Reducing Childhood Obesity through U.S. Federal Policy
A Microsimulation Analysis

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Background: Childhood obesity prevalence remains high in the U.S., especially among racial/ethnic minorities and low-income populations. Federal policy is important in improving public health given its broad reach. Information is needed about federal policies that could reduce childhood obesity rates and by how much.

Purpose: To estimate the impact of three federal policies on childhood obesity prevalence in 2032, after 20 years of implementation.
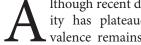
Methods: Criteria were used to select the three following policies to reduce childhood obesity from 26 recommended policies: afterschool physical activity programs, a $0.01/ounce sugar-sweetened beverage (SSB) excise tax, and a ban on child-directed fast food TV advertising. For each policy, the literature was reviewed from January 2000 through July 2012 to find evidence of effectiveness and create average effect sizes. In 2012, a Markov microsimulation model estimated each policy's impact on diet or physical activity, and then BMI, in a simulated school-aged population in 2032.

Results: The microsimulation predicted that afterschool physical activity programs would reduce obesity the most among children aged 6–12 years (1.8 percentage points) and the advertising ban would reduce obesity the least (0.9 percentage points). The SSB excise tax would reduce obesity the most among adolescents aged 13–18 years (2.4 percentage points). All three policies would reduce obesity more among blacks and Hispanics than whites, with the SSB excise tax reducing obesity disparities the most.

Conclusions: All three policies would reduce childhood obesity prevalence by 2032. However, a national $0.01/ounce SSB excise tax is the best option.
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Introduction

Although recent data suggest that childhood obesity has plateaued or begun to decline, prevalence remains high.[1,2] In 2009–2010, nearly one in three U.S. youth aged 2–19 years were overweight or obese and 17% were obese.[3] Significant disparities in obesity prevalence persist among racial/ethnic groups and by SES. More Hispanic (21.2%) and non-Hispanic black (24.3%) youth were obese in 2009–2010 than non-Hispanic white youth (14.0%).[3] Obesity is also higher among lower-income children than higher-income children.[4] Further, obese adolescents tend to remain obese as adults,[5,6] making childhood the ideal time to prevent obesity. For these reasons, policymakers are interested in effective programs and policies to reduce childhood obesity.

States and localities are increasingly using laws, regulations, and other policy tools to promote healthy eating and physical activity (PA).[7] However, federal policies can reach larger populations and fund programs that benefit populations at risk for obesity, and thus play

an essential role in improving public health. Information is needed about which federal policies could reduce childhood obesity rates and by how much. The purpose of this study is to estimate the impact of three federal policies on childhood obesity prevalence in 2032, after 20 years of implementation.

Methods

The methods used in this analysis are summarized below; see the Appendix for more details.

Microsimulation models are useful in informing health policy decision making.[8,9] In 2012, a microsimulation model (developed in TreeAge, TreeAge Software, Inc.) examined how three federal policies affect obesity-related behaviors (PA and diet); BMI; and obesity prevalence in a simulated school-aged U.S. population. The model generated annual values for these measures based on demographic and behavioral variables and then aggregated individual estimates to create population-level results. The initial population was drawn randomly from a sample of simulated school-aged children (6–12 years) and adolescents (13–18 years) with demographic characteristics matching that of the U.S., using 2010 U.S. Census data.

The model's primary outcome variables were BMI and changes in the percentage of overweight or obese youth. Obesity and overweight were determined by comparing BMI values from the model to BMI values from CDC growth charts. The current CDC definitions of obesity (BMI at or above the 95th percentile for age and sex) and overweight (BMI at or above the 85th percentile and below the 95th percentile for age and sex) were used.[10]

The microsimulation model estimated yearly changes in PA, diet, and BMI using multivariable equations developed using 2001–2010 continuous National Health and Nutrition Examination Survey (NHANES) data. The equations included measures of PA expressed in METs and dietary recall measures, including total daily calories and grams of fat, carbohydrates, and sugar. NHANES data were used to assign initial health and BMI measurements to the simulated population and then to estimate the impact of changes in health behaviors on changes in BMI over time.

Each simulated agent was initialized using a two-step process. First, age, sex, and ethnicity were assigned with the distribution of these demographic variables across the simulated population set equal to those in the 2010 U.S. Census. Second, each agent's initial BMI, level of PA, and diet were set conditioned on that agent's demographics. The distribution of each factor across the simulated population was set equal to the distribution observed for that agent's corresponding demographic group in the NHANES sample, scaled to the U.S. child and adolescent population.

The model represents changes in BMI for a simulated population over time, but the NHANES provides a series of cross-sectional estimates. To account for this difference, annual changes in BMI were estimated on the basis of age, sex, and ethnicity trends. The relative BMI remains constant until a policy intervention causes it to trend downward to a new level consistent with expected changes in behavior from the intervention. Each policy was introduced in the model independently.

Next, a systematic process was used to search and review the literature on 26 recommended policies for preventing childhood obesity. The list was narrowed to three policies in a two-step process using multiple criteria, including effectiveness, potential reach into the general population and high-risk groups, feasibility, acceptability, precision of information for modeling, and potential impact on childhood obesity.

Effectiveness was rated as "unknown," "emerging," "promising," "effective (second tier)," or "effective (first tier)."[11] The other criteria were rated low, medium/moderate, or high. The policies would (1) strengthen and expand federally funded afterschool programs to promote PA; (2) enact a \$0.01/ounce excise tax on sugar-sweetened beverages (SSBs); and (3) ban fast food TV advertising targeting children aged 12 years and under. These policies target key obesity-related behaviors through the federal policy mechanisms of appropriation, taxation, and regulation. Table 1 summarizes the policies.

Estimating Effect Sizes

PubMed and journal article references were searched from January 2000 through July 2012 to find effectiveness data for the three policies and create average effect sizes. A systematic strategy and policy definition limited the scope of the literature search and identified key data elements for the population groups targeted by each policy. The literature search and abstraction process followed methods previously described.[12] Owing to the varied nature of evidence, the general process to determine each policy's average effect size was modified as needed. Table 2 lists model inputs. Effects of interventions enter the model through increases in PA or reductions in calories, both of which are determinants of BMI z scores.

Afterschool Physical Activity Programs

The literature search generated 55 potentially relevant articles. Inclusion and exclusion criteria identified 16 articles suitable for abstraction. To be abstracted, studies needed to evaluate an afterschool intervention or program, report measures that could be used in the model, have a sample size of at least 50, describe an intervention that resembled a typical afterschool program, use randomization or a pre-test/post-test design, require participants to engage in PA, and be conducted in an Organization for Economic Cooperation and Development country. One article was eliminated during abstraction because the intervention was unclear.

Effect sizes for the 15 articles[13–27] were summarized by sample size; sex; race; location; age (school grade); baseline BMI (normal or obese); program adherence; intervention design; and intervention intensity. Because most studies did not provide sample demographics, effect sizes were averaged across all racial/ethnic groups. The policy was modeled such that all programs were offered to all youth for the entire year. The modeled intervention combined individual interventions using sample sizes and demographic breakdowns as weighting factors.

Sugar-Sweetened Beverage Excise Tax

No well-controlled trials were found that directly assessed an excise tax's impact on youth SSB consumption or the relationship between SSB consumption and childhood obesity. Instead, the literature search yielded well-controlled, econometric studies using observational data that showed a negative association between increased taxes on SSBs and SSB purchases. Few studies quantified