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doi: 10.1377/hlthaff.2009.0691
HEALTH AFFAIRS 29,
NO. 3 (2010): 372–378

How Much Should We Invest In Preventing Childhood Obesity?

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ABSTRACT Policy makers generally agree that childhood obesity is a national problem. However, it is not always clear whether enough is being spent to combat it. This paper presents nine scenarios that assume three different degrees of reduction in obesity/overweight rates among children in three age groups. A mathematical model was then used to project lifetime health and economic gains. Spending $2 billion a year would be cost-effective if it reduced obesity among twelve-year-olds by one percentage point. The analysis also found that childhood obesity has more profound economic consequences than previously documented. Large investments to reduce this major contributor to adult disability may thus be cost-effective by widely accepted criteria.

The percentage of U.S. children who are obese has tripled in the past thirty years, from less than 5 percent to nearly 20 percent among children ages 6–11.[1] Diabetes, gallbladder disease, obstructive sleep apnea, and compromised mental health are among the conditions associated with being overweight or obese.[2–5]

Obesity is defined as body mass index (BMI) equal to or greater than the ninety-fifth percentile for age and sex. Overweight is defined as BMI in the eighty-fifth through ninety-fourth percentiles. Several large cohort studies have found that obese and overweight children often remain obese and overweight as adults.[6–9]

Effects Of Obesity

Adults who were obese or overweight as adolescents have been consistently documented to develop cardiovascular disease, colon cancer, and arthritis, even if they lose the excess weight later in life.[10,11] Together, these findings suggest that adult illnesses associated with excess weight can be attributed at least in part to childhood obesity. Indeed, one study has directly related increases in the prevalence of childhood obesity/overweight to decreases in life expectancy, which may result in the first U.S. decline in life expectancy since the Great Depression.[12]

HEALTH CONSEQUENCES Americans are well aware of the serious health consequences of excess weight in childhood. A representative survey of U.S. adults in 2004 suggested strong support for limiting unhealthy foods in school vending machines and requiring physical education in schools.[13] Another survey found that New York State residents would be willing to pay $690.6 million in additional taxes annually to reverse this epidemic.[14]

Recent analyses have documented spending increases for hospitalization,[15–17] emergency room and outpatient visits, and prescription drugs[18,19] for obese and overweight children. Others have documented added expenses associated with adult obesity.[20–23] These studies suggest that reductions in obesity and overweight in children could produce short-term economic benefits for children and longer-term benefits for adults that would partly offset the cost of interventions.

GAINS FROM REDUCING CHILDHOOD OBESITY The most important gains from reducing childhood obesity are likely to be better health and quality of life in adulthood. During the past thirty years, researchers have developed standardized questionnaires to measure relative differences in perceived quality of life given a particular disease or disability, compared with "perfect" health. Richard Zeckhauser and Donald Shepard first coined the phrase "quality-adjusted life-year" (QALY) to describe a measurement that combines duration and quality of life.[24] For example, three QALYs can be attained through three years of "perfect" health or six years with half the quality of life associated with "perfect" health.

When the cost of interventions is divided by the QALYs gained through public health interventions, the resulting cost-effectiveness ratio can be compared with that of other interventions. Interventions are commonly judged worthy if their ratios are less than $50,000 per QALY gained.[25] However, a broader range of ratios—$20,000–$200,000 per QALY—has been suggested.[26]

IDENTIFYING EFFECTIVE INTERVENTIONS Effective interventions to prevent childhood obesity and overweight have not been readily identified.[27] This is in part because obesity is not simply a matter of taking in more calories than are burned in physical activity.[28] Although continued research into prevention and treatment is needed, estimating the economic benefits of successful intervention is not premature, because it enables policy makers to determine what level of investment would be worth considering in the context of developing interventions.

Economists use a method called threshold analysis[29] to facilitate decisions about health investments in which key parameters are uncertain. This method identifies a threshold at which an investment would be desirable and then examines the range of values in the uncertain parameters that would produce a desirable investment.[30] Policy makers can compare existing investments in obesity prevention against the level of investment that would be cost-effective if it achieved a given reduction in the prevalence or number of obese or overweight children.

Our analysis estimated the QALYs that would be gained in nine scenarios if the prevalence of obesity or overweight were reduced by three different amounts in each of three cohorts of school-age and adolescent children. These data were incorporated with the cost offsets of reduced short- and long-term health consequences to estimate appropriate levels of investment in a national obesity prevention program aimed at achieving a range of QALY thresholds.

Study Data And Methods

GENERAL APPROACH The analysis in this paper follows the approach taken by Rob Carter and Marjory Moodie in assessing the cost-effectiveness of childhood obesity prevention in Australia.[31] We looked at obese and overweight U.S. twelve–year-olds in 2005 and applied a cost-of-illness approach, projecting three consequences that studies suggest the children will experience: additional health care expenses during childhood, additional adult health care expenses that can be attributed to childhood obesity/overweight, and QALYs lost by obese/overweight adults who were obese/overweight children.

We then simulated the 2005 cohort of twelve-year-olds over their lifetimes, assuming a one-percentage-point decrease in the prevalence of obesity, from 16.3 percent to 15.3 percent. We recalculated their projected expenses attributable to childhood obesity as well as their lost QALYs. To calculate the value of adult QALYs saved as a result of less childhood obesity, we multiplied the QALYs by $50,000 and applied a discount in recognition of the lag between adult obesity/overweight and QALY loss. The savings in health care expenses achieved by reducing obesity were added to calculate the aggregate investment that would be cost-effective if it reduced obesity among twelve-year-olds by one percentage point. The results represented a base-case intervention scenario.

SENSITIVITY ANALYSIS Efforts to prevent childhood obesity can focus on different age groups and produce different outcomes: moving overweight children toward a normal BMI, or obese to overweight. We therefore examined eight other scenarios. First, we added two age cohorts, six- and nineteen-year-olds, and calculated the outcome for each when obesity was reduced by one percentage point, just as for twelve-year-olds. Then we varied the outcome of the intervention in each of the three cohorts to a one-percentage-point reduction in overweight, from 15.6 percent to 14.6 percent. Finally, for each cohort, we assumed a simultaneous reduction in obesity by one percentage point and an increase in overweight by one percentage point.

Because the study relied on a mathematical model, we also performed a sensitivity analysis to assess the impact of varying uncertain parameters in the model. We applied a range of 0–5 percent discount rates as recommended by the U.S. Department of Health and Human Services Panel on Cost-Effectiveness in Health and Medicine.[25] All results are presented in 2005 dollars.

Subsequent sections describe the approach to quantifying the effects of the various reductions in obesity and overweight on each of the three consequences studied. Values for most model inputs are provided in Exhibit 1. A Methodological Appendix provides a more expansive description and specifies model inputs.[32]

EXPENSES ATTRIBUTABLE TO OBESITY Data on the prevalence of childhood obesity and overweight were obtained from the 2003–2006 National Health and Nutrition Examination Survey (NHANES).[1] The data were then applied against U.S. census data[33] to calculate numbers of obese and overweight children. Data from the 2005 Nationwide Inpatient Sample (NIS)[15] and the 2001–2005 Medical Expenditure Panel Survey (MEPS)[19] were used to calculate annual per patient medical expenses attributable to childhood obesity/overweight; this value was multiplied by the number of children in the cohort.

ESTIMATES OF ADULT OBESITY ATTRIBUTABLE TO CHILDHOOD OBESITY We estimated future cases of adult obesity and overweight that can be attributed to childhood obesity and overweight using data from the Fels Longitudinal Study.[7] This study measured height, weight, and body composition data in 347 subjects from birth to age thirty-nine to assess growth trajectories and develop models that predict the likelihood of adult obesity and overweight based on BMI at different times of life. For each sex, we calculated the increased probability that an obese or overweight child would become an obese or overweight adult. We did this by subtracting the probability of being obese or overweight at age thirty-five—given a seventy-fifth-percentile BMI at age twelve—from the probability of being obese or overweight at age thirty-five, given an obese or overweight BMI at age twelve. We then multiplied the increase in the probability of adult obesity or overweight from the Fels study by the number of obese or overweight children identified from the NHANES data, to calculate the increase in the number of obese or overweight adults that can be attributed to childhood obesity and overweight. We then carried these numbers forward to estimate adult medical expenses and lost QALYs that can be attributed to childhood obesity.

EXPENDITURES IN ADULTHOOD We calculated adult expenditures attributable to childhood obesity by multiplying the number of obese or overweight adults who had been obese or overweight as children by the increase in per patient medical spending found by Eric Finkelstein and

EXHIBIT 1

Key Parameters Used In Analysis, Base Case (Sensitivity Analysis), Estimating Costs Attributable To Childhood Overweight And Obesity

Parameter	Base-case value (sensitivity analysis)	
Prevalence of obesity before intervention	16.3%	
Change in obesity prevalence	–1% (0%)	
Prevalence of overweight before intervention	15.6%	
Change in overweight prevalence	0% (–1% to +1% for intervention changing obese children to overweight)	
Age of intervention	Age 12 (ages 6 and 19)	
Discounting rate	3% (0–5%)	
Value of QALY	$50,000 ($20,000–$200,000)	
Time lag from adult obesity to loss of QALY	30 years	
Time period of additional medical spending among obese adults	35 years	
Parameter	**Overweight**	**Obese**
Incremental annual hospitalization costs, age 12	–	$27[a]
Incremental outpatient costs, ages 12–19	$126[b]	$218[b]
Incremental prescription drug costs, ages 12–19	$237[b]	$111[b]
Incremental emergency room costs, ages 12–19	–	–
Incremental medical expenditures, adult	–	$1,269[e]
Incremental annual hospitalization costs, age 6	–	$28[a]
Incremental annual hospitalization costs, age 19	–	$45[a]
Incremental outpatient costs, ages 6–11	–	$118[b]
Incremental prescription drug costs, ages 6–11	–	–
Incremental emergency room costs, ages 6–11	–	–
Incremental probability of adult obesity given BMI at age 12	6% males, 8% females[c]	26% males, 35% females[c]
Incremental probability of adult overweight given BMI at age 12	11% males, 15% females[c]	31% males, 40% females[c]
Incremental probability of adult obesity given BMI at age 6	2% males, 6% females[c]	9% males, 29% females[c]
Incremental probability of adult overweight given BMI at age 6	6% males, 10% females[c]	18% males, 33% females[c]
Incremental probability of adult obesity given BMI at age 19	16% males, 11% females[c]	60% males, 53% females[c]
Incremental probability of adult overweight given BMI at age 19	13% males, 20% females[c]	22% males, 43% females[c]
QALYs lost among adults	0.5 males, 2.9 females[d]	4.4 males, 7.2 females[d]

SOURCES See below. **NOTES** All costs are in 2005 dollars. QALY is quality-adjusted life-year. In empty cells, no incremental costs were applied for these categories in the modeling. [a]Note 15 in text. [b]Note 18 in text. [c]Note 7 in text. [d]Note 37 in text. [e]Note 34 in text (subsequently discounted by 38 percent to account for preponderance of obesity-associated expenditures in later adulthood).

colleagues using data from the 2006 MEPS.[34] Finkelstein and colleagues estimated that obese adults, on average, spent $1,429 more annually (in 2002 dollars, or $1,269 in 2005 dollars using the Medical Care Consumer Price Index)[35] than their nonobese peers. Elsewhere, Finkelstein and Derek Brown found that 38 percent of obesity-associated medical spending is incurred after age sixty-five.[36] To avoid overestimating the current value of adult medical expenses attributable to obesity, we adjusted our calculation to reflect the fact that such expenses start small and grow over a lifetime.

QALYS LOST IN ADULTHOOD We multiplied the number of adult cases of obesity and overweight attributable to childhood obesity by the number of QALYs lost among obese and overweight adults in a nationally representative sample analyzed by Peter Muennig and colleagues. These researchers used data from the 2000 MEPS, the 1990–1992 National Health Interview Survey (NHIS), and National Death Index data through 1995 to quantify the number of QALYs lost by obese or overweight adults of each sex.[37] We multiplied the QALYs lost in each sex and elevated BMI subgroup at age eighteen by the number of cases of adult obesity or overweight attributable to childhood obesity and overweight, to calculate the QALYs lost in adulthood because of childhood obesity and overweight.

Study Results

During childhood, U.S. children who were age twelve in 2005 are estimated to incur $2.77 billion in attributable medical expenses. An additional 325,254 adults will be overweight and an additional 252,295 adults will be obese as a result of elevated BMI in childhood. Obese adults will incur $3.47 billion in additional medical expenditures because they were obese or overweight as children, and 2,102,522 QALYs will be lost as a result of elevations in childhood BMI (Exhibit 2).

But with a one-percentage-point reduction in obesity among twelve-year-olds (the base-case intervention scenario), 102,749 QALYs and $260.4 million in total medical expenditures would be saved (Exhibit 3).

Exhibit 3 presents the cost offsets achieved through reductions in different BMI categories and different age groups. Reductions later in childhood generally produced higher cost offsets and QALYs saved, and one-percentage-point reductions in childhood overweight achieved the most modest economic benefits and gains in QALYs. The intermediate scenario, simultaneously reducing obesity by one percentage point and raising overweight by one percentage point, still produced large economic and QALY savings, driven in large part by the medical expenses and high QALY losses endured by obese adults.

All scenarios and discount rates produced results suggesting that large investments in preventing obesity would be cost-effective if they reduced the prevalence of obesity and overweight (Exhibit 4). In the base-case scenario, a $2.03 billion investment ($1,526 per child with elevated BMI) would produce a cost-effectiveness ratio of $50,000 per QALY if it reduced obesity by one percentage point. No discounting rate or age of intervention produced an invest-

EXHIBIT 2

Health And Economic Consequences Of Obesity/Overweight In The Cohort Of 12-Year-Olds In 2005

	Male	Female
Number of overweight children	333,615	317,802
Number of obese children	348,584	332,062
Direct medical expenditures in childhood attributable to overweight	$700.5 million	$667.3 million
Direct medical expenditures in childhood attributable to obesity	$717.8 million	$683.8 million
Adult cases of overweight attributable to childhood overweight	36,698	47,670
Adult cases of obesity attributable to childhood overweight	20,017	25,424
Adult cases of overweight attributable to childhood obesity	108,061	132,825
Adult cases of obesity attributable to childhood obesity	90,632	116,222
Direct medical expenditures among obese adults attributable to childhood overweight	$275.1 million	$349.5 million
Direct medical expenditures among obese adults attributable to childhood obesity	$1.25 billion	$1.60 billion
QALYs lost among overweight adults that can be attributable to childhood overweight	18,349	138,244
QALYs lost among obese adults that can be attributable to childhood overweight	88,074	183,054
QALYs lost among overweight adults that can be attributable to childhood obesity	54,031	385,193
QALYs lost among obese adults that can be attributable to childhood obesity	398,781	836,798
Total direct medical expenditures (child and adult) attributable to childhood overweight/obesity	**$6.24 billion**	

SOURCE Author's analysis. **NOTES** All costs are in 2005 dollars. QALY is quality-adjusted life-year.

EXHIBIT 3

Sensitivity Analysis For The Economic Benefits And Quality-Adjusted Life-Years (QALYs) Saved By Reducing Obesity/Overweight

Scenario	Medical expenditures saved in childhood	Medical expenditures saved in adulthood	QALYs saved
1-percentage-point reduction in obesity among 12-year-old cohort	$86.0 million ($80.7–$95.1 million)	$174.4 million ($116.2–$349.5 million)	102,749
1-percentage-point reduction in obesity among 6-year-old cohort	$81.4 million ($70.7–$102.0 million)	$84.5 million ($50.1–$202.2 million)	67,910
1-percentage-point reduction in obesity among 19-year-old cohort	$15.8 million	$403.0 million ($307.1–$656.5 million)	163,308
1-percentage-point reduction in overweight among 12-year-old cohort	$87.7 million ($82.3–$97.0 million)	$40.0 million ($26.7–$80.2 million)	27,418
1-percentage-point reduction in overweight among 6-year-old cohort	$60.2 million ($50.3–$79.5 million)	$17.8 million ($10.6-$42.6 million)	16,158
1-percentage-point reduction in overweight among 19-year-old cohort	$15.3 million	$96.6 million ($73.6–$157.4 million)	44,768
1-percentage-point reduction in obesity and 1-percentage-point increase in overweight among 12-year-old cohort	–$1.7 million ($1.6 to –$1.9 million)	$134.4 million ($89.5–$269.2 million)	75,331
1-percentage-point reduction in obesity and 1-percentage-point increase in overweight among 6-year-old cohort	$21.2 million ($20.4–$22.5 million)	$66.7 million ($39.6–$159.6 million)	51,753
1-percentage-point reduction in obesity and 1-percentage-point increase in overweight among 19-year-old cohort	$0.5 million	$306.4 million ($233.5–$499.1 million)	118,540

SOURCE Author's analysis. **NOTES** The exhibit presents nine intervention scenarios in which the age of the intervention and the affected body mass index (BMI) category are varied. The base-case scenario, depicted in the first row of values without parentheses, represents a one-percentage-point reduction in obesity with a 3 percent discount rate and a threshold of $50,000 per QALY. The values in the other cells without parentheses represent the result for each alternative scenario with a different age of intervention or BMI category, or both, when a 3 percent discount rate and a threshold of $50,000 per QALY are used. Ranges in parentheses represent bounds of sensitivity analyses for each scenario and intervention age group (which varies by discount rate). The value of QALYs used in the sensitivity analysis does not affect the medical expenditures saved in childhood or adulthood. There are no bounds for the QALY within each row because discount rate and value of the QALY threshold do not affect the number of QALYs saved. The value for childhood medical expenditures saved by reducing obesity/overweight at age 19 is not affected by discount rate because the intervention occurs in the year in which benefits are achieved. All costs are in 2005 dollars.

ment threshold of less than $326 million if it produced a one-percentage-point decrease in obesity prevalence. More modest scenarios in which an intervention only moved children from obese to overweight had a minimum investment of $204 million (using a threshold of $20,000 per QALY).

An expenditure of $103 million that reduced overweight prevalence by one percentage point among the six-year-old cohort would be cost-effective at $20,000 per QALY using a 5 percent discounting rate. The same reduction among nineteen-year-olds would be cost-effective even if it took $9.13 billion to achieve it, using a 0 percent discounting rate and a threshold of $200,000 per QALY.

Discussion And Limitations

The two major findings of this study are that childhood obesity has more profound short- and long-term economic consequences than previously documented, and that large investments to reduce this major contributor to adult disability may be cost-effective by widely accepted criteria. Policy makers may wish to reassess existing investment in childhood obesity/overweight prevention in light of these findings.

CONSERVATIVE APPROACH In conveying the scope of the effort that should be undertaken, we took a conservative approach, analyzing only direct health care expenditures in childhood and adulthood and QALYs lost that can be attributed to elevated childhood BMI. By limiting our analysis to these three consequences of childhood obesity, we probably obtained a lower estimate than we would have by asking a nationally representative sample of Americans how much they would be willing to pay to reduce childhood obesity. However, cost-effectiveness analyses are more commonly performed for medical and public health interventions, and this analysis more readily permits comparison of childhood obesity interventions against competing priorities.

LIMITATIONS OF MODELING Any analysis that relies on mathematical modeling is only as good as its inputs and assumptions. Although this analysis did not exhaust the studies that could have

EXHIBIT 4

Sensitivity Analysis For The Amount Of Investment That Would Yield Cost-Effective Reductions In Obesity/Overweight

	Intervention age group		
Scenario	**6-year-olds**	**12-year-olds**	**19-year-olds**
1-percentage-point reduction in obesity	$1.15 billion ($326 million–$13.9 billion)	$2.03 billion ($572 million–$21.0 billion)	$3.32 billion ($915 million–$33.3 billion)
1-percentage-point reduction in overweight	$311 million ($103 million–$3.35 billion)	$601 million ($204 million–$5.66 billion)	$907 million ($251 million–$9.13 billion)
1-percentage-point reduction in obesity and 1-percentage-point increase in overweight	$835 million ($193 million–$10.5 billion)	$1.43 billion ($348 million–$15.3 billion)	$2.41 billion ($664 million–$24.2 billion)

SOURCE Author's analysis. **NOTES** The exhibit presents nine different intervention scenarios in which the age of the intervention and the affected body mass index (BMI) category are varied. The value without parentheses represents the result when a 3 percent discount rate and a threshold of $50,000 per quality-adjusted life-year (QALY) are used. Ranges in parentheses represent bounds of sensitivity analyses for each scenario and intervention age group in which threshold is varied from $20,000 to $200,000 per QALY and discount rate is varied from 0 percent to 5 percent. All costs are in 2005 dollars.

provided data for the incremental risk of adult obesity and overweight based on childhood BMI,[38] the Fels Longitudinal Study does not exaggerate the risk of obesity/overweight in adulthood given an elevated childhood BMI. However, it is important to note that the Fels population did not necessarily reflect the demographic profile of the United States, whereas other data are nationally representative. Alternative data sources (such as childhood medical expenses attributable to childhood obesity) also exist, but they would not have influenced the results to the same extent as age of intervention, discounting rate, or elevated BMI category.

EFFECTS OF SMALL WEIGHT REDUCTIONS Interventions are also more likely to reduce weight (or reduce weight gain as part of childhood growth) than to reduce the prevalence of obesity/overweight as we modeled here. However, even small weight reductions across the population of children could achieve reductions in overweight prevalence. Claire Wang and colleagues found that the 3 percent increase in the prevalence of U.S. childhood obesity between 1988–1994 and 1999–2002 could be explained by a 4.3 kilogram average weight gain over that period.[39]

NEED FOR EFFECTIVE INTERVENTIONS Interventions that prevent childhood obesity/overweight remain elusive. This analysis is intended to show policy makers the scale of economic benefits that could be achieved once successful interventions are found, implemented, and sustained. Once an intervention is identified, a similar analysis should be reprised to assess potential cost-effectiveness in practice and account for the costs of developing and implementing it. Although obesity and overweight treatments could be examined the same way, surgical and drug therapies have so far proved unhelpful except for adolescents, and prevention is widely agreed to be the wisest approach to reduce downstream consequences of this epidemic.[40]

CONCLUSION Preventing childhood obesity and overweight will require a broad approach. This will include additional research to identify preventable risk factors; educational interventions in schools, homes, and other settings; improvements in nutrition labeling; new guidelines for marketing foods to youth; and changes in the "built environment"—houses, neighborhoods, and cities.[27] Our results suggest that additional research into interventions is necessary and that even some costly interventions of uncertain efficacy may be worth pursuing. As debate about health reform continues, this analysis underscores the need to focus on preventing childhood obesity and overweight as a cost-effective way to improve the nation's health. ■

The author acknowledges the contributions of his coauthors in previous papers whose results contributed a number of the key data inputs for this manuscript: Michael Weitzman and Yinghua Liu of New York University, Ed Fryer of the University of Arkansas for Medical Sciences, and Samprit Chatterjee of the Mount Sinai School of Medicine.

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