Modeling the Cost Effectiveness of Child Care Policy Changes in the U.S.

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Introduction: Child care facilities influence diet and physical activity, making them ideal obesity prevention settings. The purpose of this study is to quantify the health and economic impacts of a multi-component regulatory obesity policy intervention in licensed U.S. child care facilities.

Methods: Two-year costs and BMI changes resulting from changes in beverage, physical activity, and screen time regulations affecting a cohort of up to 6.5 million preschool-aged children attending child care facilities were estimated in 2014 using published data. A Markov cohort model simulated the intervention's impact on changes in the U.S. population from 2015 to 2025, including short-term BMI effects and 10-year healthcare expenditures. Future outcomes were discounted at 3% annually. Probabilistic sensitivity analyses simulated 95% uncertainty intervals (UIs) around outcomes.

Results: Regulatory changes would lead children to watch less TV, get more minutes of moderate and vigorous physical activity, and consume fewer sugar-sweetened beverages. Within the 6.5 million eligible population, national implementation could reach 3.69 million children, cost \$4.82 million in the first year, and result in 0.0186 fewer BMI units (95% UI=0.00592 kg/m^2, 0.0434 kg/m^2) per eligible child at a cost of \$57.80 per BMI unit avoided. Over 10 years, these effects would result in net healthcare cost savings of \$51.6 (95% UI=\$14.2, \$134) million. The intervention is 94.7% likely to be cost saving by 2025.

Conclusions: Changing child care regulations could have a small but meaningful impact on short-term BMI at low cost. If effects are maintained for 10 years, obesity-related healthcare cost savings are likely.
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Introduction

More than 20% of preschool-aged children in the U.S. are overweight or obese.[1] Early obesity is a risk factor for hypertension, Type 2 diabetes, cancers, and psychosocial issues throughout the life course.[2,3] Risk factors for obesity, including dietary habits, physical activity, and screen time behaviors, track from early into later childhood,[4–6] and then persist from childhood into adulthood.[7] The risk of early obesogenic behaviors persisting over the life course and the difficulty of changing long-term habits in adulthood highlight the importance of early intervention for obesity prevention.

Approximately 69% of American preschool-aged children used an out-of-home child care provider in 2005.[8] Full-day programs are responsible for up to two thirds of children's food intake per day in care.[9,10] Child care providers also often provide daily opportunities for children to participate in physical activity.[11,12] Given the importance of addressing obesity early,[13] the length of time children spend in the child care environment, and the influence child care facilities have on healthy

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behaviors, the child care setting is an ideal intervention target.[11]

Child care policies can be influenced by many actors—state licensing agencies, federal nutrition programs such as Head Start or the Child and Adult Care Food Program (CACFP), and other accreditation organizations. Many of these programs encourage serving reduced-fat milk and limiting servings of sugar-sweetened beverages (SSBs) and 100% juice. However, not all child care providers are under the jurisdiction of national nutrition programs or accrediting bodies, and instead may be subject to state or local policies that vary widely.[14] Physical activity and screen time policies are sometimes regulated by state licensing agencies, but regulations often do not strictly limit sedentary behaviors.[14,15]

Some studies have examined the efficacy of single- and multi-component obesity prevention initiatives in the child care setting.[16] However, no studies have examined the cost of conducting an obesity prevention policy initiative in the child care setting. This study estimates the health and economic impact of obesity prevention policy changes in child care environments in the U.S. to bridge this gap in the literature.

Methods

Intervention

A hypothetical state-level regulatory policy intervention was developed for this analysis. The intervention was based on current recommendations regarding healthy behavior practices in child care programs[14,17–21] and current state and local child care initiatives.[22–24] The intervention consisted of three components. The beverage component stipulated that water be made freely available throughout the program day, that SSBs be replaced with water, 100% juice be limited to 6 ounces per child per day, and whole milk be replaced with reduced-fat milk. The physical activity component required programs to provide opportunities for at least 90 minutes of moderate to vigorous physical activity (MVPA) over the course of the program day for children in full-time care. The screen time component specified that TV and computer time be educational in nature and limited to 30 minutes per week.

Current Practice

Existing practices in child care centers (CCCs) and family-based child care homes (FBCHs) (hereafter collectively referred to as "facilities") do not meet recommendations for diet, physical activity, and screen time.[16] Children in child care facilities are sedentary for most of the program day and the foods and beverages children consume do not meet dietary recommendations.[25–27] Moreover, children's screen time exceeds national recommendations,[28] especially in FBCHs.[29] Although state regulations can improve adherence to diet and physical activity recommendations in child care facilities, many states do not regulate such behaviors or regulations fall short of recommended best practices.[14,17]

Modeling Framework

The analysis is based on a modeling framework developed by a collaboration of researchers from the Harvard T.H. Chan School of Public Health, Columbia Mailman School of Public Health, and Deakin University and University of Queensland in Australia. The Assessing Cost-Effectiveness (ACE) framework[30,31] was adapted and modified by the research team to develop a model for the Childhood Obesity Intervention Cost-Effectiveness Study (CHOICES), including using U.S.-based cost and parameter inputs, among other changes described elsewhere.[32] This model was used to conduct an economic analysis of the proposed hypothetical intervention in U.S. child care facilities. The CHOICES model is a Markov-based cohort simulation model with components that model intervention implementation and short- and longer-term outcomes. Short-term changes in BMI resulting from the intervention over a 2-year period were modeled in the @RISK software program, version 6.0, based on parameter estimates from peer-reviewed randomized trials, meta-analyses, and cross-sectional studies. Next, the short-term estimated BMI changes were used to project future obesity, obesity-related comorbidities, and related healthcare expenditures over a 10-year horizon for a cohort of the 2015 U.S. population based on one million iterations of the model developed in a compiled programming language.[32,33] The Markov cohort model used a 1-year cycle length. The model calculates differences in healthcare expenditures with and without the intervention based on estimated differences in healthcare costs for obese and non-obese children as documented by Finkelstein and Trogdon.[34] These healthcare costs are reported as net present value discounted at 3% per year. The 2015 reference year was selected to evaluate the shift in BMI and healthcare costs over a meaningful 10-year policy window and to create consistency across inputs, including demographic characteristics, intervention costs, and disease rates. The model estimates changes in population BMI for 5-year age and gender groups for the cohort under the no-intervention and intervention scenarios. All data were collected and analyzed in 2014.

Because no changes in obesity-related morbidity or mortality were expected in the 10-year study modeling time frame among this cohort of very young children, and because reliable inputs for the simulation model in years beyond childhood are difficult to obtain, changes in disability-adjusted life years (DALYs) were not assessed. No effect of the interventions at the beginning of the first year and full effect throughout the second year were modeled. This approach was used to reflect recent work of Hall et al.[35] Therefore, the children in the model who would be in the intervention for less than the full 2 years (e.g., those aged 4 and 5 years who start kindergarten in Year 2 of the hypothetical intervention) were estimated to receive only half the modeled BMI benefits and incur half the costs of the 2-year intervention. Additional details on the modeling framework are reported in the overview paper by Gortmaker and colleagues.[32]

Implementation and Equity Considerations

An expert panel of stakeholders, including public health practitioners, policymakers, and researchers, met to discuss the feasibility of implementing the intervention and the impact of the intervention on equity to complement the quantitative assessment of the intervention's costs and effectiveness. These implementation considerations included strength of evidence, equity, acceptability to real-world decision makers, sustainability, feasibility, and potential for side effects.

Policy Reach

The intervention was modeled for a cohort of U.S. preschool-aged children, aged 2.5–5 years,[36] who are expected to use licensed child care facilities in 2015. Estimates for the number of eligible children, number of facilities, enrollment in facilities, and time spent in care were obtained from nationally representative child care surveys.[8,28,37,38]

A review of state regulations relevant to each policy component and enacted as of July 2014[14,39] was updated to reflect current regulations regarding child care–based obesity prevention (Figures 1A and 1B).[40] No state had regulations that met or exceeded all three intervention components in CCCs and FBCHs. Although local districts and individual centers may have policies regarding obesogenic behaviors in child care facilities, regulations below the state level and non-legislated pilot programs were not considered in the assessment of current practices.[22–24]

Estimated BMI changes from each policy component (beverage, physical activity, and screen time) were modeled separately, and were summed to assess the total intervention benefit. It was assumed that children in states with regulations that met or exceeded a policy component received no additional health benefits and incurred no costs for that component. Children in states with regulations that addressed but did not meet a proposed policy component incurred half the intervention costs and health benefits associated with that component in the model. It was assumed that 73% of facilities would fully adopt any policy component based on prior estimates of implementation of a policy intervention.[41]

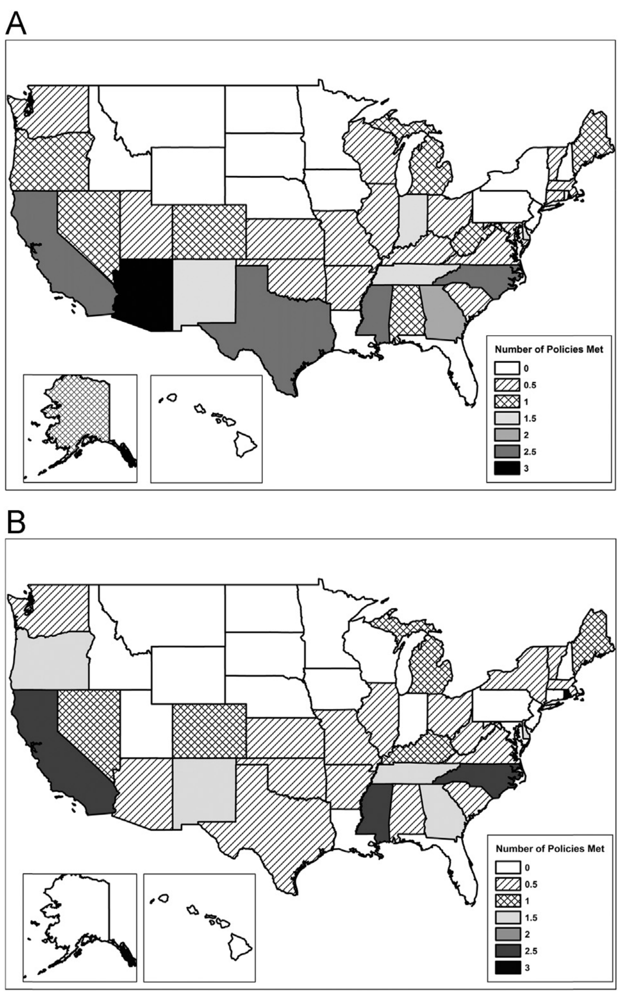

Figure 1. (A) Baseline CCC adherence to proposed regulatory policies. (B) Baseline FBCH adherence to proposed regulatory policies.
[A]CCC, child care center
[B]FBHC, family-based childcare home

Assessment of Benefit

Baseline beverage consumption data for child care settings was obtained from an observational study[26] (Table 1). Observed 100% juice consumption was below the policy limit of 6 ounces and therefore not modeled. Data from an RCT were used to estimate the change in body weight (kg) resulting from eliminating SSB consumption during child care in the primary analysis[42,43] (Table 2).

Baseline daily minutes of physical activity opportunities provided in child care programs were estimated from a report of outdoor play time in facilities[29] (Table 1). Hourly outdoor playtime estimates were obtained directly from the study authors (M. Garrison, University of Washington, personal communication, 2013). Each child was assumed to receive opportunities for 90 minutes of MVPA per program day as a result of the policy. An additional 44% of CCCs and 49% of FBCHs would need to schedule an extra 30 minutes of PA time daily as a result of the policy. For those facilities that would benefit from the policy change, the daily increase in children's MVPA was calculated by multiplying extra scheduled PA time (30 minutes) by an estimate of adherence to scheduled PA time (94%),[44] and estimates from the published literature of the percentage of PA time provided that children spend in MVPA (Table 2). The net change in BMI associated with the estimated daily increase in MVPA was calculated using results from a randomized trial that related a change in MVPA during the school day to a change in BMI (Appendix Section 1.3, available online)[48,54] (Table 2).

The effects of the screen time component of the policy intervention were modeled for the estimated 30% of CCCs and 66% of FBCHs with no regulatory limits on screen time and for facilities that do not restrict screen time to educational content only. Baseline screen time viewing estimates were obtained from two studies on screen time in child care facilities[28] (Table 1). Current evidence suggests that the relationship between screen time and weight gain is mediated by changes in energy intake related to commercial TV viewing.[55,56] The impact of screen time viewing on BMI was calculated using estimates from a randomized trial that related a change in the number of hours of TV watched per day to a change in BMI[49,57] (Table 2).

Policy implementation costs were estimated from a societal perspective; parent-incurred opportunity costs and out-of-pocket costs were not accounted for.[58] The intervention was evaluated using "steady state" assumptions. That is, the marginal annual

Table 1. Differences in Obesity-Related Behaviors, Pre- and Post-Intervention

Category	Current practice (mean)	Post-intervention (mean)	Change	Source
Beverages				
Sugar-sweetened beverage consumption (oz/day)	0.4	0.0	−0.4	Ball 2008 [26]
100% juice consumption (oz/day)	2.8	2.8	—	Ball 2008 [26]
Whole fat milk consumption (oz/day)	5.2	0.0	−5.2	Ball 2008 [26]
Reduced-fat milk consumption (oz/day)	3.8	9.0	+5.2	Ball 2008 [26]
Low-fat milk consumption (oz/day)	1.1	1.1	—	Ball 2008 [26]
Water consumption (oz/day)	—	—	+0.4[a]	Assumption
Physical activity				
Percent of CCCs scheduling at least 60 min daily PA	56%	100%	+44%	Tandon 2012 [29]
Percent of FBCHs scheduling at least 60 min daily PA	51%	100%	+49%	Tandon 2012 [29]
Screen Time[b]				
Child care centers (min/day)	12	6	−6	Tandon 2011 [28] and Lyn[c]
Family-based child care homes (min/day)	105	6	− 99	Tandon 2011 [28]

[a]Sugar-sweetened beverage consumption replaced by water consumption.
[b]In facilities that use television.
[c]Rodney Lyn, PhD, Georgia State University Institute of Public Health, personal communication, March 2012.
CCC, child care center; FBCH, family-based child care home; min, minutes; MVPA, moderate to vigorous physical activity; oz, ounces.

costs for maintaining an already implemented policy were evaluated. Costs were converted to July 2014 U.S. dollars using the U.S. Consumer Price Index.[59] Three categories of intervention costs were estimated: licensing, training, and beverage costs (Table 2). In the assessment of licensing and training costs, staff hourly wage data were obtained from the Bureau of Labor Statistics. It was assumed that all existing employees would be compensated for fringe benefits, 56% for government employees and 43% for private sector employees.[60]

It was assumed that new regulations would increase costs in existing child care regulatory agencies owing to increasing inspection time and administrative time for licensing supervisors. The cost of training facility administrators on policy adherence was accounted for, assuming administrators would receive an additional 90–120 minutes of professional development training biannually. Lastly, the cost savings to facilities from changes in beverages served was accounted for[52,61] (Table 2).

Uncertainty and Sensitivity Analyses

Probability distributions were placed around the input parameters, including time spent in care and policy adherence to account for uncertainties in exact parameter estimates (Table 2). Probabilistic Monte Carlo simulations were used to generate 95% uncertainty intervals (UIs) around results.[63]

Sensitivity analyses were conducted to test the robustness of model results, modeling effectiveness using alternative baseline behavior estimates and levels of policy adherence. Additionally, scenario analyses were conducted using alternative policy adherence estimates and outcomes. Model inputs for sensitivity and scenario analyses can be found in Appendix Section 1.2 (available online).

Results

An estimated 6.5 million of the 14.4 million preschool-aged children in the U.S. used child care facilities in 2015. The reach of the policy was mitigated by facility non-compliance (26%) and baseline state compliance with proposed policies. After consideration of these mitigating factors, the primary diet, physical activity, and screen time components were estimated to have reached 3.69, 3.32, and 1.63 million children, respectively.

The 1-year expected BMI change from the intervention versus current practice was 0.0186 kg/m^2 (95% UI=0.00592, 0.0434) per eligible child (Table 3). The physical activity, beverage, and screen time components were responsible for 28%, 32%, and 40% of BMI changes, respectively, in the primary analysis. The intervention resulted in a mean 21.4 fewer hours of screen time, 5.11 more hours of MVPA, 588 fewer ounces of whole milk, and 39.9 fewer ounces of SSBs annually per targeted child.

Table 2. Model Parameter Input Values and Range Used in Sensitivity Analyses

Parameter	Mean Value	95% UI sampled	Sources and modeling parameters
Policy reach			
Number of preschool-aged children in 2015 (million)	14.4	—	U.S. Census 2012 National Population Projections[38]
Hours per week in child care	CCC: 24.6 FBCH: 35.8	CCC: 23.9–25.3[a] FBCH: 34.8–36.8[a]	Tandon 2011,[28] ECLS-B data
Hours per day in child care	6.0	4.2–7.8[b]	Assumption
Days per week in child care	CCC: 4.1 FBCH: 4.9	CCC: 3.2–5.0 FBCH: 4.6–5.0	Calculated from hours per week and hours per day in child care
Days per year in child care	177	131–230	Calculated from hours per week and hours per day in child care
Number of facilities	CCC: 110,252 FBCH: 197,294	—	2007 Child Care Licensing Study[37]
Percent of children that use facilities (%)	CCC: 57.2 FBCH: 11.6	—	2005 National Household Education Survey[8]
Percent of facilities that comply with policy (%)	73	57–92[b]	Nutrition and Physical Activity Self-Assessment for Child Care[41]
Assessment of intervention benefit			
Height, weight of children	Varies	Varies[b]	NHANES 2009–2012
Beverage component			
Δ in SSB consumption to Δ weight (kg, primary scenario)	1.1	0.48–1.54[a]	deRuyter 2012,[42] 8 ounce serving
Physical activity component			
Percent of scheduled PA time received (%)	94	—	Williams 2009[44]
Percent of PA time that is MVPA (%, boys)	26.6	14.5–36.6[c]	Raustorp 2012,[45] Tandon, 2013,[46] and McKenzie 1997[47]
Percent of PA time that is MVPA (%, girls)	24.7	13.0–25.4[c]	Raustorp 2012,[45] Tandon 2013,[46] and McKenzie 1997[47]
1-year change in BMI per min MVPA per day	0.02	0.01–0.03[a]	Kriemler 2010[48] (see Appendix section 1.3, available online)
Screen time component			
1-year change in BMI per hour TV time per day	0.33	0.16–0.50[a]	Robinson 1999[49]
Percent of FBCH that use TV (%)	70	—	Christakis 2009[50]

(continued on next page)

Table 2. Model Parameter Input Values and Range Used in Sensitivity Analyses *(continued)*

Parameter	Mean Value	95% UI sampled	Sources and modeling parameters
Percent of CCC that use TV (%)	29	–	Christakis 2009[50]
Costs[d]			
Licensing costs			
Licensing supervisor hourly wage ($)	25.35	–	Estimated from a census of state licensing agency salaries (see Appendix section 1.1, available online)
Licensing staff hourly wage ($)	20.35	–	Estimated from a census of state licensing agency salaries (see Appendix section 1.1, available online)
Licensing staff inspection time (minutes per center)	30	15–60[b]	Expert stakeholder group consensus
Licensing supervisor % FTE	3	0–5[c]	Expert stakeholder group consensus
Training costs			
Child care center administrator hourly wage ($)	25.57	–	U.S. Bureau of Labor Statistics 2013 mean salary for Occupation 11-9031: Education Administrators, Preschool and Child Care Center/Program
Child care center administrator training time (minutes per year)	105	90[b]	Expert stakeholder group consensus
Trainer hourly wage ($)	25.35	–	Estimated from a census of state licensing agency salaries (see Appendix, section 1.1, available online)
Trainer time (minutes per center)	8	1–15[b]	Expert stakeholder group consensus
Training materials (per center; $)	10	–	Expert stakeholder group consensus
Food costs			
Cost per ounce SSB ($)	0.0612	–	Powell 2014[51]
Cost per ounce whole milk ($)	0.0295	–	Agriculture Marketing Service, U.S. Department of Agriculture[52]
Cost per ounce reduced fat milk ($)	0.0284	–	Agriculture Marketing Service, U.S. Department of Agriculture[52]
Cost per ounce water ($)	<0.001	–	Bulk price of disposable cups [53]

[a]Range represents 95% UI. Sample drawn from normal distribution.
[b]Range represents 95% UI. Sample drawn from uniform distribution.
[c]Range represents 95% UI. Sample drawn from beta distribution.
[d]All costs are reported in July 2014 U.S. dollars.
CCC, child care center; Δ, change; FBCH, family-based child care home; FTE, full-time equivalent; kg, kilogram; PA, physical activity; SSB, sugar-sweetened beverage; UI, uncertainty interval.

Table 3. Cost-Effectiveness Results

	Total (95% UI)
Intervention reach	
Eligible population (millions)[a]	6.50 (6.19, 6.82)
Number of children who use a CCC (millions)	5.77 (5.55, 5.99)
Number of children who use an FBCH (millions)	0.735 (0.645, 0.825)
Benefitting population	
SSB policy (millions)	3.69 (2.85, 4.58)
Milk policy (millions)	5.64 (5.39, 5.89)
Physical activity policy (millions)	3.32 (2.56, 4.12)
Screen time policy (millions)	1.63 (1.25, 2.03)
Short-term outcomes	
Reduction in annual SSB consumption per capita[a] (ounces)	39.9 (26.6, 56.4)
Reduction in annual whole milk consumption per capita[a] (ounces)	588 (391, 831)
Increase in annual MVPA per capita[a] (hours)	5.11 (0.0, 16.4)
Reduction in annual screen time per capita[a] (hours)	21.4 (14.7, 29.3)
First-year intervention cost ($, millions)	4.82 (−6.02, 12.6)
Total BMI units reduced (millions)	0.338 (0.107, 0.790)
Mean BMI reduction per capita[a] (kg/m^2)	0.0186 (0.00592, 0.0434)
ICER, cost per BMI unit avoided ($/(kg/m^2))	57.8 (–[b], 138)
10-year outcomes	
Intervention cost ($, millions)	8.39 (−10.4, 21.9)
Net healthcare costs ($, millions)[c]	−51.6 (−134.1, −14.2)
Net costs ($, millions)	−43.2 (−133, 4.24)
Probability of cost saving at year 10 (%)	94.7 (–)

[a]All per capita results are reported for the population of children eligible to benefit from the policy, children aged 2.5 to 5 years in the U.S. expected to use a licensed child care facility in 2015.
[b]Interventions are considered "Dominant" when they result in both a net cost savings (accounting for intervention costs and expected savings in healthcare costs) and an increase in health benefits. It is customary not to report negative ICERS because they cannot be interpreted.[63] For the short-term outcome of cost per BMI unit avoided ($/(kg/m^2)), 16% of iterations were dominant.
[c]The reduction in healthcare costs refers to the simulated difference in healthcare costs over a 10-year horizon attributable to the intervention for a baseline cohort of the U.S. population in 2015. Healthcare costs and health effects are estimated annually for 10 years and are reported as present value in 2014 U.S. dollars discounted at 3% annually.
CCC, child care center; DALYs, disability-adjusted life years; FBCH, family-based child care home; ICER, incremental cost-effectiveness ratio; MVPA, moderate to vigorous physical activity; SSB, sugar-sweetened beverage; UI, uncertainty interval.

The first-year cost of the intervention was $4.82 (95% UI=–$6.02, $12.6) million. Positive training and licensing intervention costs were mitigated by savings realized from small changes in daily beverage servings, as low-fat milk is less expensive than full-fat milk and water costs less per serving than SSBs. The short-term cost effectiveness of the intervention was $57.80 per BMI unit averted. If sustained for 10 years, these effects would result in net healthcare cost savings of $51.6 (95% UI=$14.2, $134) million. The intervention is 94.7% likely to be cost saving over a 10-year period.

Results were sensitive to alternative inputs and effectiveness pathways (Appendix Section 2.1, available online). Sensitivity analyses that assumed higher levels of policy adherence reduced total costs (–$5.92 million in sensitivity analyses vs $4.82 million in the base case). The sensitivity analysis that considered lower baseline estimates of whole milk and SSB consumption resulted in higher total intervention costs ($8.08 million vs $4.82 million), but did not result in significant differences in effectiveness measures.

The CHOICES stakeholder group voiced concerns around the potential that the policy may result in increases in tuition or child care costs, thus exacerbating disparities among low-income families who may no longer be able to afford tuition, and among families that use unlicensed programs or relatives for care and whose children may not receive health benefits from the policy. Stakeholders also expressed concerns about teacher reluctance to revise programming because of burden, lack of equipment, or personal preferences. Conversely, stakeholders believed the existing regulatory and licensing structure, and state receptiveness to adopting best practices, could aid policy implementation, raise parental awareness about appropriate diet and physical activity behaviors for preschoolers, and spill over to the home environment (Table 4).

Discussion

This is the first study to examine the potential economic impact of a multi-component child care–based obesity policy intervention. Implementing comprehensive obesity prevention policies in child care facilities appears to be a viable and cost-effective obesity prevention strategy. The modeled child care facility policy changes resulted in an estimated 0.0186 kg/m^2 per child decrease in BMI among the eligible population of 6.5 million American preschool-aged children at a cost of $57.80 per BMI unit avoided over the course of 1 year. There is a 94.7% chance that these small BMI changes early on will result in cost savings over a 10-year time horizon for the cohort of preschool-aged children enrolled in child care facilities in 2015 owing to reduced obesity-related healthcare costs incurred during childhood and adolescence.[34] Overall, the intervention would result in a net savings of $6.15 (95% UI=–$66.0, $51.9) per dollar spent administering the intervention. Because this intervention targets preschool-aged children, and because most of the health and economic consequences of obesity are not realized until adulthood, the impact of the intervention over a lifetime horizon was not estimated, as children would have to maintain the modest BMI reduction for at least 35 years to see any observed benefits related to DALYs or mortality and there would be a great deal of uncertainty around those long-term projected results.[62,64] The estimated change in BMI is equivalent to a 0.16% reduction in mean BMI among children aged 2–4 years or a 0.3% reduction in obesity prevalence in that age group.

These findings have implications for stakeholder concerns about intervention implementation and possible negative externalities. In the first year of the intervention, facilities saved on average approximately $9.99 and $44.3 per center, per year on milk and SSBs, respectively, and only spent $3.31 more per center, per year on water as a result of the beverage policy. With more than 270,000 child care facilities affected by the policy, these savings add up quickly. The expected cost savings from the beverage policy and low per capita cost of the intervention help to mitigate concerns about costs. Moreover, improving the quality of child care in low-performing facilities may improve equity across the board by leveling the playing field among facilities.

The proposed intervention would hypothetically be as or more effective in reducing BMI than other child care–based obesity interventions that have been conducted to date.[65–67] With a large target population and a total 1-year implementation cost under $2 per child, this intervention is low cost relative to smaller U.S. school- and community-based childhood obesity interventions, which range in cost from $15 to $839 per child.[68–71] Given differences in effectiveness measures[70,71] and the fact that lifetime maintenance of effects was not assumed,[68,69,72] the expected cost effectiveness of this intervention cannot be directly compared to a number of other cost-effectiveness analyses.

The observed health benefits are a function of the intervention setting and impacted population. Some potential policy interventions reach a large population across multiple ages (e.g., an SSB excise tax[43] and limiting the subsidy for TV ads for unhealthy foods[57]). BMI reductions among adults would result in more near-term obesity-related health benefits, whereas the targeted population in this study would have to wait decades to realize most of the potential health effects attributable to early BMI changes. Despite the broad potential reach of child care policy interventions, the eligible population was limited to 6.5 million of the 14.4 million preschool-aged children in the U.S. who use a child care facility. It was also assumed that only 73% of centers would comply with the policy, some states were assumed already to be in partial compliance with the policy, and children may not attend each day of the year, leading to a smaller benefitting population. However, the child care setting remains a promising vehicle for obesogenic behavior change. Existing infrastructure may be used to train administrators and monitor compliance at a low cost. The intervention may have additional spillover benefits by changing social norms and preferences for healthy eating and sedentary behavior practices, making the intervention a favorable public health strategy.

Limitations

This analysis was subject to limitations. The total impact of the intervention was estimated by summing the independent effects of the beverage, physical activity,

Table 4. Implementation and Policy Considerations

Level of evidence	Equity	Feasibility	Acceptability	Sustainability	Side effects	Social and policy norms
Concerns and considerations						
In primary analysis, data linking change in behavior (i.e., MVPA, SSB consumption, screen time) to change in BMI is derived from RCTs. Some input parameters (e.g., baseline behaviors, resource utilization, and policy reach) rely on researcher assumptions and observational data, although many are derived from analyses of national survey data.	Increase equity by bringing standards in low-quality facilities up to par with higher-quality facilities. Potential to increase disparities for poorer children enrolled in family-based child care homes or who rely on relatives for child care. Potential to increase inequities because all facilities do not have equal access to safe PA space, facilities, and equipment.	Child care programs are already regulated by states; the monitoring structure is in place. Several states have adopted individual elements of the three-part policy. Hard for providers with limited infrastructure, teacher training, and equipment to achieve PA goals. Child care programs may find it difficult to comply fully with new policies.	States receptive to adopting best practices. Teachers may be uncomfortable with leading structured PA or resistant because of child development concerns. Extra administrative burden associated with policy compliance. Will have to identify programmatic substitution for screen time. Possibility for less break time for teachers. May be teacher resistance to beverage policies because of personal preferences.	Will have to adapt policy as CACFP beverage standards change. Funding sources unclear. Potential to be an unfunded mandate at state regulatory level.	Other benefits of PA, including cardiovascular health, mental health, classroom behaviors. Health benefits other than decrease in obesity resulting from consumption of more nutrient-rich foods. Healthy behaviors may spread to home environment. Healthy behaviors may be adopted by staff in their own homes. Potential for other aspects of child care programs to be cut if budget needs rearranging from policy changes.	Increase awareness of appropriate obesity prevention policies for preschoolers.
Decision points						
Strong evidence linking behavior change to BMI change. Some uncertainty around evidence for policy reach and intervention costs.	Moderate risk of potential negative effect on equity.	Feasible with sufficient training for center directors and employees.	Acceptable to policy makers, but teachers will require training to reduce resistance to policy changes.	Sustainable if implemented. Intervention should be low-cost if all components are implemented.	Substantial benefits; financial concerns mitigated by low cost of intervention.	Strong potential benefit.

CACFP, Child and Adult Care Food Program; MVPA, moderate to vigorous physical activity; PA, physical activity; SSB, sugar-sweetened beverages.

and screen time components of the intervention. Effects from each component may not be independent, thus this approach may overestimate the total impact of policy changes on health. However, irrespective of expected health benefits, there is evidence that improving the quality of child care programs can result in long-term social and welfare benefits. [73,74]

State-level regulatory policies, but not actual facility practices, were considered when calculating the hypothetical impact of the intervention. Several states and local child care facilities have existing obesity prevention policies.[22–24] Conversely, individual facilities in states may not be fully compliant with regulatory policies[75] and parents may opt out of facility-provided meal plans. These micro-level differences in practices contribute to uncertainty around modeled effectiveness estimates. Lastly, baseline compliance with CACFP standards, which already meet the proposed beverage policy standards, among facilities that already receive CACFP funding (approximately 61% of existing centers[37,76]) may mitigate some of the economic and health benefits attributed to the beverage component of the intervention.[15] Beverage consumption estimates from CACFP facilities, which are mostly in compliance with the proposed beverage policy standards,[77] were used in sensitivity analyses (Appendix Section 1.4, available online). In the sensitivity analysis, the short-term cost effectiveness of the proposed intervention increased to $98.3 per BMI unit avoided from $57.8 per BMI unit avoided in the base case scenario. However, $98.3 per BMI unit avoided is still cost effective relative to other childhood obesity interventions.

There are limitations related to the existing evidence. Model inputs came from a variety of sources. Some effectiveness estimates were derived from small, nonrepresentative studies or were based on randomized trials among children slightly older than the preschool-aged child target population. However, inputs are consistent with other effectiveness estimates in the literature. For instance, the relationship between screen time and BMI was the same in a randomized trial including preschool-aged children[78] and the randomized trial including elementary school-aged children that was used as an input for the model.[49] Base case beverage consumption estimates for the model were derived from an observational study in one state.[26] Baseline estimates for the amount of PA time offered were derived from a self-report survey,[29] and there is no consensus as to whether increased outdoor playtime consistently leads to increased MVPA.[79–81] Finally, the policy effectiveness estimates did not account for the fact that more healthful behavior changes in child care facilities may impact behaviors outside of child care facilities. Therefore, the effects shown here may be overestimated or underestimated owing to positive spillover or negative compensating behaviors, respectively.

Although changes in BMI associated with behavior changes are supported by the published literature, the link between policy implementation and actual expected behavior change is less strong. Little existing evidence in the peer-reviewed literature links policy changes, as opposed to behavior changes, directly to BMI outcomes. However, the estimate that 73% of facilities would fully adopt any policy component that was used to translate policy changes to behavior changes is supported by the child care policy implementation literature[41] and is in line with other policy adherence estimates.[44,82]

Where direct evidence from published literature was not available, assumptions were made about inputs such as the number of days per year a child attended a center and the labor needed to administer the policy. However, many inputs were supported by evidence in the literature, and sensitivity and scenario analyses show results are fairly robust in terms of researcher assumptions.

Conclusions

This paper models the anticipated the costs and effectiveness of a multi-component regulatory policy approach to encouraging healthy behaviors among children aged 2.5–5 years in the U.S. that use child care facilities. Implementing obesity prevention policies in child care settings is likely to be cost effective relative to other childhood obesity interventions, providing 10-year cost savings and health benefits.

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Appendix

Supplementary data

Supplementary data associated with this article can be found at http://dx.doi.org/10.1016/j.amepre.2015.03.016.