 124)	81 (-68 to 219)
	+industry response	111 (27 to 224)	663 (123 to 1280)	22 (-90 to 146)	168 (-199 to 552)	105 (46 to 171)	378 (138 to 623)	89 (33 to 148)	133 (-12 to 272)
Non-Hispanic Black	*consumer behavior*	67 (-16 to 162)	48 (-225 to 326)	24 (-2 to 53)	59 (-40 to 171)	30 (10 to 56)	35 (-32 to 106)	5 (-5 to 16)	16 (3 to 28)
	+industry response	113 (25 to 218)	174 (-96 to 461)	34 (9 to 64)	87 (-14 to 199)	37 (17 to 63)	49 (-17 to 121)	8 (-2 to 20)	20 (7 to 33)
Hispanic	*consumer behavior*	111 (9 to 229)	367 (0 to 792)	30 (-3 to 62)	118 (-15 to 261)	6 (-13 to 29)	47 (5 to 98)	7 (-2 to 17)	4 (-12 to 23)
	+industry response	177 (67 to 305)	522 (168 to 968)	40 (8 to 74)	157 (23 to 303)	13 (-5 to 36)	64 (22 to 116)	11 (1 to 21)	9 (-7 to 28)
Other	*consumer behavior*	3 (-23 to 34)	33 (-40 to 122)	15 (5 to 28)	0 (-28 to 33)	5 (1 to 11)	16 (5 to 29)	-1 (-3 to 2)	4 (-8 to 17)
	+industry response	13 (-12 to 45)	63 (-10 to 156)	17 (7 to 30)	6 (-22 to 39)	6 (2 to 12)	20 (9 to 33)	0 (-2 to 3)	5 (-6 to 18)
Pancreatic									
Age	*consumer behavior*	656 (220 to 1160)		74 (-166 to 350)		362 (175 to 581)		131 (20 to 250)	
	+industry response	1160 (707 to 1730)		243 (1 to 535)		483 (293 to 708)		199 (87 to 321)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	101 (-40 to 310)	213 (-100 to 659)	-44 (-143 to 78)	-13 (-216 to 221)	79 (24 to 158)	193 (44 to 384)	56 (3 to 117)	50 (-45 to 162)
	+industry response	196 (42 to 425)	420 (85 to 911)	-10 (-111 to 120)	67 (-140 to 326)	111 (51 to 198)	250 (102 to 448)	78 (25 to 146)	84 (-10 to 203)
Non-Hispanic Black	*consumer behavior*	48 (-7 to 125)	16 (-72 to 117)	22 (-1 to 49)	27 (-18 to 78)	29 (8 to 57)	18 (-15 to 56)	5 (-5 to 17)	9 (1 to 17)
	+industry response	78 (18 to 162)	57 (-33 to 164)	31 (9 to 62)	39 (-3 to 91)	36 (15 to 65)	24 (-8 to 63)	8 (-1 to 20)	12 (4 to 19)
Hispanic	*consumer behavior*	55 (5 to 118)	175 (13 to 374)	24 (-4 to 53)	42 (-5 to 97)	4 (-10 to 20)	16 (-2 to 40)	5 (-2 to 13)	1 (-7 to 10)
	+industry response	88 (33 to 158)	245 (83 to 462)	32 (6 to 63)	57 (10 to 113)	9 (-5 to 25)	23 (5 to 48)	8 (1 to 16)	4 (-4 to 13)
Other	*consumer behavior*	-2 (-23 to 25)	16 (-23 to 63)	14 (3 to 27)	0 (-18 to 20)	7 (1 to 14)	9 (3 to 17)	0 (-3 to 3)	2 (-5 to 11)
	+industry response	7 (-14 to 36)	32 (-7 to 82)	16 (6 to 30)	3 (-14 to 24)	9 (2 to 16)	11 (5 to 19)	1 (-2 to 4)	3 (-4 to 12)

Esophageal Adenocarcinoma									
Age	*consumer behavior*	631 (33 to 1320)		78 (-255 to 423)		348 (113 to 584)		101 (-42 to 239)	
	+industry response	1150 (520 to 1870)		246 (-96 to 601)		457 (225 to 699)		161 (19 to 302)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	40 (-23 to 112)	366 (-206 to 1000)	-8 (-47 to 36)	24 (-314 to 359)	24 (6 to 47)	283 (55 to 516)	22 (4 to 41)	71 (-65 to 202)
	+industry response	81 (15 to 160)	732 (157 to 1400)	5 (-34 to 51)	152 (-176 to 495)	35 (16 to 59)	366 (142 to 602)	28 (11 to 48)	119 (-13 to 253)
Non-Hispanic Black	*consumer behavior*	9 (-1 to 20)	9 (-25 to 45)	3 (0 to 7)	10 (-6 to 28)	4 (1 to 8)	6 (-6 to 18)	1 (-1 to 2)	3 (0 to 5)
	+industry response	14 (3 to 26)	25 (-10 to 62)	4 (1 to 8)	14 (-2 to 33)	5 (2 to 9)	8 (-3 to 21)	1 (0 to 3)	4 (1 to 6)
Hispanic	*consumer behavior*	25 (2 to 52)	164 (2 to 354)	3 (-1 to 13)	40 (-7 to 99)	1 (-3 to 7)	21 (3 to 42)	1 (-1 to 4)	1 (-6 to 10)
	+industry response	40 (15 to 68)	235 (70 to 425)	5 (0 to 16)	55 (6 to 114)	3 (-1 to 8)	28 (10 to 50)	2 (0 to 4)	4 (-4 to 12)
Other	*consumer behavior*	-1 (-9 to 10)	9 (-14 to 35)	5 (1 to 9)	-1 (-10 to 10)	2 (0 to 4)	6 (2 to 10)	0 (-1 to 1)	1 (-3 to 7)
	+industry response	3 (-6 to 14)	18 (-5 to 46)	6 (2 to 10)	1 (-8 to 12)	2 (1 to 5)	7 (3 to 11)	0 (-1 to 1)	2 (-3 to 7)
Colorectal									
Age	*consumer behavior*	430 (139 to 779)		56 (-48 to 184)		150 (77 to 241)		63 (13 to 119)	
	+industry response	764 (450 to 1160)		133 (23 to 268)		203 (126 to 304)		95 (46 to 153)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	49 (-36 to 181)	119 (-75 to 391)	-21 (-65 to 40)	-10 (-89 to 97)	32 (7 to 67)	72 (11 to 150)	31 (6 to 63)	22 (-17 to 64)
	+industry response	106 (4 to 261)	248 (28 to 545)	-6 (-49 to 59)	24 (-60 to 140)	46 (20 to 85)	96 (36 to 176)	41 (16 to 76)	35 (-3 to 81)
Non-Hispanic Black	*consumer behavior*	26 (-7 to 70)	27 (-36 to 104)	8 (0 to 21)	18 (-9 to 53)	13 (4 to 24)	9 (-10 to 31)	2 (-2 to 7)	5 (0 to 10)
	+industry response	44 (9 to 94)	58 (-7 to 145)	12 (4 to 26)	25.1 (-1 to 61)	15 (7 to 27)	13 (-6 to 36)	3 (-1 to 9)	6 (2 to 12)
Hispanic	*consumer behavior*	36 (2 to 88)	136 (21 to 300)	13 (0 to 27)	37 (5 to 74)	2 (-4 to 10)	13 (2 to 28)	2 (-1 to 7)	1 (-5 to 6)

	+industry response	58 (17 to 120)	188 (65 to 366)	16 (5 to 32)	45 (14 to 84)	4 (-2 to 13)	18 (6 to 33)	4 (0 to 8)	2 (-3 to 8)
Other	*consumer behavior*	-1 (-15 to 20)	16 (-21 to 65)	5 (-1 to 11)	0 (-12 to 15)	2 (0 to 6)	5 (1 to 9)	0 (-2 to 1)	1 (-3 to 6)
	+industry response	5 (-9 to 27)	30 (-5 to 83)	6 (1 to 13)	2 (-9 to 17)	3 (1 to 7)	6 (2 to 11)	0 (-1 to 2)	2 (-2 to 7)
Stomach (Gastric Cardia)									
Age	*consumer behavior*	286 (45 to 672)		50 (-84 to 224)		149 (58 to 282)		42 (-14 to 113)	
	+industry response	513 (196 to 965)		120 (-14 to 321)		196 (105 to 342)		67 (13 to 145)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	14 (-16 to 63)	178 (-46 to 545)	-7 (-26 to 20)	21 (-109 to 194)	13 (4 to 30)	118 (29 to 248)	11 (3 to 22)	27 (-26 to 95)
	+industry response	34 (-5 to 95)	322 (43 to 766)	-1 (-19 to 30)	74 (-58 to 270)	18 (7 to 38)	152 (63 to 296)	14 (6 to 27)	45 (-6 to 121)
Non-Hispanic Black	*consumer behavior*	5 (-1 to 17)	2 (-11 to 29)	2 (0 to 5)	6 (-5 to 22)	2 (1 to 5)	3 (-5 to 13)	0 (0 to 1)	2 (1 to 4)
	+industry response	9 (2 to 22)	7 (-5 to 43)	2 (1 to 6)	9 (-2 to 26)	3 (2 to 6)	4 (-3 to 15)	1 (0 to 2)	3 (1 to 5)
Hispanic	*consumer behavior*	13 (1 to 35)	57 (-6 to 154)	5 (0 to 12)	14 (-3 to 38)	1 (-1 to 4)	6 (0 to 15)	1 (0 to 2)	0 (-2 to 4)
	+industry response	22 (5 to 47)	86 (20 to 194)	6 (2 to 14)	19 (3 to 46)	1 (-1 to 5)	8 (2 to 19)	1 (0 to 3)	1 (-1 to 6)
Other	*consumer behavior*	-1 (-5 to 7)	4 (-9 to 25)	4 (2 to 8)	0 (-7 to 10)	1 (0 to 3)	3 (1 to 7)	0 (-1 to 1)	1 (-2 to 5)
	+industry response	1 (-3 to 9)	9 (-4 to 34)	4 (2 to 8)	2 (-5 to 12)	1 (0 to 3)	4 (2 to 8)	0 (0 to 1)	1 (-2 to 5)
Multiple Myeloma									
Age	*consumer behavior*	220 (65 to 441)		51 (-29 to 150)		112 (54 to 186)		42 (6 to 84)	
	+industry response	380 (202 to 657)		105 (20 to 215)		151 (89 to 232)		63 (27 to 111)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	11 (-13 to 52)	59 (-34 to 221)	-8 (-32 to 31)	-3 (-59 to 83)	15 (2 to 41)	58 (15 to 123)	14 (1 to 35)	15 (-14 to 54)

	+industry response	26 (-7 to 81)	122 (1 to 321)	-1 (-23 to 45)	19 (-37 to 123)	22 (6 to 53)	75 (32 to 147)	19 (6 to 44)	26 (-3 to 71)
Non-Hispanic Black	*consumer behavior*	17 (-4 to 63)	14 (-40 to 115)	10 (0 to 29)	17 (-10 to 59)	12 (3 to 28)	7 (-14 to 38)	2 (-3 to 11)	6 (1 to 12)
	+industry response	29 (1 to 83)	44 (-20 to 159)	15 (3 to 37)	24 (-1 to 70)	15 (6 to 34)	11 (-8 to 45)	4 (-1 to 13)	7 (3 to 15)
Hispanic	*consumer behavior*	16 (0 to 51)	72 (9 to 193)	5 (-3 to 17)	15 (-2 to 42)	1 (-3 to 8)	10 (2 to 22)	2 (-1 to 5)	0 (-3 to 5)
	+industry response	28 (5 to 71)	100 (31 to 244)	7 (0 to 21)	21 (4 to 51)	3 (-1 to 10)	13 (5 to 26)	3 (0 to 6)	1 (-2 to 6)
Other	*consumer behavior*	0 (-3 to 6)	5 (-7 to 27)	4 (2 to 7)	0 (-6 to 7)	1 (0 to 2)	3 (1 to 6)	0 (-1 to 1)	1 (-2 to 4)
	+industry response	1 (-2 to 8)	10 (-2 to 36)	4 (2 to 8)	1 (-5 to 9)	1 (0 to 3)	4 (2 to 7)	0 (-1 to 1)	1 (-1 to 4)
Gallbladder									
Age	*consumer behavior*	136 (58 to 229)		44 (7 to 86)		65 (40 to 93)		24 (9 to 41)	
	+industry response	239 (153 to 341)		74 (36 to 119)		86 (61 to 117)		36 (20 to 53)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	22 (-10 to 64)	15 (-10 to 52)	0 (-23 to 27)	2 (-14 to 19)	16 (4 to 32)	19 (6 to 36)	13 (2 to 25)	5 (-4 to 14)
	+industry response	43 (9 to 90)	32 (4 to 72)	8 (-15 to 37)	8 (-8 to 27)	23 (10 to 40)	24 (11 to 42)	17 (6 to 30)	8 (-1 to 18)
Non-Hispanic Black	*consumer behavior*	24 (-5 to 61)	2 (-14 to 21)	10 (0 to 21)	4 (-3 to 14)	12 (4 to 23)	3 (-3 to 10)	2 (-2 to 6)	2 (0 to 3)
	+industry response	40 (10 to 80)	9 (-7 to 31)	14 (4 to 27)	6 (-1 to 17)	15 (7 to 26)	4 (-2 to 12)	3 (0 to 7)	2 (1 to 4)
Hispanic	*consumer behavior*	28 (2 to 63)	33 (-8 to 85)	9 (-4 to 23)	12 (-2 to 30)	2 (-4 to 10)	6 (1 to 13)	2 (-1 to 6)	0 (-2 to 3)
	+industry response	45 (16 to 83)	51 (9 to 106)	13 (1 to 28)	16 (3 to 35)	4 (-2 to 13)	8 (3 to 16)	4 (0 to 8)	1 (-1 to 4)
Other	*consumer behavior*	0 (-10 to 16)	2 (-5 to 12)	5 (1 to 11)	0 (-2 to 2)	3 (0 to 6)	2 (1 to 4)	0 (-1 to 1)	0 (-1 to 2)
	+industry response	4 (-6 to 21)	5 (-2 to 15)	6 (2 to 12)	0 (-1 to 3)	4 (1 to 7)	3 (1 to 5)	0 (-1 to 2)	1 (-1 to 2)
Advanced Prostate									
Age	*consumer behavior*	101 (13 to 214)		18 (-17 to 58)		33 (11 to 58)		15 (-4 to 38)	

	+industry response	174 (80 to 304)		37 (1 to 83)		43 (22 to 71)		24 (6 to 48)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	0	43 (-13 to 140)	0	0 (-29 to 35)	0	20 (3 to 42)	0	10 (-9 to 32)
	+industry response	0	82 (16 to 192)	0	11 (-17 to 50)	0	27 (10 to 51)	0	16 (-2 to 40)
Non-Hispanic Black	*consumer behavior*	0	2 (-31 to 51)	0	9 (-7 to 30)	0	7 (-5 to 20)	0	4 (1 to 9)
	+industry response	0	17 (-16 to 75)	0	13 (-2 to 36)	0	9 (-3 to 23)	0	6 (2 to 11)
Hispanic	*consumer behavior*	0	47 (7 to 103)	0	7 (-2 to 20)	0	4 (1 to 9)	0	0 (-1 to 3)
	+industry response	0	64 (23 to 127)	0	10 (1 to 25)	0	6 (2 to 11)	0	1 (-1 to 3)
Other	*consumer behavior*	0	1 (-4 to 12)	0	0 (-2 to 3)	0	1 (0 to 2)	0	0 (-1 to 2)
	+industry response	0	2 (-1 to 16)	0	0 (-2 to 3)	0	1 (1 to 2)	0	1 (-1 to 2)
Ovarian									
Age	*consumer behavior*	45 (-3 to 114)		13 (-14 to 54)		24 (9 to 51)		21 (8 to 46)	
	+industry response	87 (19 to 175)		25 (-4 to 75)		34 (14 to 64)		28 (15 to 56)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	21 (-15 to 89)	0	-3 (-29 to 38)	0	15 (2 to 41)	0	19 (6 to 43)	0
	+industry response	45 (-10 to 131)	0	5 (-21 to 52)	0	22 (5 to 51)	0	25 (11 to 52)	0
Non-Hispanic Black	*consumer behavior*	7 (-3 to 27)	0	3 (0 to 11)	0	5 (2 to 11)	0	1 (-1 to 4)	0
	+industry response	13 (-1 to 38)	0	5 (1 to 13)	0	7 (3 to 13)	0	1 (0 to 5)	0
Hispanic	*consumer behavior*	15 (0 to 48)	0	6 (-1 to 16)	0	1 (-2 to 6)	0	1 (-1 to 4)	0
	+industry response	25 (2 to 64)	0	8 (2 to 20)	0	2 (-1 to 8)	0	2 (0 to 5)	0
Other	*consumer behavior*	-5 (-13 to 9)	0	5 (1 to 10)	0	2 (0 to 4)	0	0 (-1 to 1)	0
	+industry response	-1 (-9 to 15)	0	5 (2 to 11)	0	2 (1 to 4)	0	0 (0 to 1)	0

Thyroid									
Age	*consumer behavior*	9 (2 to 22)		3 (-4 to 11)		6 (3 to 12)		4 (1 to 7)	
	+industry response	16 (7 to 33)		6 (0 to 16)		9 (5 to 15)		5 (3 to 9)	
Race/Ethnicity									
Non-Hispanic White	*consumer behavior*	0 (0 to 2)	0 (-1 to 5)	0 (-1 to 1)	-2 (-7 to 5)	0 (0 to 1)	3 (0 to 8)	1 (0 to 4)	1 (-1 to 3)
	+industry response	0 (0 to 3)	1 (0 to 9)	0 (-1 to 2)	0 (-5 to 9)	1 (0 to 2)	4 (1 to 10)	2 (1 to 4)	1 (0 to 4)
Non-Hispanic Black	*consumer behavior*	1 (0 to 5)	1 (-2 to 7)	0 (0 to 1)	0 (0 to 2)	1 (0 to 2)	0 (0 to 1)	0 (0 to 1)	0 (0 to 1)
	+industry response	2 (0 to 7)	2 (-1 to 10)	0 (0 to 2)	0 (0 to 2)	1 (0 to 2)	0 (0 to 1)	0 (0 to 1)	0 (0 to 1)
Hispanic	*consumer behavior*	3 (0 to 10)	1 (0 to 9)	1 (0 to 3)	2 (0 to 5)	0 (0 to 1)	1 (0 to 2)	0 (0 to 1)	0 (0 to 1)
	+industry response	5 (1 to 14)	2 (0 to 12)	1 (0 to 4)	2 (1 to 7)	0 (0 to 1)	1 (0 to 3)	1 (0 to 2)	0 (0 to 1)
Other	*consumer behavior*	0	0 (-1 to 3)	0 (0 to 1)	0 (-1 to 1)	0 (0 to 1)	0 (0 to 1)	0	0 (0 to 1)
	+industry response	0	0 (0 to 4)	0 (0 to 1)	0 (-1 to 2)	0 (0 to 1)	0 (0 to 1)	0	0 (0 to 1)

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.

Supplementary Table 12. Estimated health gains and costs associated with the federal menu calorie labeling on reducing cancer burdens in the US over a lifetime, one-way sensitivity analyses at 25% and 75% calorie compensation outside restaurant settings (US population=235,162,844)[1]

	Menu Calorie Labeling Policy			
	75% Compensation		**25% Compensation**	
	Consumer Behavior Median (2.5% to 97.5%)	**Consumer Behavior + Industry Response** Median (2.5% to 97.5%)	**Consumer Behavior** Median (2.5% to 97.5%)	**Consumer Behavior + Industry Response** Median (2.5% to 97.5%)
New Cancer Cases Averted, N (95% UI)				
Liver cancer	2550 (265 to 5030)	4280 (2000 to 6770)	7760 (5160 to 10500)	12800 (9790 to 16000)
Endometrial cancer	2490 (-633 to 5890)	4640 (1570 to 8070)	8890 (5500 to 12700)	15100 (11800 to 19100)
Kidney cancer	2360 (65 to 4510)	4160 (1900 to 6410)	7810 (5230 to 10000)	13000 (10400 to 15300)
Breast cancer (postmenopausal)	2060 (-616 to 5280)	3930 (1260 to 7200)	7640 (4560 to 11400)	13000 (9700 to 17200)
Pancreatic cancer	638 (51 to 1280)	1140 (536 to 1800)	2140 (1490 to 2890)	3590 (2840 to 4460)
Esophageal adenocarcinoma	598 (-239 to 1400)	1100 (262 to 1930)	2130 (1200 to 3000)	3560 (2600 to 4520)
Colorectal cancer	480 (56 to 940)	851 (423 to 1330)	1600 (1060 to 2140)	2660 (2030 to 3310)
Multiple myeloma	343 (61 to 674)	576 (281 to 950)	1050 (677 to 1480)	1730 (1240 to 2340)
Stomach cancer (cardia)	312 (-42 to 736)	533 (192 to 998)	994 (555 to 1530)	1640 (1060 to 2300)
Thyroid cancer	185 (-70 to 498)	406 (128 to 749)	851 (473 to 1310)	1470 (963 to 2100)
Gallbladder cancer	165 (70 to 274)	266 (167 to 378)	468 (348 to 602)	758 (626 to 912)
Advanced prostate cancer	162 (-28 to 360)	282 (87 to 493)	519 (304 to 768)	868 (603 to 1160)
Ovarian cancer	65 (-17 to 179)	119 (26 to 245)	228 (96 to 398)	384 (196 to 617)
Total	12700 (2430 to 24200)	22600 (12400 to 34100)	42800 (30400 to 53900)	71500 (59100 to 82800)
Cancer Deaths Prevented, N (95% UI)				
Liver cancer	2200 (199 to 4450)	3750 (1720 to 5970)	6790 (4490 to 9270)	11200 (8570 to 14100)
Breast cancer (postmenopausal)	1140 (-958 to 3640)	2420 (281 to 4990)	4980 (2540 to 7860)	8670 (6030 to 12000)
Endometrial cancer	980 (-69 to 2030)	1710 (675 to 2770)	3160 (2020 to 4450)	5270 (4120 to 6630)
Kidney cancer	939 (94 to 1820)	1630 (795 to 2520)	3020 (2080 to 3930)	4990 (4020 to 6020)
Pancreatic cancer	561 (54 to 1120)	996 (473 to 1590)	1870 (1300 to 2510)	3130 (2480 to 3890)
Esophageal adenocarcinoma	503 (-224 to 1190)	932 (203 to 1640)	1820 (1010 to 2580)	3050 (2220 to 3890)
Colorectal cancer	323 (41 to 640)	571 (280 to 910)	1080 (724 to 1440)	1800 (1390 to 2240)
Stomach cancer (cardia)	264 (-32 to 623)	446 (159 to 838)	824 (454 to 1280)	1360 (887 to 1910)
Multiple myeloma	213 (45 to 411)	350 (178 to 576)	635 (419 to 897)	1040 (757 to 1370)
Gallbladder cancer	141 (60 to 234)	226 (142 to 320)	398 (300 to 512)	644 (531 to 777)
Advanced prostate cancer	80 (-12 to 179)	135 (44 to 239)	246 (144 to 373)	410 (278 to 563)
Ovarian cancer	49 (-7 to 123)	87 (26 to 170)	162 (76 to 270)	272 (155 to 415)
Thyroid cancer	11 (1 to 24)	19 (8 to 33)	34 (21 to 53)	56 (39.9 to 81.8)
Total	7760 (1280 to 13900)	13600 (7160 to 20100)	25600 (17900 to 32300)	42500 (34600 to 49600)
Life Years Gained	34700 (5070 to 66300)	62200 (32500 to 93500)	118000 (82400 to 151000)	197000 (161000 to 232000)

QALYs Gained	51400 (9690 to 95700)	90500 (49300 to 135000)	171000 (119000 to 218000)	284000 (234000 to 334000)
Changes in Health-Related Costs, Cancer Only ($, millions)[2,3]				
Healthcare (medical) cost	-693 (-1250 to -138)	-1210 (-1770 to -660)	-2270 (-2850 to -1640)	-3760 (-4360 to -3140)
Patient time cost	-47.9 (-90.0 to -11.9)	-83.6 (-126 to -47.3)	-155 (-198 to -113)	-258 (-302 to -215)
Productivity loss	-279 (-527 to -56.6)	-490 (-743 to -271)	-929 (-1170 to -673)	-1550 (-1800 to -1290)
Policy Implementation Costs ($, millions)[2,3]				
Government cost	18.5 (14.5 to 25.1)	18.5 (14.4 to 25.5)	18.5 (14.5 to 25.1)	18.5 (14.4 to 25.5)
Administration	9.07 (8.61 to 9.56)	9.09 (8.62 to 9.55)	9.07 (8.61 to 9.56)	9.09 (8.62 to 9.55)
Monitoring	9.40 (5.45 to 16.1)	9.38 (5.30 to 16.3)	9.40 (5.45 to 16.1)	9.38 (5.30 to 16.3)
Industry cost	820 (762 to 889)	1120 (1040 to 1210)	820 (762 to 889)	1120 (1040 to 1210)
Compliance	820 (762 to 889)	823 (757 to 889)	820 (762 to 889)	823 (757 to 889)
Reformulation	-------	296 (249 to 353)	-------	296 (249 to 353)
Net Costs, Cancer Only ($, millions) [2,3,4]				
Societal perspective	-174 (-1032 to 639)	-653 (-1510 to 164)	-2520 (-3390 to -1590)	-4430 (-5310 to -3510)
Healthcare perspective	-674 (-1229 to -120)	-1190 (-1750 to -639)	-2250 (-2830 to -1620)	-3740 (-4350 to -3120)
ICER (dollars/QALY)[5]				
Societal perspective	Dominant	Dominant	Dominant	Dominant
Healthcare perspective	Dominant	Dominant	Dominant	Dominant

Abbreviations: ICER, Incremental Cost-Effectiveness Ratio; QALY, quality-adjusted life years.

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.
2. Health-related costs were inflated to 2015 US dollars using the Personal Health Care (PHC) index. Policy intervention costs were inflated to 2015 US dollars using the Consumer Price Index. Negative costs represent savings.
3. Costs are medians from 1000 simulations so may not add up to totals.
4. Net costs were calculated as policy costs minus health-related costs from reduced cancer burden. Societal perspective includes healthcare cost, patient time costs, productivity costs, and policy implementation costs; government perspective included policy costs relevant to policy implementation and program monitoring and evaluation and medical costs.
5. ICER threshold was evaluated at $150,000/QALY. Dominant represents less costly and more effective than the “no-policy intervention” scenario.

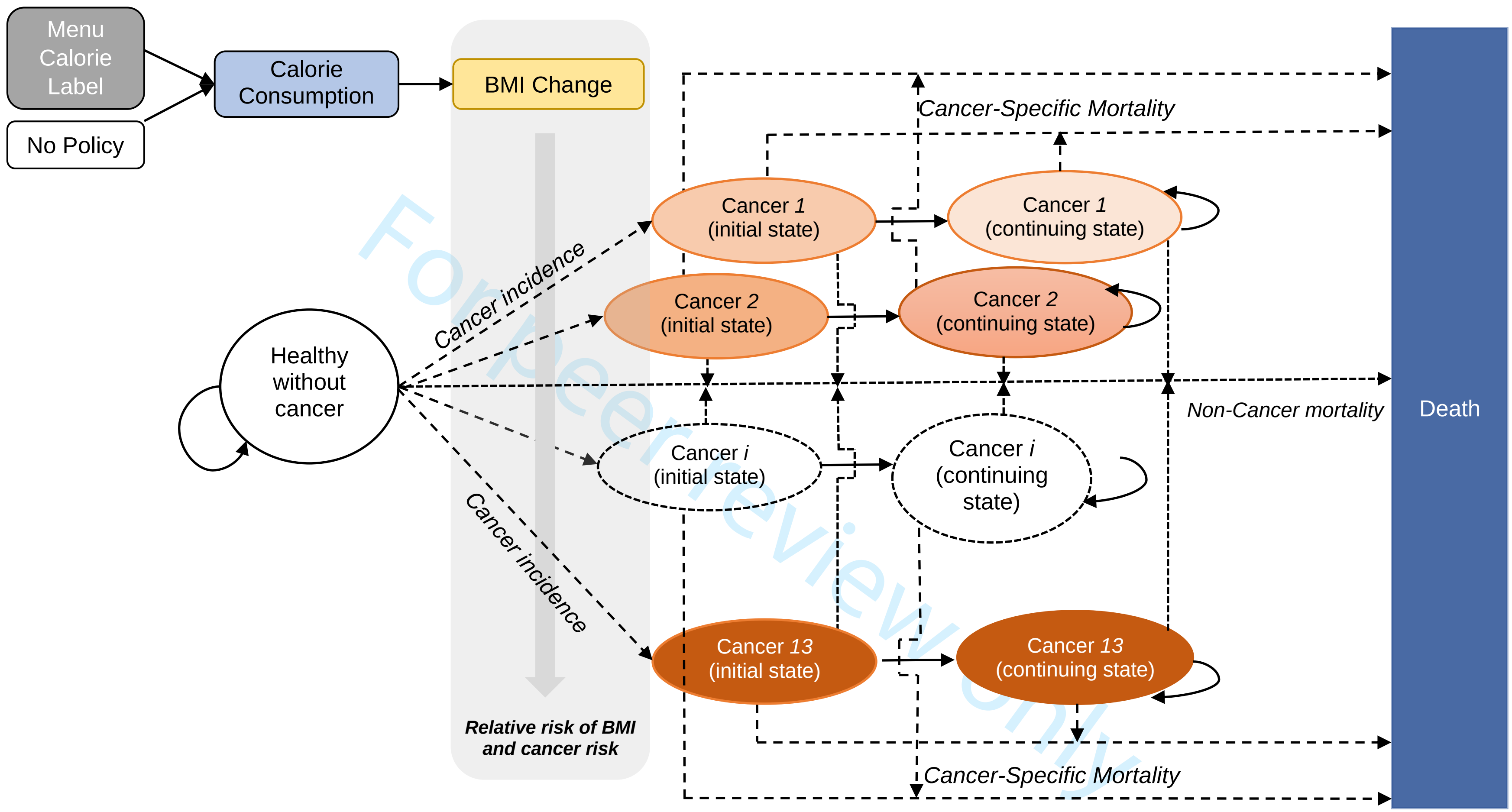
Supplementary Table 13. Estimated health gains and costs associated with the federal menu calorie labeling on reducing cancer burdens in the US over a lifetime, one-way sensitivity analysis, assuming all full-service and fast-food restaurants were covered by the policy (US population=235,162,844)[1]

	Menu Calorie Labeling Policy	
	Consumer Behavior Median (2.5% to 97.5%)	**Consumer Behavior + Industry Response** Median (2.5% to 97.5%)
New Cancer Cases Averted, N (95% UI)		
Liver cancer	7280 (4690 to 10100)	11400 (8480 to 14400)
Kidney cancer	6820 (4180 to 9460)	11100 (8470 to 13700)
Endometrial cancer	5340 (1540 to 9220)	10400 (6690 to 14300)
Breast cancer (postmenopausal)	4920 (1580 to 8420)	9380 (5960 to 13100)
Esophageal adenocarcinoma	2060 (1170 to 3060)	3260 (2310 to 4330)
Pancreatic cancer	1810 (1150 to 2600)	3000 (2290 to 3870)
Colorectal cancer	1320 (772 to 1910)	2200 (1600 to 2880)
Stomach cancer (cardia)	938 (531 to 1510)	1480 (985 to 2140)
Thyroid cancer	746 (430 to 1180)	1270 (850 to 1820)
Multiple myeloma	710 (377 to 1150)	1270 (879 to 1820)
Advanced prostate cancer	430 (208 to 681)	715 (461 to 1010)
Gallbladder cancer	329 (201 to 457)	568 (435 to 708)
Ovarian cancer	133 (20.9 to 292)	263 (109 to 468)
Total	32900 (20300 to 46000)	56400 (43700 to 69300)
Cancer Deaths Prevented, N (95% UI)		
Liver cancer	6460 (4170 to 8980)	10000 (7480 to 12800)
Breast cancer (postmenopausal)	3410 (701 to 6280)	6440 (3560 to 9750)
Kidney cancer	2620 (1610 to 3620)	4250 (3210 to 5300)
Endometrial cancer	1890 (654 to 3140)	3610 (2390 to 4900)
Esophageal adenocarcinoma	1800 (1030 to 2670)	2840 (2010 to 3750)
Pancreatic cancer	1580 (976 to 2250)	2620 (1990 to 3380)
Colorectal cancer	923 (560 to 1310)	1520 (1110 to 1970)
Stomach cancer (cardia)	785 (437 to 1270)	1240 (812 to 1790)
Multiple myeloma	431 (234 to 709)	762 (524 to 1100)
Gallbladder cancer	275 (170 to 385)	479 (366 to 601)
Advanced prostate cancer	219 (117 to 351)	353 (233 to 506)
Ovarian cancer	94 (18 to 197)	185 (91 to 317)
Thyroid cancer	27 (13 to 45)	45 (28 to 68)
Total	7760 (1280 to 13900)	34400 (26800 to 42400)
Life Years Gained	97300 (62300 to 135000)	162000 (126000 to 201000)
QALYs Gained	20500 (13100 to 28500)	230000 (178000 to 287000)
Changes in Health-Related Costs, Cancer Only ($, millions)[2,3]		

Healthcare (medical) cost	-1820 (-2500 to -1180)	-3060 (-3740 to -2400)
Patient time cost	-112 (-160 to -62.7)	-197 (-245 to -148)
Productivity loss	-692 (-976 to -401)	-1210 (-1490 to -916)
Policy Implementation Costs ($, millions)[2,3]		
Government cost	18.4 (14.7 to 25.7)	18.4 (14.7 to 25.7)
Administration	9.06 (8.56 to 9.52)	9.07 (8.60 to 9.56)
Monitoring	9.32 (5.61 to 16.5)	9.37 (5.64 to 16.6)
Industry cost	821 (764 to 888)	1120 (1040 to 1200)
Compliance	821 (764 to 888)	821 (763 to 886)
Reformulation	-------	297 (248 to 350)
Net Costs, Cancer Only ($, millions) [2,3,4]		
Societal perspective	-1780 (-2790 to -831)	-1030 (-1590 to -549)
Healthcare perspective	-1800 (-2470 to -1160)	-1670 (-2120 to -1270)
ICER (dollars/QALY)[5]		
Societal perspective	Dominant	Dominant
Healthcare perspective	Dominant	Dominant

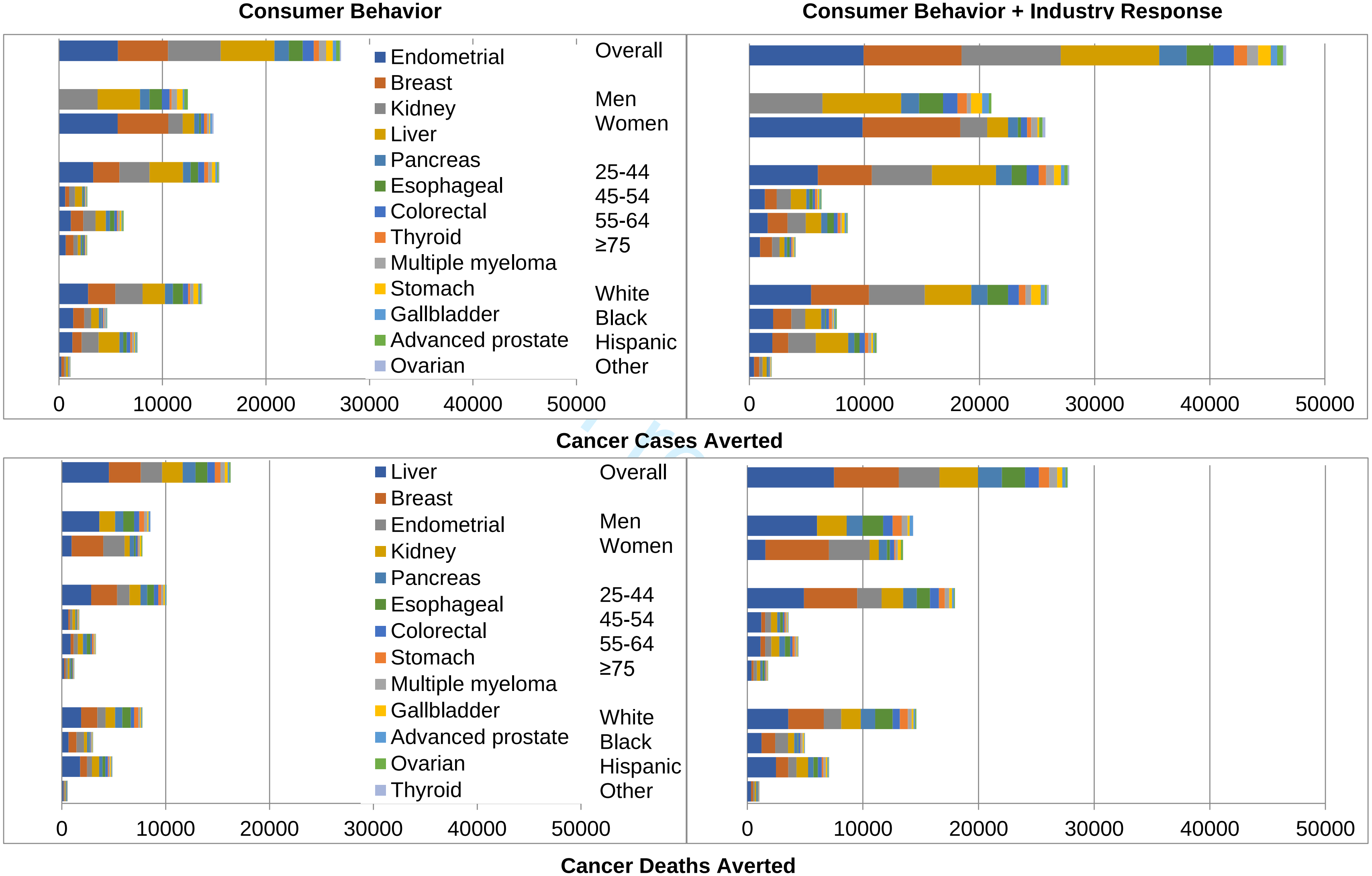
Abbreviations: ICER, Incremental Cost-Effectiveness Ratio; QALY, quality-adjusted life years.

1. Values are the median estimates (95% uncertainty intervals) of each distribution of 1000 simulations.
2. Health-related costs were inflated to 2015 US dollars using the Personal Health Care (PHC) index. Policy intervention costs were inflated to 2015 US dollars using the Consumer Price Index. Negative costs represent savings.
3. Costs are medians from 1000 simulations so may not add up to totals.
4. Net costs were calculated as policy costs minus health-related costs from reduced cancer burden. Societal perspective includes healthcare cost, patient time costs, productivity costs, and policy implementation costs; government perspective included policy costs relevant to policy implementation and program monitoring and evaluation and medical costs.
5. ICER threshold was evaluated at $150,000/QALY. Dominant represents less costly and more effective than the "no-policy intervention" scenario.

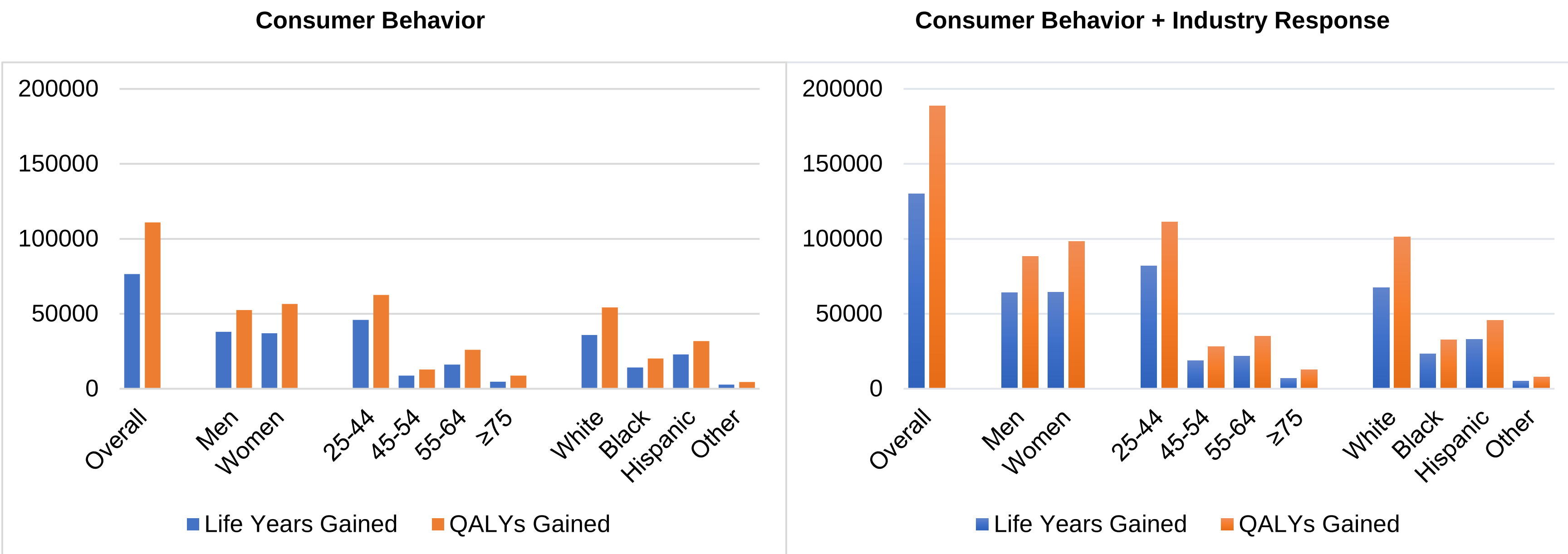


Supplementary Figure 1. Diet and Cancer Outcome Model (DiCOM)

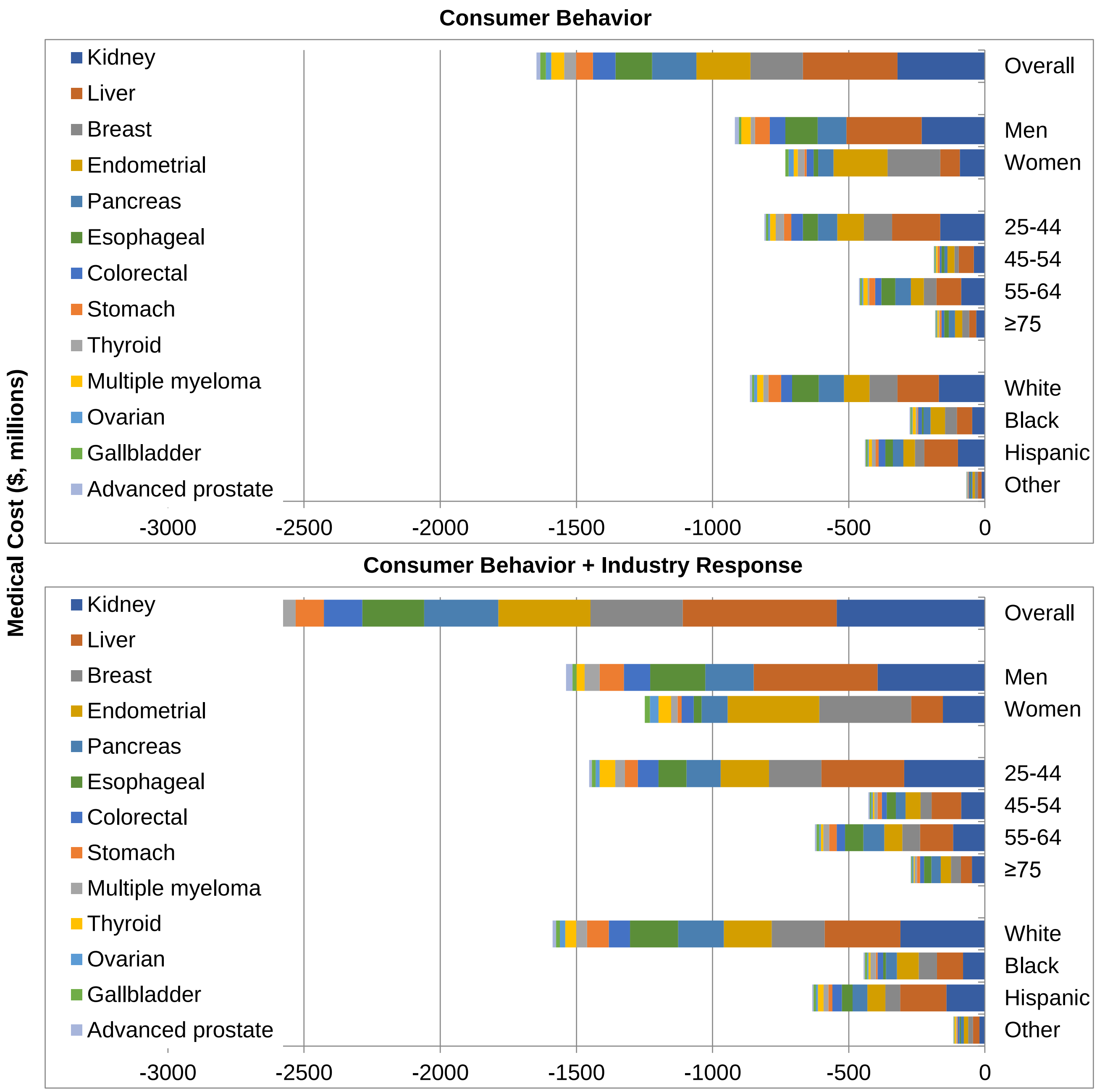
The model consists of four general health states: (a) healthy without cancer (healthy state); (b) initial cancer diagnosis (initial state) for each cancer type *i*; (c) continuing care (continuing state) for each cancer type *i*; and (d) death state. Transitions between states are based on national cancer incidence and cancer-specific mortality rates from SEER (for individual with cancer) and lifetable-based mortality rates (for individuals without cancer). The model simulates the policy impact on the number of new cases and deaths of 13 obesity-associated cancers, health-related quality of life (HRQOL), and health-related costs among U.S. adults over a lifetime by comparing a policy scenario (menu calorie label) to a non-policy scenario (status quo).



Supplementary Figure 2. Estimated reduced new cancer cases and deaths associated with the federal menu calorie labeling in the US by age, sex, race/ethnicity, and cancer type, over lifetime

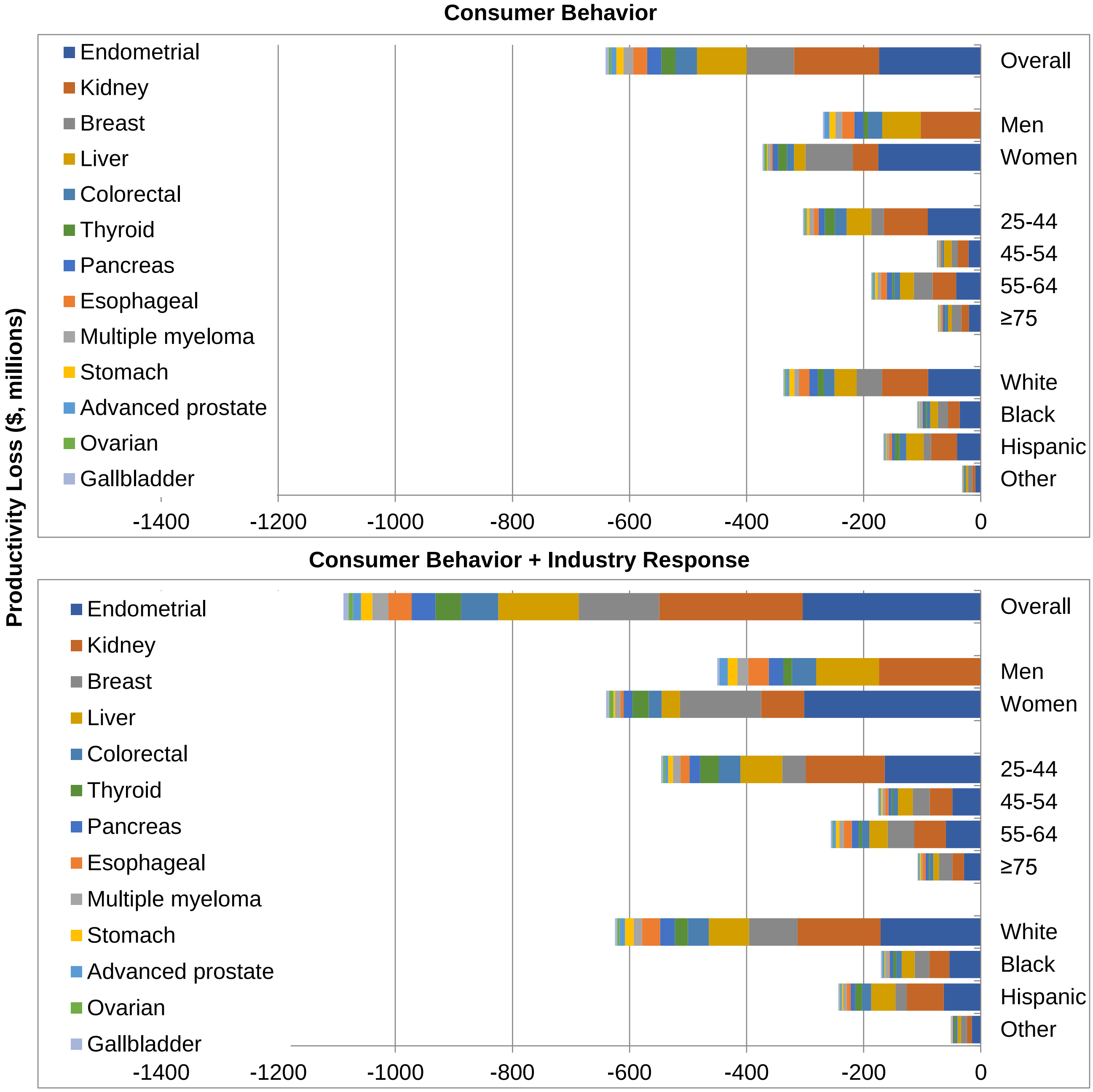


Supplementary Figure 3. Estimated life years and QALYs gained associated with the federal menu calorie labeling in the US by age, sex, and race/ethnicity, over a lifetime

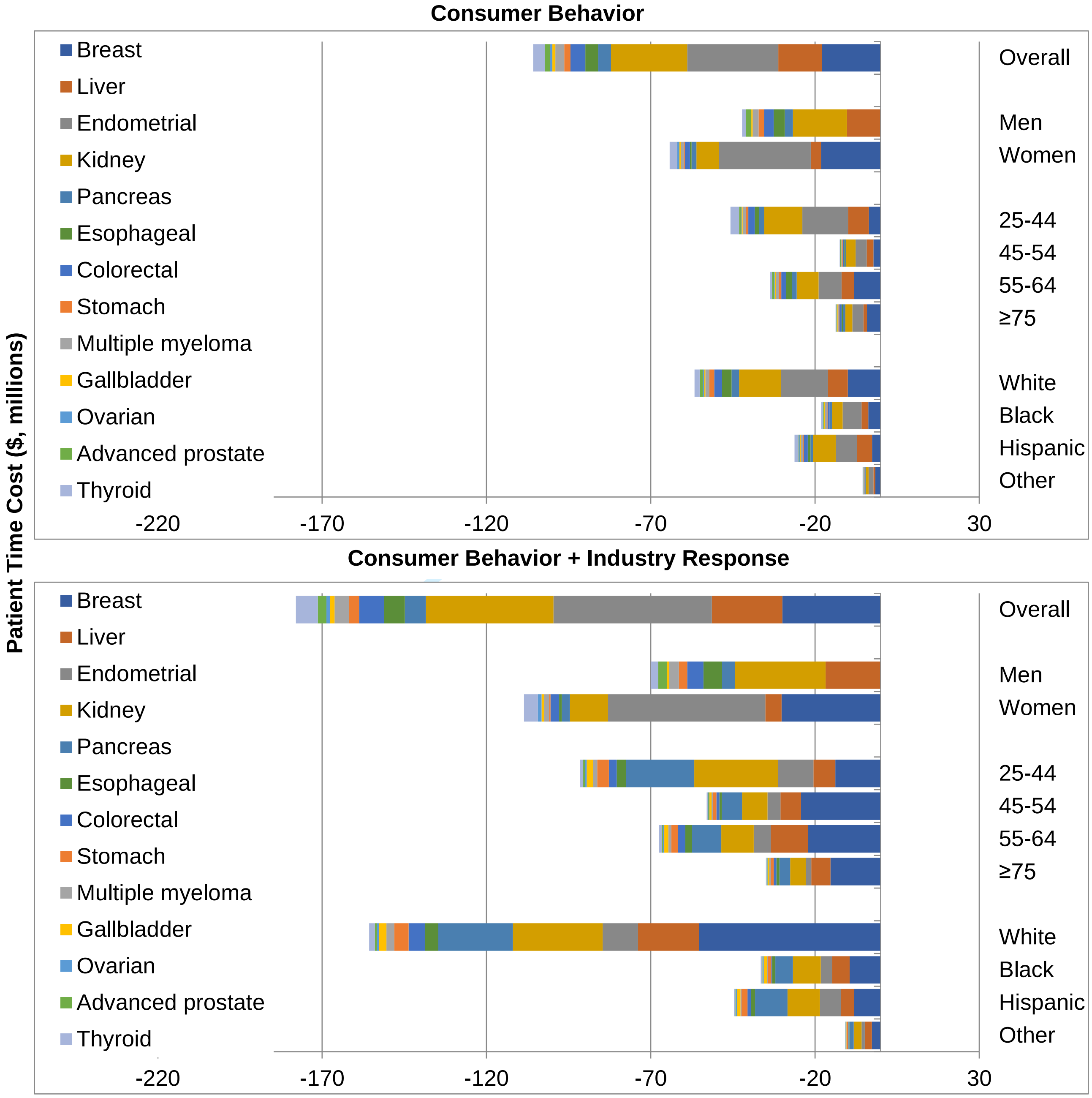


Medical Cost ($, millions)
Consumer Behavior
Kidney
Liver
Breast
Endometrial
Pancreas
Esophageal
Colorectal
Stomach
Thyroid
Multiple myeloma
Ovarian
Gallbladder
Advanced prostate
Overall
Men
Women
25-44
45-54
55-64
≥75
White
Black
Hispanic
Other
-3000
-2500
-2000
-1500
-1000
-500
0
Consumer Behavior + Industry Response
Kidney
Liver
Breast
Endometrial
Pancreas
Esophageal
Colorectal
Stomach
Multiple myeloma
Thyroid
Ovarian
Gallbladder
Advanced prostate
Overall
Men
Women
25-44
45-54
55-64
≥75
White
Black
Hispanic
Other
-3000
-2500
-2000
-1500
-1000
-500
0

(A)

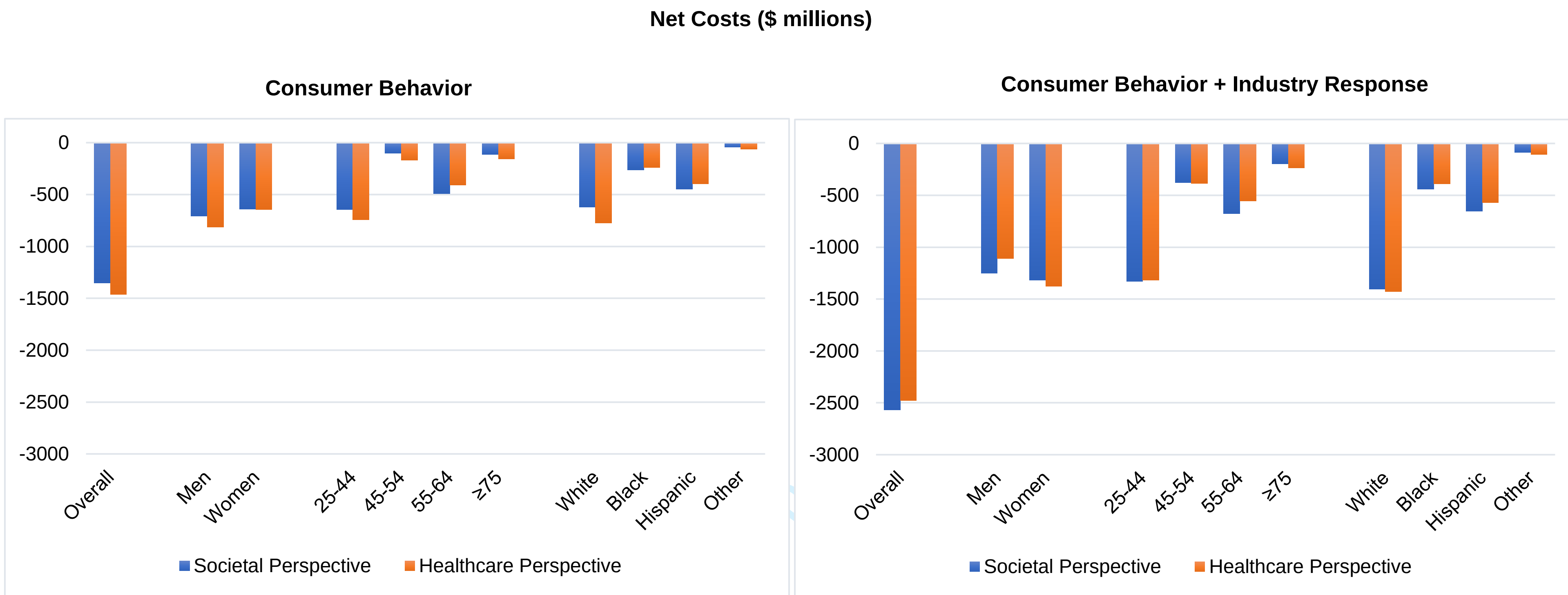

Consumer Behavior
Endometrial
Kidney
Breast
Liver
Colorectal
Thyroid
Pancreas
Esophageal
Multiple myeloma
Stomach
Advanced prostate
Ovarian
Gallbladder
Overall
Men
Women
25-44
45-54
55-64
≥75
White
Black
Hispanic
Other
-1400
-1200
-1000
-800
-600
-400
-200
0
Productivity Loss ($, millions)
Consumer Behavior + Industry Response

(B)

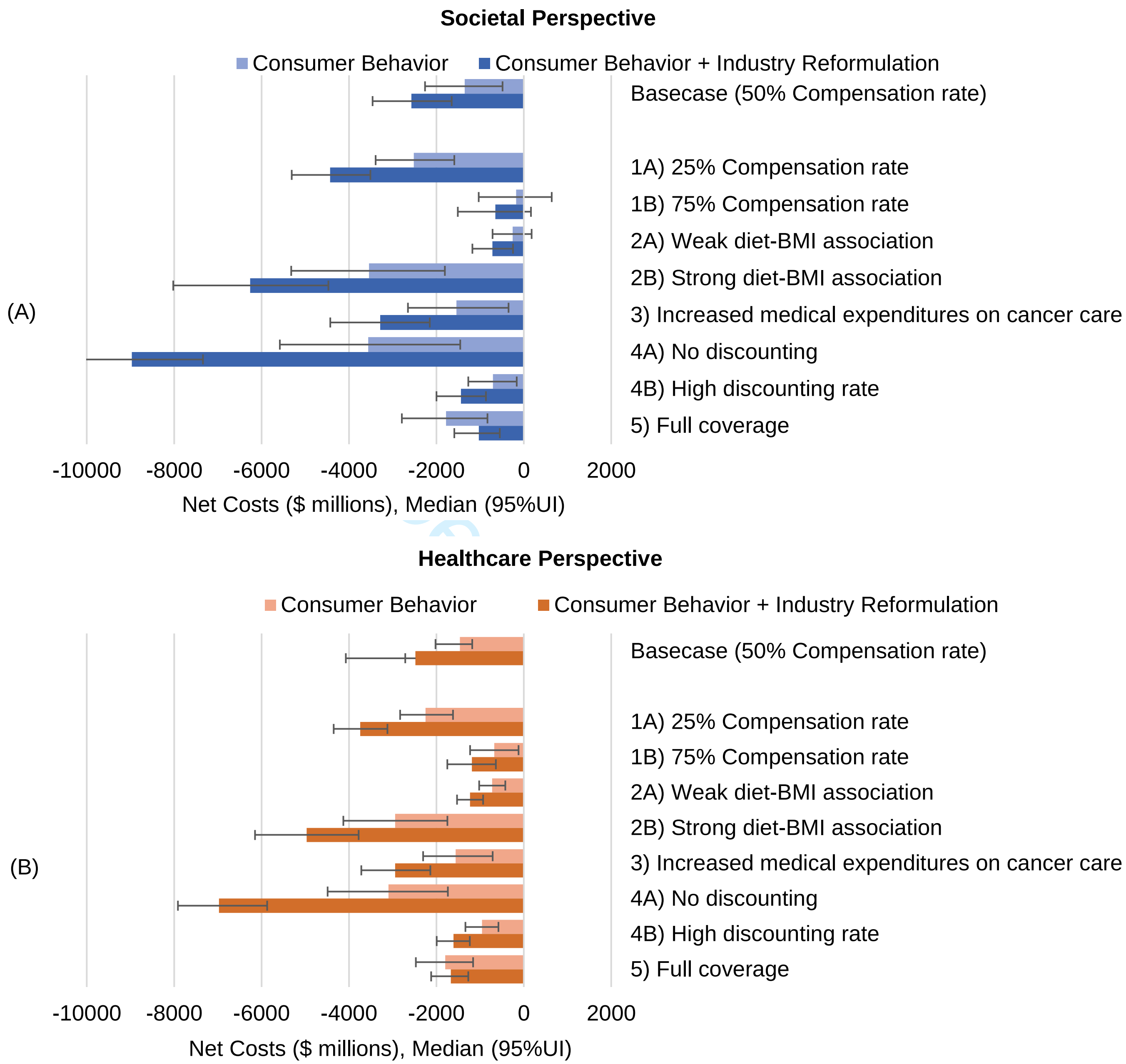


(C)

Supplementary Figure 4. Estimated changes of health-related costs associated with the federal menu calorie labeling in the US by age, sex, race/ethnicity, and cancer type, over lifetime



Supplementary Figure 5. Estimated net costs from societal and government perspectives associated with the federal menu calorie labeling policy in the US by age, sex, and race/ethnicity, over a lifetime



Supplementary Figure 6. One-Way Sensitivity Analysis of Net Costs of Menu Calorie Labeling and Obesity-Associated Cancer Rates by Varying Assumptions of Key Input Parameters From (A) Societal Perspective and (B) Healthcare Perspective

1a) assumed that only 25% of calorie reduction as a result of industry response would translate into long-term reductions in daily calories; 1b) assumed that only 75% of calorie reduction as a result of industry response would translate into long-term reductions in daily calories; 2a) weaker diet-BMI association assumed half of the base-case diet-BMI association; 2b) stronger diet-BMI association assumed two times of the base-case diet-BMI association; 3) 2% annual increase in medical expenditure on cancer care; 4a) lower discounting rate assumed 0% discounting rate; 4b) higher discounting rate assumed 5% discounting rate; and 5) assumed the coverage of the FDA's final rule increasing from 56.5% to 100% of the calories from full-service restaurants. Under base-case scenario (policy effect assumed consumer behavior: -7.3%, and industry reformulation: -5.0%; assumed that only 50% of calorie reduction as a result of industry response would translate into long-term reductions in daily calories; diet-BMI association assumed healthy-weight: 0.0015 kg/m^2 per kcal, and overweight/obese: 0.003 kg/m^2 per kcal; medical expenditure on cancer care assumed 0% annual increase; discounting rate assumed 3%; policy coverage would affect 56.5% of calories consumed at full-service restaurants and 100% of calories consumed at fast-food restaurants), the policy was cost-saving from both societal and healthcare perspectives. The policy remained cost-saving for all sensitivity analyses from the healthcare perspective and from societal perspective with additional industry reformulation. With consumer behavior alone, the policy was cost-saving under all scenarios.

CHEERS Checklist

Items to include when reporting economic evaluations of health interventions

The **ISPOR CHEERS Task Force Report**, *Consolidated Health Economic Evaluation Reporting Standards (CHEERS)—Explanation and Elaboration: A Report of the ISPOR Health Economic Evaluations Publication Guidelines Good Reporting Practices Task Force*, provides examples and further discussion of the 24-item CHEERS Checklist and the CHEERS Statement. It may be accessed via the *Value in Health* or via the ISPOR Health Economic Evaluation Publication Guidelines – CHEERS: Good Reporting Practices webpage: http://www.ispor.org/TaskForces/EconomicPubGuidelines.asp

Section/item	Item No	Recommendation	Reported on page No/ line No
Title and abstract			
Title	1	Identify the study as an economic evaluation or use more specific terms such as "cost-effectiveness analysis", and describe the interventions compared.	Page 1/Lines 1-2
Abstract	2	Provide a structured summary of objectives, perspective, setting, methods (including study design and inputs), results (including base case and uncertainty analyses), and conclusions.	Pages 3-4/ Lines 32-59
Introduction			
Background and objectives	3	Provide an explicit statement of the broader context for the study. Present the study question and its relevance for health policy or practice decisions.	Pages 5-6/ Lines 64-92
Methods			
Target population and subgroups	4	Describe characteristics of the base case population and subgroups analysed, including why they were chosen.	Page 9/ Lines 106-113
Setting and location	5	State relevant aspects of the system(s) in which the decision(s) need(s) to be made.	Page 6/Lines 96-98
Study perspective	6	Describe the perspective of the study and relate this to the costs being evaluated.	Page 12/ Lines 189-197
Comparators	7	Describe the interventions or strategies being compared and state why they were chosen.	Pages 9-10/ Lines 125-140
Time horizon	8	State the time horizon(s) over which costs and consequences are being evaluated and say why appropriate.	Page 6/ Lines 98-99
Discount rate	9	Report the choice of discount rate(s) used for costs and outcomes and say why appropriate.	Page 12 /Line 198
Choice of health outcomes	10	Describe what outcomes were used as the measure(s) of benefit in the evaluation and their relevance for the type of analysis performed.	Page 11/ Lines 158-170
Measurement of effectiveness	11a	*Single study-based estimates:* Describe fully the design features of the single effectiveness study and why the single study was a sufficient source of clinical effectiveness data.	

	11b	*Synthesis-based estimates:* Describe fully the methods used for identification of included studies and synthesis of clinical effectiveness data.	Pages 9-11/ Lines 115-170
Measurement and valuation of preference based outcomes	12	If applicable, describe the population and methods used to elicit preferences for outcomes.	
Estimating resources and costs	13a	*Single study-based economic evaluation:* Describe approaches used to estimate resource use associated with the alternative interventions. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	
	13b	*Model-based economic evaluation:* Describe approaches and data sources used to estimate resource use associated with model health states. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	Page 11/ Lines 168-170
Currency, price date, and conversion	14	Report the dates of the estimated resource quantities and unit costs. Describe methods for adjusting estimated unit costs to the year of reported costs if necessary. Describe methods for converting costs into a common currency base and the exchange rate.	Page 12/Line 197-198
Choice of model	15	Describe and give reasons for the specific type of decision-analytical model used. Providing a figure to show model structure is strongly recommended.	Supplementary Figure 1
Assumptions	16	Describe all structural or other assumptions underpinning the decision-analytical model.	Pages 9-10/ Lines 118-120, 128-129, 135-140, 145-152
Analytical methods	17	Describe all analytical methods supporting the evaluation. This could include methods for dealing with skewed, missing, or censored data; extrapolation methods; methods for pooling data; approaches to validate or make adjustments (such as half cycle corrections) to a model; and methods for handling population heterogeneity and uncertainty.	Page 13/ Lines 210-214
Results			
Study parameters	18	Report the values, ranges, references, and, if used, probability distributions for all parameters. Report reasons or sources for distributions used to represent uncertainty where appropriate. Providing a table to show the input values is strongly recommended.	Pages 7-8/Table 1
Incremental costs and outcomes	19	For each intervention, report mean values for the main categories of estimated costs and outcomes of interest, as well as mean differences between the comparator groups. If applicable, report incremental cost-effectiveness ratios.	Pages 16-17/ Table 2
Characterising uncertainty	20a	*Single study-based economic evaluation:* Describe the effects of sampling uncertainty for the estimated incremental cost and	

		incremental effectiveness parameters, together with the impact of methodological assumptions (such as discount rate, study perspective).	
	20b	*Model-based economic evaluation:* Describe the effects on the results of uncertainty for all input parameters, and uncertainty related to the structure of the model and assumptions.	Page 21/ Lines 282-295
Characterising heterogeneity	21	If applicable, report differences in costs, outcomes, or cost-effectiveness that can be explained by variations between subgroups of patients with different baseline characteristics or other observed variability in effects that are not reducible by more information.	Pages 18-19/ Lines 267-281
Discussion			
Study findings, limitations, generalisability, and current knowledge	22	Summarise key study findings and describe how they support the conclusions reached. Discuss limitations and the generalisability of the findings and how the findings fit with current knowledge.	Pages 21-24
Other			
Source of funding	23	Describe how the study was funded and the role of the funder in the identification, design, conduct, and reporting of the analysis. Describe other non-monetary sources of support.	Page 26
Conflicts of interest	24	Describe any potential for conflict of interest of study contributors in accordance with journal policy. In the absence of a journal policy, we recommend authors comply with International Committee of Medical Journal Editors recommendations.	Pages 26-27

For consistency, the CHEERS Statement checklist format is based on the format of the CONSORT statement checklist

The **ISPOR CHEERS Task Force Report** provides examples and further discussion of the 24-item CHEERS Checklist and the CHEERS Statement. It may be accessed via the *Value in Health* link or via the ISPOR Health Economic Evaluation Publication Guidelines – CHEERS: Good Reporting Practices webpage: http://www.ispor.org/TaskForces/EconomicPubGuidelines.asp

The citation for the CHEERS Task Force Report is:
Husereau D, Drummond M, Petrou S, et al. Consolidated health economic evaluation reporting standards (CHEERS)—Explanation and elaboration: A report of the ISPOR health economic evaluations publication guidelines good reporting practices task force. Value Health 2013;16:231-50.