Reaching the Healthy People Goals for Reducing Childhood Obesity
Closing the Energy Gap

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Background: The federal government has set measurable goals for reducing childhood obesity to 5% by 2010 (*Healthy People 2010*), and 10% lower than 2005–2008 levels by 2020 (*Healthy People 2020*). However, population-level estimates of the changes in daily energy balance needed to reach these goals are lacking.

Purpose: To estimate needed per capita reductions in youths' daily "energy gap" (calories consumed over calories expended) to achieve Healthy People goals by 2020.

Methods: Analyses were conducted in 2010 to fit multivariate models using National Health and Nutrition Examination Surveys 1971–2008 (N=46,164) to extrapolate past trends in obesity prevalence, weight, and BMI among youth aged 2–19 years. Differences in average daily energy requirements between the extrapolated 2020 levels and Healthy People scenarios were estimated.

Results: During 1971–2008, mean BMI and weight among U.S. youth increased by 0.55 kg/m^2 and by 1.54 kg per decade, respectively. Extrapolating from these trends to 2020, the average weight among youth in 2020 would increase by ~1.8 kg from 2007–2008 levels. Averting this increase will require an average reduction of 41 kcal/day in youth's daily energy gap. An additional reduction of 120 kcal/day and 23 kcal/day would be needed to reach *Healthy People 2010* and *Healthy People 2020* goals, respectively. Larger reductions are needed among adolescents and racial/ethnic minority youth.

Conclusions: Aggressive efforts are needed to reverse the positive energy imbalance underlying the childhood obesity epidemic. The energy-gap metric provides a useful tool for goal setting, intervention planning, and charting progress.
(Am J Prev Med 2012;42(5):437–444) © 2012 American Journal of Preventive Medicine

Introduction

Since the 1970s, the prevalence of obesity in the U.S. doubled among preschool children and adolescents, and more than tripled among children aged 6–11 years.[1] Based on the most recent data, one of every six U.S. children and adolescents aged 2–19 years are obese (defined as having a BMI ≥95th age- and gender-specific percentiles).[2,3] The prevalence of obesity is highest in lower-income populations and African-American and Hispanic populations.[4]

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0749-3797/$36.00
doi: 10.1016/j.amepre.2012.01.018

A landmark IOM report in 2006 indicated that childhood obesity prevention efforts remained too few, too small, and too fragmented[5]; it recommended setting benchmark goals to drive action plans and allocate resources.[6] Changes in obesity prevalence remain the primary metric used to track national progress on reducing childhood obesity. Each decade, the DHHS released and monitored a list of health objectives to guide the nation's health promotion and disease prevention efforts. Along with several targets for better nutrition and more-active lifestyles, *Healthy People 2010* set the goal of reducing the percentage of children and adolescents who are obese to 5%—the level observed in the early 1970s—by 2010.[7]

To meet this goal, numerous policy- and community-level initiatives have been launched to change one or both sides of the energy-balance equation for children and adolescents—by reducing calories consumed or increasing calories expended from physical activity. Despite evidence for recent stabilization,[2,4] it is clear that a 5% target was extremely ambitious (even for 2020). The new *Healthy People 2020* goal, released in November 2010, set a more modest target of reducing the prevalence of obesity by 10% from 2005–2008 levels among youth aged 2–19 years—to bring overall prevalence down to 14.6% by 2020. *Healthy People 2020* goals also specified age-specific childhood obesity targets: 9.6% among children aged 2–5 years, 15.7% among children aged 6–11 years, and 16.1% among adolescents aged 12–19 years.

These concrete Healthy People goals provide benchmarks for charting our progress in reversing the childhood obesity epidemic. However, what has been missing is a metric for linking these obesity prevalence targets to interventions with the potential to restore energy balance at the population level. The objective of this study is to propose a framework for estimating the sizes of daily per capita "energy gap" reductions (kcal/person/day) needed to reach both *Healthy People 2010* and *Healthy People 2020* prevalence targets by 2020. Estimates are developed by extrapolating annual changes in youth body weight and obesity prevalence observed during the period from 1971 to 2008 overall and among sociodemographic subgroups.

See related Commentary by Dietz in this issue.

Methods

Data

Data on height and weight among U.S. children and adolescents aged 2–19 years were obtained from the following waves of National Health and Nutrition Examination Surveys (NHANES): 1971–1975 (N=7040); 1976–1980 (N=7351); 1988–1994 (N=10,793); and 1999–2008 (N=20,680 including 1999–2000, 2001–2002, 2003–2004, 2005–2006, 2007–2008, 2009–2010).[8–11] Each wave of NHANES is an unequal probability sample with a multistage, clustered, and stratified sampling design, to ensure that each sample represents the civilian non-institutionalized U.S. population during the surveyed period. Height and weight were measured by trained examiners in mobile examination centers using standardized techniques and equipment.

For children and adolescents, obesity was defined as having a BMI greater than or equal to the age- and gender-specific 95th percentile on the CDC growth charts.[3] Sociodemographic data were collected during a home interview. Four racial/ethnic groups were defined: non-Hispanic white; non-Hispanic black; Hispanics (including Mexican American and other Hispanics); and other. Subjects were also categorized by reported household income (with 6% missing income information): lower income (<100% poverty); middle income (100%–300% poverty); and higher income (≥300% poverty). Subjects with missing anthropometric measurement were excluded.

Historical Trends in Obesity Prevalence, Weight, Height, and BMI

Average annual changes in obesity prevalence and body weight in the U.S. youth population were estimated by fitting regression models to the compiled NHANES 1971–2008 data. The fitted models estimated the average changes per year in the prevalence of obesity (%); mean weight (kg); height (cm); and BMI, controlling for age, gender, and race/ethnicity. It is assumed that using a linear model in the analysis of annual trends in obesity prevalence would not result in biased coefficient estimates but that there could be some bias in the SE and p-values because of heteroscedasticity.[12] Thus, logistic regression models were also fitted using log odds of obesity as the dependent variable for comparison.

In separate models, an indicator variable for "1999 and later" period and its interaction term with calendar year were included. Differences in the slope of trends were tested (overall; by age group: 2–5 years, 6–11 years, and 12–19 years; by race–ethnicity; and by income group) to examine whether the trends differed in the more recent period (1999–2008) compared to the historic trend (1971–2008). The period 1999–2008 was chosen because that was the time frame used in recent analyses suggesting a stabilization of the obesity trend in NHANES data.[2,4]

All point estimates and their 95% CIs were adjusted for the complex survey design, including clusters, strata, and unequal probability of sampling using SUDAAN, version 10.0.1, including RLOGIST to fit logistic models and REGRESS to fit linear models. Both crude models unadjusted for covariates as well as multivariable-adjusted models were fitted. Goodness of fit is assessed using R^2 statistics (Cox & Snell, 1989) for both procedures. All p-values are two-tailed. The analyses were conducted in 2010. The 2009–2010 data points (released in September 2011) were added to contrast with historic trends, but these data were not used for trend projection or energy gap calculations.

Estimating "Energy Gap" Targets for Healthy People Goals

Using the regression models, mean body weight and BMI for the year 2020 were projected by extrapolating past trends. With little change in average height among U.S. youth in the past few decades, the observed trend in obesity was assumed to be driven by increased body weight. The difference between predicted mean body weight in 2020 and observed means in 2007–2008 (latest NHANES data at the time of analysis) was calculated. The mean body weight in two hypothetic scenarios was also calculated: if *Healthy People 2020* goals were reached by 2020, and if the earlier, more ambitious *Healthy People 2010* goals were reached by 2020.

Based on these models, the calendar year in the past in which the obesity prevalence rates were equivalent to the *Healthy People 2010* and *Healthy People 2020* goals, and the corresponding mean body weight, were determined (Appendix A, available at www.ajpmonline.org). For example, to reach the *Healthy People 2020* goals among adolescents aged 12–19 years, the calendar year with 16.1% on the smoothed prevalence trend line was ascertained (i.e., 2002). The mean body weight for that year (i.e., 64.3 kg) was then used as the target mean weight required to achieve the 16.1% *Healthy People 2020* goal set for this age group. Similarly, mean weights in the past when childhood obesity prevalence was 5% were used to represent the target mean weights if *Healthy People 2010* goals were to be achieved.

For each scenario, the corresponding daily energy requirement was estimated using published equations of basal metabolic rate and activity-related energy expenditure, assuming "light" physical

Table 1. Annual change in percentage obese, height, weight, BMI, and BMI *z*-score, 1971–2008

	Dependent variable				
Children and adolescents	**% obese**	**Height (cm)**	**Weight (kg)**	**BMI**	**BMI *z*-score**
All					
Model 1	0.37 (0.023)	0.03 (0.01)	0.154 (0.01)	0.055 (0.003)	0.015 (0.001)
Model 2	0.06 (0.03)	−0.01 (0.01)	0.001 (0.02)	0.002 (0.005)	−0.0001 (0.01)
Aged 2–5 years					
Model 1	0.18 (0.03)	0.04 (0.01)	0.03 (0.005)	0.015 (0.002)	0.010 (0.001)
Model 2	0.08 (0.04)	0.02 (0.01)	0.007 (0.005)	0.001 (0.003)	0.001 (0.002)
Aged 6–11 years					
Model 1	0.40 (0.03)	0.06 (0.01)	0.130 (0.012)	0.050 (0.004)	0.016 (0.001)
Model 2	0.002 (0.06)	−0.03 (0.02)	−0.014 (0.022)	−0.002 (0.007)	−0.001 (0.002)
Aged 12–19 years					
Model 1	0.039 (0.03)	0.04 (0.01)	0.230 (0.016)	0.072 (0.005)	0.015 (0.001)
Model 2	0.095 (0.05)	−0.02 (0.02)	0.012 (0.032)	0.008 (0.009)	0.0004 (0.002)
Non-Hispanic white					
Model 1	0.33 (0.03)	0.04 (0.01)	0.14 (0.01)	0.048 (0.004)	0.013 (0.001)
Model 2	0.03 (0.05)	−0.01 (0.02)	−0.01 (0.02)	−0.001 (0.007)	−0.0004 (0.002)
Non-Hispanic black					
Model 1	0.45 (0.03)	0.06 (0.01)	0.142 (0.2)	0.079 (0.005)	0.020 (0.001)
Model 2	0.07 (0.04)	−0.01 (0.02)	0.002 (0.02)	0.004 (0.006)	0.000 (0.001)
Hispanic					
Model 1	0.36 (0.06)	0.04 (0.02)	0.140 (0.02)	0.049 (0.007)	0.011 (0.002)
Model 2	0.09 (0.09)	−0.03 (0.02)	−0.03 (0.03)	−0.011 (0.009)	−0.004 (0.002)

Note: Model 1 values are adjusted β (SE) for trend. Model 1 is a linear regression model based on NHANES 1971–2008 data and contains linear calendar year to estimate annual changes in the dependent variable, adjusted for gender; age groups (except for age-stratified results); and race/ethnicity (except for race/ethnicity–stratified results). All β estimates are significant at the $p=0.01$ level.
Model 2 values are β (SE) for difference after 1999. Model 2 contains the same parameters as Model 1 except for an interaction term multiplying the indicator for "post 1999" and calendar year, testing for difference in slope for the period 1999–2008. None of the β estimates were significant at the $p=0.05$ level.

activity level for U.S. children and adolescents (Appendix A, available online at www.ajpmonline.org).[13] The differences in the predicted daily energy requirements at different weight levels were calculated as the proposed proxy for the sizes of the average energy gap[14,15] that would need to be eliminated to prevent further increases in obesity and to achieve Healthy People goals. These estimates represent population-level energy gaps rather than targets set for individual children who need to lose weight or are at risk of becoming overweight.

Results

Secular Trends in Obesity and Average Weight

Appendix B (available online at www.ajpmonline.org) summarizes the sample size and prevalence of obesity across time periods covered by NHANES surveys. Controlling for age, gender, and race/ethnicity, there was a small increase in mean height during the past 30 years among U.S. youth (Table 1; +0.3 cm per decade, p-value for trend <0.01). In contrast to the small changes in average height, average body weights increased significantly by 1.54 kg (95% CI=1.34, 1.74 per decade), with larger increases among adolescents.

Similarly, mean BMI has increased substantially and significantly since 1970: with an overall mean BMI increase of 0.55 kg/m^2 (95% CI=0.49, 0.61) per decade, and greater increases among older children, adolescents, and non-Hispanic black youth. As for the prevalence of obesity, after controlling for age, gender, and race– ethnicity, a linear trend from 1971 to 2008 suggests an increase of 3.7% per decade in obesity prevalence (Table 1 and Figure 1).

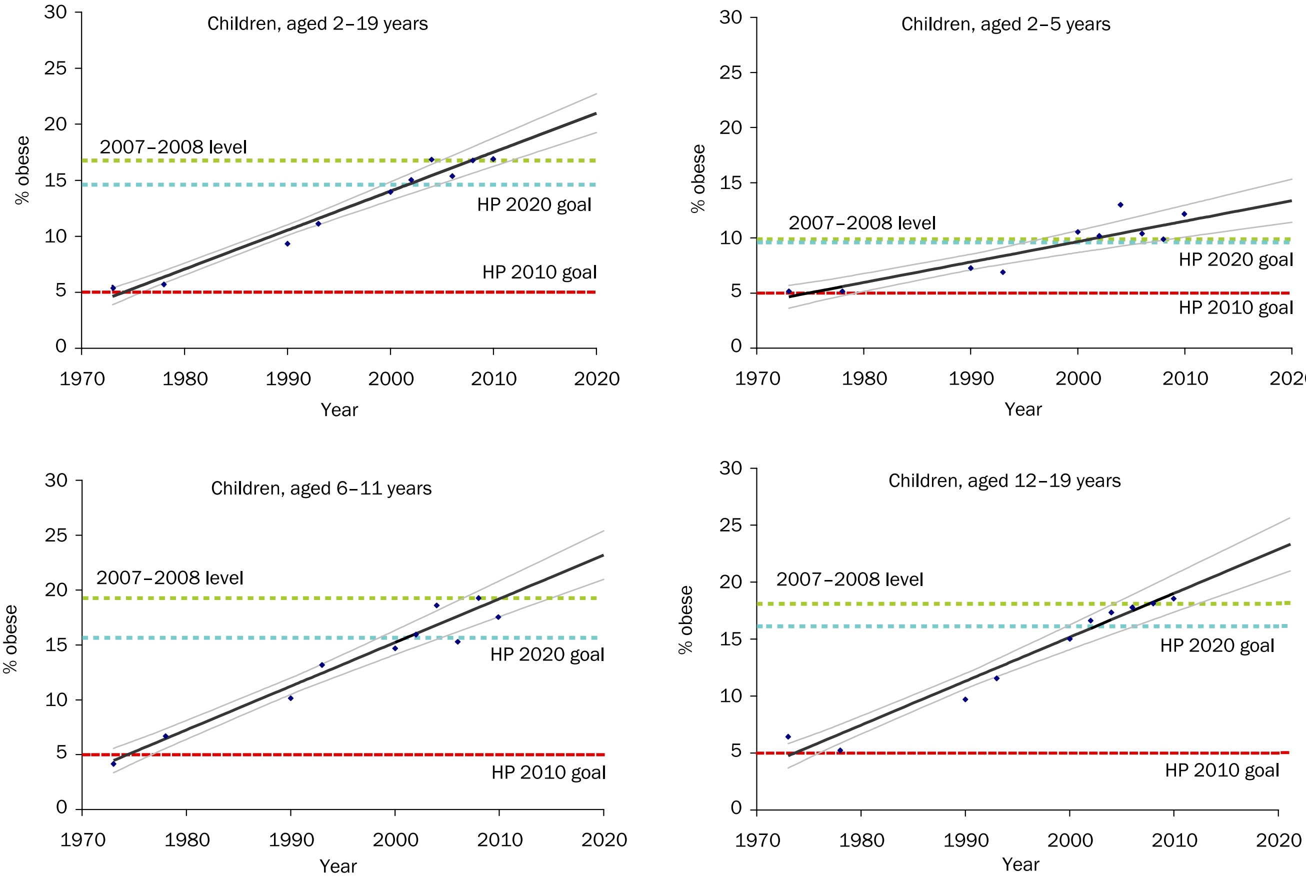

Figure 1. Observed and predicted prevalence of childhood obesity, 1971–2020

Note: Point estimates on the prevalence of obesity—defined as having a BMI equal to or greater than the age- and gender-specific 95th percentile based on the CDC growth chart—are from National Health and Nutrition Examination Surveys, 1971–2008. These estimates are adjusted for age, gender, and race distribution. Black lines represent the fitted trend. Gray lines represent the 95% prediction intervals. *Healthy People* (HP) *2010* goals are set at 5% prevalence of childhood obesity for those aged 6–19 years, represented by dotted red lines. Green dotted lines represent the 2007–2008 prevalence level. Blue dotted lines represented *Healthy People 2020* goals. The latest NHANES data points (2009–2010) were added to contrast the historic trends and were not used for trend projection or energy gap calculations.

The unadjusted (crude) models produce similar results (data not shown). Fitting a logistic model did not improve the goodness of fit (R^2 changes from 0.25 in a linear model to 0.26).

A separate series of models (Model 2 in Table 1) were fitted and included an interaction term of calendar year and an indicator for the "1999 and after" period. This model explicitly tests the hypothesis that there was a significant change in trend (slope) after 1999. None of the interaction terms were significant, indicating no change in the slope of increasing obesity prevalence during the period from 1999 to 2008 compared to the period from 1971 to 1998 (p-value for difference in slope=0.08; coefficient is positive). This suggests that the observed prevalence trend in the most recent decade is statistically consistent with the longer-term upward trend dating back to the early 1970s.

Similarly, no significant differences were found in the slopes for mean weight, mean BMI, or BMI z-score comparing the trend during 1999–2008 and the longer-term trend during 1971–1998 at $p=0.05$ (Table 1). The only significant coefficients indicate an increase in the rate of rising obesity prevalence among non-Hispanic whites aged 2–5 years (+0.122% per year, $p=0.02$); non-Hispanic blacks aged 12–19 years (+0.14% per year, $p=0.048$); and those aged 2–5 years and 12–19 years with household incomes between 100% and 300% times the poverty level (+0.11% per year, $p=0.04$, and 0.166% per year, $p=0.004$, respectively) after 1999. Finally, the newly released 2009–2010 data on obesity prevalence estimates fell within the prediction intervals of historic trends (Figure 1). These findings provide the basis for projecting to 2020 using historic trends (1971–2008).

Reaching *Healthy People 2010* and *Healthy People 2020* Goals by 2020

Based on the fitted models, if past trends continue, the prevalence of childhood obesity is projected to be approximately 21% (95% CI=19, 23) in 2010 (Figure 1), approximately four times higher than the *Healthy People 2010* target of 5%. Extrapolations from past trends would project a 1.8-kg higher mean body weight in 2020 than in 2007–2008 for U.S. children and adolescents. The predicted increase is higher for adolescents aged 12–19 years (2.7 kg above the 2007–2008 level) than for younger children (0.6 kg among children aged 2–5 years and 1.2 kg among children aged 6–11 years; Table 2).

Table 2 shows the predicted body weight and the corresponding per capita daily energy requirements (kcal/day) for 2007–2008, for 2020, and if Healthy People goals were to be achieved by 2020. For all children and adolescents aged 2–19 years, an average net reduction of 41 kcal/day in energy surplus would be required to prevent further increase from 2007–2008 levels. This estimate ranges from an average of 17 kcal/day per capita for those aged 2–5 years and 37 kcal/day per capita for those aged 6–11 years, to 67 kcal/day per capita for those aged 12–19 years.

The estimated additional reductions in energy gap (Figure 2) needed to achieve the *Healthy People 2020* goal is, on average, 23 kcal/day per capita. The corresponding average per capita age group–specific reductions are 5 kcal/day for those aged 2–5 years, 40 kcal/day for those aged 6–11 years, and 31 kcal/day for those aged 12–19 years. To reach the more aggressive *Healthy People 2010* goal by 2020 would require much steeper reductions in mean energy gap: 120 kcal/day for those aged 2–19 years overall; 33 kcal/day for those aged 2–5 years; 149 kcal/day for those aged 6–11 years; and 177 kcal/day for those aged 12–19 years.

There is a substantial variability by race–ethnicity (Table 2): non-Hispanic black and Mexican-American youth are farther from achieving Healthy People goals than non-Hispanic whites (Table 2). Extrapolation from past trends (1971–2008) among non-Hispanic black children suggests a 3.2-kg increase in mean weight from 2007–2008 to 2020, placing this group 10.6 kg above the mean body weight levels in the early 1970s. Among adolescents aged 12–19 years, the group farthest from reaching the *Healthy People 2010* goals, reaching the goal would require narrowing their current energy gap by an estimated 164 kcal/day (non-Hispanic white); 286 kcal/day (non-Hispanic black); and 201 kcal/day (Mexican-American), respectively.

Discussion

Monitoring secular trends using long time series of nationally representative population data is an essential component of goal setting and policy planning.[15] Using surveys from 1971 to 2008, the current paper describes the upward trends in obesity prevalence, body weight, BMI, and BMI *z*-scores among the U.S. pediatric population. Consistent with prior studies,[16] since the early 1970s U.S. youth have increased their average BMI by 0.5 per decade and their average weight by 1.5 kg per decade. If these trends continue unchanged through 2020, an average U.S. child will be 1.8 kg heavier than a child in 2007–2008 of the same age, and more than one in five will be obese. The current analyses indicated that it is necessary to eliminate an average of 41 kcal/day per capita to halt the rising trend in mean body weight. To reverse the trend and reach the Healthy People goals by 2020 would require an additional reduction of 23 kcal/day per capita (*Healthy People 2020* goal) and 120 kcal/day to reach the more ambitious, *Healthy People 2010* goal.

Conceptually, increasing obesity is due to an accumulation of small but positive daily excesses of calories consumed relative to calories burned over and above those required for healthy growth and development.[14] Over years and even decades, these small daily surpluses lead to two outcomes: average body weights higher than projected under-normal growth; and a higher energy requirement to maintain the new weight. Note that these estimates represent an average from a population and prevention perspective; required reductions in energy gap are likely much larger for children at the upper percentiles as well as for children who are at high risk for becoming obese.[17]

Previous analysis estimated that an average reduction of 110–165 kcal/day in energy surplus could have prevented excess weight gain seen in U.S. children and youth over a 10-year period. Those children who became obese adolescents, however, gained roughly six times more excess weight over 10 years, and the corresponding energy gap would be 600–1100 kcal/day.[17] These results may imply that preventing weight gain at an earlier age through small decreases in energy intake and increases in energy expenditure is more achievable than attempts to lose weight once a child has already become obese. However, accurate methods are not yet available to apply such an energy-balance framework to predict weight changes for individual children, because existing models do not properly account for the dynamic energy partitioning between fat and lean tissue during various phases of growth.[14]

How do we work toward these targets by tipping the energy balance in the right direction? One can apply the energy gap framework to a rapidly growing list of strategies to promote healthier eating and more-active lifestyles in childhood. For example, one can estimate the potential caloric impact of removing all sugar-sweetened beverages from schools,[18] a policy strategy attempted by several school districts around the country, including the

Table 2. Projected mean body weight and average energy gap reduction needed to reach Healthy People goals by 2020

	Mean weight (kg)				Difference in average energy requirement (energy gap, kcal/day)		
Age, years	NHANES 2007–2008	2020 projections (assuming past trends continue)	If *Healthy People 2020* goal achieved	If *Healthy People 2010* goal achieved	To prevent further increase from 2007–2008 levels	To reach *Healthy People 2020* goal by 2020	To reach *Healthy People 2010* goal by 2020
All children and adolescents							
2–19	45.2	47.0	44.2	39.9	41	23	120
2–5	17.3	17.9	17.2	16.3	17	5	33
6–11	35.1	36.3	33.7	30.1	37	40	149
12–19	65.6	68.3	64.3	58.2	67	31	177
Non-Hispanic white							
2–19	45.1	46.5	44.5	40.1	33	13	113
2–5	17.2	17.6	17.3	16.4	14	N/A[a]	25
6–11	35.1	35.5	33.8	30.3	14	39	144
12–19	65.4	67.9	65.2	58.6	59	5	164
Non-Hispanic black							
2–19	47.1	50.3	44.2	39.7	74	64	168
2–5	17.4	18.1	17.3	16.6	21	4	26
6–11	35.8	38.9	34.1	30.4	93	50	163
12–19	69.1	73.8	64.3	57.2	115	115	286
Mexican-American							
2–19	44.7	46.2	42.2	39.2	35	56	126
2–5	17.3	17.6	17.0	16.2	10	9	34
6–11	34.8	36.4	32.9	29.4	48	59	164
12–19	64.9	67.0	61.9	56.6	49	74	201
Lower-income							
2–19	45.6	48.1	43.3	38.5	57	53	162
2–5	17.3	17.6	16.8	16.3	9	16	33
6–11	34.7	37.2	33.1	28.8	76	47	176
12–19	67.0	70.7	63.2	55.6	88	91	275
Middle-income							
2–19	45.2	47.0	43.9	40.6	41	29	104
2–5	17.6	18.3	17.3	16.3	22	9	40
6–11	35.0	36.2	33.6	30.6	36	44	135
12–19	65.8	68.4	64.1	59.3	64	40	157
Higher-income							
2–19	44.6	45.6	44.6	40.8	23	N/A[a]	87
2–5	16.9	17.4	17.3	16.7	15	N/A[a]	7
6–11	34.9	35.0	34.4	31.5	3	18	105
12–19	64.6	66.3	64.8	59.5	39	N/A[a]	124

[a]Goal already achieved.

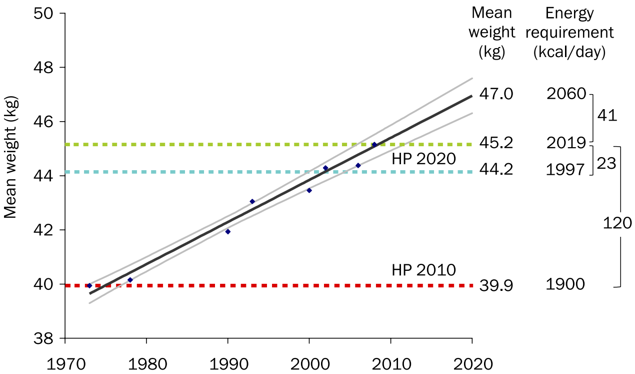

Figure 2. Predicted changes in mean body weight and resulting differences in energy requirement

Note: Requirements are energy-gap reductions needed to achieve *Healthy People 2010* and *Healthy People 2020* goals by 2020 among those aged 2–19 years. Solid lines (and accompanying gray lines marking the 95% prediction interval) represent projected trend in average weight of U.S. youth, based on regression models fitted to the National Health and Nutrition Examination Survey data from 1971 to 2008. The dashed red line marks the scenario in which the *Healthy People 2010* goals of 5% childhood obesity (similar to prevalence in the early 1970s) are reached. The dashed blue line marks the scenario in which the *Healthy People 2020* goals (14.6% obese) are reached. The size of the daily average energy-gap reductions (shown at far right) needed to prevent further change from the 2007–2008 level (dashed green line) was estimated by the predicted differences in average energy requirements between the projected 2020 mean weight and the mean weight in 2007–2008.

Boston public schools.[19] If all such beverages consumed at schools were replaced with water and were uncompensated from intake elsewhere, such intervention could reduce the energy gap by approximately 12 kcal/day (Appendix C, available online at www.ajpmonline.org). A similar reduction may be achieved by industry-initiated changes.[20]

School physical education programs (i.e., SPARK[21]) could increase energy expenditure among those aged 9–11 years by approximately 19 kcal/day. An afterschool program was found to increase energy expenditure by 25 kcal/day among students in Grades K–5.[22] Moreover, reducing TV-viewing time by 1 hour per day could reduce the energy gap by approximately 100 kcal/day, through reducing eating while watching, exposure to food and beverage advertising, and sedentary behavior.[23,24] Increasing physical activity and reducing sedentary behaviors are clearly important strategies to restore youth energy balance.[25]

As in all population projections, one major limitation of the present study is the uncertainty from extrapolating past trends. Because of the potential interactions of growth, family, and community factors, trends in childhood obesity may be more volatile than obesity in adults. Nevertheless, the trends to date, especially in adolescents, are remarkably consistent (Figure 1). Likewise, estimating the impacts of population-level policy and environmental interventions on daily calories consumed and/or expended is far from precise and is confounded by differences in physical and social environments, social network dynamics, and quality of program implementation.

Despite these limitations, there is great value in analytically connecting population-level childhood obesity trend projections with the energy-gap framework to define targets and interventions that have the potential to halt or reverse rising childhood obesity levels, especially in high-risk populations. For instance, the Robert Wood Johnson Foundation and the NIH are cofunding the Collaborative Obesity Modeling Network to model the impacts of multiple policy and environmental interventions (e.g., restricting access to sugar-sweetened beverages, requiring daily physical activity, limiting youth screen time at home, some industry efforts)[17,26,27] on the energy gaps and youth obesity levels. More recently, the National Collaborative on Childhood Obesity Research has initiated the Envision project to apply different energy-balance models to comparatively evaluate projections of the impacts of different policy and environmental changes (www.nccor.org/projects_envision.html).

Other initiatives are applying modeling approaches to prioritizing childhood prevention efforts based on their estimated cost effectiveness.[28] For example, the Australian Accessing Cost-Effectiveness in Obesity[29] examined a broad range of interventions and revealed several highly cost-effective interventions; many of them are environmental and policy-driven, such as reducing junk-food advertising to children and multifaceted school-based programs to improve the nutrition and physical activity levels. How to mobilize resources and political will to implement effective and cost-effective interventions is a pivotal question in reversing energy imbalance among children and adolescents. The trend projection and its energy gap model described here represent one of the many modeling approaches that may be helpful to both scientists and policymakers.

We thank Kevin Hall, PhD, and Carson Chow, PhD (NIH/NIDDK), for their methodologic advice on the analysis. We also acknowledge Shawn Nowicki, MPH, for his assistance in preparing the manuscript.

This work was supported in part by grants from the Robert Wood Johnson Foundation (no. 260639) and the CDC (U48/DP00064-00S1) including the Nutrition and Obesity Policy, Research and Evaluation Network. This work is solely the responsibility of the authors and does not represent the official views of the Robert Wood Johnson Foundation or the CDC.

No financial disclosures were reported by the authors of this paper.

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Appendix

Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.amepre.2012.01.018.