



## Shape Up Somerville's return on investment: Multi-group exposure generates net-benefits in a child obesity intervention<sup>☆</sup>

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### ABSTRACT

Community-based interventions may reduce and prevent childhood obesity by transforming the environments in which children live, learn, and play through a series of interventions implemented throughout the community that encourage healthy behaviors. While empirical support is building for the effectiveness of such interventions, little is known about the economic costs and benefits of community-wide childhood obesity interventions. This study examined whether the benefits of a community-wide, child-focused, obesity prevention intervention, Shape Up Somerville: Eat Smart Play Hard (SUS), exceeded its costs by estimating its return on investment.

The SUS intervention study occurred in Somerville, Massachusetts (and in two additional geographic areas, which were the study's control group) during the 2003/04 and 2004/05 school years. We estimated SUS's costs using SUS data over the two-year intervention. We estimated benefits (i.e., healthcare costs and productivity losses averted for children and their parents) over a ten-year time horizon using SUS effectiveness results and other sources. SUS generated an estimated \$1.51 in savings for every \$1.00 invested in the program (return on investment of \$0.51). Over ten years, the estimated costs averted were over \$500,000 with net benefits of \$197,120 (2014 dollars).

SUS was estimated to be a cost-saving intervention when examined over a ten-year time horizon. The excess benefits generated by SUS likely arose from the community-wide nature of the intervention which extended exposure (and estimated benefits) beyond children to parents as well. These results illustrate that allocating resources to community-wide, child-focused obesity prevention interventions may be a beneficial investment.

### 1. Introduction

Community-wide environmental change programs are a possible solution to address the multiple social and environmental influences that contribute to childhood obesity (Glickman et al., 2012; Institute of Medicine of The National Academies, 2012; Whitacre et al., 2009; Olson, 2014). These programs transform the individuals' environments (Glickman et al., 2012; Institute of Medicine of The National

Academies, 2012; Whitacre et al., 2009; Olson, 2014) to promote healthy dietary practices and physical activity. Despite the building evidence regarding the effectiveness of community-wide environmental change programs in reducing/preventing childhood overweight and obesity (Bleich et al., 2013; Wolfenden et al., 2014; Economos et al., 2007; Economos et al., 2013; Economos and Hennessy, 2011) and the 2012 recommendation by the Institute of Medicine (IOM) that a system-wide approach is needed to address the obesity epidemic (Glickman

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et al., 2012) the question remains as to whether the benefits of such holistic programs exceed the costs.

Community-wide environmental change programs involve multiple components across several sectors and presumably necessitate the expenditure of more resources to integrate, implement, and manage than single component interventions. However, the scope and scale of community-wide environmental change programs entail benefits likely differ from those of single component/sector interventions. For instance, community-wide environmental change childhood obesity prevention programs may also influence adults (Coffield et al., 2015) increasing the programs' benefits. Moreover, adult-based benefits may occur sooner than children-based benefits (Gortmaker et al., 2015) and thus be discounted less in a present discounted value calculation.

While the costs and benefits of several single component/sector child obesity interventions have been estimated (Gortmaker et al., 2015; Cawley and Datar, 2017; Lobstein et al., 2015) similar information for community-wide environmental change obesity prevention programs is lacking (Bagnall et al., 2019). To help address this need, this study estimates the return on investment of Shape Up Somerville (SUS), a participatory-based research study that altered multiple environments to reduce and prevent childhood obesity (Economos et al., 2007). SUS, as noted by the IOM, illustrates a "whole system" approach to reducing and preventing childhood obesity (Glickman et al., 2012). Thus, this analysis offers insight into the possible return on investment of a nationally recognized whole system approach to reducing and preventing childhood obesity and provides information for communities to use while discussing the practicality and sustainability of community-wide environmental change programs.

SUS's costs and benefits were estimated through a return on investment ratio (ROI). Estimating SUS's ROI provides an evaluation of whether the costs of implementing and managing SUS over two years were lower than SUS's estimated 10-year post-intervention benefits (i.e., healthcare costs and productivity losses averted).

## 2. Methods

SUS (Economos et al., 2007; Economos et al., 2013; Goldberg et al., 2009; Economos and Curtatone, 2010) was a community-based intervention that was constructed through a community-based participatory research process (Economos et al., 2007). SUS components were designed to jointly influence the physical activity levels and dietary habits of early elementary school children by altering multiple environments in which they interacted on a daily basis. By changing children's environments, the intervention should also have changed many environments in which other Somerville residents interact. SUS's intervention components were formulated through stakeholder input, community-level factors, and formative and published research. The resulting intervention focused on schools, before- and after-school programs, households, and the community at large. As illustrated in Appendix A, community-wide components included restaurant and city government initiatives, built environment changes to enhance physical activity, physician and clinic staff training, and others (Economos et al., 2007).

While SUS is now a long-standing program, its effectiveness was evaluated through a non-randomized, controlled, research trial that spanned two school years, from the 2003/04 school year through the 2004/05 school year (Economos et al., 2007). Previous researchers calculated SUS's effectiveness; BMI z-score and BMI metrics from these studies were used here to estimate SUS's benefits. Economos et al. reported that the body mass index (BMI) z-scores (calculated from measured anthropometric data according to standard guidelines) of children exposed to SUS significantly decreased by 0.057 points (95% CI: -0.08, -0.04) relative to children in control communities (Economos et al., 2013). While Coffield et al. estimated that the self-reported BMI of treatment group parents, relative to control group parents, decreased significantly by 0.411 units (95% CI: -0.725, -0.097) over the course of the study (2003/04 school year through the 2004/05 school year)

(Coffield et al., 2015).

### 2.1. Return on investment

The return on investment ratio (ROI) used to assess SUS's costs and benefits indicates the per dollar net benefit or loss generated from each dollar invested in SUS. A positive ROI indicates returns in excess of cost; ROI was selected as this study's metric as it allows a comparison of costs and benefits in monetary terms. A modified societal perspective (Cradock et al., 2017) approach was taken; participant time required to engage in SUS was not included as a cost (Cradock et al., 2017) while quality of life changes were excluded as possible benefits. SUS's ROI was estimated over a 10-year time horizon, which began at the conclusion of the SUS evaluation study. The 10-year period was based upon previous research that found obesity interventions may continue to influence participants' behaviors 10-years after exposure (Hatzis et al., 2010; Epstein et al., 1990; Thomas et al., 2014). It was assumed that SUS's treatment effect depreciated over the 10-year time horizon.

SUS's ROI (Eq. 1) consisted of program costs and benefits (i.e., costs averted). Program costs included SUS's non-research based costs for the 2003/04 and 2004/05 school years. Benefits attributed to SUS exposure consisted of the healthcare costs averted for children and their parents and the productivity losses averted for parents. Children and parents throughout Somerville (population, 2000: 77,478) (United States, Census Bureau, n.d.) were likely exposed to the SUS intervention. However, 1600 children and 1453 parents were used to estimate SUS's benefits. These conservative population numbers were based on the number of children exposed to SUS in 1st-3rd grade classrooms and the number of households who received SUS parent newsletters (Economos et al., 2007). Based upon the percentage of treatment households that identified as married (Economos et al., 2007) it was estimated that the 811 households who received SUS parent newsletters consisted of 1453 parents. The children and parent populations were adjusted annually for possible mortality (Appendix B). Future benefits were discounted at the recommended annual rate of 3% (Sanders et al., 2016). Capital expenditures were annuitized at a 3% rate (Corso and Haddix, 2003). Healthcare costs were adjusted to 2014 dollars using the Center for Medicare Studies' Health Care Expenditure Price Index (US Department of Health and Human Services, Agency for Healthcare Research and Quality, Medical Expenditure Panel Survey, n.d.) while all other costs were adjusted to 2014 dollars using the Consumer Price Index (US Bureau of Labor Statistics, n.d.).

$$\text{Return on investment} = \frac{\text{benefits (i. e., costs averted)} - \text{program costs}}{\text{program costs}} \quad (1)$$

### 2.2. SUS program costs

Costs associated with evaluating SUS were excluded from SUS's program costs; the program cost estimate was intended to reflect the cost to replicate SUS without the formative and other research. Program cost was estimated directly from SUS documents for the first study year. Year two program cost estimates were projected from year one costs and events that occurred during the second study year; detailed outlays were only available for year one at the start of this analysis. SUS's program cost consisted of four subcategories: labor cost, capital equipment cost, material cost, and facility cost. Labor cost included items such as trainings, community outreach, on-site coordination, professional development, and paying substitute teachers to instruct courses while teachers attended SUS-based trainings.

Capital equipment (e.g., foodservice equipment) was annuitized at a 3% rate and assumed to have a 10-year lifespan and no scrap value (Corso and Haddix, 2003). The first two-years of each annuitized equipment's value were allocated to SUS's program cost. In addition to

sport equipment, material cost included items such as a SUS banner for the family 5k, copy paper, gas, postage, and the estimated value of donated goods (e.g., gift cards, coolers, fresh produce). Facility costs included office space (348 square feet) and utilities. Office space cost was based upon Boston, Massachusetts rental rates while utility costs were based upon rates for the New England region.

### 2.3. SUS benefits

Appendix B details the steps taken to estimate SUS's benefits. Briefly, SUS's benefits were projected for each time horizon year for children and parents separately using population level data. These separate, annual calculations adjusted for projected changes in SUS's exposed population size and depreciation in SUS's treatment effect over the 10-year time horizon. The annual calculations also permitted adjustments in healthcare costs and productivity changes that likely occurred as the sample aged. SUS's total benefit was the sum of the 10-annual child and the 10-annual parent benefit calculations. The annual benefit calculation for children was the product of a population-wide treatment effect and the healthcare costs associated with a one-point BMI z-score change. The annual calculation for parents was the product of a population-wide treatment effect and the sum of the healthcare costs and productivity changes associated with a one-point BMI change.

The population-wide treatment effects for children and parents, for the first time horizon year, were calculated as each group's published SUS treatment effect size (Economos et al., 2013; Coffield et al., 2015) multiplied by the number of people in each group's exposed population (Economos et al., 2007). SUS's treatment effect size over the 10-year time horizon is unknown. While it has been assumed elsewhere that treatment effect sizes remain constant after interventions, (Wang et al., 2003; Brown III et al., 2007) the effect of a treatment likely depreciates as time passes (Dalziel and Segal, 2006; Dalziel and Segal, 2007). In the absence of a known depreciation rate for SUS's treatment effect, a search was conducted to locate an empirical-based depreciation rate to use in the SUS' models. We were unable to locate such a result for children; however, Thomas et al. found that adults with an average baseline weight-loss of 31.3 kg regained, on average, 26.2% of their baseline weight-loss at the end of a 10-year, post-baseline period (Thomas et al., 2014). Based upon this study, we estimated that SUS's treatment effect size depreciated or diminished by 2.62% annually for both children and parents. Due to the novelty of incorporating a depreciating treatment effect, we estimated the "breakeven" depreciation rate (i.e., rate that SUS's treatment effect size could decrease by while its estimated costs remained "covered" or equal to the program's estimated benefits).

To estimate the healthcare costs associated with BMI z-score (children) and BMI (parents) changes, data were pooled from the 2008–2013 cross-sectional Medical Expenditure Panel Surveys (MEPS) (US Department of Health and Human Services, Agency for Healthcare Research and Quality, n.d.). Stata 14 (STATA [computer program], 2015) and 15 (STATA [computer program]. StataCorp, 2017) survey commands were used to account for MEPS's complex survey design. Twenty age-specific samples were created from the MEPS data, corresponding to the age (children) or age group (parents) of the SUS exposed population at each time horizon year. This has the advantage of capturing changes over the life course in the relationship between BMI and healthcare costs; it does have the tradeoff, however, of relying on smaller sample sizes for each age-specific estimate than would be available if all ages were pooled.

A two-part regression model was estimated for each sample to calculate the healthcare costs attributable to a one-point BMI z-score (children) or BMI (parent) change while controlling for socioeconomic and demographic covariates (Appendix B). If a significant association ( $p \leq 0.05$ ) was not present in a model, the healthcare cost averted for that year was \$0.00.

Possible productivity losses averted due to SUS were estimated

annually for parents; the estimate, for each time horizon year, was the product of: a) number of sickness-related missed workdays associated with a 1-point BMI change, b) parent population-wide SUS treatment effect, and c) median daily wage of the MEPS sample which was estimated with SAS software version 9.4 (SAS Software, 2002-2005). Each year's sample was age-group specific and drawn from the pooled MEPS dataset. Because sickness-related missed workdays are count data, their association with BMI was estimated using a zero-inflated negative binomial regression model, with controls for socioeconomic and demographic factors (Appendix B).

Additional models were estimated to gauge the sensitivity of the results. First, estimates were calculated using treatment effect size reductions of 0% to 10% in one-unit increments to examine how the annual 2.62% depreciation of SUS's treatment effect size influenced SUS's ROI. The 0% reduction was used in previous studies, (Wang et al., 2003; Brown III et al., 2007) while SUS's treatment effect size completely dissipates in 10-years with a 10% annual reduction. Secondly, an annual ROI, with lower and upper intervals, was estimated to illustrate ROI changes over the time horizon; the lower and upper intervals were based on the 95% confidence intervals from the healthcare costs and productivity-based regressions and the median wage estimates. The first year of the annual ROI estimates presents the worst case scenario; the scenario where SUS's estimated treatment effect size completely dissipates at the end of the first year. Sensitivity analyses, where parameters varied singularly and jointly, were also conducted using @RISK (@Risk [computer program], 2015).

## 3. Results

### 3.1. SUS estimated program cost

SUS's two-year program cost was estimated as \$384,717 (Table 1; Appendix Table 6). The labor required to generate community partners and support was estimated to be less intense during year two. Labor costs remained the same for school-based labor positions and professional development in year two; however, all other year two labor costs were modeled as 70% of year one labor costs. The cost of fresh produce also contributed to differences between the two years. In year one, Somerville schools received fresh produce donations valued at \$43,863, which were included as a year one cost (Goldberg et al., 2009) While

**Table 1**  
Shape Up Somerville's<sup>a</sup> 2-year estimated cost<sup>b</sup>.

	Year 1	Year 2	Total
Material cost <sup>c</sup>	\$69,755	\$25,775	\$95,530
Equipment cost <sup>d</sup>	\$12,544	\$12,544	\$25,087
Labor cost <sup>e</sup>	\$130,873	\$107,073	\$237,947
Facility cost <sup>f</sup>	\$13,076	\$13,077	\$26,153
Total	\$226,248	\$158,469	\$384,717

<sup>a</sup> The study occurred in Somerville, Massachusetts (and in two additional geographic areas, which were the study's control group) during the 2003/04 and 2004/05 school years.

<sup>b</sup> Non-research based costs needed to replicate SUS up to the end of the second-school year of the SUS research study; all values reported in 2014 dollars.

<sup>c</sup> Material cost include items such as food donations, incentives, office supplies, printing, sport equipment, material for parent forums, and clothing.

<sup>d</sup> Equipment costs include items such as an oven, other kitchen equipment, and SUS curriculum. Equipment was annuitized over 10-years assuming a \$0.00 scrap value. Equipment cost represents two-years of this annuitized value.

<sup>e</sup> Labor costs included community and parent outreach, professional development, substitute teachers, newsletters/material preparation, on-site consultation, and other such items.

<sup>f</sup> Facility costs include office space and utilities. The cost of office space was based upon Boston, Massachusetts market rates while utility costs were based upon utility rates for New England.

**Table 2**  
Shape Up Somerville's<sup>a</sup> estimated benefits over the ten-year, post-intervention period<sup>b</sup>.

Post-SUS year	Child benefits		Parent benefits			Combined	
	Healthcare <sup>c,d</sup>	Total child	Health-care <sup>c</sup>	Productivity gains <sup>c</sup>	Total parent	Total	Cumulative
1	Note d	\$0.00	\$42,071	\$10,450	\$52,522	\$52,522	\$52,522
2		\$0.00	\$44,110	\$9983	\$54,093	\$54,093	\$106,614
3	-\$27,660	-\$27,660	\$45,601	\$10,105	\$55,706	\$28,046	\$134,660
4		\$0.00	\$46,189	\$9781	\$55,971	\$55,971	\$190,631
5	\$46,518	\$46,518	\$45,517	\$9680	\$55,197	\$101,715	\$292,346
6	\$31,622	\$31,622	\$43,956	\$9196	\$53,152	\$84,774	\$377,120
7		\$0.00	\$43,975	\$8758	\$52,733	\$52,733	\$429,853
8		\$0.00	\$43,442	\$8357	\$51,799	\$51,799	\$481,652
9		\$0.00	\$42,753	\$7971	\$50,724	\$50,724	\$532,377
10		\$0.00	\$41,975	\$7485	\$49,460	\$49,460	\$581,837

<sup>a</sup> The study occurred in Somerville, Massachusetts (and in two additional geographic areas, which were the study's control group) during the 2003/04 and 2004/05 school years.

<sup>b</sup> All values reported in 2014 dollars.

<sup>c</sup> Healthcare benefit is the product of each year's: exposed population, SUS treatment effect, and a significant regression coefficients illustrating the relationship between healthcare costs and a 1-point BMI (parents) or BMI z-score (children) change (see Appendix, Table 3.) Medical Expenditure Panel Survey (MEPS) Data from the 2008–2013 years was used to estimate healthcare costs associated with BMI or BMI z-score changes (US Department of Health and Human Services, Agency for Healthcare Research and Quality, n.d.).

<sup>d</sup> If a significant relationship ( $\rho \leq 0.05$ ) was not found healthcare based-benefits were \$0.00 for the examined year.

<sup>e</sup> Productivity gains is the product of each year's exposed population, SUS treatment effect, median wage, and a transformed coefficient from a negative binomial regression model illustrating the relationship between missed workdays due to illness and a 1-point BMI change (see Appendix, Table 4.). MEPS data from the 2008–2013 years was used to estimate the missed work days associated with BMI changes (US Department of Health and Human Services, Agency for Healthcare Research and Quality, n.d.).

the cost of fresh produce remained higher in year two relative to before SUS's implementation, this additional cost was offset through other changes (Goldberg et al., 2009). Accordingly, no additional fresh produce costs were added to the year two cost estimates.

The majority (61.8%) of SUS's program cost was labor-based (\$237,947). Food donations and other donated goods, considered costs despite being donated, were the two largest expenditures in the material cost category (24.8% of program cost). Capital expenditures (6.5% of program cost) were low relative to the other categories as purchased equipment was annuitized over 10-years. Facility rent and utilities made up 6.8% of program cost.

### 3.2. SUS estimated benefits

SUS exposure was estimated to reduce healthcare spending and productivity losses by \$581,837 over the 10-year time horizon (Table 2). For each age group of parents, a lower BMI was associated with significantly ( $\rho \leq 0.05$ ) lower healthcare costs as well as fewer sickness-related missed workdays. For children, there were two ages where a lower BMI z-score was associated with significantly lower healthcare costs: ages 14–15 (year 5 after the program) and 15–16 (year 6). For one child age (12–13; year 3) a lower BMI z-score was associated with significantly higher healthcare costs; (Finkelstein and Trogon, 2008) although likely spurious, for consistency, the increase in healthcare costs at this age associated with SUS's estimated BMI z-score changes, was deducted from the program.

### 3.3. Estimated return on investment

Overall, SUS generated a projected \$1.51 in savings for every \$1.00 invested in the program. SUS's estimated 10-year return per dollar of investment was \$0.51 (Fig. 1). From a net-benefit perspective, SUS generated benefits of \$197,120 more than its program costs over the 10-year time horizon. SUS generated estimated benefits over each year of the time horizon (Table 2), with total benefits exceeding total costs starting in year 7 (Fig. 1). SUS's estimated benefits exceeded its estimated costs in years 10 and 5 in the lower and upper ROI estimates (Fig. 1).

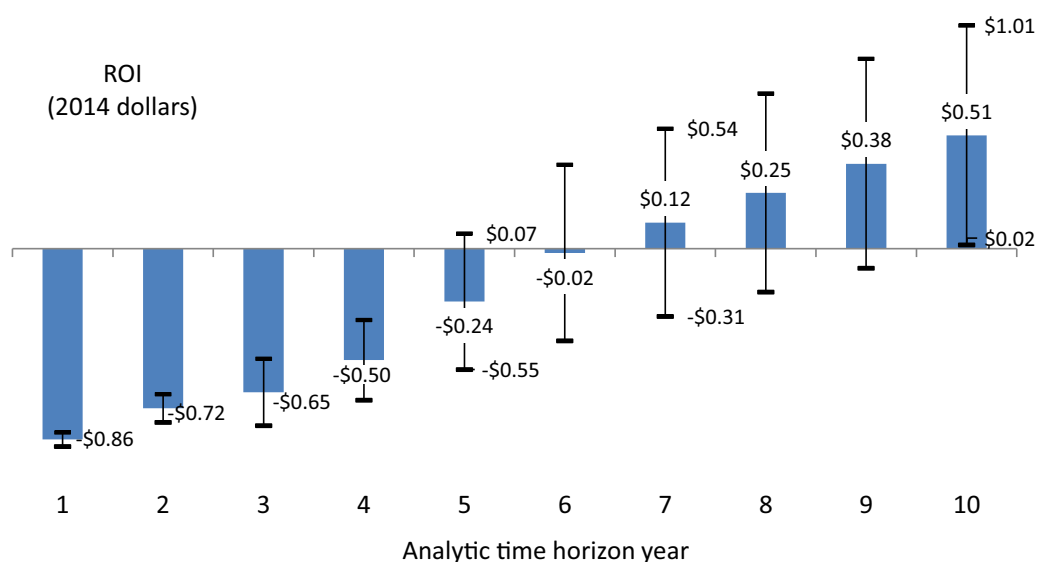
Fig. 2 illustrates SUS's ROI over the time horizon under different

yearly treatment effect size depreciation rates. SUS's ROI remains positive until 76.20% of SUS's treatment effect size dissipates over the 10-year period resulting in SUS's annual treatment effect size breakeven depreciation rate of 7.62%. In the sensitivity analysis, SUS returned a positive ROI in 90.0% of 5000 multivariate iterations (Table 3) with an average ROI of \$0.19 (95% uncertainty interval: -\$0.09, \$0.50).

## 4. Discussion

SUS generated an estimated positive return on investment (ROI). There has been increased interest in using a system-wide approach to obesity prevention, (Glickman et al., 2012) but empirical evidence on the effectiveness of this approach is limited. This paper contributes to the evidence base, demonstrating that SUS, a community-wide environmental change program, generated a positive ROI. Every \$1 invested in SUS returned a projected \$1.51 in benefits over the 10-year time horizon; SUS's estimated 10-year net benefit was \$197,120 and total benefits exceeded total costs starting in year 7. Notably, SUS's ROI was positive despite the modest effect the program had on children's BMI z-scores and parents' BMIs; SUS was net beneficial largely due to its reach. While it is useful to compare the ROI of various alternative programs to ensure efficient resource allocation, comparing SUS's ROI to other obesity prevention interventions is challenging due to methodological differences across studies (Doring et al., 2016; McKinnon et al., 2016). In addition, to our knowledge, this is the first economic analysis of a whole system obesity intervention, preventing ROI comparisons. However, the results do illustrate the promise of such interventions relative to single component interventions.

Finkelstein and Trogon argued that childhood obesity interventions should be evaluated on the ability to control weight and improve health relative to other interventions, not on the potential for short term savings, (Finkelstein and Trogon, 2008) because many benefits of childhood obesity prevention are not realized until adulthood. SUS's estimated child-only benefits of \$50,479 were not sufficient to cover SUS's costs. However, SUS was a community-wide intervention that was estimated to influence children and parents. The program's estimated influence on parents provided estimated benefits of \$531,357, which were sufficient to offset SUS estimated program costs within 10-years. The benefits that arise from SUS's multiple group exposure helps



**Fig. 1.** Shape Up Somerville's<sup>1</sup> cumulative return on investment (ROI) by post-intervention year<sup>2</sup> with lower and upper ROIs<sup>3</sup>.

1. The study occurred in Somerville, Massachusetts (and in two additional geographic areas, which were the study's control group) during the 2003/04 and 2004/05 school years. 2. ROIs calculated as:  $[ROI = (costs\ averted - program\ cost)/program\ cost]$ , where costs averted cumulate over the time horizon. Costs averted consist of estimated healthcare costs and productivity losses averted due to SUS for both exposed children and parents. Program cost consists of the resources required to implement and manage SUS over the 2-year research study. 3. The high-low bars illustrate the ROI point estimates when the ROI calculations were generated with the upper and lower 95% confidence intervals.

Intervals from the healthcare costs and productivity-based regressions and the median wage estimates (additional results from these models are available from the authors).

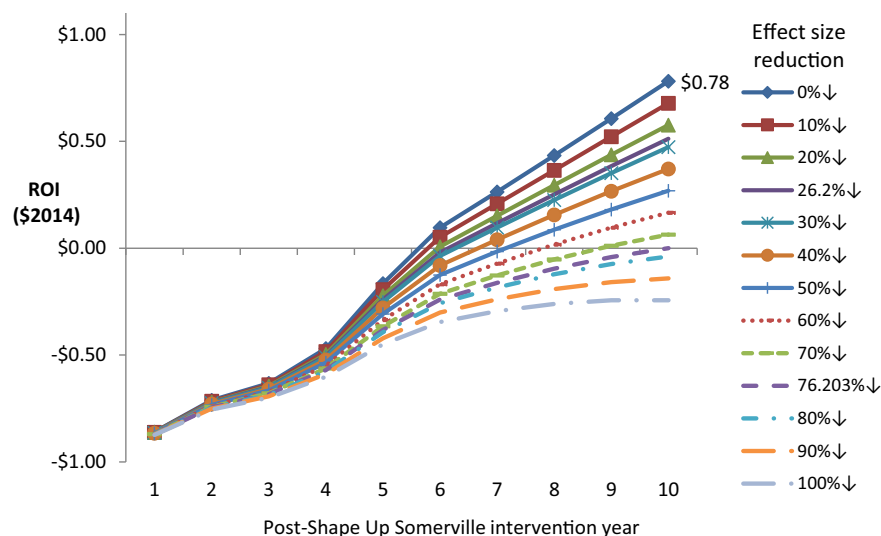
explain the results and, more importantly, illustrates a key benefit of community-wide interventions: exposing multiple groups to an intervention may generate positive externalities or benefits beyond the targeted population.

SUS's positive ROI is important from a public health expenditure and stakeholder support perspective. Stakeholders across the United States, such as health systems, health insurance firms, and major corporations have identified the importance of community-based interventions, workplace wellness initiatives, and obesity prevention (Olson, 2014; Katz et al., 2013). This study estimates that incentives exist for stakeholders to continue to participate in SUS-like interventions. For instance, firms may benefit from less worker absenteeism and health insurance firms may benefit from lower healthcare costs.

This study has limitations. First, SUS's benefits were estimated exclusively on the study population of children and parents; other residents likely benefited from SUS's community-wide nature (Economos et al., 2007; Economos et al., 2013; Coffield et al., 2015). For instance, the greater community may have benefited from SUS components such as the farmer's market initiative. While the costs of such components were included in the ROI estimate, any benefits realized by the greater community were omitted.

Estimating the long-term benefits of obesity interventions while possible (Hatzis et al., 2010; Epstein et al., 1990; Thomas et al., 2014), is challenging (Dalziel and Segal, 2006). A challenge here was that the persistence of SUS's weight loss over the 10-year time horizon was unknown; accordingly, we assumed a diminishing treatment effect size for children and adults based upon the empirical literature (Thomas et al., 2014). While this extension may partially address the critique of using a constant treatment effect size (when the long-term effect size is unknown), (Dalziel and Segal, 2006; Dalziel and Segal, 2007) it required applying an adult-based measure to children. However, estimating the models without children to account for this limitation, SUS's estimated ROI remained positive (\$0.38).

While SUS's ROI remained positive in 100% of the 5000 sensitivity analysis trials where either year two labor or food costs fluctuated, the absence of actual year two program cost data was a limitation. Not accounting for the opportunity cost of the time people spent (Cradock et al., 2017) participating in SUS and excluding any benefits realized from possible quality of life changes were also limitations (Elbe et al., 2018). In addition, although some costs incurred by community members (e.g., community events) were included in the estimates, additional community-based costs were likely and not included; a limitation



**Fig. 2.** Shape Up Somerville's<sup>1</sup> return on investment (ROI) rates under different treatment effect reduction scenarios<sup>2</sup>.

1. The study occurred in Somerville, Massachusetts (and in two additional geographic areas, which were the study's control group) during the 2003/04 and 2004/05 school years. 2. ROIs calculated as:  $[ROI = (costs\ averted - program\ cost)/program\ cost]$ , where costs averted cumulate over the time horizon. Costs averted consist of estimated healthcare costs and productivity losses averted due to SUS for both exposed children and parents. Program cost consists of the resources required to implement and manage SUS over the 2-year research study.

**Table 3**  
Shape Up Somerville's<sup>a</sup> return on investment (ROI) rates under varying variable assumptions<sup>b</sup>.

	Sensitivity analyses return on investment (ROI) outcomes	
	Mean ROI	95% uncertainty interval
Individual component sensitivity analysis		
Component allowed to vary:		
Treatment size <sup>c,d</sup>	0.512	(0.228; 0.798)
Annual treatment size reduction <sup>c,e</sup>	0.350	(0.212; 0.480)
Discount rate <sup>c,f</sup>	0.395	(0.307; 0.480)
Healthcare costs <sup>c,g</sup>	0.512	(0.394; 0.637)
Missed workdays <sup>c,h</sup>	0.512	(0.500; 0.526)
Median daily wages <sup>c,h</sup>	0.512	(0.511; 0.514)
Cost measure		
Year 2 labor costs <sup>c,i</sup>	0.514	(0.421; 0.616)
Year 2 food costs <sup>c,j</sup>	0.447	(0.355; 0.510)
Multivariate sensitivity analysis (all components above allowed to vary)		
Overall result	0.194	(−0.087; 0.501)

<sup>a</sup> The study occurred in Somerville, Massachusetts (and in two additional geographic areas, which were the study's control group) during the 2003/04 and 2004/05 school years.

<sup>b</sup> Sensitivity analyses were conducted using @RISK ([computer program], 2015). A triangular distribution (Wang et al., 2003; Brown III et al., 2007) for each variable with 5,000 iterations was used in these sensitivity analyses. The parameters for the components used in the sensitivity analysis are illustrated in Appendix B, Table 7.

that would make the results more liberal. Limitations were also present in the healthcare costs and productivity estimates. First, while a longitudinal dataset following SUS respondents would be optimal to calculate these estimates, in the absence of this data, MEPS, a cross-sectional dataset representative of the U.S. population, was used. Second, using self-reported BMIs in the healthcare cost and productivity models may cause the cost savings to be over or underestimated (Cawley et al., 2015). Similarly, while the healthcare cost estimates were estimated with national data, and on annual basis to account for changes in healthcare costs as the population aged, the standard methods used to generate these results may produce conservative estimates relative to more innovative modeling methods that account for the endogeneity of BMI and omitted variables (Cawley and Meyerhoefer, 2012).

Studies that correct for the endogeneity of BMI find greater savings in healthcare costs associated with reductions in BMI of children (Biener et al., 2017a) and adults (Biener et al., 2017b). For instance, replacing the costs associated with a one-unit BMI change estimated here with estimates (Biener et al., 2017b) generated through the more innovative “endogeneity correction” approach: increased SUS's estimated adult health benefits by over \$400,000, generated an estimated breakeven point at year 4, and a ten-year ROI of \$1.59. In this calculation, a singular (instead of multiple as used in this study) estimated benefit associated with a one-unit BMI change was applied across all adult age groups; however, this example illustrates that this study's estimates are likely conservative. Finally, the results are based upon published effectiveness studies; any limitations from these studies would also apply to this research.

## 5. Conclusion

This study demonstrates that community-wide, obesity prevention interventions may be an efficient use of public resources. Every \$1 invested in SUS returned a projected \$1.51 in healthcare cost and productivity losses averted (ROI: \$0.51) over a ten-year horizon. The scope of community-wide environmental change interventions is valuable and helps to justify SUS's estimated cost savings. While targeting children, SUS was also found to yield benefits to parents. These estimated parent-

based benefits alone were large enough to offset the cost of the program intended for children. Additional research is required to document the long-term persistence of child weight loss and the resulting benefits in terms of healthcare costs and productivity. Moreover, a challenge for such programs is that the savings accrue to different groups than those that pay the costs. The reductions in job absenteeism would benefit workers while healthcare cost reductions would benefit health insurance plans and employers, but the costs of the programs are borne by schools and other community organizations. This illustrates one challenge to community-wide programs: how to motivate schools and local governments to undertake the necessary costs when they do not directly recoup their costs.

## Highlights

- Shape Up Somerville is a participatory-based, community-wide, childhood obesity intervention.
- Shape Up Somerville generated estimated benefits in excess of estimated program costs.
- SUS's community-wide nature, which extended estimated benefits beyond children to parents as well, helps explain the result.
- The results illustrate that community-based, child-focused obesity interventions may be a beneficial investment.

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## Conflict of interest

Cawley has personal fees outside of this study from Novo Nordisk and grants from the Robert Wood Johnson Foundation. Collins and Economos have a patent curriculum with royalties paid associated with Shape Up Somerville. Carlson, Coffield, Lee, and Nihiser reported no conflict of interest.

## Appendix B. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pmedr.2019.100954>.

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