Trends in the Association of Poverty With Overweight Among US Adolescents, 1971-2004

Richard A. Miech, PhD, MPH
Shiriki K. Kumanyika, PhD, MPH
Nicolas Stettler, MD, MSCE
Bruce G. Link, PhD
Jo C. Phelan, PhD
Virginia W. Chang, MD, PhD

Context Prevalence of adolescent overweight in the United States has increased substantially during the past 3 decades. Whether socioeconomic disparities in adolescent overweight increased, decreased, or remained constant during this period is not known.

Objective To examine trends in adolescent overweight from 1971 to 2004 by family poverty status, as well as trends in potentially relevant eating and physical activity behaviors.

Design, Setting, and Participants Four cross-sectional, nationally representative surveys (US National Health and Nutrition Examination Surveys [NHANES] of 1971-1974, 1976-1980, 1988-1994, and 1999-2004) were examined for trends in the prevalence of overweight among adolescents aged 12 to 17 years by family poverty status.

Main Outcome Measures Prevalence of adolescent overweight, defined as body mass index at or above the 95th percentile for age and sex in the 2000 Centers for Disease Control and Prevention growth charts. Intermediate outcomes were physical inactivity in the past 30 days, proportion of caloric intake from sweetened beverages (24-hour recall), and whether respondent skipped breakfast (24-hour recall).

Results Trends in the association of adolescent overweight with family poverty differed by age stratum ($P=.01$). In 12- to 14-year-old adolescents, prevalence did not significantly differ by family poverty status in any of the surveys; however, among non-Hispanic black adolescents, overweight prevalence increased faster in nonpoor vs poor families. In contrast, a widening disparity that disfavored adolescents from poor families was present in the 15- to 17-year-old adolescents. This trend was similar among male, female, non-Hispanic white, and non-Hispanic black adolescents, resulting in an overall prevalence of overweight in 1999-2004 more than 50% higher among adolescents in poor vs nonpoor families (23.3% vs 14.4%, respectively; $P<.001$). Additional analyses suggest that physical inactivity, sweetened beverage consumption, and skipping breakfast may contribute to these disparities.

Conclusions Trends of increasing overweight showed a greater impact in families living below the poverty line vs not living below the poverty line among older (15-17 years) but not younger (12-14 years) adolescents. Furthermore, physical inactivity, high consumption of sweetened beverages, and breakfast skipping may be candidate targets for prevention programs aimed at reducing this recently emerged disparity.

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THE PREVALENCE OF OVERweight status among adolescents in the United States has more than doubled during the past 3 decades.[1-3] This increase has been noted among male and female adolescents, and across different racial and ethnic groups.[1,2,4] Recent data from 1999 through 2004 show no evidence that the trend is reversing.[1] As the prevalence of adolescent overweight increases, so too will its associated consequences, including type 2 diabetes mellitus, hypertension, obstructive sleep apnea, poor quality of life, and increased morbidity and mortality in adulthood.[5-8]

Whether the increasing prevalence of adolescent overweight is characterized by larger, smaller, or unchanged disparities in overweight status across socioeconomic strata is not known but is important for evaluating the success of recent efforts by the Department of Health and Human Services to reduce health disparities.[9] To address this question, we examined trends in the prevalence of overweight among adolescents aged 12 to 17 years by family poverty status in 4 nationally representative, cross-sectional data sets spanning from 1971 to 2004.

Author Affiliations: Department of Mental Health, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, Md (Dr Miech); Center for Clinical Epidemiology and Biostatistics, University of Pennsylvania School of Medicine, Philadelphia (Drs Kumanyika and Stettler); Division of Gastroenterology, Hepatology, and Nutrition, The Children's Hospital of Philadelphia, Philadelphia, Pa (Dr Stettler); Departments of Epidemiology (Dr Link) and Sociomedical Sciences (Drs Link and Phelan), Mailman School of Public Health, Columbia University, New York, NY; New York State Psychiatric Institute, New York (Dr Link); and Veterans Affairs Center for Health Equity Research and Promotion, Department of Medicine, University of Pennsylvania School of Medicine, and Department of Sociology, University of Pennsylvania, Philadelphia (Dr Chang).
Corresponding Author: Richard A. Miech, PhD, MPH, Department of Mental Health, Bloomberg School of Public Health, Johns Hopkins University, 624 N Broadway, Hampton House #853, Baltimore, MD 21205 (rmiech@jhsph.edu).

Our primary goal was to test the hypothesis that the disparity in overweight has widened among US adolescents. Individuals in the upper social strata are generally better able to protect themselves from diseases and conditions that are highly preventable[10,11] and may have been better able to resist the factors responsible for the current obesity epidemic. Because environmental influences on adolescent overweight differ substantially across older and younger adolescents,[12,13] we considered the possibility that any widening in the disparity may vary by age among adolescents. A secondary goal of our study was to examine the potential role of behaviors related to energy intake and energy expenditure in disparities of adolescent overweight.

METHODS

Surveys

Data were from the US National Health and Nutrition Examination Survey (NHANES) program of the National Center for Health Statistics, Centers for Disease Control and Prevention (CDC). Each NHANES cross-sectional survey provides national estimates for the US population at the time of the survey, enabling examination of trends over time. In each survey, the NHANES program selected a nationally representative sample of the US civilian noninstitutionalized population by using a complex, stratified, multistage probability cluster sampling design. The analyses of our study use data from NHANES I (1971-1974), NHANES II (1976-1980), and NHANES III (1988-1994). Beginning in 1999, NHANES became a continuous survey without a break between cycles; therefore, our study also uses data from the first 6 years of the continuous NHANES (1999-2004). NHANES III and NHANES 1999-2004 have been approved by institutional review boards and include written informed consent by study participants or their legal guardians. Institutional review board approval using current standards was not obtained for NHANES I or II, but internal human subjects review was conducted.

Outcome Measures

Adolescents' weight and height were measured by trained technicians in mobile examination centers who used standardized procedures and equipment. Overweight status was defined as recommended by the CDC. Unlike the definitions for adults, the CDC uses the term *overweight* rather than the term *obesity* to refer to the highest body mass index (BMI, calculated as weight in kilograms divided by height in meters squared) category for children and adolescents. Overweight in adolescents is identified as BMI at or above the 95th percentile for sex and age, according to the 2000 CDC growth charts for the United States.[14] The BMI growth charts are based on national data collected between 1963 and 1994; therefore, the prevalence of overweight may exceed 5% in recent surveys. Additional analyses were performed substituting the outcome of adolescent overweight status with the following: at risk for overweight or overweight, defined as a BMI at or above the 85th percentile for age and sex in the 2000 CDC growth charts; unadjusted BMI; and BMI, adjusted for age and sex using standard deviation scores (z scores).

A parent or caretaker of the participating adolescent was asked to sum the income of all family members (eg, earnings, unemployment compensation, or social security). The poverty income ratio is the ratio of a family's income to the US Census Bureau's poverty threshold, which varies with the number and ages of family members and is revised yearly.[15,16] For example, the US poverty threshold for a family of 4 with 2 dependent children in 2004 was $19 157.[17] The poverty income ratio allows comparison across time because it is continually revised to account for inflation. In our analysis, family poverty is a dichotomous variable that indicates a poverty income ratio of less than 1. In the 4 NHANES surveys, the percentage of adolescents in poverty was 16%, 18%, 22%, and 19% in chronological order. Poverty is a strategic measure of socioeconomic status in studies of overweight because poverty is linked to both poor diet and physical inactivity.[18-20] We did not include education because educational categories have shifted substantially in meaning and value during the 3 decades covered in our study.

Proportion of caloric intake from sweetened beverages was derived from the 24-hour dietary recall interviews of the NHANES 1999-2002 (currently the most recently released NHANES dietary recall) and the NHANES 1988-1994, which collected dietary information using similar procedures and codes. At the mobile examination centers, participants reported all food eaten in the prior 24-hour period (midnight to midnight) by using a structured interview procedure.[21-24] For each respondent, the amount of kilocalories derived from sweetened beverages (as indexed by foods with prefixes 924-927 inclusive in the Nutrient Database System[25]) divided by the total kilocalories consumed was calculated. Breakfast skipping was defined as a dichotomous variable coded 1 for respondents who reported 0 calories from breakfast in the 24-hour recall data. Analyses that use the 24-hour recall data excluded respondents with missing information (3% of respondents with information on BMI in each of the 2 NHANES surveys). Physically inactive was defined as a dichotomous measure indicating respondents who reported both no vigorous and also no moderate physical activity during the 30 days before the questionnaire interview in NHANES 1999-2004. Analyses that used this variable excluded respondents with missing information (4% of respondents with information on BMI). A comparable measure of physical inactivity was not included in earlier NHANES surveys.

Age and sex were self-reported at the time of examination in the mobile examination center. Race was based on interviewer observation in NHANES I and II, and on self-report in later NHANES surveys. Hispanic ethnicity was based on self-report in NHANES II and later surveys; NHANES I did not collect sufficient information to identify His-

panic respondents. Year of NHANES survey was coded as 0 for NHANES 1971-1974, 6 for NHANES 1976-1980, 19 for NHANES 1988-1994, and 29 for NHANES 1999-2004 to indicate the time between surveys.

Data Analysis and Statistical Methods

Data were analyzed using STATA version 8.0.[26] Pregnant female adolescents were excluded from the analysis. All surveys used a complex sampling design and drew individuals from preselected strata and primary sampling units. All analyses used the NHANES-provided sampling weights that were calculated to take into account unequal probabilities of selection resulting from the sample design, nonresponse, and planned oversampling of selected subgroups. Standard errors were calculated with STATA version 8.0 using Taylor series linearization. $P<.05$ was considered statistically significant.

Analyses included tests of 2-way and 3-way multiplicative interaction terms in regression equations.[27,28] All regressions with interactions included the necessary subcomponents. For example, a test of a 3-way interaction included the 3 necessary 2-way interaction terms and the 3 main components.

RESULTS

Survey Respondents

TABLE 1 shows the unweighted sample sizes for each analytic stratum. For NHANES II (1976-1980), the number of Hispanic and non-Hispanic other race respondents was too small to support statistical analysis; therefore, the analysis did not include separate analyses for these groups. Limited sample sizes also precluded meaningful analyses of the association with poverty by sex within race/ethnicity.

Prevalence of Adolescent Overweight

FIGURE 1 shows the prevalence of adolescent overweight by 3 levels of family income, age, and NHANES survey. These results show that differences in the prevalence of adolescent overweight were most evident among respondents aged 15 to 17 years in the last 2 NHANES surveys. Figure 1A illustrates the lack of large disparities in adolescent overweight, at any age, in the first 2 NHANES surveys. Figure 1B shows that in the last 2 NHANES surveys, differences in the prevalence of adolescent overweight between family income levels was substantially larger among respondents aged 15 to 17 years than it was among respondents aged 12 to 14 years. The results also indicate that the largest discrepancy in adolescent overweight was for families below poverty level compared with other income levels, in which the prevalence of adolescent overweight was similar. Subsequent analyses used the dichotomous variable below poverty level as a measure of family income and examined potential differences in trends between adolescents aged 12 to 14 years and 15 to 17 years.

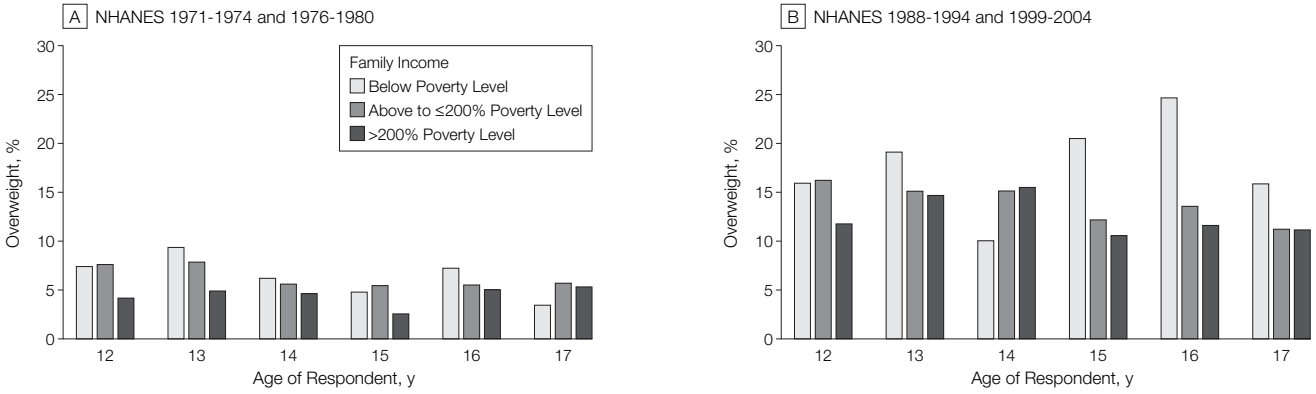
To test whether a disparity in overweight by family poverty widened in re-

Table 1. Number of Survey Respondents by Family Poverty, Sex, Race/Ethnicity, and NHANES Survey*

	No. of Unweighted Survey Respondents							
	NHANES I 1971-1974		NHANES II 1976-1980		NHANES III 1988-1994		NHANES 1999-2004	
	Not in Poverty	In Poverty	Not in Poverty	In Poverty	Not in Poverty	In Poverty	Not in Poverty	In Poverty
12-14 y								
Overall	800	266	758	189	700	427	1672	795
By sex								
Female	403	139	361	100	389	219	874	412
Male	397	127	397	89	311	208	798	383
By race/ethnicity								
Non-Hispanic white			616	75	259	42	561	91
Non-Hispanic black			77	79	211	188	487	310
Hispanic			47	33	219	193	576	378
Non-Hispanic other			18	2	11	4	48	16
15-17 y								
Overall	738	223	753	179	666	380	1593	688
By sex								
Female	355	114	340	87	349	190	749	313
Male	383	109	413	92	317	190	844	375
By race/ethnicity								
Non-Hispanic white			637	79	255	30	544	73
Non-Hispanic black			67	73	220	157	465	268
Hispanic			33	25	176	188	545	334
Non-Hispanic other			16	2	15	5	39	13

Abbreviation: NHANES, National Health and Nutrition Examination Survey.
*NHANES I did not collect sufficient information to categorize the Hispanic ethnicity of the respondents. Analysis of information from the 24-hour recall uses only NHANES 1999-2002, for which sample sizes are about one-third smaller than those sizes reported here for NHANES 1999-2004.

Figure 1. Adolescent Overweight by Poverty Status, NHANES Survey, and Age of Respondent



NHANES indicates National Health and Nutrition Examination Survey. Overweight is defined as at least the 95th percentile body mass index for age, as defined by the 2000 Centers for Disease Control and Prevention growth chart.

Table 2. Prevalence of Overweight Status for Adolescents Aged 12 to 14 Years for Each NHANES Survey by Poverty, Sex, and Race/Ethnicity

	Overweight Status, % (SE)				Absolute Difference of Growth in Poverty Over Survey, %
	NHANES I 1971-1974	NHANES II 1976-1980	NHANES III 1988-1994	NHANES 1999-2004	
Overall					
Not poor	6.52 (.77)	4.45 (.85)*	11.64 (2.23)	16.78 (1.40)	–1.86
Poor	7.75 (2.28)	7.62 (1.85)	13.08 (3.22)	16.72 (1.52)	
Female					
Not poor	7.30 (1.36)	4.98 (1.14)*	11.16 (2.66)	16.03 (2.03)	–1.46
Poor	9.65 (3.27)	10.24 (3.63)	11.89 (4.81)	18.34 (2.50)	
Male					
Not poor	5.75 (1.08)	3.97 (1.12)	12.05 (2.97)	17.50 (1.82)	–2.25
Poor	6.02 (3.06)	4.55 (2.35)	14.35 (4.16)	15.03 (2.20)	
Non-Hispanic white					
Not poor		5.13 (1.00)	10.87 (2.75)	14.96 (1.88)	–3.03
Poor		6.29 (2.53)	12.62 (5.77)	14.49 (3.30)	
Non-Hispanic black					
Not poor		1.69 (1.21)†	19.12 (3.36)*	22.76 (1.49)*	–20.44†
Poor		9.16 (3.76)	12.11 (2.27)	17.84 (2.13)	

Abbreviation: NHANES, National Health and Nutrition Examination Survey.
*Difference across poverty is statistically significant at $P<.10$.
†Difference across poverty is statistically significant at $P<.05$.

cent decades, the analysis included all adolescents aged 12 to 17 years in 1 analysis pool that combined all NHANES surveys and tested whether the prevalence of adolescent overweight increased more for adolescents in poverty compared with those not in poverty. These results did not support a widening or a narrowing disparity for the combined group of adolescents. The empirical model consisted of the 3 variables of family poverty, year of NHANES, and the multiplicative interaction of these 2 variables as predictors of adolescent overweight. The interaction term was not large or statistically significant, indicating that for the group of adolescents aged 12 to 17 years disparities in overweight did not change over the 4 NHANES surveys (unexponentiated $\beta=.003$; 95% confidence interval [CI], –.01 to .02; $P=.70$). However, this model did not take into account the possibility that disparities in adolescent overweight may differ by age group.

Preliminary analysis (Figure 1) led us to test whether a widening disparity in adolescent overweight by family poverty was specific to older adolescents (15-17 years). A widening disparity specific to older age groups would be indicated by a 3-way interaction of age group (15-17 vs 12-14 years), poverty, and year of survey. This 3-way interaction term was statistically significant (unexponentiated $\beta=.033$; 95% CI, .007-.059; $P=.01$) and indicated that analysis of trends in poverty and adolescent overweight should consider separately the age groups 12 to 14 years and 15 to 17 years. Subsequent analyses stratified the sample by these age categories.

Trends in the distribution of overweight by family poverty among adolescents aged 12 to 14 years are shown in TABLE 2 and FIGURE 2A. In general, at no year of NHANES surveys did the prevalence of overweight status significantly differ across poor and nonpoor families among all adolescents aged 12 to 14 years, or within any of the sex and racial/ethnic subsamples. Table 2 also shows the change in the disparity over the period covered by the surveys and in almost all cases the change was small. An exception was found among non-Hispanic black adolescents aged 12 to 14 years, for whom a disparity in adolescent overweight reversed over time so that the prevalence of overweight was higher among nonpoor families compared with poor families by the last years of the NHANES survey.

TABLE 3 shows trends in the distribution of overweight by family pov-

erty for adolescents aged 15 to 17 years. Results for all adolescents aged 15 to 17 years are shown in Table 3 and depicted graphically in Figure 2B. In general, the prevalence of overweight increased over the period of the surveys at a faster rate among adolescents from poor families compared with nonpoor families. In the first 2 NHANES surveys (1971-1974 and 1976-1980), no difference in the prevalence of overweight between poor and nonpoor families was apparent, but in the last 2 NHANES surveys (1988-1994 and 1999-2004), adolescents in poor families had a higher prevalence of overweight than adolescents in nonpoor families. This trend was apparent in all the sex and racial/ethnic subgroups, although it was not always statistically significant. The absolute difference between the prevalence of overweight for adolescents from poor vs nonpoor families increased by approximately 11% during the course of the survey. About the same magnitude in the increase of disparity over time was shown in each sex and racial/ethnic subgroup, despite different initial levels of disparities in overweight.

In confirmatory analyses using alternative outcomes of at risk for overweight or overweight, BMI, or BMI *z* score, results were similar or stronger than they were in the analyses of the outcome of adolescent overweight. Among all adolescents aged 15 to 17 years, a significant increase in disparity for each of these outcomes by family poverty during the study period was present, as well as in the subgroups of female, male, non-Hispanic white, and non-Hispanic black adolescents. These trends were not present among adolescents aged 12 to 14 years.

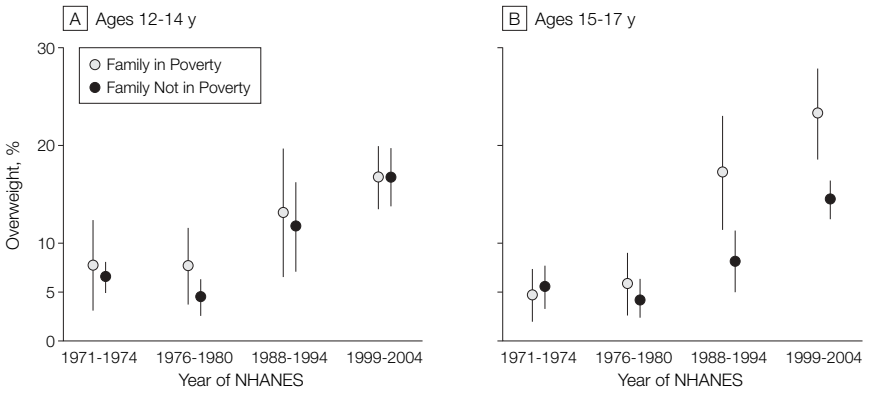
Behaviors Related to Energy Expenditure and Dietary Intake

We next examined the extent to which the trends in adolescent overweight documented could plausibly result from comparable major trends in behaviors related to energy expenditure and consumption. These analyses centered on the older adolescents (15-17 years) in the most recent NHANES surveys and examined whether any disparity in these trends by family poverty were more pronounced in comparison both with younger adolescents (12-14 years) in the same NHANES survey and older adolescents (15-17 years) in the previous NHANES surveys (data permitting). We first considered self-reported physical inactivity in NHANES 1999-2004, which was significantly associated with overweight among older adolescents aged 15 to 17 years (odds ratio [OR], 1.71; 95% CI, 1.12-2.62), although not among younger adolescents aged 12 to 14 years (OR, 0.77; 95% CI, 0.47-1.25).

Physical Activity Trends

A disparity in physical inactivity by family poverty was more pronounced for older compared with younger adolescents in the cross-sectional NHANES 1999-2004 (FIGURE 3A). The predicted scores come from a model in

Figure 2. Trend in Adolescent Overweight by Poverty Status and NHANES Surveys, 1971-2004



NHANES indicates National Health and Nutrition Examination Survey. Overweight is defined as at least the 95th percentile body mass index for age, as defined by the 2000 Centers for Disease Control and Prevention growth chart. Error bars indicate 95% confidence intervals of observed values.

Table 3. Prevalence of Overweight Status for Adolescents Aged 15 to 17 Years for Each NHANES Survey by Poverty, Sex, and Race/Ethnicity

	Overweight Status, % (SE)				Absolute Difference of Growth in Poverty Over Survey, %
	NHANES I 1971-1974	NHANES II 1976-1980	NHANES III 1988-1994	NHANES 1999-2004	
Overall					
Not poor	5.46 (1.08)	4.05 (0.82)	8.04 (1.51)*	14.38 (0.92)*	10.64†
Poor	4.67 (1.34)	5.76 (1.52)	17.16 (2.86)	23.27 (2.25)	
Female					
Not poor	5.68 (1.26)	4.51 (1.07)	6.28 (1.92)‡	11.89 (1.37)†	9.61
Poor	6.70 (2.35)	6.18 (2.38)	15.74 (3.69)	20.89 (4.56)	
Male					
Not poor	5.25 (1.50)	3.62 (1.21)	9.75 (2.51)	16.71 (1.38)†	11.74
Poor	2.08 (1.26)	5.31 (2.61)	18.76 (5.60)	25.34 (3.83)	
Non-Hispanic white					
Not poor		2.90 (0.55)‡	8.25 (1.97)*	12.27 (1.14)†	7.21
Poor		6.51 (2.49)	24.53 (6.82)	20.57 (4.60)	
Non-Hispanic black					
Not poor		11.84 (4.68)	6.29 (1.73)‡	22.39 (2.39)	14.65
Poor		5.58 (2.02)	12.38 (3.16)	25.24 (1.97)	

Abbreviation: NHANES, National Health and Nutrition Examination Survey.
*Difference across poverty is statistically significant at $P<.01$.
†Difference across poverty is statistically significant at $P<.05$.
‡Difference across poverty is statistically significant at $P<.10$.

which physical inactivity was modeled as a function of family poverty status, age, and an age-squared term (for which $P<.01$). A multiplicative interaction of age and family poverty status was not statistically significant. However, the disparity in physical inactivity by poverty status increased with age, measured by the absolute difference in the prevalence of physical inactivity. This absolute difference in the predicted score was 6.6% among respondents aged 12 years (13.0% vs 6.5%), and it increased by age 17 years to 11.2% (23.8% vs 12.6%). The relative difference in the predicted score was similar across all ages and indicated that adolescents in poor families had about twice the level of physical inactivity compared with adolescents from nonpoor families. Among adolescents aged 12 to 17 years, girls reported significantly more physical inactivity than boys (13% vs 8%, $P<.001$), but the percentage increase in inactivity from ages 12 to 17 years was similar across sex. The earlier NHANES surveys did not contain similar measures of physical inactivity to allow historical comparison.

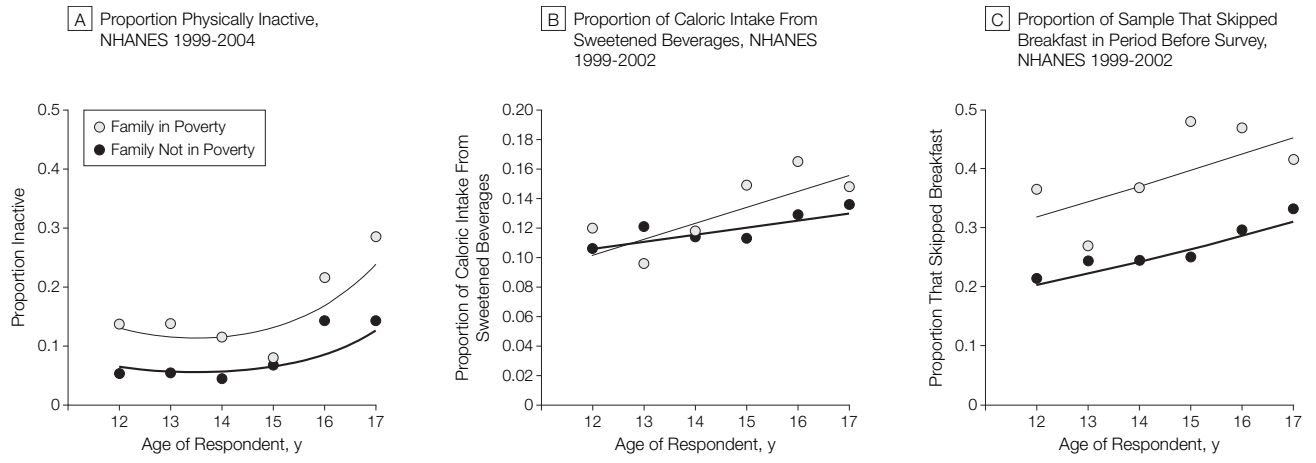
Dietary Trends

We next examined whether major trends in dietary behaviors in recent decades have disproportionately affected older adolescents in poverty. We considered the major dietary trends that have been identified in an extensive literature review[29] and for which good measures existed in the NHANES surveys. These included sweetened beverage consumption, breakfast skipping, percentage of calories consumed while eating away from home, and percentage of calories from snacking between meals. The first 2 factors were significantly associated with overweight among adolescents aged 12 to 17 years in NHANES 1999-2002 ($P<.001$ for both, respectively), but the second 2 factors were not associated with overweight and therefore were not considered any further.

A disparity across poverty status in percentage of calories from sweetened beverages was greater for older vs younger adolescents in the cross-sectional NHANES 1999-2002 (Figure 3B). Predicted results are shown from an analysis in which proportion of calories from sweetened beverages was modeled as a linear function of age (an age-squared term that would have indicated a curvilinear function was not significant), family poverty status, and the multiplicative interaction of these 2 variables ($P = .07$). The borderline statistically significant interaction suggests that the disparity in this risk factor across poor and nonpoor families (adolescents) became larger with increasing age.

Because the last 2 NHANES surveys (1988-1994 and 1999-2002) contain similar dietary measures, they allowed comparison of caloric intake from sweetened beverages during the past decade. The analyses indicated that a disparity across poverty status in proportion of calories from sweetened beverage consumption significantly increased across the 2 surveys, and this increase was concentrated among adolescents aged 15 to 17 years in poor families. For the combined age-group 12 to 17 years, the percentage of caloric intake from sweetened beverages significantly increased from 10.6% in NHANES 1988-1994 to 12.2% in NHANES 1999-2002 ($P = .01$). This increase was concentrated among respondents aged 15 to 17 years (from 10.7% to 13.2%, $P = .003$) and was not present among respondents aged 12 to 14 years (from 10.6% to 11.3%, $P = .28$). Among respondents aged 15 to 17 years, the increase across the last 2 NHANES surveys (1988-1994 and 1999-2002) was significantly larger in poor families (from 9.2% to 15.4%) compared with nonpoor families (from 11.1% to 12.6%).

Figure 3. Trends in Risk Factors for Adolescent Overweight by Age and Poverty Status



NHANES indicates National Health and Nutrition Examination Survey. Predicted results are from regression equations of outcome on year of age and poverty status. A, Equation includes an age-squared term. B, Equation includes a multiplicative interaction of poverty status and age. C, Equation includes only year of age and poverty status as predictor variables.

This finding was indicated by a positive, multiplicative interaction ($P=.002$) of NHANES survey and poverty status in a model predicting proportion of calories from sweetened beverages that combined adolescents aged 15 to 17 years from both NHANES surveys into 1 analysis pool.

Figure 3C shows a disparity across poverty status in the prevalence of breakfast skipping in NHANES 1999-2002 that had a similar magnitude across all adolescents aged 12 to 17 years. This disparity ($P<.001$) appears to have emerged recently because, in the NHANES 1988-1994 survey, breakfast skipping was not significantly associated with poverty status for the combined group of adolescents aged 12 to 17 years ($P=.10$). Among older adolescents aged 15 to 17 years, the absolute difference in the disparity increased from 1.1% to 16.2% across the last 2 NHANES surveys (the prevalence for poor vs nonpoor families was 32.7% vs 31.7% in NHANES 1988-1994 and 45.6% vs 29.4% in NHANES 1999-2002, respectively). This increase was significant ($P=.02$) in analyses that tested the interaction of NHANES survey and poverty status in a combined pool of respondents from NHANES 1999-2002 and NHANES 1988-1994. Among younger adolescents aged 12 to 14 years, the absolute difference in the disparity did not significantly change across the last 2 NHANES surveys (the prevalence for poor vs nonpoor families was 33.5% vs 21.7% in NHANES 1988-1994 and 33.6% vs 23.5% in NHANES 1999-2002, respectively).

COMMENT

We examined whether socioeconomic disparities in adolescent overweight status increased, decreased, or remained constant during the past 3 decades and whether these trends varied by age among US adolescents. Our results indicated an increasing disparity in adolescent overweight status by family poverty among adolescents aged 15 to 17 years but not among adolescents aged 12 to 14 years. For the older adolescents, the magnitude of the increase in the disparity was similar across the demographic subgroups of male, female, non-Hispanic white, and non-Hispanic black respondents. For the younger adolescents, no disparity in overweight by family poverty was apparent for any demographic group at any of the 4 survey years; although among non-Hispanic black adolescents, the overall rate of overweight during the course of the surveys increased faster in nonpoor vs poor families, a finding consistent with trends in the adult population.[30]

To our knowledge, our study is the first to document an increasing disparity in overweight by poverty status in any US population group. These results challenge the current conclusion that disparities in overweight by poverty status have not increased in the United States, a conclusion based on analyses of adults[31] and also from data from the mid-1990s that combined younger and older adolescents into a single group.[32] Our findings that later adolescence is a life stage with a unique association between poverty and overweight is plausible because both food choices and physical activity levels in adolescence differ considerably from those earlier in childhood[33,34] and adulthood.[35,36] Our results therefore point to the utility of a life-course perspective that takes into account findings specific to life stages.

What factors explain an overweight disparity by poverty status that is specific both to older adolescents and also more recent NHANES surveys? The observed differences across older vs younger adolescents are consistent with the greater autonomy that comes with increasing age. Adolescents aged 15 to 17 years vs those aged 12 to 14 years have more opportunities to purchase their own food and determine their own leisure time pursuits and also have more discretionary income with which to act on their preferences.

After identifying trends in poverty and adolescent overweight among older adolescents, we then examined ex post facto trends in specific behaviors that may play a role in this disparity. Our analysis investigated dietary behaviors with documented increases in recent years,[29] including sweetened beverage consumption, eating out, and snacking between meals. We also examined physical inactivity[37,38] and breakfast skipping, which observational studies show to be associated with adolescent overweight.[39] A behavior involved in the emerging disparity identified in our study should fulfill a specific and detailed set of 4 expectations. This disparity should have higher prevalence for those families in poverty, higher prevalence among adolescents who are overweight, show a greater disparity by poverty status among older vs younger adolescents, and have developed in recent years.

Proportion of calories from sweetened beverages followed this exact pattern of findings, suggesting that recent trends in sweetened beverage consumption among older adolescents may, at least in part, explain the disparity in overweight status. Physical inactivity also followed this pattern of findings, although measures were restricted to the most recent NHANES survey and historical comparisons were not possible. Other studies have noted that physical inactivity among adolescents has been increasing in recent years.[40] These results suggest that policy and prevention efforts that target these behaviors for overweight[41,42] can be further justified and motivated by the potential of these efforts to reduce an emerging socioeconomic disparity in adolescent overweight.

Breakfast skipping also came close to fulfilling all 4 criteria, with the exception that in the most recent NHANES survey the recently emerged disparity had the same magnitude for younger and older adolescents. These results point to breakfast skipping as a factor that warrants more attention in the study of adolescent overweight. To our knowledge, there has been no randomized controlled trial of breakfast promotion for overweight prevention or treatment, and many of the intervening mechanisms remain speculative. One longitudinal

study[43] showed that adolescents with normal weight who skipped breakfast were more likely to experience BMI increases over time. This result supports possible mechanisms, such as rebound overeating at lunch and dinner, a poor dietary pattern characterized by soda and snacking in place of regular meals, or possibly a biological effect associated with efficient calorie utilization after long periods of not eating. At the same time, breakfast skipping may also be used as a dieting strategy among overweight individuals.

Our study was limited to analysis of risk factors that were measured in the NHANES surveys, and these are likely only a subset of a much larger pool that are at work in the emerging disparity in adolescent overweight by poverty. Availability of energy-dense food,[44,45] perceived dangerousness of neighborhoods,[46] and limited access to supermarkets that sell nutritious, low-calorie food[47] are a few examples of additional circumstances that are currently linked to adolescent overweight and warrant more attention in analysis of disparities in overweight. At the same time, current influences that have fostered a socioeconomic disparity in adolescent overweight have emerged recently and new factors may emerge in the near future. Ultimately, successful intervention and prevention of the emerging disparity will require constant surveillance of potential intervening mechanisms and, ideally, attention to the upstream influences that set these intervening mechanisms into motion.[11]

Our study has some limitations. The BMI-based definition for adolescent overweight is recommended by the CDC, but the best way to identify overweight and obesity in children is still a subject of debate.[3] Another limitation is that data from Hispanic adolescents could not be meaningfully analyzed due to differences in sampling strategies and in measurement of Hispanic ethnicity across the NHANES surveys. Furthermore, the sample sizes were too small to allow examination of sex differences within racial/ethnic groups over time, which are present among adults.[30,31,48,49] The cross-sectional design and methods used for NHANES limit investigation to only broad, major risk factors for overweight and do not have the precision to measure small, cumulative energy imbalances of only dozens of calories that can lead to overweight if experienced over protracted periods.[50] Finally, our measurement of family socioeconomic status is limited to self-reported family income, because the NHANES data lack consistent measures of other socioeconomic status components, such as family education, wealth, neighborhood conditions, and past socioeconomic status experience. Socioeconomic status is a multidimensional construct and single measures of socioeconomic status should be accompanied by measures of other socioeconomic status dimensions when data are available.[51]

Counterbalancing these limitations are the strengths of our study. The main study finding of an increasing socioeconomic disparity in overweight among adolescents aged 15 to 17 years was robust across 4 different weight status indices and across sex and racial subgroups. Additional strengths include the NHANES measurement of height and weight by trained technicians, which removes the results from the potential biases associated with self-reports,[52,53] and that the sample is representative of all US adolescents.

In conclusion, a widening disparity in overweight that disadvantages adolescents in poor families has emerged in the 15- to 17-year-old age group in recent years. These results suggest that efforts to reduce health disparities in the United States require monitoring of population health, so that emergent disparities and their underlying causes can be detected and addressed at early stages of their development.

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Study concept and design: Miech, Kumanyika, Link, Phelan, Chang.
Acquisition of data: Miech.
Analysis and interpretation of data: Miech, Kumanyika, Stettler, Link, Phelan, Chang.
Drafting of the manuscript: Miech, Kumanyika, Stettler, Chang.
Critical revision of the manuscript for important intellectual content: Miech, Kumanyika, Stettler, Link, Phelan, Chang.
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