A Decade of Shape Up Somerville:
Assessing Child Obesity Measures 2002-2011

SHAPE UP SOMERVILLE

50 Evergreen Ave., Somerville, Massachusetts
(617) 625 - 6600
www.ci.somerville.ma.us/departments/health/sus

Foreword

Dear Reader,

Healthy and happy residents are the foundation of a thriving community. In Somerville, we strongly believe that using data to drive our decision-making yields more meaningful policies and therefore better quality of life for our residents. This report underscores the value of data to measure the impact of our programs and services, to guide planning and stretch the value of taxpayer dollars. We believe that the decisions we make today, using data and a community approach to problem-solving, will have a lifelong positive impact on our residents and in our community. Evaluating the impact of community programming on health outcomes is challenging and complex, but ultimately very worthwhile. This report is among the first to chronicle children's weight status changes over the course of a decade in a city engaged in deliberate efforts to improve access to healthy foods and physical activity and to encourage healthy eating and active living.

The City of Somerville, Massachusetts, along with our academic and community partners and public and private funders, have made a significant investment in making Somerville a healthier place to live, work, play and raise a family, particularly with our work over the last ten years. Shape Up Somerville, a three year research study convened by Dr. Christina Economos and the Tufts University Friedman School of Nutrition – undertaken from 2002-2005 - demonstrated the positive change that can be made in resident's lives and, more specifically, in healthier weight status among youth when community stakeholders come together around policy, environment and systems changes that make the healthy choice the easy choice. Subsequently, Dr. Virginia Chomitz, the report's lead author, and the Institute for Community Health, have pioneered the use of community-generated data for evaluation of Somerville's expanding efforts to improve resident physical fitness and nutrition. In their evaluation of child fitness and weight status from 2006/07 and 2010/11, results suggest that children's weight status outcomes have continued to show improvement over the past decade.

Since 2002, Somerville has established itself as an innovator in community-based obesity prevention. We've been doing this work longer than most communities, and with great depth and commitment. That has meant significant upgrades to our school food service program; today, the Somerville Public Schools Food & Nutrition Services

program is one of the best in the nation. Somerville has created new and innovative physical activity programming in the schools, made our streets safer and more accessible to bicyclists and pedestrians, and renovated and/or added parks and open spaces. We have a robust healthy dining program. We've expanded our Farmers Market program to include 2 outdoor, 2 indoor and 4 mobile markets, all of which accept nutrition assistance programs. We've introduced recreation programming that encourages physical activity such as SomerStreets – our Open Streets Initiative - and expanded exciting programs by adding dynamic activity spaces throughout the City. This year, we became the first community in the Commonwealth of Massachusetts to add an urban agriculture ordinance, designed to create easier access to healthy foods, and to reintroduce our residents to their food source. And we're not stopping anytime soon. The City recently approved a 20 year comprehensive plan, a blueprint for our future, that will continue to increase access to healthy foods and opportunities for physical activity for years to come. We're committed to providing a healthy environment for our residents. Thanks to support by The Robert Wood Johnson Foundation and First Lady Michelle Obama and her Let's Move campaign, our efforts continue to gain national recognition.

Somerville continues to be a leader in the national community-based obesity prevention movement, and with this report, Somerville establishes itself as an innovator in tackling the evaluation of long-term community-based obesity prevention efforts. The results presented here though, only demonstrate the potential that continuous health outcome measures have in assessing impact. Now is the time for local, state and national partners to invest in data systems that will allow us to robustly evaluate our programs and policies and definitively attribute health status change to community improvements.

In good health,

Joseph Curtatone, Mayor, City of Somerville

Tony Pierantozzi, Superintendent, Somerville Public Schools

Karen Hacker, Executive Director, Institute For Community Health

Contents

Authors

Virginia Rall Chomitz, Department of Public Health and Community Medicine, Tufts University School of Medicine, Boston, MA and Institute for Community Health, Cambridge, MA

Jaime Corliss, City of Somerville, MA

Lisa Arsenault, Institute for Community Health, Cambridge, MA

Kenneth Chui, Department of Public Health and Community Medicine, Tufts University School of Medicine, Boston, MA

Bernice R. Garnett, Institute for Community Health and Harvard School of Public Health

Christina Economos, Friedman School of Nutrition Science and Policy, Tufts University

Contributors

Joseph Curtatone, City of Somerville, MA

Karen Hacker,
Institute for Community Health

Rich Bell, Active Living by Design

Lisa Brukilacchio, Somerville Community Health Agenda, Cambridge Health Alliance

Vince McKay, Somerville Public Schools

Susana Morgan,
Somerville Public Schools

Paulette Renault-Caragianes,
City of Somerville, MA

David Hudson, City of Somerville, MA

Tom Champion, City of Somerville, MA

Jackie Rossetti, City of Somerville, MA

Tina J. Kauh,
Robert Wood Johnson Foundation

Laurie Lennon, Burness Communications

Christine Payne,
Institute for Community Health

Graphic Design
Colin Barr, barr.colin.t@gmail.com

Photography
Gary Langley, gary@blinddogphoto.com

Acknowledgements

We gratefully acknowledge the generosity and support of Shape Up Somerville's funders; the Robert Wood Johnson Foundation, Active Living by Design, MA Department of Public Health Mass in Motion and Health Disparities Reduction programs. A special thank you for the City of Somerville Health Department School Nurses for their ongoing efforts in gathering the height and weight data from our students.

Summary and Recommendations

Somerville, MA, is a densely populated, diverse city that has participated in multiple community-engaged initiatives to promote healthy eating, active living, and healthy weight over the past decade 2002-2011. Known collectively as Shape Up Somerville (SUS), the initiatives have served as an exemplary national model of community-based systems change. As Somerville and other communities engage in promoting healthy eating and active living over many years, there is increased need to evaluate these long-term community-based obesity prevention efforts and understand their impact on improving health outcomes.

This report was developed to document changes in obesity outcome measures among Somerville children during the SUS decade. We hope to generate dialogue regarding appropriate methods and outcome measures for community-based obesity prevention, their interpretation, and translation of population health and economic impact of Body Mass Index (BMI) change. We also hope that communities who have been or are contemplating working on these issues, will find this report helpful in understanding the magnitude of change in BMI that can be expected at the population level, the value of monitoring data, and the context for interpreting their findings.

We used three different data sources for this ten-year retrospective report - a previously published research study and community data collected at two different time points on Somerville Public School students for program evaluation and surveillance purposes. This report, which is not peer-reviewed by researchers, used these data to characterize changes in BMI percentile and weight status (underweight, healthy weight, overweight and obese) during the time period in which each set of data were collected and to track weight status among individual students over time.

Each of the analyses demonstrated that Somerville school children experienced small but statistically significant declines in average BMI percentile during the timeframe that was studied. Specific findings include:

Shape Up Somerville (SUS) Research study (previously published) first year results (fall 2003 and spring 2004)[1]

- The Tufts University Shape Up Somerville Research team reported that before the

intervention started in the fall 2003, 24.4% of Somerville 1st - 3rd grade students were obese and 20.0% were overweight.

- Over the course of a school year (nine months):
  - Children's average BMI percentile declined about one percentile point among students in Somerville (385 students) compared with comparison communities (793 students).
  - It was estimated that overweight Somerville students participating in SUS gained about a pound less than children in the other communities.

Carol M. White Physical Education for Progress (PEP) program one year evaluation results (spring 2006 and spring 2007)

- The Institute for Community Health evaluation team found that at baseline in spring 2006, among the 1,079 4th - 7th students studied, 28.6% were obese and 20.2% were overweight. The average BMI percentile of the students was 73.0. Black/African-American students had the highest rates of obesity.
- Over the course of twelve months:
  - The proportion of students who were of healthy weight increased significantly.
  - Male students' average BMI percentile declined significantly.
  - It was estimated that male students who were overweight in 2006 gained about a pound less than if they had stayed on their weight gain trajectory [1].

Somerville Public Schools BMI surveillance program one year evaluation results (spring 2010 - spring 2011)

- The Institute for Community Health evaluation team found that at baseline in spring 2010, among the 1,533 K - 7th students studied, 30.1% were obese, and 17.9% were overweight. The average BMI percentile of the students was 73.9. Hispanic students had the highest rate of obesity.
- Over the course of twelve months:
  - The proportion of students who were obese declined significantly.

- Student's average BMI percentile declined significantly.
- It was estimated that students who were overweight in 2010 gained about a pound less than if they had stayed on their weight gain trajectory.

The analysis of data collected during three sequential windows of time during a decade of community-engaged interventions demonstrated significant decreases in average BMI percentile among school-aged children who were exposed to SUS interventions for at least a school year. Thus, while we cannot prove that SUS caused the demonstrated changes in weight status or BMI, the SUS model of community engagement and systems change continues to demonstrate promise for combating childhood obesity. It should be noted that because different research methods and study populations were used in each analysis, the results of the three analyses cannot be directly compared with each other.

Recommendations

The results and limitations of our report underscore the importance of continuously monitoring health outcomes and using robust evaluation designs. Most communities across the United States do not have a continuous weight status outcome measurement system to monitor BMI over time.

We recommend:

- To assess weight status changes over time, and provide assurance that results are directly associated with the obesity prevention initiatives, communities need long-term outcome monitoring systems to collect comparable data continuously over many years. Ideally, data would be systematically collected across states so that comparisons to communities with similar populations and without intervention efforts could be made to understand the impact of community efforts.
- Data from monitoring systems should be used to guide planning and resource allocation to the most vulnerable and at-risk populations.
- Long term leadership and commitment to health monitoring systems are critical to success. Robust measurement systems require commitment to data collection equipment, training for data collectors, database management, analytic capacity, communication of results and attention to ethical considerations.
- Given the porous borders of communities, a coordinated effort among local municipalities and state and federal agencies is essential to addressing the

multitude of factors that impact the weight of populations.

- Academic and research partnerships with local and state agencies may enhance local community capacity to collect, manage, and analyze weight status data.

Providing context for interpreting the results of our analyses

The following contextual factors should be taken into consideration when interpreting the results of our (and other) studies on children's weight status:

Q. What are some considerations for interpreting community weight status data?

- Since underlying obesity rates vary greatly by race/ethnicity and economic status among the general public, rates of obesity will change within a community to reflect demographic shifts. Changing demographics within a community makes it difficult to determine whether obesity has worsened or improved over time and whether changes are attributable to any intervention or to changing demographics (or both). Lower income and communities of color bear the disproportionate burden of obesity [2]. If a community becomes more racially diverse over time, as is the case in Somerville, obesity rates would be expected to rise.
- Since community health promotion efforts often evolve over time, the "dose" of any intervention effort may also change and could differentially impact obesity rates within a community. Changes in health promotion efforts reflect changes in program funding, priorities, and the target audience for programs (such as children or adults, or specific racial/ethnic groups). As you might expect, the Shape Up Somerville intervention has evolved over the past decade. Earlier efforts focused predominately on school children and their families, with changes in educational programs, food service, physical education, and after-school activities. Later efforts have focused more on community-level policy and promotional efforts, with city-level changes to encourage walking and bicycling (bike lanes, traffic-calming, park and playground improvements) and healthy food access (farmer's markets, healthy restaurants).

Q. What are some special considerations for working with child or student weight status data?

- Since growing children should gain weight (and height), it is important to measure and report on changes to excess weight gain. A decrease in excess weight gain represents the physiological culmination of a complex interaction between an

individual's behaviors and metabolic processes. Therefore, the culmination of subtle individual-level changes often result in what could be perceived of as very small changes at the community-level. Our expectation should be that we see small, incremental change in healthy weight status at the community level over a long period of time.

- Since the underlying rates of obesity vary by children's age, it is difficult to compare obesity rates between groups of children with dissimilar ages. Younger children (on average) have lower rates of obesity than do older children and gain and lose weight differently. Thus, the SUS study measured younger children (grades 1-3) than the PEP evaluation (grades 4-8) and, therefore we would expect that the obesity rates would be different. The Somerville BMI Surveillance program evaluation had a broader spectrum of ages (grades K-8).
- Since school and community populations are dynamic, studies are often not measuring the same children over time. Children grow up and move through the school system. Over the decade that is chronicled here, Somerville students who were in 1st grade in the SUS research study in 2002 were in 10th grade during the Somerville BMI surveillance program in 2010. With an approximate 15% turnover rate among students in the schools each year, it is possible that less than 50 students out of 385 Somerville students who participated in the original SUS study may have also been in the Surveillance program data in 2011.
- Since obesity tracks from childhood into adulthood, small positive changes in children's weight status at the community level may translate to big cumulative impact over time on the social consequences of obesity and the incidence and seriousness of diabetes and chronic disease.

Known collectively as Shape Up Somerville (SUS), the initiatives have served as an exemplar national model of community-based systems change.

Background

This report provides the reader with an overview of the changes in the weight status of Somerville's children during the decade 2002 – 2012 when Somerville, Massachusetts had the vision and good fortune to participate in multiple community-engaged initiatives to promote healthy eating, active living, and healthy weight. Known collectively as Shape Up Somerville (SUS), the initiatives have served as an exemplar national model of community-based systems change. Indeed, among other honors, Somerville is included as a model program in the Michelle Obama–initiated Let's Move Campaign, has received funding and recognition by the Robert Wood Johnson Foundation as a one of nine "leading sites" for the Healthy Kids, Healthy Communities national program and is a participating community in the MA Department of Public Health's Mass in Motion program.

Why this report, now?

Over the past thirty years, the obesity epidemic has worsened throughout the United States. The rise in obesity explains 27% of the increase in health care spending between 1987 and 2001 [3]. Since 1980, the prevalence of obesity has tripled, such that about 12.5 million, or 17% children 2-19 years old are obese [4]. Figure 1 shows the trajectory of obesity among children in the past 45 years. Obese children are at increased risk of chronic diseases, social issues and more likely to be remain obese as adults [5]. Based on simulation models, researchers have estimated that by 2030 another 65 million US adults will be obese contributing to an increase in $48-66 million/year in combined medical costs for treating obesity and related preventable diseases, such as diabetes [6]. As childhood obesity tracks into adulthood, preventing excess weight among American youth has to be a sustained national priority to improve lives, reduce the burden of chronic diseases and to reduce health care expenditures.

Nationally and locally, health and civic leaders are seeking evidence of strategies that have shown promise toward curbing overweight and obesity. In the shorter term, proactive changes in city policies and school environments are designed to increase the number of residents meeting physical activity and nutrition benchmarks. Improvement in weight status is a long-term measure of a community's success in combating obesity and reducing health care costs.

The City of Somerville has been a laboratory for community-based obesity prevention and may serve as a model for hundreds of mid-size cities across the United States [7]. It is a dense, diverse, urban city near Boston whose citizens are at increased risk of overweight and obesity due to the diversity of their socio-demographic composition. Somerville is one of the few cities in the United States that has deliberately engaged in community-wide healthy weight promotion efforts for a substantial period of time. Both because of its status as an "every" town and as a leader in obesity prevention, it is important to assess evidence of the success of this community-wide approach on the weight status of one of the City's most vulnerable constituents – its school children. Thus the purpose of this report is to provide documentation on the assessments of weight status during this past decade of intervention and to provide context for interpreting our findings.

The City of Somerville is a laboratory for community-based obesity prevention.

Weight Status Measures: the most common method for determining whether adults and children are either overweight or obese is based on a measure called the Body Mass Index (BMI) which is based on a mathematical equation of weight and height (kg/m^2).

Adults – Overweight is defined as having a BMI greater than or equal to 25. Adults with a BMI greater than or equal to 30 are considered obese. Those with a BMI over 40 are considered extremely obese [8]. For a 5'4" woman, a BMI of 30 means she weighs more than 175 pounds. For a 6' man, it means that he weighs more than 220 pounds.

Children – Because children's BMI increases as they age and grow, an overweight classification cannot be based on a single cutoff point; rather the determination of whether a child is over-weight is a function of age and sex-specific percentiles based on the Growth Charts for the United States as issued by the Centers for Disease Control and Prevention (CDC).

Children with a BMI above the 95th percentile for their age and sex are considered obese; between the 85th and 95th percentile are considered overweight, between the 5th and 85th percentile are considered healthy weight, and under the 5th percentile are considered underweight [9].

Childhood Obesity Prevalence and Trends

Addressing obesity is a national and, in Massachusetts, a state-wide priority. First Lady Michele Obama has made childhood obesity prevention a focus of her work in the White House [10] with her Let's Move Campaign and obesity is a top health issue listed among the national Healthy People 2020 goals [11]. The Robert Wood Johnson Foundation, the nation's largest philanthropy devoted exclusively to health and health care, committed to investing 500 million dollars to reverse the childhood obesity epidemic by 2015 [12]. The MA Department of Public Health rolled out Mass in Motion, a statewide obesity campaign in 2009 [13]. Although obesity rates are highest in those living in poverty and in certain ethnic minority groups, over the last two generations, it has spread to every corner of our country and to all groups.

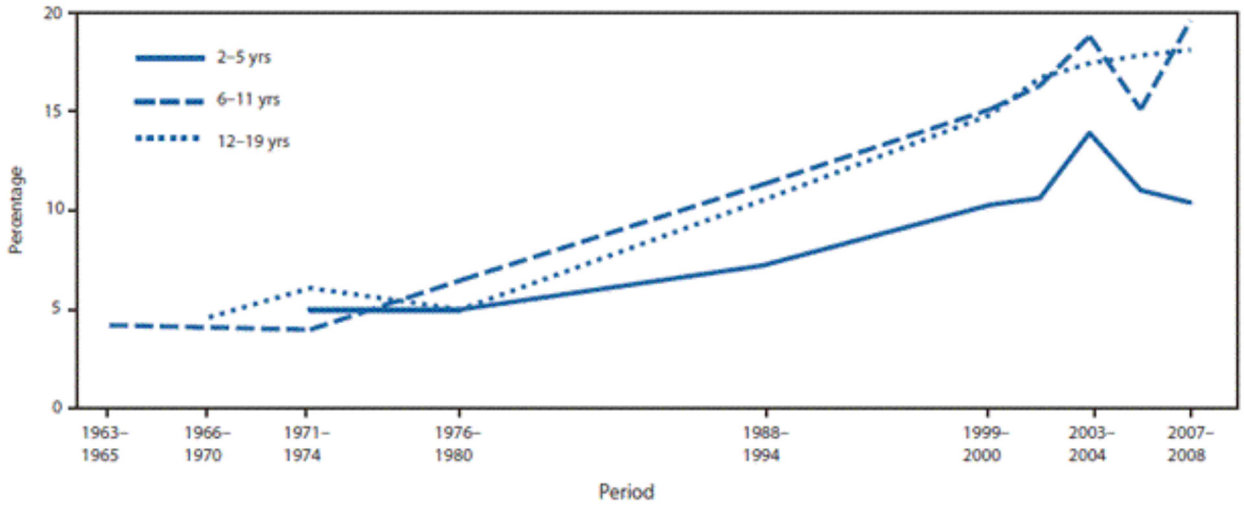


Figure 1: Prevalence of obesity among children and adolescents, by age group—United States, 1963–2008
(Source: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6002a2.htm)

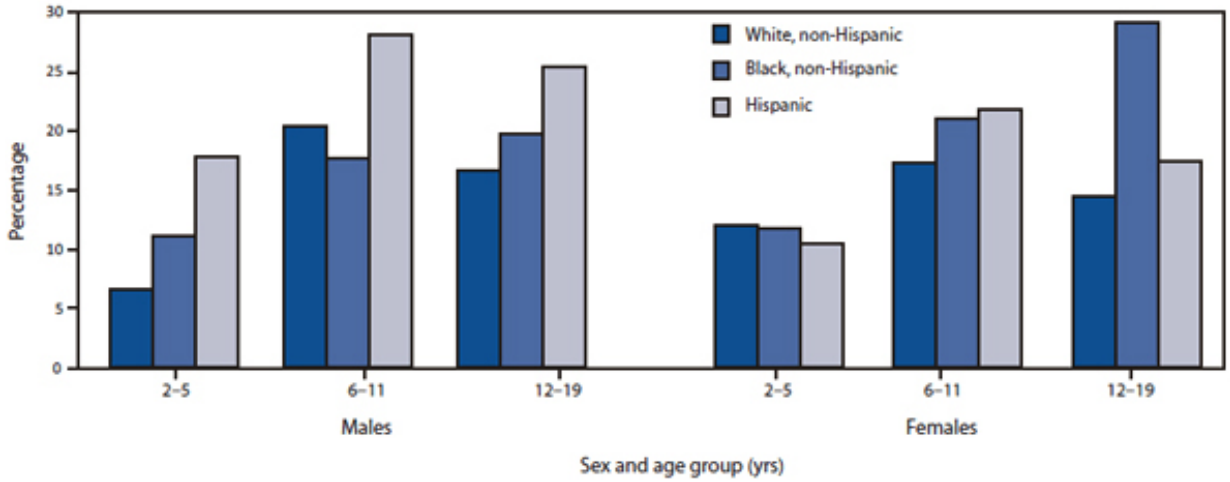


Figure 2: Prevalence of obesity among children and adolescents, by sex, age group and race/ethnicity–United States, 2007–2008

Hispanic and African American children have the highest rates of overweight and obesity – 40% respectively; with 31% of Native American children close behind, compared with white children at 16% and Asian children at 13% [2]. Figure 2 demonstrates the dramatic disparities in the prevalence of obesity among children in the United States by age and race/ethnicity. Hispanic boys and African-American girls are disproportionately affected by obesity [14]. Childhood overweight and obesity rates also vary by geography. Obesity rates are highest in the southeast states. The obesity prevalence in Mississippi (22%), was highest, while Oregon (10%), was lowest [15]. Massachusetts was in the middle range, with 13% obesity and 30% overweight.

Massachusetts was in the middle range, with 13% obesity and 30% overweight.

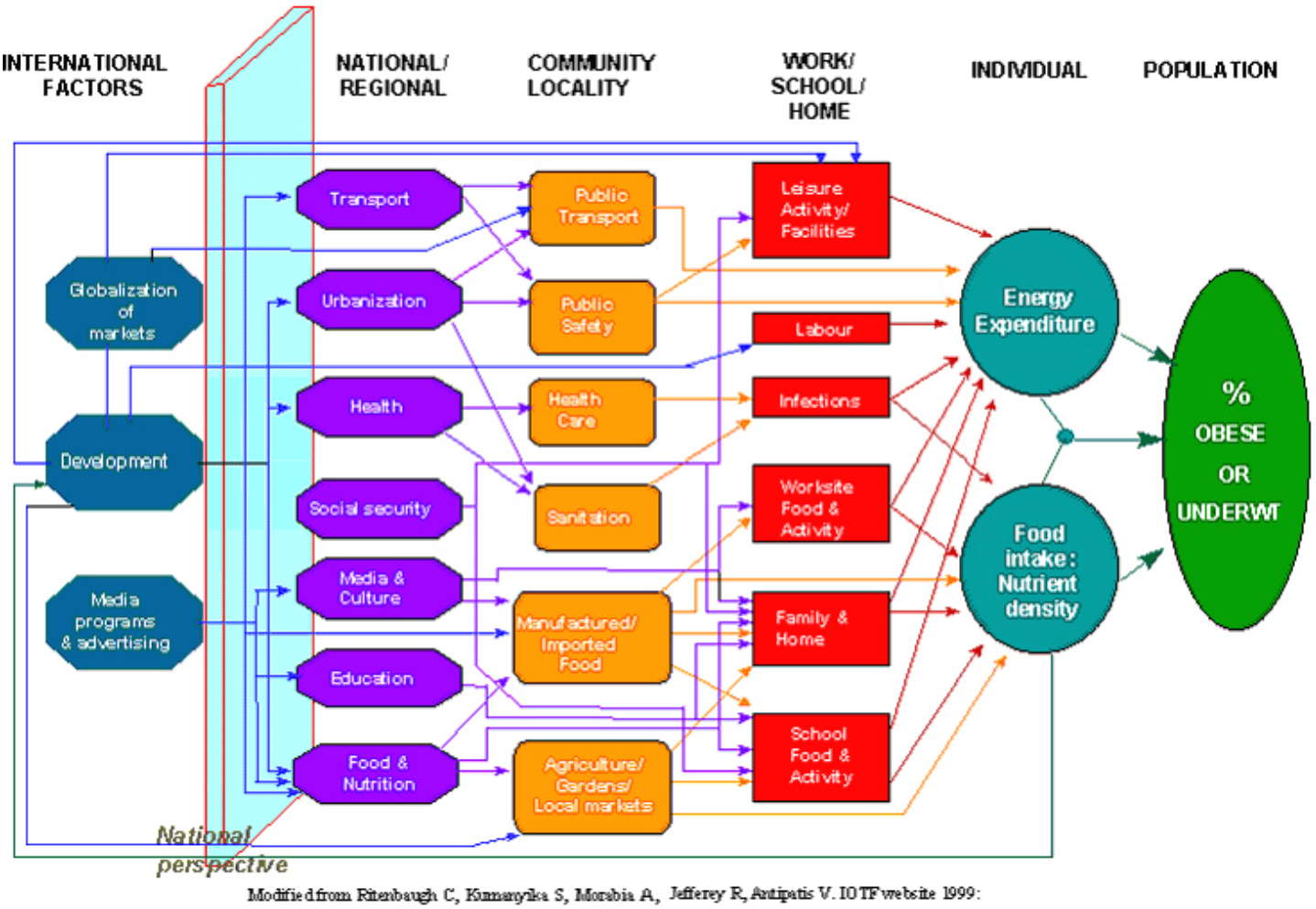


Figure 3. An ecological perspective on the inter related systems and factors influencing obesity [16].

The causes of overweight and obesity are complex

Figure 3 illustrates the dynamic interrelationship of "systems" at each level of an ecological model that together can determine a population's weight status. For an individual, an imbalance of energy consumed as calories that are not burned off through physical activity and the daily metabolic processes of life can result in excess fat and weight. Research indicates that the behavioral components that contribute to overweight and obesity - physical activity and eating behaviors are constructed socially – that is, they are learned through habits and routines and reinforced by one's environment that includes work/school/home systems, community, national and international systems and factors [16].

Multi-level Obesity Prevention Community-Engaged Initiatives in Somerville, MA

In Somerville, intervention efforts to confront obesity have embraced the complexity of the problem through multi-level approaches to promote active living and healthy eating. The past decade has provided major opportunities

for Somerville to participate in multiple innovative school-based and community-based initiatives to promote healthy eating, active living, and healthy weight. Several grants and city programs provided funding for specific programs and studies that are known collectively as Shape Up Somerville (SUS). The participatory, collaborative nature of these efforts has promoted robust partnerships with community stakeholders and city agencies creating synergistic and reinforcing efforts.

Some efforts, from regional to individual, to promote active living in Somerville include:

- Advocacy and planning for regional mass transportation (Green Line Extension) and a companion multi-use path;
- Local Somerville development of bicycle lanes and traffic calming measures, parks and playground enhancements, and safety measures;
- Physical Education and gymnasium equipment improvements in the local schools and physical activity programming in after-school programs;
- Education and self-assessment through fitness testing in the schools and improved counseling regarding physical activity in health centers.

In Somerville, intervention efforts to confront obesity have embraced the complexity of the problem through multi-level efforts to promote active living and healthy eating.

Some multi-level efforts to promote healthy foods and eating in Somerville include:

- State/regional efforts related to nutrition standards in schools and publicly-owned enterprises;
- Healthy restaurant and market program, additional farmers' markets and CSA drop-off sites and the use of EBT cards/SNAP benefits to purchase fruits and vegetables at farmers' markets;
- School food-service enhancements and school-yard gardens;
- Nutrition education in schools and cooking classes during after-school programs;
- Improved counseling and medical record keeping in health centers.

Q. Why is it so difficult to prove "cause-and-effect" between community interventions and BMI change?

Community-based interventions do not fit neatly into "classic" research design. The "gold standard" study design for demonstrating causation is a "randomized control trial" or RCT where comparable subjects are randomly assigned to an intervention or a "control" or non-intervention group. The intervention is then delivered comparably to all study participants. Data on the outcome measure is collected before and after the intervention and the pre- to post-intervention changes to the outcome measure are compared between the intervention and control group. Most obesity-prevention activities cannot be "randomly" allocated to communities, nor are communities completely comparable based on their demographic, political, economic, geographic, or infrastructure profile. In addition, many communities today are engaged in healthy eating and active living promotion, so the contrast between "intervention" and "non-intervention" communities can be blurred.

Results from a retrospective evaluation of a decade of Promoting Healthy Weight in Somerville 2002-2011

Challenges to assessing change in weight status among Somerville children

It is challenging to measure the impact of Somerville's healthy eating and active living on changes in BMI among the population. First, Somerville did not have a continuous data set of children's health indicators during this period, nor a sustained comparison community to compare results over time. This is typical of communities that have depended on an array of funding sources and grants that have supported different goals over time.

Secondly, Somerville has a dynamic population that reflects changing demographics and

"porous" borders. Families move in and out of the community frequently, which means that children with varying levels of "exposure" to the SUS intervention are entering and leaving the school system and potentially "diluting" any observed effectiveness of the intervention on high BMI or excess weight. In addition, the children who have moved into the district are somewhat more likely to be of Hispanic origin, a group that is disproportionately overweight.

We used three different data sources for this ten-year retrospective report – a previously published research study and community data collected at two different time points on Somerville Public School students for program evaluation and surveillance purposes.

Somerville schools are becoming increasingly diverse...

The changing face of Somerville Public School children in the past decade: Based on 2010 Census data, the current population of Somerville is approximately 75,750, representing a small decrease (2.23% decline) from the 2000 Census level [17]. The 2000 Census (total population 77,478) found the density of Somerville to be 18,868 persons per square mile and the land area to be 4.21 total square miles, making it the most densely populated city in New England.

Increasing diversity in Somerville schools: Changes in local, state, US and global economies tend to impact the demographics of the student population, as demonstrated in the Somerville schools. Between the 2003/04 academic year and the 2010/11 academic year, the demographic composition of the students in the Somerville public schools shifted [18]. Somerville public schools are becoming increasingly diverse – more diverse than the city itself or Massachusetts's public schools as a whole, with the largest growth in Hispanic students.

Figure 4 shows the increase in the proportion of Hispanic and Asian students; and a decrease in the proportion of White and Black students. In 2003/04, almost half of students (46%) were White; by 2010/11 just over a third of the students were White (38%). There was a corresponding increase in the percent of Hispanic students – from about 30% in to 38%, and an increase in Asian or "other" race from 8% to 11%. The schools saw a slight decrease in the proportion of Black students - from about 17% to 14% in the same time period.

Figure 5 demonstrates that Somerville public school children speak less English at home and a slightly higher proportion of students are from lower income homes between the 2003/04 academic year and the 2010/11 academic year. In the past decade, the percent of students whose first language was not English increased from 49% to 52%, and the percent of low-income students increased from 61% to 68%. The classification of low income reflects a family's eligibility for the USDA school meal program.

Somerville public school student population is dynamic. According to the annual student stability rate established by the MA Department of Education, the stability of the student body in Somerville has increased over the past few years. In the 2007/08 academic year, 79.8 percent of Somerville students were enrolled throughout the full school year while in 2010/11 the rate had increased to 90.6 percent [19].

Background on study methods

In the past decade, weight status data were collected in three contexts among Somerville public school students to measure and track obesity in the community. These data were used to characterize changes in BMI percentile and weight status (such as healthy weight,

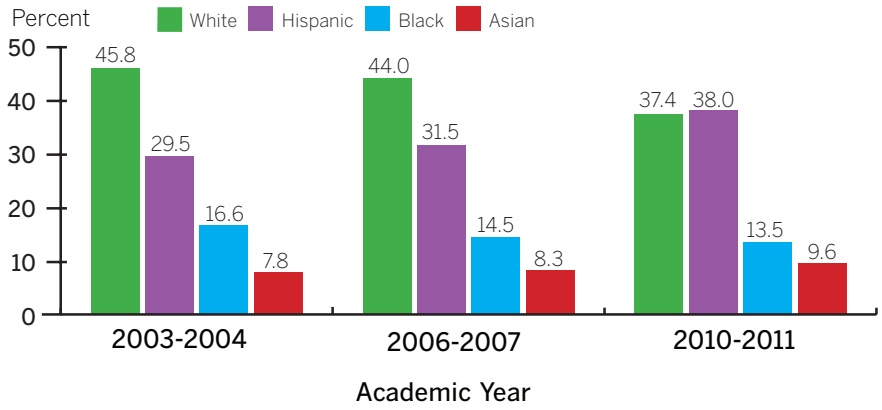


Figure 4. Student's racial/ethnic composition in the Somerville Public Schools (2003/04-2010/11)

overweight, and obese) during the time period in which each set of data were collected. Each had the benefit of tracking weight status within individual students over time.

- The CDC-funded **Shape Up Somerville project,** led by Tufts University Friedman School of Nutrition Science and Policy, conducted a quasi-experimental (non-randomized) intervention study among 1st - 3rd grade students in Somerville (intervention) and two comparison communities for 9-months during one school year (fall 2002 – spring 2003).
- The US Department of Education funded Carol M. White Physical Education Program **(PEP) Evaluation**, led by the Institute for Community Health followed a group of 4th - 7th grade Somerville students for 12 months during two school years (spring 2006 – spring 2007) [20].
- The **Somerville Public Schools BMI Surveillance Program**, collected data from students who were screened for BMI under Massachusetts General Law (M.G.L. Chapter 71, Section 57 and 105 CMR 200.000). With technical support from the Institute for Community Health, data were collected on students in grades 1, 4, 7 and 10 in accordance with state regulation and were supplemented with data from kindergarten and grades 2, 3, 5 6 and 8. Students (K - 7th grade) were followed for 12 months during two school years (spring 2010 - spring 2011).

The data were gathered by different types of collectors, with somewhat different protocols, and with different equipment: Shape Up Somerville used research staff to collect data, the PEP evaluation used graduate students, and the BMI surveillance program used school nurses supplemented by graduate students for the grades not mandated in the surveillance program. A comparison of the methods used in the three studies is detailed in Table 1.

In the past decade, the percent of low income students increased from 61% to 68%.

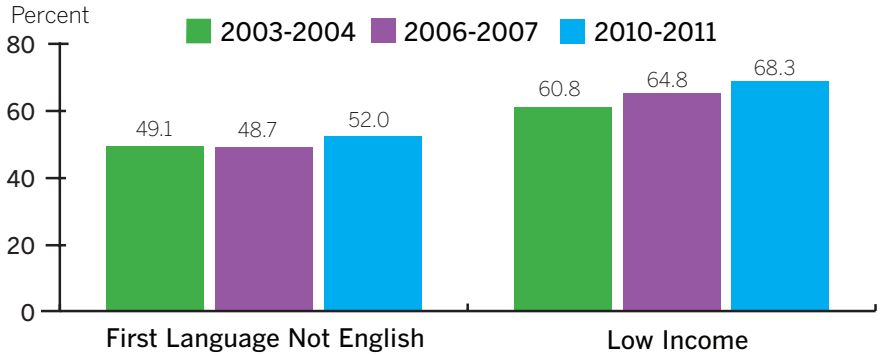


Figure 5. Student's home language and income status in the Somerville Public Schools (2003/04-2010/11)

Table 1. Comparison of the methods used to assess change in weight status

	Shape Up Somerville Study	Physical Education Program (PEP) Evaluation	Somerville Public Schools BMI Surveillance Program
Funding	United States Center for Disease Control Research Grant	United States Department of Education Grant (PEP: Physical Education Project)	Massachusetts Department of Public Health Mandate to collect BMI data in select grades
Project Type	Research: Quasi-Experimental Intervention	Evaluation	Screening and Surveillance
Length of grant funding	Three years 2002 - 2005	Three years 2005 - 2008	[1] On-going since 2010
Sector Involvement	Schools and Community	Schools and After School Programs	Schools
HEIGHT AND WEIGHT MEASUREMENTS			
Data collectors	Tufts Research Staff	Tufts Graduate Students	School Nurses
Rounds of Measures	Triplicate Measures	Duplicate Measures	Single Measures
ANALYTIC SAMPLE			
Student Participants	Intervention / Comparison Groups	Somerville only: All enrolled students were eligible to be included	Somerville only: All enrolled students were eligible to be included
	Included students had active written consent from parents	Excluded students had written exemption from parents/guardian or were absent on either measurement day	Excluded students had written exemption from parents/guardian or were absent on either measurement day
	32% of total eligible Somerville students	75% of total eligible Somerville students	52% of total eligible Somerville students
	Somerville N = 385 Comparison Sites N = 793	N = 1,079	N = 1,533
Time frame of data collection (Baseline to Follow-up)	Nine months	Twelve months	Twelve months
	Baseline: Fall 2003	Baseline: Spring 2006	Baseline: Spring 2010
	Follow-up: Spring 2004	Follow-up Spring 2007	Follow-up Spring 2011
Grade Level at Baseline	1st to 3rd	4th to 7th	K to 7th
Analysis	[2] Descriptive statistics; Independent t-tests, chi-square tests; Multivariable models to assess changes in BMI z-scores between intervention and comparison students; See details of methods in published study for details Reference	Descriptive statistics: Change in BMI measures, including weight status and BMI percentiles, were examined using McNemar's tests and paired sample t-tests. Change was also examined within gender, race, and grade level. P< .05 was considered statistically significant	Descriptive statistics: Change in BMI measures, including weight status and BMI percentiles, were examined using McNemar's tests and paired sample t-tests. Change was also examined within gender, race, and grade level. P< .05 was considered statistically significant

Shape Up Somerville (SUS) grant: Funding from Centers for Disease Control 2002-2006:
Goals of the grant were to influence every part of an early elementary schoolchild's day – before, during, and after- school to promote healthy eating and physical activity and their weight status.
Intervention included:

- *Food service enhancements to improve breakfast and lunch and staff professional development*
- *Walk to school activities*
- *SUS classroom curriculum and professional development*
- *School wellness policy development*
- *SUS After-school curriculum and professional development*
- *Outreach and education to home through materials, forums, events*
- *"SUS approved" restaurants*
- *Community outreach and capacity building through policy development, trainings, media placements*

Shape Up Somerville Study – First year results (Previously published)

The following discussion is a summary of the first year results of the SUS research project. Researchers from Tufts University received CDC funding for a Shape Up Somerville intervention, which included components designed to promote healthy eating and physical activity for children before school, during school, after school, at home, and in the community. The focus of the grant was on students in grades 1-3 in the Somerville Public Schools. Please refer to the published work for details on methods and results [1]. Likewise, descriptions of the SUS project are published elsewhere [1, 21, 23].

The evaluation of the intervention involved a comparison of BMI data (compiled from height and weight data) from students in 1st - 3rd grade from three communities (Somerville and two very demographically and geographically similar cities) whose parents consented to participate in the study. Measurements (height, weight, dietary, physical activity and contextual measures) from 385 Somerville students (32% of the eligible students), and 793 comparison community students were collected before the intervention (September/October 2003) and after the first nine months of intervention (May/June 2004). Any changes in the BMI measures among Somerville children were compared to the changes in BMI measurements calculated from the children in the comparison communities. All statistical analysis controlled for baseline BMI, sex, grade, age, race, primary language spoken at home, and school,

The study showed positive association of the intervention on change in BMI 2003-2004. While almost half (44.4%) of the Somerville 1st – 3rd grade children were either overweight (20%) or obese (24.4%) before the intervention study, results from this study indicate a modest, though statistically significant decline in BMI, in a population of high-risk early elementary school Somerville children relative to children without an obesity prevention intervention. That is, BMI percentile for Somerville children, declined approximately one percentile point compared with the comparison communities after controlling for the factors listed above. For an average height, overweight 8 year-old child, this decrease translates to the prevention of an additional weight gain of 1.1 lbs in a male child and 1.3 lbs in a female child [1].

The study showed positive effect of the intervention on change in BMI 2003-2004.

Physical Education Program (PEP) Evaluation

The Somerville Public School Department received a United States Department of Education Carol M. White Physical Education Program grant for four years 2005-2008. The project was designed to improve student's weight status, fitness, physical activity and healthy eating through improvements to physical education programs, the school food service, and after-school programming. The focus of the grant activities was on 4th through 8th grade students. The Institute for Community Health conducted the evaluation of the grant.

Other Shape Up Somerville activities were also occurring during the PEP time frame – notably a USDA funded grant known as Growing Healthy supported school-based vegetable gardens and fruit and vegetable promotion in the school cafeteria, and an RWJF funded Active Living by Design grant supported city planning infrastructure and partnership development to improve walking and biking opportunities in Somerville.

Physical Education Program (PEP) Grant to the Somerville Public School Department: US Department of Education 2004-2008

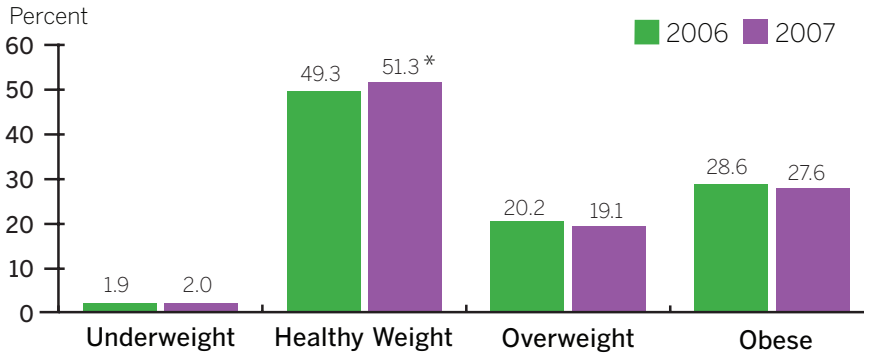
Goals of the grant were to improve student weight status and fitness through improved and sustainable in-school delivery of physical education and nutrition services and enhanced after-school activities.

Grant Provided:

- Physical Education equipment and gymnasium improvements, professional development to teachers
- Food Service professional development, food, recipe and menu development
- Fitness testing, BMI screening and monitoring
- In partnership with Somerville after-schools – physical activity and nutrition programming and equipment
- Nutrition instruction during the school day

The evaluation of the PEP program included a descriptive analysis of the changes in BMI measures (compiled from height and weight data) from Somerville public school students who were in 4th-8th grade in each of the grant funded school years. Demographic (age, gender, race/ethnicity) data were provided by the public school department for each student. To assess change within individual students, the analytic sample presented in this report focused on two rounds of data collection, spring 2006 (termed baseline) and spring 2007 (termed follow-up) and included 1,079 students who were in grades 4th-7th grade at baseline and thus in 5th-8th grade at follow-up (approximately 75% of total students enrolled in those grades over the time period). Tables 1 – 4 in the appendix provide the one-year obesity prevalence, incidence, and remission rates for the PEP evaluation sample as well as the one-year change in mean BMI percentile values.

Healthy weight increased between 2006 to 2007: Among students in the analytic sample, almost half were either overweight (20.2%) or obese (28.6%) at baseline. One year later, the proportion of students who were at a healthy weight increased modestly, but statistically significantly, from about 49% to 51% (see figure 6).

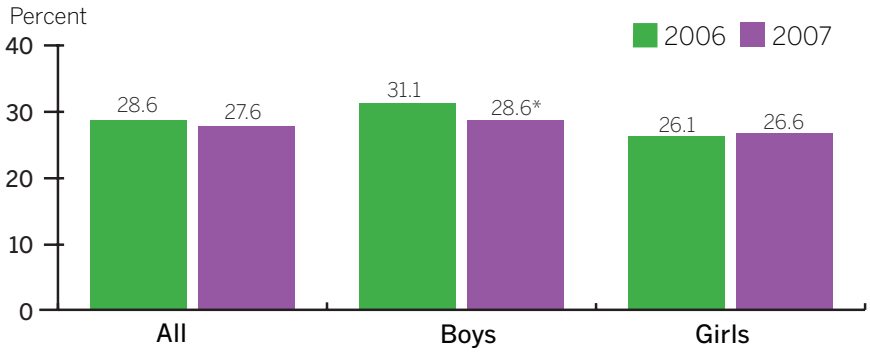


N= 1,079; matched sample with observations in both years
*P<0.05, statistically significant change (McNemar's Test)

Figure 6. Weight Status of Somerville Public School Students 2006 and 2007 (4th and 8th grade)

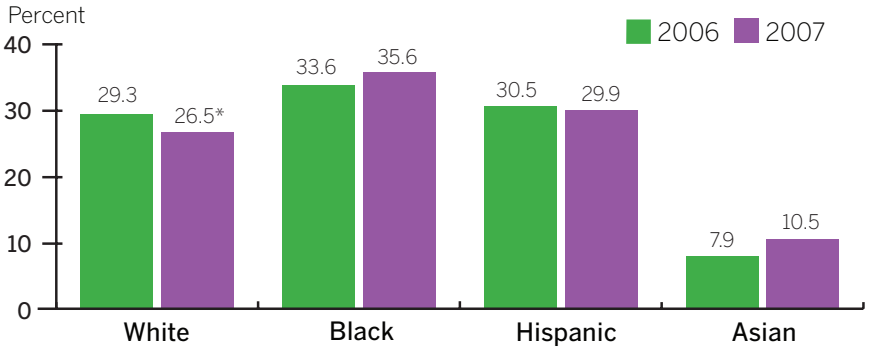
As shown in Figure 7, a higher proportion of boys were obese than girls at baseline, and the obesity prevalence among boys declined significantly over 12 months. The prevalence of obesity overall and among girls did not drop to a statistically significant degree. 12.3% of all students moved out of the obese category into a healthier weight category (remission) while 3.5% became obese during the 12-month study period (incidence) – See appendix tables 2 and 3. Obesity remission and incidence among boys were 14.1% and 2.7% respectively, and 10.1% and 4.3% among girls.

Figure 8 shows racial/ethnic disparities in the rates of obesity among Somerville school children. Black students had the highest prevalence of obesity (34%) at both observation time points while Asian students has the lowest prevalence (10%). Between 2006 to 2007, the proportion of white students who were obese declined significantly from 29% to 27%.



N= 1,079 (with observations in both years)
N= 564 boys and 533 girls
*P<0.05, statistically significant change (McNemar's Test)

Figure 7. Percent of Somerville students who were obese, 2006 and 2007 (4th and 8th grade)



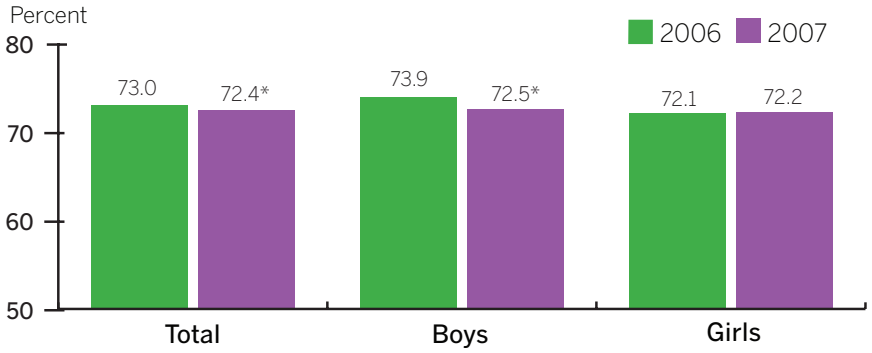
N= 1,079 (with observations in both years)
N= 509 White, 149 Black, 335 Hispanic, and 76 Asian
*P<0.05, statistically significant change (McNemar's Test)

Figure 8. Percent of Somerville students who were obese by race / ethnicity 2006 and 2007 (4th and 8th grade)

Looking at this data another way

Changes in actual BMI percentiles were also examined. In spring 2006, the average BMI was in the 73rd percentile for-age and gender; boys' BMI was on average in the 74th percentile and girls was in the 72nd percentile (see Figure 9). There were statistically significant declines in the average BMI percentile between 2006 and 2007 among boys (73.9 percentile vs. 72.5 percentile) and among White students (71.7 percentile vs. 70.7 percentile), and Black students (76.4 percentile vs. 74.7 percentile) (see Figure 10).

There was a statistically significant decline in the average BMI percentile overall...



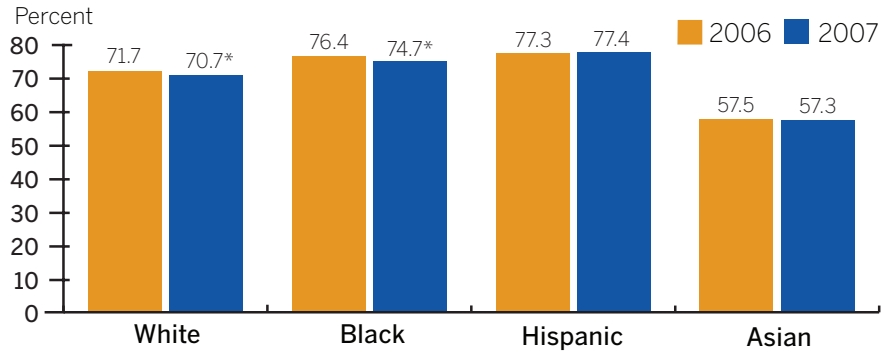
N= 1,079 (with observations in both years)
N= 546 boys and 533 girls
*P<0.05, statistically significant change (paired samples t-test)

Figure 9. Somerville student's average BMI percentile in 2006 and in 2007 (4th and 8th grade)

Putting the information into perspective

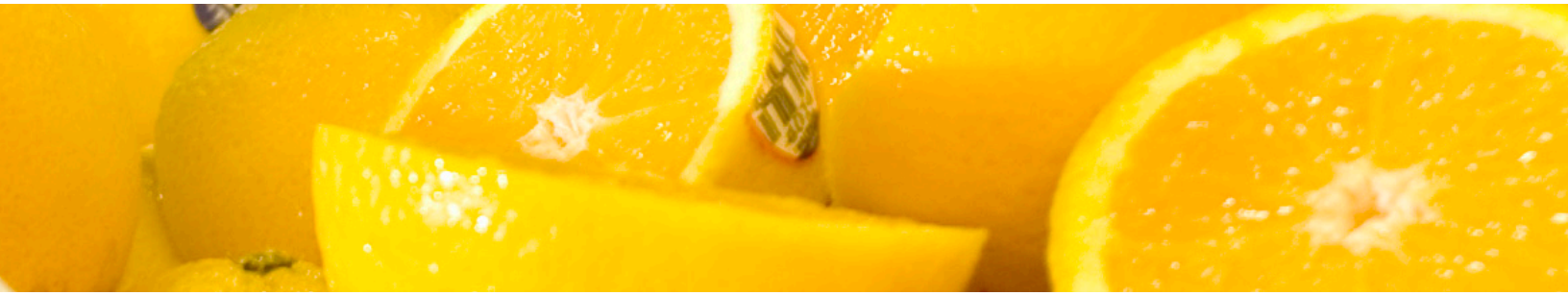
To present results from the PEP program evaluation in a manner similar to the quasi-experimental Shape Up Somerville Study (which had comparison communities), we estimated how much LESS weight a child gained during the year that he or she was in the PEP program, than if the child's had continued to gain weight at their baseline BMI percentile on the CDC growth chart. We estimated the difference in the average BMI percentile from 2006 to 2007 while assuming the child would continue at the 50th percentile for height. See Technical appendix for detailed methods in estimating change in weight.

If the BMI percentile for a ten-year old boy at the 85th percentile BMI for-age and gender (overweight) in 2006 changed by the average amount for boys (-1.47), this translates to a decrease in the expected weight gain of over one pound (-1.1 lb) for boys. If the boy was in the 95th percentile (obese) at baseline in 2006, the prevention of additional weight gain at follow-up in 2007 would be even more compelling at over three pounds (-3.5 pounds). However, as noted above, girls during this time period did not experience significant change in BMI percentile. Using the average change among girls (+0.18), a ten year-old girl in the 85th percentile at baseline (overweight) would be



N= 1,533 (with observations in both years)
N = 509 White, 149 Black, 335 Hispanic, 76 Asian
*P<0.05, statistically significant change (paired samples t-test)

Figure 10. Somerville student's average BMI percentile by race/ethnicity in 2006 and in 2007 (4th and 8th grade)



expected to have gained about a quarter of a pound (+0.22lbs) by follow-up in 2007.

In summary, for the students who participated in the PEP grant and other SUS activities for at least a year between the spring of 2006 and the spring of 2007, the proportion of students who were of healthy weight increased and the average male student BMI percentile decreased significantly. These declines translate to an estimate that boys who were overweight in 2006 gained about a pound less and obese boys gained about three pounds less than if they had continued on their initial weight gain trajectory. Results were consistently statistically significant among white students and boys.

Results were consistently statistically significant among white students and boys.

Somerville Public Schools BMI Surveillance Program 2010 - 2011

Support for Shape Up Somerville was provided through many sources, including these programs, which were funded by the Robert Wood Johnson Foundation:

Active Living by Design (2003-2008) Goals were to improve the infrastructure and capacity of Somerville to promote physical activity and active living for all residents through partnership development, programming, promotion of physical activity and opportunities for activity, developing policies and physical or "built" environment supportive of physical activity

Healthy Eating by Design (2005-2007) Goal was to improve low income and immigrant families' access to local healthy food at farmers' markets in Somerville

Sustainability grant (2009-2010) Goal was to provide staff support to Active Living and Shape Up Somerville efforts as efforts were transitioned to Somerville staff.

Healthy Kids Healthy Communities (2007-2013) Goal is to implement healthy eating and active living policy - and environmental-change initiatives that support healthier communities for children and families with a focus on children who are at highest risk for obesity.

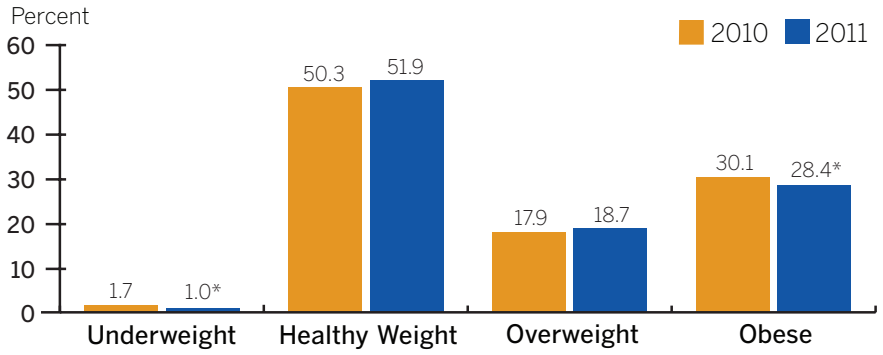
Beginning in school year 2009/10, Somerville Public Schools collected BMI on students in compliance with a new MA Department of Public Health regulation [24]. "In February 2009, Massachusetts promulgated amendments to the regulations on Physical Examination of School Children, 105 CMR 200.000, to improve the screening and monitoring of the health assessment of children across the Commonwealth. Among other changes, the amended regulations require screening for height and weight and the recording and reporting of the BMI for all students in grades 1, 4, 7 and 10 (or of comparable age)." The Somerville public school nurses collected height and weight data on ALL eligible students in the mandated grades.

Shape Up Somerville staff, along with Tufts University graduate students, collected height and weight data on the non-mandated years (kindergarten, 2nd, 3rd, 5th, 6th, and 8th grade) in spring 2010 and again in spring 2011. The Institute for Community Health provided analytic support to the program.

Shape Up Somerville activities during this time period included a USDA supported fruit and vegetable program in the school cafeteria, school gardens and City of Somerville and RWJF supported community level activities focused on improving access to healthy foods and physical activity through policy and environmental changes.

The BMI surveillance data was used for descriptive analysis of the changes in BMI measures and weight status of Somerville public school students who were in kindergarten - 8th grade in the Spring of 2010 and the Spring of 2011.

Demographic (age, gender, race/ethnicity) data were provided by the public school department. To assess change within individual students, the analytic sample presented in this report focused on both rounds of data collection, Spring 2010 (termed baseline) and Spring 2011 (termed follow-up) and included 1,533 Somerville students who were in grades K - 7th at baseline and thus were in 1st - 8th grade at follow-up (approximately 52% of total enrolled in the eligible grades during the time period). Tables 5 – 8 in the appendix provide the one-year obesity prevalence, incidence, and remission rates for the BMI Surveillance sample as well as the one-year change in mean BMI percentile values.



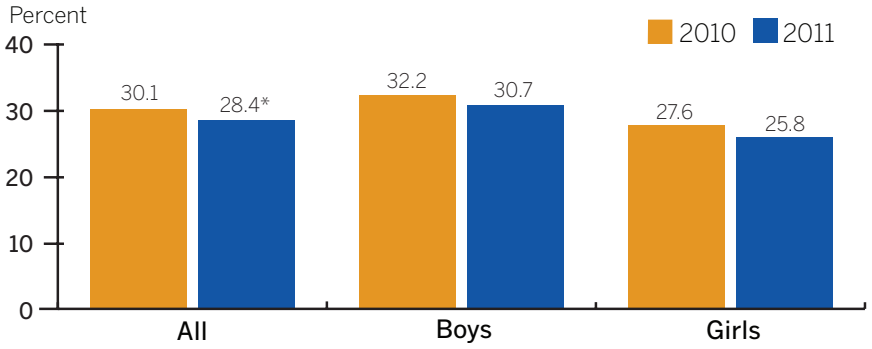
N= 1,533 (with observations in both years)
*P<0.05, statistically significant change (McNemar's Test)

Figure 11. Somerville Public School Students according to their weight status in 2010 and 2011 (K - 8th grade)

Obesity decreased between 2010 and 2011: Among students in the analytic sample, almost half were either overweight (17.9%) or obese (30.1%) at baseline. One year later, the proportion of students who were obese declined significantly from about 30% to 28%. (See figure 11). Underweight (also an unhealthy weight status category) also saw statistically significant decline between 2010 and 2011.

As shown in Figure 12, a higher proportion of boys were obese than girls in both years of observation. While the overall prevalence of obesity declined significantly, the declines observed among boys and girls separately did not reach statistical significance. Presented from an individual level, 17.4% of students moved out of the obese category into a healthier weight category (remission) while 5.1% became obese during the 12-month study period (incidence) – See appendix tables 5 and 6. Obesity remission and incidence among boys were 18.0% and 6.4% respectively, and 16.5% and 3.7% among girls.

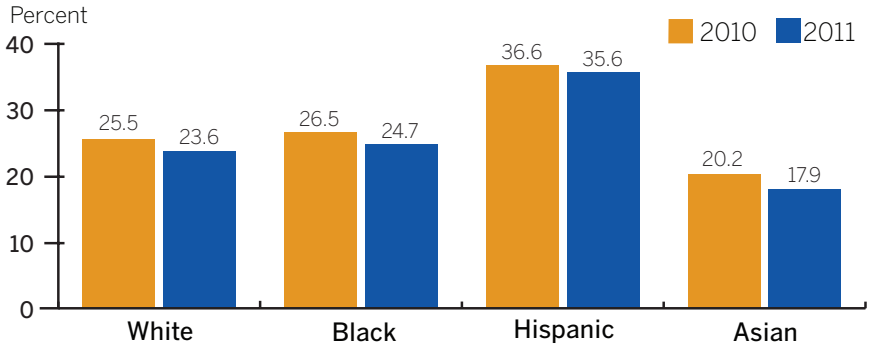
...the proportion of students who were obese declined significantly from about 30% to 28%.



N= 1,533 (with observations in both years)
N = 830 boys and 703 girls
*P<0.05, statistically significant change (McNemar's Test)

Figure 12. Percent of Somerville students who were obese by gender, 2010 and 2011 (K - 8th grade)

As was observed in the PEP evaluation, Figure 13 shows significant racial/ethnic disparities in the rates of obesity among Somerville school children. However, in 2010, Hispanic students had the highest prevalence of obesity (36%) at both observation points while Asian students had the lowest prevalence (20%). Between 2010 and 2011 no individual racial/ethnic group experienced a statistically significant change in weight status.



N= 1,533 (with observations in both years)
N = 526 White, 170 Black, 683 Hispanic, 134 Asian

Figure 13. Percent of Somerville students who were obese by race / ethnicity 2010 and 2011 (K - 8th grade)

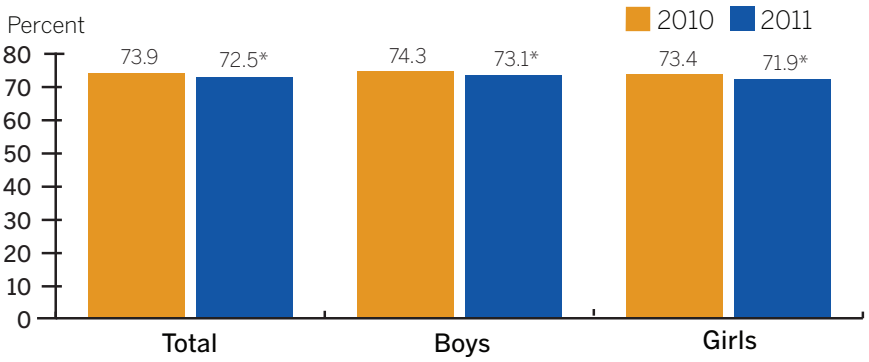
Figure 13 shows significant racial/ethnic disparities in the rates of obesity among Somerville school children.

Looking at this data another way

In spring 2010, the average BMI was in the 74th percentile for age and gender; boys' BMI was on average in the 74th percentile and girls was in the 73rd percentile (see Figure 14). There were significant declines in the average BMI percentile between 2010 and 2011 in the overall population and among both boys and girls. Statistically significant declines were also observed among white students (70.4 percentile vs. 68.8 percentile) and Hispanic students (79.0 percentile vs. 77.0 percentile) (see Figure 15).

Putting the information into perspective

As with the PEP evaluation, we estimated how much LESS weight a child gained in the year than if the child's weight gain had continued at their baseline BMI percentile on the CDC growth chart. See Technical appendix for detailed methods for estimating change in weight.



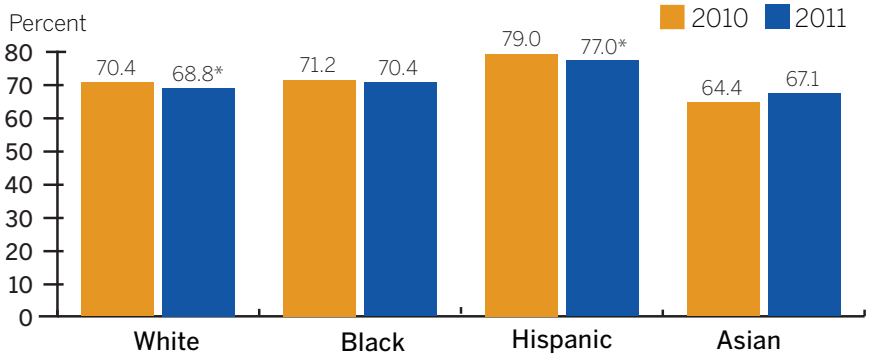
N= 1,533 (with observations in both years)
N = 830 boys and 703 girls
*P<0.05, statistically significant change (paired samples t-test)

Figure 14. Somerville student's average BMI percentile in 2010 and in 2011 (K - 8th grade)

If the BMI percentile for a ten-year old child at the 85th percentile BMI for age and gender (overweight) in 2010 changed by the average amount for a boy (-1.24) or girl (-1.49), this translates to a decrease in the expected weight gain of just under one pound (-0.88 lb) for boys and over a pound (-1.1 lbs) for girls at follow-up in 2011. If the child was in the 95th percentile (obese) at baseline in 2010, the prevention of additional weight gain at follow-up in 2011 is almost three pounds (-2.86 lbs) for boys and almost four pounds (-3.74 lbs) for girls.

In summary, for the students who participated in the Somerville Public Schools BMI surveillance program in 2010 and 2011, the proportion of students who were obese decreased about 6% and the average student BMI percentile decreased significantly. These declines translate to an estimate that Somerville students who were overweight in 2010 gained about a pound less and obese students gained about three to four pounds less than if they had continued on their 2010 weight gain trajectory. Between 2010 and 2011 no individual racial/ethnic group experienced a statistically significant change in weight status.

... overall the proportion of students who were obese decreased about six percent and the BMI percentile decreased significantly.



N= 1,533 (with observations in both years)
N = 526 White, 170 Black, 683 Hispanic, 134 Asian
*P<0.05, statistically significant change (paired samples t-test)

Figure 15. Somerville student's average BMI percentile by race/ethnicity in 2010 and in 2011 (K - 8th grade)

Conclusions

The analysis of data collected during three sequential windows of time during a decade of community-engaged interventions demonstrated that Somerville school children experienced small but statistically significant declines in average BMI percentile during the timeframes that were studied. Thus, while we cannot prove that SUS caused the demonstrated changes in weight status or BMI, the SUS model of community engagement and systems change continues to demonstrate promise for combating childhood obesity.

The results of the three analyses cannot be directly compared with each other because different research methods and study populations were used in each analysis. However, a few trends were noted that should be considered during SUS program planning and monitored over time in Somerville. In both the PEP and BMI surveillance studies, boys were more likely to trend toward higher BMI percentile scores and were more likely to be obese than girls. Likewise, specific communities of color had higher average BMI percentile scores and were more likely to be obese (Black/African American students in the PEP project and Hispanic students in the BMI surveillance studies). These trends in Somerville mirror national disparity statistics. Especially since Somerville school children are becoming more ethnically and socio-economically diverse over time, SUS activities should continue to focus on targeting vulnerable groups.

Annual, consistent weight assessment of school children is necessary to monitor changes in weight status over time and to direct local intervention efforts. Ongoing efforts to collect systematic, continuous regional data are also important to support national efforts in understanding the obesity epidemic and what is working to blunt it. Somerville, as is the case for many mid-size cities in the United States, will need to continue to invest in data collection and data processing systems to achieve a robust, sustained system of health outcome monitoring. Somerville's extensive collaborations with academic and community health partners has fostered local capacity-building and methods development. Continuous health outcome monitoring in Somerville, as in other communities, will benefit from these continued collaborations.

Appendix I: The PEP Evaluation and the SPS BMI Surveillance Program

Table 1. *Physical Education Program (PEP) Evaluation:* Prevalence of obesity among Somerville students by demographic characteristics

	2006	2007	Δ	Sig
Overall	**28.6%**	**27.6%**	↓	
Gender:				
Boys (N=546)	31.1%	28.6%	↓	*
Girls (N=533)	26.1%	26.6%	↑	
Grade Level in 2006:				
4th (N=286)	28.7%	29.0%	↑	
5th (N=271)	31.7%	28.8%	↓	
6th (N=285)	26.0%	25.3%	↓	
7th (N=237)	28.3%	27.4%	↓	
Race/Ethnicity:				
White (N=509)	29.3%	26.5%	↓	*
Black (N=149)	33.6%	35.6%	↑	
Hispanic (N=335)	30.5%	29.9%	↓	
Asian (N=76)	7.9%	10.5%	↑	

Prevalence calculated as (# obese at time point)/(total # students at time point) x 100
***P<0.05,** statistically significant change (McNemar's Test)

Table 2. *Physical Education Program (PEP) Evaluation:* Incidence (new cases) of obesity from baseline to follow-up among Somerville students by demographic characteristics

	2006-2007
Overall	**3.5%**
Gender:	
Boys (N=546)	2.7%
Girls (N=533)	4.3%
Grade Level in 2006:	
4th (N=286)	2.9%
5th (N=271)	3.2%
6th (N=285)	3.8%
7th (N=237)	4.1%
Race/Ethnicity:	
White (N=509)	2.2%
Black (N=149)	6.1%
Hispanic (N=335)	4.3%
Asian (N=76)	4.3%

Incidence calculated as (# obese at time 2)/(# non-obese at time 1) x 100

Table 3. *Physical Education Program (PEP) Evaluation:* Remission of obesity among Somerville students by demographic characteristics

	2006-2007
Overall	**12.3%**
Gender:	
Boys (N=546)	14.1%
Girls (N=533)	10.1%
Grade Level in 2006:	
4th (N=286)	6.1%
5th (N=271)	16.3%
6th (N=285)	13.5%
7th (N=237)	13.4%
Race/Ethnicity:	
White (N=509)	14.8%
Black (N=149)	6.0%
Hispanic (N=335)	11.8%
Asian (N=76)	16.7%

Remission calculated as (# not obese at time 2)/(# obese at time 1) x 100

Table 4. *Physical Education Program (PEP) Evaluation:* Change in BMI percentile among Somerville students by demographic characteristics

	2006	2007	Δ	Sig
Overall	**73.01**	**72.36**	↓	*
Gender:				
Boys (N=546)	73.94	72.47	↓	*
Girls (N=533)	72.06	72.24	↑	
Grade Level in 2006:				
4th (N=286)	72.49	70.82	↓	*
5th (N=271)	73.35	72.94	↓	
6th (N=285)	70.89	70.94	↑	
7th (N=237)	75.70	75.25	↓	
Race/Ethnicity:				
White (N=509)	71.68	70.72	↓	*
Black (N=149)	76.44	74.72	↓	*
Hispanic (N=335)	77.31	77.36	↑	
Asian (N=76)	57.54	57.27	↓	

Prevalence calculated as (# obese at time point)/(total # students at time point) x 100
***P<0.05,** statistically significant change (paired samples t-tests)

Table 5. *Somerville Public Schools BMI Surveillance Program 2010 – 2011:* Prevalence of obesity among Somerville students by demographic characteristics

	2010	2011	Δ	Sig
Overall	**30.1%**	**28.4%**	↓	*
Gender:				
Boys (N=830)	32.2%	30.7%	↓	
Girls (N=703)	27.6%	25.8%	↓	
Race/Ethnicity:				
White (N=526)	25.5%	23.6%	↓	
Black (N=170)	26.5%	24.7%	↓	
Hispanic (N=683)	36.6%	35.6%	↓	
Asian (N=134)	20.2%	17.9%	↓	
Grade Level in 2010:				
K (N=257)	29.2%	28.0%	↓	
1st (N=236)	28.4%	26.3%	↓	
2nd (N=162)	38.3%	35.8%	↓	
3rd (N=336)	32.1%	30.7%	↓	
4th (N=216)	24.5%	27.3%	↑	
5th (N=46)	26.1%	23.9%	↓	
6th (N=216)	29.6%	25.0%	↓	*
7th (N=64)	31.3%	26.6%	↓	

Prevalence calculated as (# obese at time point)/(total # students at time point) x 100

Table 6. *Somerville Public Schools BMI Surveillance Program 2010 – 2011:* Incidence (new cases) of obesity from baseline to follow-up among Somerville students by demographic characteristics

	2010-2011
Overall	**5.1%**
Gender:	
Boys (N=830)	6.4%
Girls (N=703)	3.7%
Race/Ethnicity:	
White (N=526)	3.8%
Black (N=170)	4.0%
Hispanic (N=683)	7.2%
Asian (N=134)	3.7%
Grade Level in 2010:	
K (N=257)	9.3%
1st (N=236)	1.8%
2nd (N=162)	5.0%
3rd (N=336)	6.1%
4th (N=216)	8.0%
5th (N=46)	2.9%
6th (N=216)	1.3%
7th (N=64)	0.0%

Incidence calculated as (# obese at time 2)/(# not obese at time 1) x 100

Table 7. *Somerville Public Schools BMI Surveillance Program 2010 – 2011:* Remission of obesity among Somerville students by demographic characteristics

	2010-2011
Overall	**17.4%**
Gender:	
Boys (N=830)	18.0%
Girls (N=703)	16.5%
Race/Ethnicity:	
White (N=526)	18.7%
Black (N=170)	17.8%
Hispanic (N=683)	15.2%
Asian (N=134)	25.9%
Grade Level in 2010:	
K (N=257)	26.7%
1st (N=236)	11.9%
2nd (N=162)	14.5%
3rd (N=336)	17.6%
4th (N=216)	13.2%
5th (N=46)	16.7%
6th (N=216)	18.8%
7th (N=64)	15.0%

Remission calculated as (# not obese at time 2)/(# obese at time 1) x 100

Table 8. *Somerville Public Schools BMI Surveillance Program 2010 – 2011:* Change in BMI percentile among Somerville students by demographic characteristics

	2010	2011	Δ	Sig
Overall	**73.89**	**72.53**	↓	*
Gender:				
Boys (N=830)	74.32	73.08	↓	*
Girls (N=703)	73.37	71.88	↓	*
Race/Ethnicity:				
White (N=526)	70.42	68.77	↓	*
Black (N=170)	71.21	70.37	↓	
Hispanic (N=683)	78.98	77.03	↓	*
Asian (N=134)	64.43	67.06	↑	
Grade Level in 2010:				
K (N=257)	74.84	71.85	↓	*
1st (N=236)	72.91	70.32	↓	*
2nd (N=162)	77.12	76.13	↓	
3rd (N=336)	74.30	73.86	↓	
4th (N=216)	72.51	73.25	↑	
5th (N=46)	71.33	71.93	↑	
6th (N=216)	72.62	70.26	↓	*
7th (N=64)	74.09	72.95	↓	

Prevalence calculated as (# obese at time point)/(total # students at time point) x 100

Appendix II: Technical Appendix for Estimating Change In Weight

Prepared by Ken Chui (Kenneth.chui@tufts.edu)

Estimating The Expected Change In Weight

The general concept is to compare two scenarios: i) change in weight if the child stays in the same growth trajectory in the gender- and age-adjusted BMI-for-height reference chart, and ii) "extract" change in weight of the child with the change in BMI accounted for. If there is no change in BMI percentile score, the difference between the two estimates will be zero. If there is change, we could postulate such "difference-of-difference" as a manifestation of some external factors, such as implementation of programs, change in policy, alteration in physical activity behavior or dietary patterns, and other unmeasured factors. The technique does not imply causality, but merely to provide a "what if" scenario. The following protocols detail how such estimates were derived.

Creating the "sample subjects"

First we derive two line charts (one for male, one for female) that show weight against BMI percentile score. To do this, we created a simulated anthropometry data set with the following variables:

- Age: ranged from 59.5 months (5 yrs old) to 167.5 months old (14 yrs old), with an increment of 2 months.
- Height: height in cm, taken from reference stature-for-age data from the CDC growth reference (http://www.cdc.gov/growthcharts/clinical_charts.htm). We selected the median height (50th percentile) as the reference height for each gender and unique age.
- Weight: for each unique pair of age and height, we impute a range of weight. The data were taken from the weight-for-age published in the CDC growth reference. To ensure our final BMI percentile scores included most of our studied children, we opted for covering the full range of age-adjusted weight, from 14 kg to 100 kg, with an increment of 0.1 kg.

The data were created for each gender, resulting in a data set with 17,222 cases that represented almost all possible combinations of height and weight between the age of 5 and 14 years old. The data were then processed with the SAS program available at CDC (http://www.cdc.gov/nccdphp/dnpao/growthcharts/resources/sas.htm) to generate BMI percentile score and z-score. This final data set contained both

age- and gender-specific BMI percentile scores and weight, which are the required variables for our reference plots. All data management described was performed with SAS software version 9.2 (SAS Institute Inc. Cary, NC, USA, 2008).

Plotting the data

Figures 1 and 2 are two examples of the reference plots for boys and girls, respectively. The curves indicate different combinations of weight and BMI percentile for children who are between age 10 and 11 years old and of median height. The vertical distance between the curves denote the "expected change in weight" if BMI percentile score did not change. Three reference vertical lines were placed at BMI percentile = 75th, 85th, and 95th.

By contrasting these "expected change in weight" values with the actual observed data from the three studies in Somerville, we could then trace the change in weight while allowing both height and age to vary. For example, in the boy chart, for a sample boy (age 10, height at median of age 10), he is expected to be about 34.9 kg. If his BMI percentile does not change, by next year (age 11, height at median of age 11) he would weigh about 38.8 kg. The net change is 3.9 kg. If in the follow up measure, we found boy's BMI percentile to have lowered (e.g. 74th), then his expected weight at 11 would be 38.5 kg, resulting in a difference of 38.5–34.9 = 3.6 kg. The difference-of-difference is then 3.9–3.6 = 0.3 kg. Similar comparisons can also be computed with BMI percentile scores at other levels, such as 85th and 95th. We interpolated the expected change in weight for the evaluation of the Physical Education Program and the Somerville Public Schools BMI Surveillance Program in the report with the same method. Graphing of the data was done with R software version 2.14.1 (R Development Core Team, 2011).

Pros and cons

An advantage of this method is that we can convey some perceivable differences in weight in virtually any combination of height, weight, age, and gender. However, this method does have some limitations. First, because the vast number of combinations, we can only showcase a "sample subject." In our case, we opted for age 10, which was represented in both evaluation studies. We also assume the sample subject is of median height in order to keep the explanation simple. Second, although we interpreted the finding as an individual-level predictive model, the model is actually depicting average population trend. Sometimes, inter-personal variation due to biological factors and behavioral factors could significant deviate our estimated "difference-in-difference." Without individual-level nationally representative data (which are not available), we would not be able to control for such inter-personal difference. Hence, we opted for adopting this point-estimation-only approach without any confidence interval.

Figure 1: Projected change in weight against BMI percentile for boys with median height

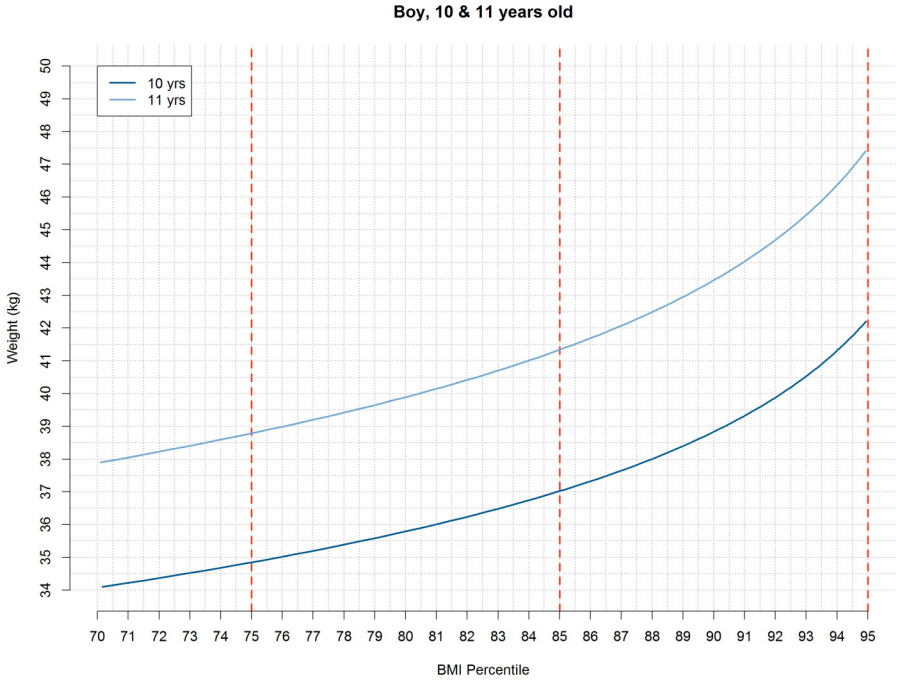
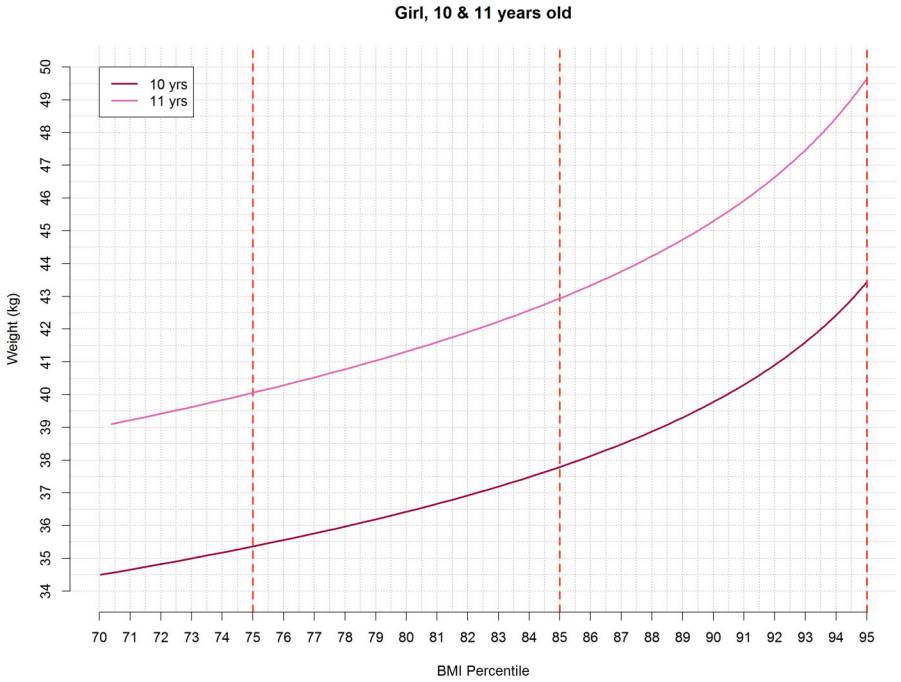


Figure 2: Projected change in weight against BMI percentile for girls with median height



Sources

1. Economos CD, Hyatt RR, Goldberg JP, et al. ***A Community Intervention Reduces BMI z-score in Children: Shape Up Somerville First Year Results***. Obesity 2007;15(5):1325-1336.
2. Singh GK, Kogan MD, Van Dyck PC, et al. ***Racial/ethnic, socioeconomic, and behavioral determinants of childhood and adolescent obesity in the United States: analyzing independent and joint associations.*** Annals of epidemiology 2008;18(9):682-695.
3. Cawley J. ***The economics of childhood obesity.*** Health Affairs; 29(3):364-371.
4. Ogden CL, Carroll MD, Curtin LR, et al. ***Prevalence of overweight and obesity in the United States, 1999-2004.*** JAMA: the journal of the American Medical Association 2006;295(13):1549-1555.
5. Ebbeling CB, Pawlak DB, Ludwig DS. ***Childhood obesity: public-health crisis, common sense cure.*** The lancet 2002;360(9331):473-482.
6. Wang YC, McPherson K, Marsh T, et al. ***Health and economic burden of the projected obesity trends in the USA and the UK.*** The lancet; 378(9793): 815-825.
7. ***2000 Census: US Municipalities Over 50,000: Ranked by 2000 Population.*** [cited 2011 April]; Available from: http://www.demographia.com/db-uscity98.htm
8. ***Centers for Disease Control and Prevention. Defining Overweight and Obesity.*** [cited; Available from: http://www.cdc.gov/obesity/adult/defining.html
9. ***Centers for Disease Control and Prevention. Basics About Childhood Obesity*** [cited; Available from: http://www.cdc.gov/obesity/childhood/basics.html
10. Wojcicki JM, Heyman MB. ***Let's move, A childhood obesity prevention from pregnancy and infancy onward.*** New England Journal of Medicine; 362(16): 1457-1459.
11. ***Healthy People 2020. Nutrition and Weight Status.*** [cited; Available from: http://www.healthypeople.gov/2020/topicsobjectives2020/overview.aspx?topicid=29
12. ***Robert Wood Johnson Foundation. Childhood Obesity***. [cited; Available from: http://www.rwjf.org/childhoodobesity/
13. ***Centers for Disease Control and Prevention, National Center for Health Statistics. Obesity and Overweight.*** [cited; Available from: http://www.cdc.gov/nchs/fastats/overwt.htm
14. Bell J, Rogers VW, Dietz WH, et al. ***CDC grand rounds: childhood obesity in the united states.*** Morbidity and Mortality Weekly Report;60(2):42-46.

15. Singh GK, Kogan MD, van Dyck PC. ***Changes in state-specific childhood obesity and overweight prevalence in the United States from 2003 to 2007.*** Archives of Pediatrics and Adolescent Medicine;164(7):598.

16. Kumanyika SK, Obarzanek E, Stettler N, et al. ***American Heart Association Council on Epidemiology and Prevention, Interdisciplinary Committee for Prevention. Population-based prevention of obesity: the need for comprehensive promotion of healthful eating, physical activity, and energy balance: a scientific statement from American Heart Association Council on Epidemiology and Prevention, Interdisciplinary Committee for Prevention (formerly the expert panel on population and prevention science).*** Circulation 2008;118(4):428-464.

17. ***United States Census 2010. Middlesex County, Somerville MA.*** [cited; Available from: http://www.sec.state.ma.us/census/middlesex.htm

18. ***Massachussetts Department of Secondary and Elementary Education. School and District Profiles.*** [cited; Available from: http://profiles.doe.mass.edu/

19. ***Massachusetts Department of Education. Student Mobility Rates.*** [cited; Available from: http://www.doe.mass.edu/infoservices/reports/mobility/

20. ***Institute for Community Health. Somerville, Healthy Kids, Healthy Communities.*** [cited; Available from: http://icommunityhealth.org/2011/12/01/somerville-health-kids-healthy-communities/

21. Economos CD, Folta SC, Goldberg J, et al. ***A community-based restaurant initiative to increase availability of healthy menu options in Somerville, Massachusetts: Shape Up Somerville.*** Preventing Chronic Disease 2009;6(3).

22. Goldberg JP, Collins JJ, Folta SC, et al. ***Retooling food service for early elementary school students in Somerville, Massachusetts: the Shape Up Somerville experience.*** Preventing Chronic Disease 2009;6(3):A103.

23. Folta SC, Goldberg JP, Economos C, et al. ***Assessing the use of school public address systems to deliver nutrition messages to children: Shape up Somerville, audio adventures.*** Journal of school health 2006;76(9):459-464.

24. ***BMI-for-Age Screening Guidelines for Schools. Massachusetts Department of Public Health.*** [cited; Available from: http://www.mass.gov/eohhs/docs/dph/com-health/school/bmi-screening-guidelines-for-schools.pdf