

Appendix
Simulating the Impact of Sugar-Sweetened Beverage Warning Labels in Three Cities
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Appendix Table 1. Starting Input Values

Variable	Baltimore	San Francisco	Philadelphia
Cohort size	6,784	5,497	20,171
Gender, %			
Male	56.6	50.4	57.1
Female	43.7	49.6	42.9
Ethnicity, %			
White	13.5	40.7	22.9
Black	82	5.4	55.5
Other	4.5	53.9	14.6
Never consumes SSB, %			
White males	27.7	27.7	27.7
White females	34.8	34.8	34.8
Black males	25.6	25.6	25.6
Black females	32.3	32.3	32.3
Other males	31.3	31.3	31.3
Other females	39.1	39.1	39.1
Starting prevalence, %			
Obese	15.8	26.1	19.7
Overweight	25.8	13.1	23

SSB, sugar sweetened beverage

APPENDIX FILE 1

Hall KD, Butte NF, Swinburn BA, Chow CC. Dynamics of childhood growth and obesity: development and validation of a quantitative mathematical model. *Lancet Diabetes Endocrinol.* 2013;1(2):97–105.

For each agent, for each day, weight change occurs because of an imbalance of energy consumed and energy expended for the day. The difference between energy consumed and energy expended defines the energy gap for that agent for that day. An energy gap greater than zero will cause an increase in weight, and an energy gap less than zero will cause a decrease in weight. Change in weight occurs in both fat and fat-free tissue mass. Each day, the energy consumed is the total calories consumed from eating and drinking events. The energy expended for the day is a combination of five components: a constant sex-specific resting energy expenditure fit to resting energy expenditure study data, the daily energy cost of maintaining existing fat and fat-free tissue, the calories expended during physical activity, the energy cost of synthesizing new fat and fat-free tissue, and thermogenesis.

The calculated energy gap for the agent is then split between fat tissue and fat-free tissue based on the P-ratio of the agent. The P-ratio defines the fraction of energy imbalance accounted for by changes in fat-free mass. The equation for the P-ratio takes the form:

$$p = \frac{C}{C + FM}$$

where FM is the fat mass of the agent and

$$C = 10.4(kg) \times \left(\frac{\rho_{FFM}}{\rho_{FM}} \right)$$

where ρ_{FFM} is the energy density of fat-free mass for the agent, and ρ_{FM} is the energy density of fat mass. The energy density of fat mass is a constant, whereas the energy density of fat-free mass comes from the following equation:

$$\rho_{FFM} \approx 4.3 \left(\frac{kcal}{kg^2} \right) \times FFM(kg) + 837 \left(\frac{kcal}{kg} \right)$$

where ρ_{FFM} is the energy density of fat-free mass and FFM is the current fat-free mass of the agent. This equation was derived through a linear fit to reference body protein and fat-free mass data.

The P-ratio is based on the Forbes relationship that describes the change in fat-free mass for infinitesimal changes in body weight. The Forbes relationship is based on cross-sectional body composition data and is defined as:

$$\frac{dFFM}{dBW} = \frac{10.4}{10.4 + FM}$$

where $dFFM$ is the change in fat-free mass, dBW is the change in body weight, and FM is the fat mass of the agent.

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The split results in a separate energy gap for both fat tissue and fat-free tissue. At this point, for people aged <20 years, additional energy is added to the fat-free tissue energy gap, based on an age dependent function representing the net effect of physiological processes that occur as a child moves towards adulthood. The growth function is the following second order polynomial:

$$g(t) \approx Ae^{-(t-t_A)/\tau_A} + Be^{-(t-t_B)^2/2\tau_B^2} + De^{-(t-t_D)^2/2\tau_D^2}$$

Where $g(t)$ represents growth energy, t is the age of the agent in years, and constants $A, B, D, t_A, t_B, t_D, \tau_A, \tau_B, \tau_D$ are best fit parameters obtained using the down-hill simplex algorithm from the Berkeley Madonna software. These values are sex specific and were fit to reference body composition time courses in males and females. This method is design to approach zero as the agent transitions to adult ages.

Both the fat and fat-free tissue specific energy gaps are converted to weight change in kilograms by multiplying each energy gap by the energy density of the particular tissue type (defined above).

The sum of the new lean and fat tissue masses becomes the new weight of the person.

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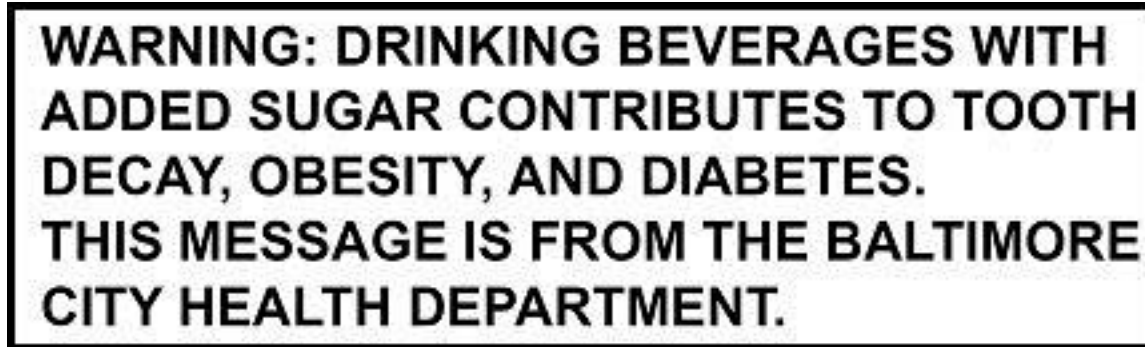
Appendix Table 2. Food Source Frequenting Data

Eating event and food source	Food source frequenting data, NHANES 2010–2012, %
Snack 1 Home	13.56
Snack 1 Small grocer/corner store	77.09
Snack 1 Convenience store	9.35
Snack 2 Home	5.32
Snack 2 Small grocer/corner store	85.72
Snack 2 Convenience store	8.97
Snack 3 Home	5.27
Snack 3 Small grocer/corner store	83.20
Snack 3 Convenience store	11.53
Dinner home	84.46
Dinner carryout	8.19
Dinner restaurant	7.35

Notes: Food and drinks consumed at home assumed to be purchased from supermarket.
NHANES 2010–2012 store frequency data used to calibrate the model.

NHANES, National Health and Nutrition Examination Survey

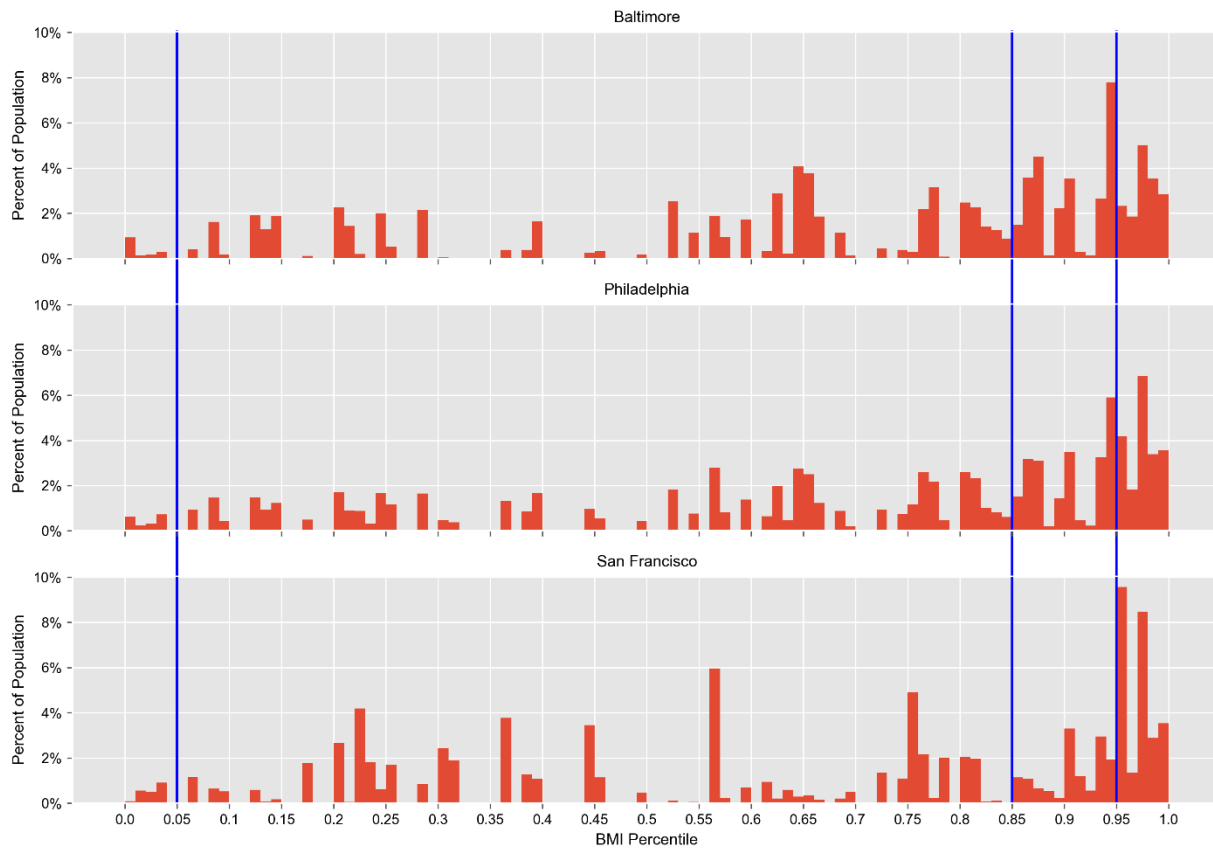
Appendix Figure 1. Warning label.



Notes: This is an example of a warning label that would be placed at the point of purchase in sugar sweetened beverage retailers. The model assumes comprehending this label requires a basic reading level.

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Appendix Figure 2. Starting population BMI percentile distributions across cities.



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Appendix Table 3. Model Output Data

Variable	Efficacy of intervention	Change in SSB consumption from baseline (95% range)	Percent change in obesity prevalence from baseline (95% range)	Percent change in overweight prevalence from baseline (95% range)	Percent change in overweight and obese prevalence from baseline (95% range)	Change in mean BMI for obese population (95% range)	Change in mean BMI for total population (95% range)
Baltimore							
SSB warning labels in all locations							
All food sources	4%	-0.034 (-0.047, -0.023)	-1.08 (-1.87, -0.62)	-0.08 (-1.25, 0.84)	-1.16 (-2.29, -0.21)	-0.09 (-1.75, 1.53)	-0.12 (-0.42, 0.34)
All food sources	8%	-0.066 (-0.08, -0.053)	-1.69 (-2.75, -0.97)	-1.39 (-3.59, 0.49)	-3.08 (-4.97, -1.13)	-0.25 (-1.7, 1.17)	-0.26 (-0.56, 0.07)
All food sources	12%	-0.096 (-0.11, -0.082)	-2.05 (-3.29, -1.06)	-2.93 (-5.31, -0.4)	-4.98 (-7.36, -2.6)	-0.19 (-2.01, 1.86)	-0.38 (-0.74, 0.01)
25% calorie compensation	8%	-0.066 (-0.081, -0.05)	-1.45 (-2.43, -0.76)	-0.69 (-2.52, 0.97)	-2.15 (-3.86, -0.59)	-0.25 (-1.77, 1.17)	-0.24 (-0.53, 0.1)
50% calorie compensation	8%	-0.063 (-0.075, -0.047)	-1.06 (-1.67, -0.56)	-0.07 (-1.16, 0.9)	-1.13 (-2.17, -0.28)	0.12 (-1.57, 1.87)	-0.09 (-0.42, 0.22)
75% calorie compensation	8%	-0.063 (-0.08, -0.045)	-0.62 (-1.09, -0.19)	0.08 (-0.97, 0.75)	-0.54 (-1.41, 0.1)	0.18 (-1.16, 1.86)	-0.03 (-0.33, 0.38)
49% below basic reading level							
All food sources	4%	-0.018 (-0.027, -0.009)	-0.59 (-1.2, -0.12)	-0.05 (-1.07, 0.7)	-0.64 (-1.5, -0.02)	0.08 (-1.46, 2.34)	-0.08 (-0.4, 0.29)
All food sources	8%	-0.033 (-0.05, -0.02)	-0.95 (-1.93, -0.09)	-0.73 (-2.12, 0.81)	-1.67 (-2.94, -0.38)	-0.16 (-1.84, 1.45)	-0.14 (-0.45, 0.27)
All food sources	12%	-0.051 (-0.07, -0.028)	-1.07 (-2.02, -0.24)	-1.81 (-3.62, -0.14)	-2.88 (-4.74, -1.01)	-0.26 (-1.98, 1.6)	-0.22 (-0.59, 0.17)
75% of corner stores compliant	8%	-0.058 (-0.073, -0.042)	-1.56 (-2.56, -0.78)	-1.1 (-3.25, 0.7)	-2.64 (-4.59, -0.87)	-0.25 (-2.08, 1.7)	-0.25 (-0.57, 0.13)
50% of corner stores compliant	8%	-0.052 (-0.066, -0.038)	-1.54 (-2.65, -0.78)	-0.77 (-2.79, 0.84)	-2.33 (-4.13, -0.9)	-0.09 (-1.84, 1.93)	-0.21 (-0.52, 0.11)
75% of supermarkets compliant	8%	-0.059 (-0.072, -0.045)	-1.59 (-2.39, -0.77)	-1.14 (-3.57, 0.69)	-2.74 (-4.63, -1.24)	-0.02 (-1.85, 2.1)	-0.19 (-0.57, 0.21)
50% of supermarkets compliant	8%	-0.053 (-0.064, -0.041)	-1.51 (-2.48, -0.68)	-0.72 (-2.47, 1.09)	-2.23 (-3.73, -0.93)	-0.26 (-2.03, 1.75)	-0.23 (-0.55, 0.16)
33% less effective among low SES	8%	-0.057 (-0.069, -0.042)	-1.57 (-2.67, -0.81)	-1.25 (-3.13, 0.67)	-2.82 (-4.5, -1.28)	-0.22 (-1.82, 1.94)	-0.25 (-0.57, 0.15)

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50% less effective among low SES	8%	-0.053 (-0.067, -0.04)	-1.53 (-2.67, -0.72)	-0.84 (-2.82, 1.06)	-2.37 (-4.15, -0.94)	-0.06 (-1.8, 1.93)	-0.2 (-0.53, 0.3)
Intervention excluding schools	8%	-0.062 (-0.074, -0.046)	-1.71 (-2.88, -0.84)	-1.18 (-3.5, 0.9)	-2.89 (-4.69, -1.1)	0.1 (-1.42, 2.07)	-0.19 (-0.49, 0.18)
Intervention only at supermarkets							
At all supermarkets	4%	-0.014 (-0.018, -0.009)	-0.53 (-0.87, -0.22)	0.17 (-0.49, 0.78)	-0.36 (-1.01, 0.07)	-0.02 (-1.59, 1.75)	-0.04 (-0.32, 0.32)
At all supermarkets	8%	-0.028 (-0.034, -0.021)	-0.95 (-1.55, -0.54)	0.01 (-0.89, 0.97)	-0.94 (-2.04, -0.15)	0.13 (-1.48, 2.19)	-0.06 (-0.39, 0.38)
Intervention only at small grocers							
At all small grocers	12%	-0.033 (-0.04, -0.019)	1.08 (-1.61, -0.62)	-0.06 (-1.38, 1.0)	-1.14 (-2.53, -0.29)	0.01 (-1.7, 2.09)	-0.11 (-0.44, 0.39)
At all small grocers	8%	-0.023 (-0.028, -0.018)	-0.84 (-1.34, -0.5)	0.12 (-0.79, 0.92)	-0.73 (-1.62, -0.06)	0.05 (-1.49, 2.05)	-0.06 (-0.41, 0.43)
San Francisco							
SSB warning labels in all locations							
All food sources	4%	-0.03 (-0.043, -0.012)	-1.93 (-3.45, -0.74)	1.47 (0.1, 2.92)	-0.47 (-1.47, 0.12)	-0.13 (-0.8, 0.62)	-0.1 (-0.35, 0.12)
All food sources	8%	-0.065 (-0.078, -0.051)	-4.08 (-5.96, -2.2)	3.1 (0.97, 5.2)	-0.98 (-2.28, -0.08)	-0.2 (-0.69, 0.5)	-0.21 (-0.38, 0.04)
All food sources	12%	-0.094 (-0.11, -0.074)	-5.25 (-7.55, -2.93)	3.83 (0.96, 6.61)	-1.42 (-2.9, -0.22)	-0.44 (-0.99, 0.27)	-0.38 (-0.57, -0.15)
25% calorie compensation	8%	-0.064 (-0.075, -0.05)	-3.11 (-4.75, -1.49)	2.43 (0.54, 3.97)	-0.68 (-1.59, -0.0)	-0.15 (-0.74, 0.52)	-0.18 (-0.4, 0.06)
50% calorie compensation	8%	-0.063 (-0.076, -0.049)	-1.96 (-3.41, -0.78)	1.51 (0.43, 2.94)	-0.45 (-1.4, 0.07)	-0.1 (-0.67, 0.55)	-0.12 (-0.33, 0.13)
75% calorie compensation	8%	-0.064 (-0.076, -0.052)	-0.83 (-1.75, -0.0)	0.61 (-0.22, 1.51)	-0.23 (-0.74, 0.12)	-0.04 (-0.52, 0.64)	-0.05 (-0.28, 0.22)
49% below basic reading level							
All food sources	4%	-0.027 (-0.038, -0.018)	-1.31 (-2.79, -0.42)	0.98 (-0.13, 2.55)	-0.33 (-1.1, 0.14)	-0.11 (-0.61, 0.59)	-0.09 (-0.28, 0.12)
All food sources	8%	-0.047 (-0.062, -0.028)	-2.91 (-4.7, -1.06)	2.2 (0.27, 4.09)	-0.71 (-1.68, 0.03)	-0.2 (-0.76, 0.44)	-0.18 (-0.41, 0.03)
All food sources	12%	-0.068 (-0.09, -0.049)	-3.76 (-6.61, -1.72)	2.68 (0.3, 5.56)	-1.08 (-2.48, -0.16)	-0.26 (-0.84, 0.57)	-0.25 (-0.46, -0.03)

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75% of corner stores compliant	8%	-0.059 (-0.071, -0.046)	-3.61 (-5.96, -1.6)	2.81 (0.65, 5.0)	-0.8 (-1.83, -0.01)	-0.24 (-0.74, 0.48)	-0.22 (-0.43, -0.02)
50% of corner stores compliant	8%	-0.053 (-0.064, -0.041)	-3.24 (-5.14, -1.67)	2.52 (0.61, 4.27)	-0.72 (-1.63, 0.05)	-0.24 (-0.81, 0.49)	-0.21 (-0.42, 0.04)
75% of supermarkets compliant	8%	-0.058 (-0.07, -0.045)	-3.61 (-5.68, -1.78)	2.73 (0.86, 4.85)	-0.88 (-2.09, 0.05)	-0.26 (-0.74, 0.38)	-0.22 (-0.44, -0.0)
50% of supermarkets compliant	8%	-0.051 (-0.06, -0.039)	-2.99 (-4.95, -1.26)	2.24 (0.19, 4.14)	-0.76 (-1.87, 0.05)	-0.25 (-0.75, 0.32)	-0.19 (-0.4, 0.06)
33% less effective among low SES	8%	-0.06 (-0.071, -0.047)	-3.75 (-6.0, -2.17)	2.83 (1.18, 5.1)	-0.91 (-2.03, -0.15)	-0.28 (-0.79, 0.2)	-0.24 (-0.43, -0.01)
50% less effective among low SES	8%	-0.058 (-0.071, -0.043)	-3.69 (-5.75, -1.91)	2.81 (0.57, 5.24)	-0.88 (-2.08, -0.15)	-0.24 (-0.79, 0.39)	-0.21 (-0.43, 0.02)
Intervention excluding schools	8%	-0.062 (-0.074, -0.05)	-3.97 (-6.14, -2.34)	3.11 (0.72, 5.31)	-0.87 (-2.04, -0.08)	-0.26 (-0.82, 0.51)	-0.22 (-0.45, 0.06)
Intervention only at supermarkets							
All supermarkets	4%	-0.018 (-0.022, -0.013)	-0.55 (-1.19, -0.13)	0.35 (-0.19, 0.91)	-0.2 (-0.66, 0.14)	0.03 (-0.57, 0.66)	-0.03 (-0.23, 0.19)
All supermarkets	8%	-0.031 (-0.037, -0.025)	-1.58 (-2.57, -0.71)	1.17 (0.1, 2.38)	-0.41 (-1.07, 0.12)	-0.15 (-0.65, 0.53)	-0.12 (-0.31, 0.13)
Intervention only at small grocers							
All small grocers	12%	-0.038 (-0.044, -0.031)	-2.2 (-3.39, -1.11)	1.7 (0.39, 2.94)	-0.5 (-1.36, 0.07)	-0.17 (-0.69, 0.43)	-0.14 (-0.34, 0.06)
All small grocers	8%	-0.027 (-0.032, -0.022)	-1.33 (-2.23, -0.67)	1.04 (0.19, 2.0)	-0.29 (-0.87, 0.12)	-0.06 (-0.72, 0.59)	-0.06 (-0.3, 0.17)
Philadelphia							
SSB warning labels in all locations							
All food sources	4%	-0.033 (-0.046, -0.021)	-1.21 (-1.92, -0.6)	0.27 (-0.48, 0.97)	-0.94 (-1.7, -0.33)	-0.06 (-0.77, 0.7)	-0.11 (-0.3, 0.09)
All food sources	8%	-0.064 (-0.075, -0.051)	-2.17 (-3.07, -1.42)	-0.36 (-1.39, 0.83)	-2.54 (-3.95, -1.34)	-0.18 (-0.97, 0.46)	-0.24 (-0.41, -0.06)
All food sources	12%	-0.095 (-0.111, -0.081)	-2.9 (-4.02, -2.07)	-1.32 (-2.95, 0.12)	-4.21 (-5.95, -2.84)	-0.41 (-1.17, 0.43)	-0.39 (-0.6, -0.18)
25% calorie compensation	8%	-0.064 (-0.078, -0.053)	-1.84 (-2.65, -1.16)	-0.01 (-1.07, 0.93)	-1.85 (-3.11, -1.01)	-0.2 (-0.89, 0.58)	-0.2 (-0.36, 0.05)
50% calorie compensation	8%	-0.064 (-0.077, -0.05)	-1.22 (-1.95, -0.64)	0.25 (-0.34, 0.87)	-0.97 (-1.59, -0.37)	-0.03 (-0.71, 0.84)	-0.12 (-0.3, 0.11)

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75% calorie compensation	8%	-0.065 (-0.078, -0.052)	-0.64 (-1.14, -0.25)	0.25 (-0.3, 0.66)	-0.39 (-0.97, -0.03)	0.08 (-0.61, 1.02)	-0.03 (-0.2, 0.17)
49% below basic reading level							
All food sources	4%	-0.019 (-0.028, -0.012)	-0.69 (-1.27, -0.31)	0.17 (-0.34, 0.7)	-0.53 (-1.12, -0.07)	0.02 (-0.71, 0.81)	-0.04 (-0.22, 0.16)
All food sources	8%	-0.039 (-0.053, -0.026)	-1.29 (-2.01, -0.66)	-0.21 (-1.02, 0.58)	-1.5 (-2.43, -0.71)	-0.14 (-0.78, 0.54)	-0.15 (-0.32, 0.02)
All food sources	12%	-0.058 (-0.078, -0.036)	-1.79 (-2.83, -0.84)	-0.65 (-1.96, 0.65)	-2.44 (-3.77, -1.03)	-0.32 (-1.08, 0.45)	-0.26 (-0.45, -0.05)
75% of corner stores compliant	8%	-0.06 (-0.072, -0.049)	-2.05 (-2.69, -1.41)	-0.23 (-1.36, 0.83)	-2.28 (-3.33, -1.42)	-0.22 (-0.97, 0.54)	-0.24 (-0.45, -0.05)
50% of corner stores compliant	8%	-0.053 (-0.065, -0.04)	-1.86 (-2.63, -1.12)	0.07 (-1.06, 1.2)	-1.79 (-2.9, -0.83)	-0.11 (-0.95, 0.67)	-0.2 (-0.41, 0.01)
75% of supermarkets compliant	8%	-0.057 (-0.07, -0.045)	-1.94 (-2.67, -1.22)	-0.16 (-1.45, 0.92)	-2.11 (-3.39, -1.19)	-0.2 (-0.85, 0.5)	-0.22 (-0.4, -0.03)
50% of supermarkets compliant	8%	-0.05 (-0.064, -0.038)	-1.77 (-2.52, -1.05)	0.01 (-1.18, 1.06)	-1.76 (-2.79, -0.91)	-0.17 (-0.79, 0.45)	-0.2 (-0.38, 0.02)
33% less effective among low SES	8%	-0.056 (-0.067, -0.047)	-1.97 (-2.72, -1.27)	-0.02 (-1.01, 1.07)	-2.0 (-2.84, -0.95)	-0.15 (-0.83, 0.59)	-0.2 (-0.4, -0.01)
50% less effective among low SES	8%	-0.052 (-0.063, -0.04)	-1.79 (-2.5, -1.15)	-0.03 (-1.31, 0.72)	-1.82 (-2.75, -1.05)	-0.14 (-0.83, 0.66)	-0.2 (-0.39, -0.02)
Intervention excluding schools	8%	-0.062 (-0.076, -0.049)	-2.14 (-3.02, -1.39)	-0.28 (-1.31, 0.76)	-2.42 (-3.67, -1.49)	-0.27 (-1.01, 0.42)	-0.25 (-0.43, -0.04)
Intervention only at supermarkets							
All supermarkets	4%	-0.014 (-0.02, -0.008)	-0.54 (-0.76, -0.28)	0.14 (-0.17, 0.41)	-0.4 (-0.79, -0.12)	0.0 (-0.7, 0.83)	-0.05 (-0.19, 0.15)
All supermarkets	8%	-0.029 (-0.035, -0.023)	-1.09 (-1.52, -0.69)	0.24 (-0.4, 0.82)	-0.85 (-1.37, -0.33)	-0.04 (-0.74, 0.97)	-0.1 (-0.28, 0.08)
Intervention only at small grocers							
All small grocers	12%	-0.032 (-0.039, -0.026)	-1.13 (-1.57, -0.74)	0.15 (-0.4, 0.69)	-0.97 (-1.53, -0.46)	-0.07 (-0.79, 0.65)	-0.11 (-0.28, 0.08)
All small grocers	8%	-0.022 (-0.026, -0.016)	-0.79 (-1.12, -0.55)	0.23 (-0.28, 0.66)	-0.57 (-1.02, -0.12)	-0.1 (-0.68, 0.65)	-0.09 (-0.26, 0.1)