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Secular trends in weight status and weight-related attitudes and behaviors in adolescents from 1999 to 2010

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Abstract

Objective—To examine secular trends from 1999 to 2010 in weight status and weight-related attitudes and behaviors among adolescents.

Methods—A repeated cross-sectional design was used. Participants were from Minneapolis/St. Paul middle schools and high schools and included 3,072 adolescents in 1999 (mean age 14.6±1.8) and 2,793 adolescents in 2010 (mean age 14.4±2.0). Trends in weight-related variables were examined using inverse probability weighting to control for changes in sociodemographics over time.

Results—The prevalence of obesity among boys increased by 7.8% from 1999 to 2010, with large ethnic/racial disparities. In black boys the prevalence of obesity increased from 14.4% to 21.5% and among Hispanic boys, obesity prevalence increased from 19.7% to 33.6%. Trends were more positive among girls: weight status did not significantly increase, perceptions of overweight status were more accurate, the use of healthy weight control behaviors remained high, dieting decreased by 6.7%, unhealthy weight control behaviors decreased by 8.2% and extreme weight control behaviors decreased by 4.5%.

Conclusions—Trends indicate a need to intensify efforts to prevent obesity and other weight-related problems, particularly for boys from ethnic/racial minorities. The decreases in unhealthy weight control behaviors among girls are encouraging.

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Keywords

Obesity; Adolescents; Dieting; Weight control; Secular trends; Racial disparities

Over the past decade there has been increased attention on obesity in the scientific community and the popular media (Barry et al., 2011; Kim and Willis, 2007; Lawrence, 2004; Saguy and Almeling, 2008; Saguy and Gruys, 2010). Adolescents may be vulnerable to messages about weight, given the central role of body image during this lifestage, and their frequent use of different media with messages about obesity, cultural ideals of thinness, and both healthy and unhealthy weight management strategies (Rideout et al., 2010). Therefore, an important question is: How have weight status and weight-related attitudes and behaviors changed in adolescents over the past decade?

The current study examines secular trends in weight status and weight-related attitudes and behaviors from 1999 to 2010. This study expands upon previous studies (Broyles et al., 2010; Chao et al., 2008; Delva et al., 2006; Eaton et al., 2010; Foti and Lowry, 2010; Lowry et al., 2005; Ogden et al., 2010) by exploring trends in a broad array of weight-related variables in girls and boys. Because of ethnic/racial disparities in weight-related health (Chao et al., 2008; Delva et al., 2006; Neumark-Sztainer et al., 2002a), interactions with ethnicity/race are examined. Findings have implications for the development of interventions to prevent obesity and other weight-related problems in youth.

METHODS

Study Design and Population

A repeated cross-sectional study design was used to compare weight-related variables between 1999 and 2010 among adolescent participants in Project EAT (Eating and Activity in Teens). Data from 1999 are from Project EAT-I, the first wave of a longitudinal study following adolescents into young adulthood (Neumark-Sztainer et al., 2002a; Neumark-Sztainer et al., 2002b; Neumark-Sztainer et al., 2006). Data from 2010 are from EAT 2010, a multi-level study examining weight-related outcomes in adolescents. Study procedures were approved by the University of Minnesota's Institutional Review Board Human Subjects Committee and by the research boards of the participating school districts.

In Project EAT-I, students from 31 public middle schools and high schools in the Minneapolis/St. Paul metropolitan area completed surveys and anthropometric measures (Neumark-Sztainer et al., 2002a; Neumark-Sztainer et al., 2002b). For EAT 2010, a new cohort of students from 20 public schools in the same metropolitan area completed similar surveys and anthropometric measures. To facilitate the examination of secular trends, the earlier study sample was restricted to 27 schools from the two urban school districts that participated at both time points. The study sample includes 3,072 adolescents from 1999 and 2,793 adolescents from 2010 (See **Table 1** for socio-demographic characteristics).

Survey Development and Measures

Survey development was guided by a theoretical framework (Bandura, 1986; Sallis et al., 2008; Story et al., 2008), expert review, qualitative input from adolescents (Neumark-Sztainer et al., 1999), and pilot testing. Test-retest reliability was assessed in diverse adolescent samples at EAT-I (n=161) and at EAT 2010 (n=129); psychometric properties from 2010 are reported here. This subsample was 70% non-Hispanic white and equally divided on gender. All of the following non-anthropometric data were based on adolescent report on the EAT surveys.

Weight status—Measured heights and weights were taken following the same standardized procedures at both time points (Gibson, 1990). Body mass index (BMI) values were calculated and sex- and age-specific cutoff points used to classify respondents as overweight ($\geq 85^{\text{th}}$ percentile) and obese ($\text{BMI} \geq 95^{\text{th}}$ percentile) were based on reference data from the Centers for Disease Control and Prevention growth tables (Kuczmarski et al., 2000).

Weight-related attitudes—*Perceived weight status* was assessed with the question: “At this time do you feel that you are. . . very underweight, somewhat underweight, about the right weight, somewhat overweight or very overweight?” Adolescents responding that they were somewhat or very overweight were coded as perceiving themselves as overweight (Test-retest agreement [perceived overweight versus nonoverweight] = 90%). Participants with BMI values $\geq 85^{\text{th}}$ percentile who perceived themselves as overweight were coded as having an *accurate perception of overweight status*. Conversely, participants with BMI values $< 85^{\text{th}}$ percentile who perceived themselves to be overweight were coded as having an *inaccurate perception of overweight status*.

Body dissatisfaction was assessed with a modified version of the Body Shape Satisfaction Scale (Pingitore et al., 1997). Adolescents reported satisfaction with 10 body parts using five Likert response categories ranging from very dissatisfied to very satisfied. Item responses were summed with higher scores indicative of greater body dissatisfaction (Score range: 10-50; Cronbach's $\alpha = 0.93$; Test-retest $r = 0.65$).

Weight-related behaviors—*Trying to lose weight* was assessed with the question: “Are you currently trying to. . . ‘lose weight,’ ‘stay the same weight,’ ‘gain weight,’ or ‘I am not trying to do anything about my weight’?” (Test-retest agreement = 82%).

Dieting was assessed with the question “How often have you gone on a diet during the last year? By ‘diet’ we mean changing the way you eat so you can lose weight.” Responses were dichotomized into nondieters (responded never) and dieters (other responses) (Test-retest agreement [nondieter versus dieter] = 82%).

Healthy weight control behaviors were assessed with the question: “Have you done any of the following things in order to lose weight or keep from gaining weight during the past year?” (yes/no for each method). Behaviors included: exercise, ate more fruits and vegetables, ate less high-fat foods, and ate less sweets. Responses for this measure were modified for the 2010 survey (never/rarely/sometimes/on a regular basis) and those reporting the use of one or more weight control behavior “sometimes” or “on a regular basis” were coded as using healthy weight control behaviors (Test-retest agreement [never/rarely versus sometimes/regular basis] = 88%).

Unhealthy and extreme weight control behaviors were assessed with the question: “Have you done any of the following things in order to lose weight or keep from gaining weight during the past year?” (yes/no for each method). Behaviors categorized as unhealthy included: fasted, ate very little food, used a food substitute (powder or a special drink), skipped meals, and smoked more cigarettes. Behaviors categorized as extreme included: took diet pills, made myself vomit, used laxatives, and used diuretics. (Test-retest agreement = 85% for unhealthy behaviors and 96% for extreme behaviors).

Binge eating was assessed with the question: “In the past year, have you ever eaten so much food in a short period of time that you would be embarrassed if others saw you (binge eating)” (yes/no). If participants responded yes, they were asked, “During the times when you ate this way, did you feel you couldn't stop eating or control what or how much you

were eating” (yes/no). (Test-retest agreement = 90% [first question] and 75% [second question]).

Self-weighting was assessed by asking adolescents to indicate how strongly they agreed with the statement, “I weigh myself often” (strongly disagree, disagree, agree, strongly agree) (Test-retest agreement [agree versus disagree] = 85%).

Socio-demographic characteristics—*Ethnicity/race* was assessed with the question: “Do you think of yourself as...? (1) White, (2) Black or African American, (3) Hispanic or Latino, (4) Asian American, (5) Native Hawaiian or Pacific Islander, (6) American Indian or Native American, or (7) Other” (Test-retest agreement = 98-100%). Since very few adolescents reported “Hawaiian or Pacific Islander” or did not report their ethnicity/race, they were coded as “mixed/other”.

Socioeconomic status (SES) was determined primarily using the higher education level of either parent and secondarily using family eligibility for public assistance, eligibility for free or reduced-cost school meals, and parental employment status (Neumark-Sztainer et al., 2002b; Sherwood et al., 2009).

Statistical Analysis

To test for secular changes in weight-related outcomes, it was important to control for demographic shifts in the study population from 1999 to 2010. Taking the demographic makeup of the 2010 sample as the reference, inverse probability weighting was used for the 1999 sample (Robins et al., 2000). Weights for the 1999 sample were created using predicted odds from a logistic regression of the 2010 or 1999 indicator on age, race, SES, gender and two-way interactions. Adolescents’ weights for the 1999 sample were set equal to the predicted odds of being in the 2010 sample rescaled to the sum of the total sample size in 1999; weights for the 2010 sample were fixed at 1. Proper control of the demographic shift using the weights was achieved as evidenced by the non-significant differences in the weighted 1999 sample compared to the 2010 sample (**Table 1**). For analyses stratified by ethnicity/race, additional inverse probability weights were created using similar methodology to ensure balance of age and SES between 1999 and 2010 within each ethnic/racial group.

Tests for secular trends in continuous and dichotomous outcome variables were conducted using two sample t-tests and chi-square tests, respectively, with the inverse probability weights incorporated for the 1999 sample. All analyses were stratified by gender. Levels of missing data were low and individuals with missing data on certain outcomes were deleted from the respective analysis. In 2010, missing data per survey variable ranged from 0.2% to 3.6%, while in 1999 the range was 2.0%-8.3%. Missing data for observed weight status was 1.7% in 2010 and 13.8% in 1999. Differences over time are due to improved data collection by a more experienced research team. Although there were some differences by year, tests for differential missing found no systematic differences across gender, race, or SES.

Additional regression analyses tested an ethnicity/race by year interaction for each outcome variable. For cases in which significant interactions were found, we ran additional regressions stratified by ethnicity/race and gender. All analyses were performed in SAS 9.2.

RESULTS

Secular trends from 1999-2010 in weight-related variables by gender

The mean BMI and percentages of adolescent boys with BMI values at or above the 85th and 95th percentiles were significantly higher in 2010 than in 1999 in analyses adjusting for

socio-demographic changes in the study participants over time (**Table 2**). Boys were more likely to perceive themselves as overweight and reported greater body dissatisfaction in 2010 than in 1999; however, accurate perceptions of overweight did not increase. Findings related to weight-related behaviors were mixed: efforts to try to lose weight, healthy weight control behaviors increased; dieting, unhealthy weight control behaviors, and binge eating remained constant; and extreme weight control behaviors and frequent self-weighing decreased.

Findings among adolescent girls were more positive (Table 2). The mean girls' BMI was the same in both 1999 and 2010 and the prevalence of overweight and obesity did not significantly increase during the study period although the increase in obesity prevalence bordered on statistical significance ($p=.051$). Body dissatisfaction did not change over time, but overweight girls were more likely to accurately perceive themselves as overweight in 2010 than in 1999. The percentages of girls engaging in healthy weight control behaviors increased over time and there were large decreases in dieting, unhealthy weight control behaviors, extreme weight control behaviors, and frequent self-weighing.

Ethnic/racial patterns in secular trends from 1999-2010

Interactions with ethnicity/race were examined to determine if trends between 1999 and 2010 differed across ethnic/racial groups. In boys, statistically significant interactions were found for BMI ($p=.037$) and overweight ($p<.010$), but not for obesity ($p=.261$) by ethnicity/race. Among girls, none of these interactions were significant. Mean BMI values and percentages of overweight and obese adolescents in 1999 and 2010 are presented for each of the ethnic/racial groups in **Table 3**. Although not always statistically significant, trends show large ethnic/racial disparities with no significant changes in weight status among white boys and increases among boys reporting other ethnic/racial backgrounds. For example, between 1999 and 2010 the percentage of overweight/obese black boys increased from 23.6% to 36.7% ($p<.001$). Few other statistically significant and meaningful interactions between trends in weight-related variables and ethnicity/race were found (data not shown).

DISCUSSION

This study examined secular trends from 1999 to 2010 for a broad array of weight-related outcomes among adolescents. Overall, trends are suggestive of both disturbing and positive trends. Although the prevalence of obesity remained constant in white boys, there was a large increase in boys from other ethnic/racial groups. The large ethnic/racial disparities in trends suggest that weight-related messages may be influencing white boys, but strongly indicate a need for interventions and policies targeting ethnically/racially diverse groups of boys. The situation among girls was more positive as weight status did not significantly increase and perceptions of overweight status were more accurate. Furthermore, girls reported increases in healthy weight control behaviors and large decreases in unhealthy weight control behaviors. It may be that social norms regarding dieting and the use of unhealthy weight control behaviors are beginning to improve among young women, perhaps due to efforts from the eating disorders field, which have tended to focus on females.

Comparisons with findings from the national Youth Risk Behavior Survey (YRBS) reveal some similarities and differences for trends in weight-related outcomes (Centers for Disease Control and Prevention a; Centers for Disease Control and Prevention b). From 1999 to 2009, the YRBS found small increases in the prevalence of obesity in boys and girls which were not of statistical significance. As in the current study, increases in obesity prevalence appear to be larger among some ethnically/racially diverse boys than among white boys. The YRBS also examined unhealthy weight control behaviors, albeit using fewer and different

items to Project EAT. As in the current study, the YRBS found significant decreases in unhealthy weight control behaviors, particularly among girls.

Study strengths, study limitations, and strategies for addressing limitations should be taken into account in interpreting the findings. The unique repeated cross-sectional study design allowed for the study of secular trends from 1999 to 2010, a period during which much attention was directed toward weight-related topics (Barry et al., 2011; Kim and Willis, 2007; Lawrence, 2004; Saguy and Almeling, 2008). The large and diverse study population, measured heights and weights, and the breadth of questions assessing different weight-related variables are additional study strengths. However, data were collected in one urban area; thus, generalizations should be made cautiously. Furthermore, although data were collected in the same school districts in both 1999 and 2010, there were demographic shifts in the population. Given these shifts, all analyses utilized inverse probability weighting so that the 1999 sample was matched demographically to the 2010 sample. This matching was done to ensure that identified trends were not merely a function of the demographic changes in the population.

The large increase found in weight status among ethnically/racially diverse boys is concerning and indicates a strong and immediate need for interventions targeting these groups. However, the decrease in unhealthy weight control behaviors in girls suggests that efforts to prevent obesity may not have had harmful effects on other weight-related attitudes and behaviors of concern and/or that counter efforts from the eating disorders field have been able to override some of these harmful effects (Dánielsdóttir et al., 2009; National Eating Disorders Association, 2010). The large decreases in unhealthy weight control behaviors in girls should have positive implications in terms of reducing risk for both obesity and eating disorders (Neumark-Sztainer et al., 2007). In summary, study findings suggest that we should strive toward prevention approaches that address the broad array of weight-related problems that are prevalent in youth, continue to work with girls, and intensify efforts to reach boys, particularly those from diverse ethnic/racial backgrounds.

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Highlights

Over the past decade, the prevalence of obesity greatly increased among adolescent boys, with large ethnic/racial disparities.

From 1999-2010, there was a large decrease in the use of unhealthy weight control behaviors in adolescent girls.

Findings suggest a need for developing obesity interventions that reach boys from ethnically/racially diverse backgrounds.

Social norms regarding unhealthy weight control behaviors may be improving in adolescent girls.

We need prevention approaches that address the broad array of weight-related problems.

Comparisons of socio-demographic characteristics in actual 1999, weighted 1999 and actual 2010 samples from Minneapolis/St. Paul used to examine secular trends in weight-related outcomes^a

Table 1

	1999 sample		Weighted 1999 sample		2010 sample		p-value ^b
	n	%	n	%	n	%	
Gender							0.968
Male	1499	48.8	1436	46.7	1307	46.8	
Female	1573	51.2	1636	53.3	1486	53.2	
Ethnicity/race							0.999
White	1029	33.5	587	19.1	525	18.8	
Black	723	23.6	885	28.8	808	28.9	
Asian	753	24.5	615	20.0	555	19.9	
Hispanic	243	7.9	513	16.7	472	16.9	
Native American	133	4.3	110	3.6	102	3.7	
Mixed/Other	191	6.2	362	11.8	331	11.8	
Socio-economic status							0.999
Low	683	22.2	1168	38.0	1072	38.4	
Low-middle	601	19.5	655	21.3	595	21.3	
Middle	755	24.6	521	16.9	471	16.9	
High-middle	513	16.7	388	12.7	347	12.4	
High	358	11.7	224	7.3	203	7.3	
Not reported	162	5.3	116	3.8	105	3.7	
Age in years: Mean (SD)	3072	14.6 (1.8)	3072	14.5 (1.8)	2793	14.4 (2.0)	0.255

^aThe weighted 1999 sample used inverse probability weighting (Robins et al., 2000) based on the odds of being in the 2010 sample given demographics. Weighting was done to allow for an examination of secular trends in weight-related outcomes independent of demographic shifts in the population (see text in statistical analysis section). Both the unweighted and weighted 1999 demographics are provided for ease of comparison.

^b p-values are presented for differences between the weighted 1999 and 2010 samples, based on chi-square tests for gender, ethnicity/race and socio-economic status and t-tests for age.

Table 2

Trends in weight-related variables among middle and high school adolescents from Minneapolis/St. Paul from 1999 to 2010

	Boys			Girls		
	1999 weighted sample ^a	2010	Difference in proportions or (Cohens d) ^c	1999 weighted sample ^a	2010	Difference in proportions or (Cohens d) ^c
	n=1499 ^c	n=1307 ^c		n=1573 ^c	n=1486 ^c	
<u>Weight status</u>						
BMI (Mean)	23.1	23.7	(0.11)	23.7	23.8	(0.02)
Overweight: BMI ≥ 85 th percentile (%)	33.9	41.7	7.8	36.9	38.6	1.7
Obese: BMI ≥ 95 th percentile (%)	18.2	26.0	7.8	16.3	19.1	2.8
<u>Weight-related attitudes</u>						
Perceive oneself as overweight (%)	23.6	29.1	5.5	40.7	42.0	1.3
Inaccurately perceive oneself as overweight (%)	5.9	7.1	1.2	21.9	21.4	-0.5
Accurately perceive oneself as overweight (%)	59.0	60.1	1.1	65.5	75.1	9.6
Body dissatisfaction (Mean) ^d	23.4	25.3	(0.20)	27.3	26.8	(-0.05)
<u>Weight-related behaviors</u>						
Trying to lose weight (%)	23.8	29.5	5.7	43.4	45.0	1.5
Dieting (%)	30.4	31.1	0.7	52.5	45.8	-6.7
Healthy weight control behaviors (%)	74.5	83.4	8.9	83.4	87.2	3.8
Unhealthy weight control behaviors (%)	39.6	38.1	-1.5	58.4	50.2	-8.2
Extreme weight control behaviors (%)	6.1	3.9	-2.2	11.3	6.8	-4.5
Binge eating (%)	4.6	6.3	1.7	10.7	9.6	-1.1
Frequent self-weighing (%)	30.7	26.9	-3.8	36.3	30.6	-5.7

^aThe 1999 sample was weighted to allow for an examination of secular trends in weight-related outcomes independent of demographic shifts in the population.

^cDifference in proportions is calculated for dichotomous outcomes as simply the difference in the proportions ([positive numbers indicate increases from 1999 to 2010 while negative values indicate decreases over time). Cohens d (difference/standard deviation) is calculated for the continuous outcome variables BMI and body dissatisfaction (values of 0.1-0.3 typically indicate small effect sizes).

^cNumbers may vary slightly due to missing values for specific variables. Numbers are considerably lower for variables "inaccurately and accurately perceive oneself as overweight" since only non-overweight adolescents are included in the denominator for inaccurate perceptions and only overweight respondents are included in the denominator for accurate perceptions of overweight status.

^dScales range from 10 (very satisfied) to 50 (very dissatisfied) for "body dissatisfaction".

Table 3

Trends in weight status by ethnicity/race in adolescent boys and girls from Minneapolis/St. Paul: 1999 to 2010^a

	n	BMI (Mean)	Boys			Girls		
			BMI (Mean)	Overweight (BMI ≥ 85th percentile) (%)	Obese (BMI ≥ 95th percentile) (%)	Overweight (BMI ≥ 85th percentile) (%)	Obese (BMI ≥ 95th percentile) (%)	
White								
1999	542	23.9		40.7	24.4	39.4	17.0	
2010	277	22.5		29.7	18.3	29.8	14.5	
p-value		<.001		.003	.056	.012	.404	
Black								
1999	333	22.4		24.0	14.3	45.8	24.2	
2010	379	23.4		36.7	21.5	45.0	20.9	
p-value		.030		<.001	.022	.826	.274	
Asian								
1999	354	22.7		31.7	18.4	25.9	9.9	
2010	260	24.6		50.2	33.5	27.5	13.4	
p-value		<.001		<.001	<.001	.641	.173	
Hispanic								
1999	134	24.3		43.5	20.3	42.4	15.1	
2010	216	24.6		49.5	33.6	42.9	22.0	
p-value		.709		.291	.011	.929	.174	
Native American								
1999	58	23.6		58.4	31.7	40.6	21.1	
2010	48	24.9		67.4	41.3	54.9	35.3	
p-value		.246		.358	.322	.126	.090	
Mixed/Other								
1999	78	22.9		33.2	13.4	39.6	21.9	
2010	127	23.2		42.7	21.8	42.7	21.6	
p-value		.695		.200	.160	.608	.952	

^aThe 1999 sample was weighted to allow for an examination of secular trends in weight-related outcomes independent of demographic shifts in the population.