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Health-related quality of life and body mass index among US adolescents

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Abstract

Purpose—To examine the magnitude of differences in health-related quality of life (HRQOL) by body mass index (BMI) in a population-based sample of United States adolescents overall and by sex, and to provide national prevalence estimates of reported HRQOL outcomes for not only obese and overweight but also underweight adolescents.

Methods—From the 2001 through 2010 cross-sectional National Health and Nutrition Examination Surveys, we estimated the percentages of four HRQOL outcomes—self-rated health, physically unhealthy days, mentally unhealthy days, and activity limitation days—in four BMI categories—obese, overweight, normal weight, and underweight—of approximately 6,000 US adolescents aged 12–17 years. We also estimated the percentages for boys and girls separately.

Results—Substantial gaps in self-rated health exist between normal-weight adolescents and those who are obese and overweight, but not underweight. Eighteen percent (95 % CI 15–22) of obese adolescents reported fair or poor health compared to only 5 % (95 % CI 4–7) of normal-weight adolescents. Thirty-seven percent (95 % CI 33–42) of obese adolescents reported excellent or very good health, compared to 65 % (94 % CI 63–67) of normal-weight adolescents. However, all BMI groups reported similar percentages of physically unhealthy days, mentally unhealthy days, and activity limitation days. The associations between HRQOL and BMI groups did not vary by sex. Boys generally reported significantly better self-rated health and mental health than girls. Specifically, obese boys reported better self-rated health, mental health, and fewer activity limitation days than obese girls.

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Conclusions—Substantially, significant differences in some domains of HRQOL are found between above normal-weight and normal-weight US adolescents. This relationship between BMI and HRQOL is robust and observed among both boys and girls.

Keywords

Adolescents; Body mass index; Health-related quality of life (HRQOL); National Health and Nutrition Examination Surveys (NHANES); Obesity; Overweight; Underweight

Introduction

Obesity is a major public health challenge in the United States [1]. The prevalence of obesity among adolescents increased from 5 % in 1976 to 18 % in 2010 [2, 3]. Furthermore, an estimated 15 % of adolescents are overweight [3]. The US Healthy People 2020 process has identified a reduction in the rate of obesity among children and adolescents as an important decennial objective [4]. Obese or overweight adolescents are at a risk of developing psychological problems (e.g., low self-esteem or depression), cardiovascular diseases, and other adverse medical conditions (e.g., metabolic disturbances including type 2 diabetes) [5–11]. However, the association between being obese or overweight and adolescent health-related quality of life (HRQOL) is less clear [12–20]. Additionally, little is known about how being underweight is associated with adolescent HRQOL.

Health-related quality-of-life measures an individual's or group's perceived physical or mental health over time [21, 22]. It assesses the physical, social, and psychological functions of health and well-being. Adolescents with different body weights have been found to have different levels of HRQOL [12–20]. In general, obese or overweight adolescents report worse HRQOL than normal-weight adolescents, but this association with body weight is complex and is not fully examined. Additionally, the magnitude of differences within these groups on reported HRQOL has not been well documented.

Some researchers suggest that obesity or overweight affects all domains of children and adolescents' HRQOL (social, school, psychological, and physical functioning) [12, 14, 15]; others have found that it more profoundly affects physical health [6, 10, 11, 17, 19]. Some research shows that obesity is associated with impaired social and psychological health [13, 16, 19], whereas others have found no such association [18]. This lack of consensus might result from the use of clinical or small samples with limited generalizability. One exception, however, is that of Swallen et al. [18], who used a nationally representative sample (the US National Longitudinal Study of Adolescent Health), and found that, compared to normal-weight adolescents, obese and overweight adolescents reported worse general and physical health but similar mental and social health. Additionally, another study further showed that the association between HRQOL and body weight is sex-specific, but this study used a sample of Australian adolescents [20]. Unfortunately, population-based studies of adolescent obesity and HRQOL are few, and existing studies are often limited to special or non-US. populations [20, 23, 24]. Because of these limitations, the magnitude of differences in the association between HRQOL and body weight for US adolescents has not be determined. To

better study and track adolescent health in the United States, nationally reliable estimates for this age group are needed.

The Centers for Disease Control and Prevention (CDC) has developed a set of standard HRQOL measures (self-rated health, physically unhealthy days, mentally unhealthy days, and activity limitation days) to monitor population health [21, 22]. Compared to other HRQOL instruments for children and adolescents such as the Pediatric Quality of Life Inventory (PedsQL), the CDC's "Unhealthy Days" measures have unique advantages. For instance, these measures have been included in many population-based datasets for many years and enable the surveillance and comparisons of different health conditions of nationally representative samples of adolescents consistently over time [22]. Although the CDC's measures might have not been widely used on adolescents, they have been found to be valid instruments for this age group [25, 26] and can be used as proxy indicators for adolescent health for generating national baseline estimates. Specifically, since 2001, these core measures have been incorporated into the ongoing National Health and Nutrition Examination Survey (NHANES) [27]. NHANES data are also particularly suitable for examining how adolescent HRQOL is affected by body weight, often represented by body mass index (BMI), nationally over time, because, instead of self-reported heights and weights, these data include more reliable measured heights and weights.

However, to the best of our knowledge, no other studies have examined the associations between adolescent HRQOL based on the CDC's HRQOL measures and BMI from NHANES. No other study has used this dataset to provide prevalence estimates for adolescent HRQOL on a national level in the United States. Therefore, our study aims at measuring the magnitudes of the differences in each domain of the HRQOL measures among adolescents classified by their BMIs. Estimates from our study can be used as national baseline data to compare and evaluate adolescent health status. Because the association between adolescent HRQOL and BMI might vary by sex [3, 18, 20], we stratified by sex to explore the association by BMI category within each sex and also to compare both sexes to each other.

Our study complements previous research by assessing whether HRQOL differed among these four adolescent BMI groups by using a population-based sample. We overcome the limitations of previous research that uses small or unrepresentative samples and are able to determine the magnitude and the direction of associations between HRQOL and BMI among US adolescents. Findings from our study might also be particularly useful for health scientists, professionals, and policy-makers concerned with tracking and improving adolescent health.

Methods

The 2001–2010 NHANES, a nationally representative multistage cross-sectional survey designed to study the health and nutritional status of the noninstitutionalized US civilian population, provided data for our study [27]. The NHANES program started in the early 1960s and has become an ongoing survey in two-year cycles in the United States since 1991. It collects information on the vital health and nutritional status of the nation and enables

prevalence estimates of many diseases such as cardiovascular disease or diabetes and risk factors such as smoking and binge drinking. NHANES is funded by the National Center for Health Statistics (NCHS) of the CDC. Its protocol and administration have been approved by the NCHS's Research Ethics Review Board, and all NHANES participants provide informed consent. Different from many other national surveys, NHANES includes a health examination component along with a household interview. The health examination component includes an additional interview, a physical examination, and laboratory tests conducted at a mobile examination center (MEC). During the physical examination, trained health technicians measure participants' height and weight.

NHANES initially screened 7,380 adolescents for interview, 97 % (=7,087) of whom were examined later at the MEC. For this study, we also excluded 56 pregnant girls (see below), leaving 7,031 adolescents 12–17-year old from 2001 through 2010 examined at the MEC.[1] Among those adolescents, approximately 93 % of them answered questions about their HRQOL. After exclusion of missing values for the covariates included in our study (see Table 1 for the sample sizes in each covariate category), the final analysis sample size varied with the HRQOL measure used—self-rated health (N = 6,017), physically unhealthy days (N = 6,013), mentally unhealthy days (N = 6,011), and activity limitations days (N = 6,013) (Tables 2, 3). We also excluded 56 pregnant girls from our analysis only from 2001 through 2006 since data on adolescent pregnancy status are not publicly available after 2006. We thus might have inadvertently included some pregnant girls in our analysis since 2007, but pregnancy status did not affect our results because our point estimates did not vary even after including pregnant girls in the analyses (results not shown).

The HRQOL measures in our study include self-rated health, physically unhealthy days, mentally unhealthy days, and activity limitation days [21]. The self-rated health measure is derived from responses to the question "Would you say that in general your health is (1) Excellent, (2) Very Good, (3) Good, (4) Fair, or (5) Poor?" We grouped these responses into fair or poor health, good health, and very good or excellent health. The physically unhealthy days measure is derived from responses to the question, "Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?" The mentally unhealthy days measure is derived from responses to the question, "Now thinking about your mental health, which includes stress, depression, and problems with emotions, for about how many days during the past 30 days was your mental health not good?" The activity limitation days measure is derived from responses to the question, "Are you limited in any way in any activities because of physical, mental, or emotional problems?" Because of the skewed distribution of these "unhealthy days" measures and the small sample sizes reporting individual days, we grouped responses for these separate measures into zero days, 1–13, and 14–30 days.[2] We recoded responses of "Do not know/Not sure" and "Refused" as missing and excluded them from the analysis.[3]

[1]All of these remaining adolescents had complete records of their measured heights and weights.
[2]These cut-off methods have also been used in many previous studies to represent the degree of severity for "Unhealthy Days" measures [34]. For instance, adolescents who reported ≥14 days of mentally unhealthy days would be considered as having frequent mental distress.
[3]Very few adolescents (<0.1%) gave "Do not know/Not sure" answers or refused to answer the questions.

We used the BMI, calculated as the weight in kilograms divided by height in meters squared (kg/m^2), which correlates with body fatness and classifies adolescents into weight categories that may lead to health problems—obese, overweight, and underweight. BMI has been found to be a valid indicator of body adiposity among obese and overweight adolescents and children [28, 29]. Specifically, we calculated BMI percentiles and z-scores for each adolescent NHANES participant based on the reference population from the CDC's 2000 BMI-for-age growth charts [30]. Based on the recommended cut-off criteria from the CDC, we classified adolescents at or above the 95th percentile of the sex-specific BMI-for-age as obese, between the 85th and 95th percentile as overweight, between the 5th and 85th percentile as normal weight, and under the 5th percentile as underweight [31].

Because some demographic characteristics and risk factors may affect the association between BMI and HRQOL, we adjusted for these variables as potential confounders [14–20]. Demographic characteristics controlled for include sex, race/ethnicity (non-Hispanic White, non-Hispanic Black, Mexican American, or Other Race), age (12–14 or 15–17-year old), and the family poverty–income ratio (PIR: low income (≤130 %), middle income (>130–350 %), or high income (>350 %)).[4] Regarding race/ethnicity, we combined all other Hispanics and other races into one category and used Mexican Americans for the Hispanic group based on an analytical guideline from NHANES due to a deficiency in sample sizes for all other Hispanics before 2007 [27]. Risk factors adjusted for include cigarette smoking (Never smoker, Past smoker, or Current smoker) and leisure-time physical inactivity[5] (Physically inactive or Physically active). We also controlled for the interview year based on the calendar years of the five NHANES biennial survey cycles (2001–2002, 2003–2004, 2005–2006, 2007–2008, and 2009–2010). To assess whether sex differences affected the association among BMI categories and reported HRQOL, we used in our models an interaction term[6] between BMI category and sex, which enabled us to calculate separate estimates for each sex.[7]

We used multinomial logistic regression[8] to calculate the HRQOL outcomes both as the unadjusted proportions (unadjusted percentages[9]) and as predicted marginal percentages[10] adjusted for potential confounders by BMI categories alone and by these categories within each sex. Because the unadjusted percentages are very similar to the adjusted percentages

[4]This variable is an index for the ratio of family income to poverty, based on the Department of Health and Human Services' (HHS) poverty guidelines [27]. In 2008, for a family of four, a PIR of 130% was equivalent to $29,000 and a PIR of 350 % was approximately equivalent to $77,000 [35].

[5]Adolescents were defined as physically active if they answered yes to either the survey question asking if they ever participated in any vigorous-intensity sports, fitness, or recreational activities or the question asking if they ever participated in any moderate-intensity sports, fitness, or recreational activities. Adolescents were classified physically inactive if they answered no to both of these questions.

[6]The software we used, SAS-callable SUDAAN 10, requires creating interaction terms to obtain predicted marginal proportions for each sex.

[7]We also examined the interactions between BMI and income as well as between BMI and race/ethnicity, and found that these interactions were not statistically significant after controlling for all other covariates in the model and thus were not reported.

[8]Originally, we considered other statistical models such as proportional-odds ordinal logistic regression, but the proportional-odds assumption was not met. Because we are more interested in estimating the magnitude of differences such as percentages for our outcome variables, the nominal multinomial logistic regression model fits our data adequately with fewer assumptions.

[9]We chose to report percentages because, based on our experience, they are more easily understood than other statistics such as odds ratios and regression coefficients.

[10]These adjusted percentages are based on the predicted marginal proportions estimated from the multinomial logistic regression as the average of the predicted responses in each category if all the respondents had been in that category after adjustment for the covariates.

(the differences between them range from 0.7 to 5.1 %), we report only adjusted percentages and their 95 % confidence intervals (CI) (Tables 2, 3). We also estimated the adjusted odds ratios ("Adjusted OR") for different BMI categories relative to normal-weight adolescents to assess the associations between BMI and HRQOL. We presented these Adjusted OR in Table 4 of the Appendix, but did not include them in Tables 2 and 3 because odds ratios can be calculated from the percentages in these tables, but the percentages cannot be calculated from the odds ratios. Moreover, the tabulated percentages enable comparisons among all the BMI groups, but the odds ratios require specifying an arbitrary reference group. In cross-sectional studies like this one, finally, odds ratios may also exaggerate relative risks between group percentages when the percentage in the reference group is large [32]. Because nonoverlapping 95 % CI imply statistically significant differences (below the significance level of 0.05) between percentages in Table 2 and 3, we did not report *P* values associated with *t* tests or Wald chi-square tests for the comparisons between BMI categories on HRQOL outcomes to avoid redundancy. Additionally, we also presented results from multinomial logistic regression such as odds ratios and their 95 % confidence intervals for all other confounders/covariates in Table 4 of the Appendix for reference purpose, but did not discuss them in the Results section.[11] We performed all analyses in SAS-callable SUDAAN 10.0 to account for respondent sample MEC weights and the strata and the primary sampling units in NHANES' complex sample survey design [33].

Results

Descriptive statistics

Overall, 18 % of adolescents aged 12–17-year old were classified as obese, 16 % as overweight, 62 % as normal weight, and 5 % as underweight (Table 1). Sixty-two percent of our sample was non-Hispanic White, and 50 % from 15-to-17-year old. Approximately, 81 % reported never-smoking cigarettes, but 11 % reported currently smoking. Finally, 88 % reported being physically active.

Self-rated health

Obese and overweight adolescents reported significantly worse self-rated health than normal-weight adolescents. Only 37 % of obese adolescents and 54 % of overweight adolescents reported excellent or very good health, significantly less than normal-weight adolescents (65 %) after adjusting for demographic characteristics, cigarette smoking, physical activity, and interview year (Table 2). Compared to normal-weight adolescents, obese adolescents reported excellent or very good health relative to good health 60 % less often (Adjusted OR 0.4, 95 % CI OR 0.3–0.4) and overweight adolescents, 40 % less often (Adjusted OR 0.6, 95 % CI 0.5–0.8). Nineteen percent of obese adolescents reported fair or poor health compared to 5 % of normal-weight adolescents (Adjusted OR 2.6, 95 % CI 2.0–3.5). Underweight adolescents reported excellent or very good health about as often as normal-weight adolescents.

[11]Although the effects of these covariates (e.g., race/ethnicity and PIR) on adolescent HRQOL are of interest to many researchers, we did not discuss them in the Results section because the main focus of our paper was to examine the relationship between BMI and HRQOL after controlling/adjusting for these confounders/covariates.

Generally, the direction of the association between BMI categories and self-rated health did not vary by sex (Table 3). Obese and overweight boys and girls both reported significantly worse self-rated health than normal-weight boys and girls. Specifically, 19 % of obese boys and 20 % of obese girls reported fair or poor health, significantly higher than that in normal-weight boys (5 %) and girls (6 %). Sixty-nine percent of normal-weight boys reported excellent or very good health, significantly more than that in any other BMI category (obese boys: 40 %; overweight boys: 59 %; underweight boys: 53 %). Similarly, 62 % of normal-weight girls reported excellent or very good health, significantly greater than that in overweight girls (49 %) and obese girls (34 %) but not that in underweight girls (62 %).

Boys also generally reported better self-rated health than girls. The percentage of normal-weight boys reporting excellent or very good health significantly exceeded that for all girl BMI categories except that for underweight girls (Table 3).

Physically unhealthy days

The percentages in different categories of reported physically unhealthy days did not differ statistically significantly across the BMI categories overall (Table 2) or for either boys or girls (Table 3).

Mentally unhealthy days

Overall, mentally unhealthy days did not statistically significantly differ across the BMI categories (Table 2). This lack of association between mentally unhealthy days and BMI categories occurred among both boys and girls (Table 3). However, boys generally reported better mental health than girls. Specifically, 65 % of normal-weight boys reported zero mentally unhealthy days, significantly higher than comparable percentages among any girl BMI categories. Significantly, more overweight boys (62 %) and obese boys (62 %) reported zero mentally unhealthy days than not only obese girls (48 %) but also normal-weight girls (51 %).

Activity limitation days

All BMI categories reported similar percentages of activity limitation days. This lack of differences did not change within each sex. However, 82 % of normal-weight boys and 83 % of obese boys reported zero activity limitation days, both significantly more than the 70 % of obese girls who reported zero activity limitation days (Table 3).

Discussion

Previous studies have shown inconsistent or contradictory conclusions regarding the relationships between adolescent BMI categories and HRQOL. However, many of these studies were based on small and unrepresentative clinical or school samples. These studies often used standardized measures such as Pediatric Quality of Life Inventory (PedsQL) to assess adolescent HRQOL [12, 15, 18, 20], but these measures are often not included in national ongoing surveillance data in the United States because of their length. Because of this limitation in sampling, comparisons of different health outcomes and diseases for adolescents across years might be problematic. In contrast, the CDC’s HRQOL measures are

comparable with other measures and may be particularly useful for tracking adolescent health on a national level over time. Our study thus extended previous studies by using a large population-based sample over several years and the CDC's HRQOL measures. Our study also fills in a gap in previous research by assessing the magnitude of differences between HRQOL outcomes within each BMI category. To the best of our knowledge, our study is the first that provides national prevalence estimates for adolescent HRQOL by BMI in the United States. Findings from our study can be used as baseline estimates for future research.

Consistent with previous research, obese and overweight adolescents reported worse self-rated health than normal-weight adolescents. Substantial gaps are found between normal-weight and obese and overweight adolescents. Because obese and overweight adolescents might generally experience more psychological problems such as depression and are at a higher risk of developing adverse medical conditions such as cardiovascular disease and diabetes, it is not surprising that they are more likely to report worse general health [5–8]. Although previous studies have consistently found obesity to have a significant impact on physical health, this consistency is less obvious regarding its impact on mental health [12–19]. Our study did not find any other significant differences between BMI categories in terms of reported physical or mental health or in reported activity limitation days. The discrepancies between our and others' studies might be due to the different physical and mental health measures used. Importantly, we also did not find significant differences in reported HRQOL between underweight and normal-weight adolescents. Although the small sample of underweight adolescents may have reduced the statistical power to detect differences, this finding is still noteworthy since no other study has documented underweight adolescents' HRQOL in a nationally representative sample.

Different from one recent study on Australian adolescents [20], after stratifying on sex, we found no sex-specific patterns between BMI and HRQOL among US adolescents. As with the overall sample, normal-weight boys and girls generally reported better HRQOL than overweight and obese boys and girls with respect to self-rated health but not to physical health, mental health, or activity limitation.

Furthermore, our findings support those in previous studies that have shown boys generally report better health than girls [3, 18]. In our study, compared to most BMI categories in girls, normal-weight boys reported better self-rated health and mental health but not better physical health and activity limitation. We also found that obese boys reported better self-rated health, mental health, and fewer activity limitation days than obese girls.

Our study is subject to several limitations. First, although the four CDC HRQOL measures have face validity, the "Healthy Days" measures (physically, mentally, and activity limitation days) might not be sensitive enough to detect differences among adolescents. One report on the cognitive testing of the CDC's HRQOL measures suggests that adolescents may rate their health accurately but are less likely to take into account the 30-day time frame when reporting the "Healthy Days" measures [25]. Another study of adolescents has also shown that self-rated health correlates only weakly with the "Healthy Days" measures [26]. Therefore, the insensitivity of our measures might have reduced our ability to detect

differences in this study. Compared to multiple item, standardized adolescent HRQOL scales, the four-item CDC HRQOL measures are broader and may also not be sensitive enough to distinguish differences among specific HRQOL domains. Additionally, the distributions for the "Unhealthy Days" measures were skewed because a large proportion of adolescents reported zero physically and mentally unhealthy days as well as zero activity limitation days. Consequently, these measures might not discriminate well among those who reported better health (for instance, zero unhealthy days). Second, NHANES HRQOL data are self-reported and not corroborated by others (for example, parents, teachers), making them subject to misclassification. Thus, adolescents' ability to correctly understand and interpret the questions might have affected our findings. Third, because the NHANES is cross-sectional, the associations we observed may not be causal and may result from potential confounders. Although we adjusted for several confounders in our study, and although these adjustments did not change our findings, we still may have omitted other important confounders. For example, we did not adjust for more specific health outcomes or comorbidities, such as diabetes mellitus and cardiovascular disease, which are associated with BMI and affect HRQOL [8–11], because the prevalence of such comorbidities among adolescents in this population-based study was too small to affect this study's findings. Moreover, we also did not adjust for other more common chronic diseases among adolescents such as asthma in our final report because we found it did not significantly change the association between BMI and HRQOL. However, future, larger, population-based studies should consider adjusting for these comorbidities if their prevalence is high enough among adolescents or if they significantly affect adolescent HRQOL. Finally, NHANES does not have information on variables such as parental education or body image, so that we could not examine their effects on the association between BMI and HRQOL.

In conclusion, despite certain limitations, our study expanded on previous research and demonstrated a robust association between poor self-rated health and being obese and overweight among a population-based sample of adolescents in the United States. Results from our study show that statistically significant gaps exist between adolescents who are above normal weight and normal weight. Findings from our study might be particularly useful for policy-makers and health professionals who utilize national estimates and want to monitor adolescent health and to develop interventions for addressing obesity and quality of life among adolescents.

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Abbreviations

HRQOL	Health-related quality of life
BMI	Body mass index
NHANES	National Health and Nutrition Examination Surveys
MEC	Mobile examination center

PIR	Poverty-income ratio Adjusted OR Adjusted odds ratio
CI	Confidence intervals
N	Sample size

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Appendix

See Tables 1–4.

Table 1

Body mass index categories, sociodemographic characteristics, risky behaviors, and interview years among adolescents, 12–17-year old—National Health and Nutrition Examination Survey, 2001–2010 (N = 7,031)

Characteristics	Sample size	Weighted percentage[a]
Body mass index categories		
Underweight	292	4.5
Normal weight	4,175	61.9
Overweight	1,150	15.9
Obese	1,414	17.7
Sex		
Boys	3,585	50.5
Girls	3,446	49.5
Race/ethnicity		
Non-Hispanic White	2,020	61.5
Non-Hispanic Black	2,175	14.5
Mexican American	2,090	11.8
All other race	746	12.2
Age		
12–14-year old	3,522	50.0
15–17-year old	3,509	50.0
Family poverty–income ratio[b]		
Low-income family	2,594	27.8
Middle-income family	2,512	37.2
High-income family	1,497	35.0
Cigarette smoking[c]		
Never smoker	5,208	80.8
Past smoker	569	8.3
Current smoker	602	10.9
Physical inactivity[d]		
Physically active	5,794	88.3
Physically inactive	853	11.7
Interview year		
2001–2002	1,827	19.9
2003–2004	1,654	19.5
2005–2006	1,613	20.0

Characteristics	Sample size	Weighted percentage[a]
2007–2008	933	20.2
2009–2010	1,004	20.4

[a] These are weighted percentages (after applying NHANES MEC weights), not the corresponding percentages for each of the variable based on their sample sizes in the preceding column

[b] Sample size = 6,603 (excluding missing values)

[c] Sample size = 6,379 (excluding missing values)

[d] Sample size = 6,647 (excluding missing values)

Table 2

Adjusted percentages of the CDC'S health-related quality-of-life measures among adolescents, 12–17-year old, by body mass index category—National Health and Nutrition Examination Survey, 2001–2010

Body mass index category	*N*	Excellent/very good Percentages (95 % CI)	Good Percentages (95 % CI)	Fair/poor Percentages (95 % CI)
Self-rated health				
Underweight	199	56.3 (46.9–65.3)	34.1 (25.9–43.3)	9.7 (5.6–16.2)
Normal weight	3,633	65.2 (63.1–67.2)	29.7 (27.6–31.8)	5.2 (4.2–6.2)
Overweight	972	53.8 (50.1–57.5)	37.5 (33.8–41.3)	8.7 (6.8–11.1)
Obese	1,213	37.1 (33.2–41.2)	43.9 (40.0–47.7)	19.1 (15.9–22.7)
		0 days	1–13 days	14–30 days
Physically unhealthy days				
Underweight	199	53.9 (44.2–63.3)	42.6 (34.2–51.5)	3.5 (1.2–9.6)
Normal weight	3,630	59.6 (57.2–61.9)	36.1 (33.8–38.5)	4.3 (3.4–5.4)
Overweight	971	65.6 (60.9–70.0)	31.9 (27.9–36.2)	2.5 (1.5–4.3)
Obese	1,213	60.7 (57.1–64.1)	34.1 (30.5–37.9)	5.2 (3.7–7.4)
Mentally unhealthy days				
Underweight	199	48.7 (39.4–58.2)	40.2 (30.8–50.4)	11.0 (5.2–21.8)
Normal weight	3,628	58.0 (55.8–60.1)	35.8 (33.8–37.8)	6.2 (5.3– 7.4)
Overweight	971	57.2 (52.6–61.7)	34.5 (30.7–38.6)	8.2 (6.0–11.2)
Obese	1,213	55.4 (52.0–58.8)	37.5 (34.2–41.0)	7.0 (5.2–9.5)
Activity limitation days				
Underweight	198	76.7 (67.4–84.0)	19.7 (13.6–27.8)	3.6 (1.1–10.8)
Normal weight	3,630	79.2 (76.9–81.3)	18.8 (16.9–20.8)	2.0 (1.4–2.9)
Overweight	972	78.9 (74.8–82.5)	19.3 (15.9–23.2)	1.8 (1.0–3.2)
Obese	1,213	77.2 (73.6–80.4)	19.8 (16.7–23.3)	3.0 (1.9–4.8)

Model adjusted for demographic characteristics (sex, race/ethnicity, age, and family poverty–income ratio), risky behaviors (smoking status and physical inactivity), and interview years (NHANES survey cycles)

N sample sizes (excluding missing values), *95 % CI* 95 % Confidence intervals for adjusted percentages

Table 3

Adjusted percentages of the CDC's HEALTH-related quality-of-life measures among adolescents, 12–17-year old, by body mass index category for each sex—National Health and Nutrition Examination Survey, 2001–2010

Body mass index category	*N*	Boys			*N*	Girls		
		Excellent/very good Percentages (95 % CI)	Good Percentages (95 % CI)	Fair/poor Percentages (95 % CI)		Excellent/very good Percentages (95 % CI)	Good Percentages (95 % CI)	Fair/poor Percentages (95 % CI)
Self-rated health								
Underweight		114 53.1 (41.0–64.8)	36.8 (25.2–50.1)	10.1 (4.8–20.2)	85	61.8 (47.1–74.7)	29.3 (17.9–44.2)	8.8 (3.8–19.3)
Normal weight		1,856 68.8 (65.5–71.9)	26.5 (23.6–29.7)	4.6 (3.5–6.1)	1,777	61.5 (58.5–64.3)	32.9 (29.9–36.1)	5.6 (4.4–7.3)
Overweight		473 59.3 (53.8–64.5)	33.5 (28.1–39.3)	7.3 (4.4–11.8)	499	48.5 (42.8–54.2)	41.5 (36.1–47.1)	10.0 (7.5–13.2)
Obese		627 40.4 (34.7–46.3)	41.1 (36.2–46.1)	18.5 (14.5–23.4)	586	33.8 (28.1–39.9)	46.7 (41.5–52.0)	19.5 (15.1–24.9)
		0 days	1–13 days	14–30 days		0 days	1–13 days	14–30 days
Physically unhealthy days								
Underweight	114	49.3 (36.4–62.2)	48.1 (36.4–60.0)	2.7 (0.4–16.6)	85	60.6 (44.7–74.6)	34.8 (22.4–49.8)	4.6 (1.4–13.4)
Normal weight	1,854	61.8 (58.8–64.8)	35.0 (31.9–38.3)	3.2 (2.2–4.6)	1,776	57.4 (54.0–60.7)	37.3 (34.0–40.6)	5.4 (4.1–7.1)
Overweight	473	67.5 (61.0–73.4)	30.0 (24.5–36.2)	2.5 (1.2– 5.2)	498	63.6 (56.9–69.9)	33.8 (28.1–40.0)	2.6 (1.3–5.3)
Obese	627	61.9 (56.7–66.8)	30.8 (25.8–36.3)	7.3 (4.8–11.0)	586	59.4 (54.6–64.1)	37.8 (32.9–43.0)	2.7 (1.4–5.2)
Mentally unhealthy day								
Underweight	114	52.6 (39.4–65.5)	34.7 (22.7–49.1)	12.7 (5.2–27.9)	85	45.5 (32.6–58.9)	46.4 (33.9–59.5)	8.1 (3.0–20.2)
Normal weight	1,853	65.0 (62.0–68.0)	30.3 (27.6–33.1)	4.7 (3.4–6.4)	1,775	50.7 (47.7–53.8)	41.5 (38.3–44.7)	7.8 (6.3–9.6)
Overweight	473	62.0 (55.7–67.9)	32.3 (27.2–37.9)	5.7 (3.2–10.1)	498	52.3 (46.5–58.0)	37.0 (31.9–42.5)	10.7 (7.2–15.5)
Obese	627	62.3 (57.0–67.3)	31.8 (26.8–37.3)	5.9 (3.6–9.5)	586	48.4 (43.6–53.2)	43.5 (39.1–48.1)	8.1 (5.4–12.0)
Activity limitation days								
Underweight	114	70.1 (57.5–80.2)	25.0 (17.0–35.0)	5.0 (1.4–16.6)	84	86.9 (75.2–93.5)	11.8 (5.4–23.6)	1.4 (0.2–9.5)
Normal weight	1,854	81.5 (78.4–84.2)	16.9 (14.4–19.8)	1.6 (0.8– 3.1)	1,776	76.9 (74.0–79.6)	20.7 (18.2–23.5)	2.4 (1.6–3.6)
Overweight	473	79.7 (74.3–84.1)	18.8 (14.4–24.0)	1.6 (0.7– 3.4)	499	78.1 (72.4–82.8)	20.0 (15.6–25.2)	2.0 (0.8–4.6)
Obese	627	83.3 (78.9–86.9)	14.4 (11.2–18.4)	2.3 (1.0–5.2)	586	70.3 (65.1–75.1)	25.8 (21.2–31.2)	3.8 (2.4–6.1)

Model adjusted for demographic characteristics (race/ethnicity, age, and family poverty–income ratio), risky behaviors (smoking status and physical inactivity), and interview years (NHANES survey cycles)

N sample sizes (excluding missing values), *95 % CI* 95 % confidence intervals for adjusted percentages

Table 4

Results of multinomial logistic regression: odds ratios for the body mass index categories and all covariates among adolescents, 12–17 years old—National Health and Nutrition Examination Survey, 2001–2010

	Excellent/very good versus good		Fair/poor versus good	
	Odds ratio (95 % CI)	***P* values**	**Odds ratio (95 % CI)**	***P* values**
Self-rated health				
Body mass index (ref: normal weight)				
Underweight	0.7 (0.5–1.1)		1.6 (0.8–3.3)	
Overweight	0.6 (0.5–0.8)	< .0001	1.4 (0.9–2.0)	
Obese	0.4 (0.3–0.4)	< .0001	2.6 (2.0–3.5)	< .0001
Sex (ref: girls)				
Boys	1.4 (1.2–1.6)	< .0001	1.0 (0.8–1.3)	
Race (ref: all other race)				
Non-Hispanic White	1.1 (0.8–1.5)		1.1 (0.6–1.8)	
Non-Hispanic Black	0.8 (0.5–1.1)		1.4 (0.8–2.5)	
Mexican American	0.6 (0.4–0.8)	.0016	1.2 (0.7–2.1)	
Age (ref: 15–17 years old)				
12–14 years old	0.9 (0.8–1.1)		1.1 (0.8–1.4)	
Family poverty-income ratio (ref: high-income families)				
Low-income families	0.7 (0.6–0.8)	.0004	1.4 (1.0–2.0)	
Middle-income families	0.8 (0.7–10)	.0394	1.7 (1.2–2.4)	.003
Cigarette smoking (ref: current smokers)				
Never smokers	2.3 (1.8–3.0)	< .0001	0.8 (0.6–1.2)	
Past smokers	1.5 (1.1–2.1)	< .0168	1.0 (0.6–1.6)	
Physical inactivity (ref: physically inactive)				
Physically active	1.3 (1.0–1.6)		0.8 (0.5–1.1)	
Interview year (ref: 2009–2010)				
2001–2002	1.5 (1.1–2.0)	.0063	0.7 (0.4–1.1)	
2003–2004	1.5 (1.1–2.0)	.0037	0.6 (0.4–1.1)	
2005–2006	1.2 (0.9–1.5)		0.8 (0.5–1.3)	
2007–2008	1.1 (0.8–1.5)		0.9 (0.5–1.5)	
	1–13 versus 0 days		14–30 versus 0 days	
Physically unhealthy days				
Body mass index (ref: normal weight)				
Underweight	1.3 (0.9–1.9)		0.9 (0.3–2.9)	
Overweight	0.8 (0.6–1.0)	0.0381	0.5 (0.3–1.0)	.0459
Obese	0.9 (0.8–1.1)		1.2 (0.8–1.8)	
Sex (ref: girls)				
Boys	0.9 (0.8–1.0)		0.8 (0.5–1.2)	
Race (ref: all other race)				

	Excellent/very good versus good		Fair/poor versus good	
	Odds ratio (95 % CI)	***P* values**	**Odds ratio (95 % CI)**	***P* values**
Non-Hispanic White	0.7 (0.5–1.0)		1.4 (0.6–3.1)	
Non-Hispanic Black	0.6 (0.4–0.8)	.0017	0.8 (0.4–1.8)	
Mexican American	0.6 (0.4–0.8)	.0004	0.6 (0.3–1.4)	
Age (ref: 15–17 years old)				
12–14 years old	1.0 (0.9–1.2)		1.0 (0.6–1.6)	
Family poverty-income ratio (ref: high-income families)				
Low-income families	0.9 (0.7–1.1)		1.1 (0.7–1.8)	
Middle-income families	0.9 (0.7–1.1)		1.0 (0.7–1.6)	
Cigarette smoking (ref: current smokers)				
Never smokers	0.7 (0.6–1.0)	.0418	0.5 (0.3–0.8)	.0024
Past smokers	0.7 (0.5–1.0)	.0473	0.7 (0.4–1.4)	
Physical inactivity (ref: physically inactive)				
Physically active	1.4 (1.1–1.8)	.0029	1.0 (0.5–1.9)	
Interview year (ref: 2009–2010)				
2001–2002	0.9 (0.7–1.2)		1.2 (0.6–2.3)	
2003–2004	0.7 (0.5–0.9)	.0115	1.1 (0.5–2.4)	
2005–2006	0.7 (0.6–1.0)	.0289	0.9 (0.4–1.9)	
2007–2008	1.0 (0.7–1.3)		1.3 (0.6–2.7)	
Mentally unhealthy days				
Body mass index (ref: normal weight)				
Underweight	1.4 (0.9–2.1)		2.2 (0.9–5.4)	
Overweight	1.0 (0.8–1.2)		1.3 (0.9–2.1)	
Obese	1.1 (1.0–1.3)		1.2 (0.8–1.7)	
Sex (ref: girls)				
Boys	0.6 (0.5–0.7)	< .0001	0.5 (0.3–0.7)	< .0001
Race (ref: all other race)				
Non-Hispanic White	0.8 (0.5–1.1)		1.0 (0.5–1.8)	
Non-Hispanic Black	0.6 (0.4–0.9)	.0100	0.6 (0.3–1.1)	
Mexican American	0.6 (0.4–0.9)	.0041	0.5 (0.3–0.9)	.0168
Age (ref: 15–17 years old)				
12–14 years old	0.9 (0.7–1.0)		0.7 (0.5–1.0)	
Family poverty–income ratio (ref: high-income families)				
Low-income families	1.1 (0.9–1.4)		1.3 (0.9–1.9)	
Middle-income families	1.0 (0.9–1.2)		1.4 (0.9–2.1)	
Cigarette smoking (ref: current smokers)				
Never smokers	0.5 (0.4–0.6)	< .0001	0.3 (0.2–0.5)	< .0001
Past smokers	0.7 (0.5–1.0)	.0279	0.7 (0.4–1.2)	
Physical Inactivity (ref: physically inactive)				
Physically active	1.5 (1.1–1.9)	.0019	1.0 (0.7–1.5)	
Interview year (ref: 2009–2010)				
2001–2002	0.7 (0.5–0.9)	.0017	0.4 (0.3–0.6)	< .0001

	Excellent/very good versus good		Fair/poor versus good	
	Odds ratio (95 % CI)	***P* values**	**Odds ratio (95 % CI)**	***P* values**
2003–2004	0.6 (0.5–0.7)	< .0001	0.4 (0.2–0.7)	.0008
2005–2006	0.6 (0.5–0.8)	< .0001	0.4 (0.2–0.6)	< .0001
2007–2008	0.9 (0.7–1.1)		0.8 (0.5–1.2)	
Activity limitation days				
Body mass index (ref: normal weight)				
Underweight	1.1 (0.7–1.8)		1.8 (0.5–6.9)	
Overweight	1.0 (0.8–1.3)		0.9 (0.5–1.6)	
Obese	1.1 (0.8–1.4)		1.6 (0.8–3.0)	
Sex (ref: girls)				
Boys	0.8 (0.6–0.9)	.0035	0.7 (0.4–1.2)	
Race (ref: All other race)				
Non-Hispanic White	1.3 (0.9–2.0)		2.8 (1.0–8.0)	.0436
Non-Hispanic Black	1.3 (0.9–2.0)		3.0 (1.1–8.5)	.0368
Mexican-American	1.3 (0.8–1.9)		1.3 (0.5–3.9)	
Age (ref: 15–17 years old)				
12–14 years old	1.0 (0.8–1.1)		1.0 (0.6–1.7)	
Family poverty–income ratio (ref: high-income families)				
Low income families	0.9 (0.8–1.2)		1.0 (0.5–1.9)	
Middle income families	0.9 (0.8–1.2)		1.3 (0.7–2.5)	
Cigarette smoking (ref: current smokers)				
Never smokers	0.7 (0.5–0.9)	.0085	0.4 (0.2–0.7)	.0007
Past smokers	0.8 (0.5–1.3)		0.6 (0.3–1.6)	
Physical inactivity (ref: physically inactive)				
Physically active	1.3 (0.9–1.7)		2.0 (0.9–4.2)	
Interview year (ref: 2009–2010)				
2001–2002	0.8 (0.6–1.0)		0.6 (0.3–1.2)	
2003–2004	0.6 (0.4–0.8)	.0010	0.5 (0.2–1.1)	
2005–2006	0.6 (0.5–0.9)	.0038	0.7 (0.3–1.5)	
2007–2008	0.7 (0.5–1.0)	.0449	2.4 (1.1–5.3)	.0229

95 % CI 95 % confidence intervals for odds ratios, *ref* reference category