Trends in Abdominal Obesity Among US Children and Adolescents

WHAT'S KNOWN ON THIS SUBJECT: Previous studies have shown that prevalence of abdominal obesity among US children and adolescents increased significantly between 1988 to 1994 and 2003 to 2004. However, little is known about time trends in abdominal obesity since 2003 to 2004.

WHAT THIS STUDY ADDS: In 2011 to 2012, 18.87% of children and adolescents aged 2 to 18 years were abdominally obese, as defined by waist circumference. The prevalence of abdominal obesity leveled off among US children and adolescents between 2003 to 2004 and 2011 to 2012.

abstract

BACKGROUND AND OBJECTIVE: Previous studies have shown that the prevalence of abdominal obesity among US children and adolescents increased significantly between 1988 to 1994 and 2003 to 2004. However, little is known about time trends in abdominal obesity since 2003 to 2004. This study was designed to provide updated national estimates of childhood abdominal obesity and examine the trends in childhood abdominal obesity from 2003 to 2012.

METHODS: Data were from the National Health and Nutrition Examination Survey (NHANES), conducted during 5 time periods (2003–2004, 2005–2006, 2007–2008, 2009–2010, and 2011–2012). A total of 16 547 US children and adolescents aged 2 to 18 years were included. Abdominal obesity is defined as a waist circumference (WC) greater than or equal to the gender- and age-specific 90th percentile based on data from NHANES III (1988–1994) or a waist/height ratio (WHtR) $\geq$0.5

RESULTS: In 2011 to 2012, 18.87% of children and adolescents aged 2 to 18 years were abdominally obese as defined by WC; 33.29% of those aged 6 to 18 years were abdominally obese as defined by WHtR. Mean WC and WHtR and the prevalence of abdominal obesity remained stable between 2003 to 2004 and 2011 to 2012, independent of gender, age, and race or ethnicity. However, abdominal obesity decreased across survey years among non-Hispanic white children.

CONCLUSIONS: The prevalence of abdominal obesity leveled off among US children and adolescents between 2003 to 2004 and 2011 to 2012. *Pediatrics* 2014;134:e334–e339

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KEY WORDS

abdominal obesity, waist circumference, waist-to-height ratio, children

ABBREVIATIONS

CVD—cardiovascular disease
NHANES—National Health and Nutrition Examination Survey
WC—waist circumference
WHtR—waist to height ration

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Childhood obesity is a serious public health problem worldwide, including in the United States.[1] BMI is the most widely recognized surrogate of obesity, but it does not provide information about the distribution of body fat.[2] Anthropometric measures such as waist circumference (WC) and waist/height ratio (WHtR), used for defining abdominal obesity, are better than BMI for predicting risk of hypertension, type 2 diabetes, metabolic syndrome, cardiovascular disease (CVD), and all-cause mortality.[3,4] Importantly, the US National Institutes of Health recommends WC screening, especially in overweight or obese adults (BMI ≥25.0).[5]

To prevent and control an epidemic of obesity, it is necessary to monitor secular trends in obesity through population surveillance. Abdominal obesity among US children and adolescents increased dramatically between 1988 to 1994 and 1999 to 2004 according to the National Health and Nutrition Examination Survey (NHANES) III and the continuous NHANES 1999 to 2004.[6] However, it is unclear whether abdominal obesity has continued to increase since 2004.

Using the most recent national data from NHANES since 2004, we examined the secular trends of WC, WHtR, and abdominal obesity among children and adolescents aged 2 to 18 years in the United States.

METHODS

Design and Subjects

The NHANES population is a complex, multistage probability sample of the US civilian, noninstitutionalized adults and children; details are described elsewhere.[1] Since 1999 the NHANES has been conducted annually by the National Center for Health Statistics of the Centers for Disease Control and Prevention. A questionnaire was administered during a home interview, and physical measurements including weight, height, and WC were measured at the mobile examination center. Written informed consent was obtained from parents or children aged 2 to 18 years. The NHANES was approved by the National Center for Health Statistics Ethics Review Board.

Measurements and Definitions

Examiners obtained height, weight, and WC measurements by using standardized protocols and calibrated equipment.[1,6] Height was measured to the nearest 0.1 cm without shoes on a portable stadiometer.[1] WC was measured with a steel measuring tape to the nearest 0.1 cm at the high point of the iliac crest at minimal respiration when the participant was in a standing position.[6] Abdominal obesity is defined as WC greater than or equal to the gender- and age-specific 90th percentile based on data from NHANES III (1988–1994).[6] In addition, a WHtR ≥0.5 defined abdominal obesity for youth aged 6 to 18 years because this cutoff may overestimate the prevalence of abdominal obesity in children aged 2 to 5 years.[7]

Statistical Analysis

Children with WC or WHtR values less than or greater than mean ± 4 SD were excluded from all analyses, as were pregnant subjects. Analyses were conducted in SAS version 9.2 (SAS Institute, Inc, Cary, NC). All analyses were adjusted for the weights and complex survey design of the NHANES. The SAS SURVEYLOGISTIC procedure was used to test differences in distributions of gender, age, and race or ethnicity between 5 cycle surveys. Time trends in mean WC and WHtR and the prevalence of abdominal obesity between 2003 to 2004 and 2011 to 2012 were examined with the SAS SURVEYREG and SURVEYLOGISTIC procedures, respectively. Data were examined with respect to age, gender, and race or ethnicity, when applicable. A two-sided $P < .05$ was considered statistically significant.

RESULTS

Characteristics of the Study Population

Table 1 shows the characteristics of study population in 5 survey periods (2003–2004, 2005–2006, 2007–2008, 2009–2010, and 2011–2012). The distributions of gender, age, and racial and ethnic groups were homogeneous between the 5 periods (all *P*s > .05).

Trends in Mean WC and WHtR Among US Children and Adolescents

Mean WC and WHtR remained stable among US children and adolescents across surveys between 2003 to 2004 and 2011 to 2012 and by age, gender, and racial or ethnic group, except for children aged 6 to 11 years, whose WC and WHtR marginally decreased (Table 2).

TABLE 1 Characteristics of US Children and Adolescents Aged 2–18 y, NHANES 2003–2004 to 2011–2012

	2003–2004	2005–2006	2007–2008	2009–2010	2011–2012	*P*
All, *n*	3580	3840	2998	3093	3036	
Age group, %						
2–5 y	21.07	21.20	22.72	22.32	21.93	.94
6–11 y	35.53	35.55	34.59	34.71	35.93	
12–18 y	43.40	43.25	42.69	42.96	42.14	
Gender, %						
Boys	51.25	51.52	51.39	50.85	50.44	.97
Girls	48.75	48.48	48.61	49.15	49.56	
Race or ethnicity, %						
Non-Hispanic white	60.86	60.05	58.50	55.95	53.70	.54
Non-Hispanic black	15.01	14.56	14.79	13.46	14.86	
Mexican American	12.53	13.27	13.57	15.27	15.11	
Other race	11.60	12.12	13.14	15.32	16.33	

TABLE 2 Trends in WC and WHtR Among US Children and Adolescents Aged 2–18 y, NHANES 2003–2004 to 2011–2012

	2003–2004		2005–2006		2007–2008		2009–2010		2011–2012		Absolute Increase	*P* for Trend
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE		
WC, cm												
All	69.14	0.54	68.55	0.59	68.52	0.67	68.60	0.31	68.97	0.40	−0.16	.53
Age group												
2–5 y	51.92	0.24	51.58	0.21	51.40	0.25	51.59	0.29	51.49	0.20	−0.43	.69
6–11 y	65.48	0.49	64.03	0.59	65.14	0.50	64.30	0.26	64.93	0.56	−0.54	.06
12–18 y	80.49	0.77	80.58	0.55	80.38	0.74	80.90	0.46	81.51	0.69	1.03	.45
Gender												
Male	69.29	0.65	68.60	0.73	68.74	0.76	68.57	0.55	68.37	0.54	−0.92	.75
Female	68.97	0.56	68.49	0.59	68.29	0.84	68.62	0.30	69.58	0.61	0.61	.59
Race or ethnicity												
Non-Hispanic white	70.15	0.74	68.98	0.93	69.20	0.84	68.66	0.56	69.52	0.83	−0.63	.52
Non-Hispanic black	67.81	0.56	67.94	0.74	67.63	0.61	69.61	0.71	67.70	1.05	−0.11	.39
Mexican American	69.07	0.82	69.49	0.79	68.57	0.80	69.38	0.67	70.06	0.62	0.99	.48
WHtR												
All	0.490	0.003	0.487	0.002	0.489	0.002	0.488	0.001	0.492	0.002	0.002	.52
Age group												
2–5 y	0.505	0.002	0.506	0.002	0.504	0.002	0.505	0.002	0.504	0.002	−0.001	.76
6–11 y	0.484	0.003	0.477	0.003	0.482	0.002	0.476	0.002	0.481	0.004	−0.003	.04
12–18 y	0.487	0.005	0.487	0.003	0.486	0.004	0.488	0.002	0.495	0.004	0.008	.54
Gender												
Male	0.485	0.003	0.481	0.002	0.484	0.003	0.483	0.002	0.484	0.003	−0.001	.86
Female	0.496	0.004	0.494	0.003	0.494	0.003	0.493	0.002	0.500	0.004	0.004	.51
Race or ethnicity												
Non-Hispanic white	0.491	0.004	0.485	0.003	0.488	0.004	0.483	0.002	0.490	0.004	−0.001	.36
Non-Hispanic black	0.479	0.003	0.479	0.004	0.479	0.002	0.487	0.003	0.482	0.005	0.003	.40
Mexican American	0.503	0.003	0.511	0.004	0.509	0.005	0.508	0.002	0.509	0.003	0.006	.59

Time trends in mean WC and WHtR from 2003–2004 to 2011–2012 were examined with a multiple linear regression model, with adjustment for age, gender, and race or ethnicity, when applicable.

Trends in Prevalence of Abdominal Obesity Among US Children and Adolescents

In 2011 to 2012, 18.87% of children and adolescents aged 2 to 18 years were abdominally obese (as defined by WC); 33.29% of those aged 6 to 18 years were abdominally obese (defined by WHtR). Compared with 2003 to 2004, the prevalence of abdominal obesity in 2011 to 2012, as defined by WC and WHtR, did not change in the total population or by age, gender, and racial or ethnic group, except for non-Hispanic white children (Table 3).

Influence of Demographic Factors on Abdominal Obesity Among US Children and Adolescents

As shown in Table 4, compared with children aged 2 to 5 years, those aged 12 to 18 years (odds ratio [OR] = 1.31; 95% confidence interval [CI], 1.16–1.47) were more likely to be abdominally obese as defined by WC. In addition, girls (boys as referent: OR = 1.11; 95% CI, 1.01–1.23) and Mexican American (non-Hispanic white as referent: OR = 1.49; 95% CI, 1.32–1.70) were more likely to be abdominally obese. Similar results were found when abdominal obesity was defined as WHtR ≥0.5 (Table 4).

DISCUSSION

In the current study, trends in mean WC and WHtR and the prevalence of abdominal obesity remained stable among US children and adolescents between 2003 to 2004 and 2011 to 2012, which is consistent with the trends reported for general obesity (defined by BMI) between 2003 to 2004 and 2011 to 2012 in this young population.[1] Our findings have important public health implications because abdominal obesity is a better indicator of many chronic diseases (eg, hypertension, diabetes, CVD) and death than general obesity. Although the prevalence of abdominal obesity has leveled off in recent years among US children and adolescents, it is still high, being 18.87% (defined by WC) in participants aged 2 to 18 years and 33.29% (defined by WHtR) in those aged 6 to 18 years, suggesting an urgent need for lifestyle modifications to lower abdominal obesity.

The stable trends in mean WC and WHtR and prevalence of abdominal obesity were consistent in each age, gender, and racial or ethnic group, except for children aged 6 to 11 years, where a decreasing trend in WHtR was observed. Notably, girls, adolescents, and Mexican American youth were more abdominally obese than boys, children, and non-Hispanic whites, respectively. The youth in these specific subgroups should be targeted as a high priority for intervention efforts to reduce abdominal obesity.

Data on recent trends in abdominal obesity are few in children and adolescents. A previous NHANES study showed that WC and the prevalence of abdominal

TABLE 3 Trends in the Prevalence of Abdominal Obesity Among US Children and Adolescents Aged 2–18 y, NHANES 2003–2004 to 2011–2012

	2003–2004		2005–2006		2007–2008		2009–2010		2011–2012		Absolute Increase	*P* for Trend
	%	SE	%	SE	%	SE	%	SE	%	SE		
WC ≥90th percentile												
All	17.75	1.22	17.54	1.22	18.53	1.06	17.26	0.75	18.87	1.26	1.13	.83
Age group												
2–5 y	16.98	1.92	18.24	1.75	15.34	1.93	14.95	1.46	14.25	1.24	−2.72	.31
6–11 y	17.38	1.47	14.84	1.96	19.10	1.17	18.09	0.96	17.51	1.99	0.13	.62
12–18 y	18.43	1.75	19.41	1.46	19.75	1.29	17.80	1.38	22.44	1.89	4.01	.37
Gender												
Male	17.73	1.42	16.65	1.37	18.26	1.15	17.00	0.73	16.57	1.45	−1.16	.88
Female	17.77	1.59	18.48	1.65	18.81	1.43	17.53	1.09	21.22	1.78	3.45	.48
Race or ethnicity												
Non-Hispanic white	18.22	1.82	16.40	1.78	18.26	1.27	14.99	1.39	18.44	2.15	0.22	.47
Non-Hispanic black	16.31	1.31	17.40	1.92	16.67	1.50	20.68	2.21	17.10	1.35	0.79	.61
Mexican American	20.96	1.15	25.45	1.77	23.92	2.36	22.64	1.42	24.17	1.09	3.21	.25
WHtR ≥0.5												
All	34.14	2.26	31.14	1.60	33.11	1.41	30.50	0.83	33.29	1.35	−0.85	.25
Age group												
6–11 y	33.01	2.10	27.16	2.41	30.78	1.16	28.53	1.13	29.56	2.20	−3.45	.23
12–18 y	35.06	3.06	34.40	1.47	34.99	2.05	32.08	1.27	36.47	1.56	1.40	.32
Gender												
Male	31.59	2.62	27.88	1.17	31.65	1.92	28.10	1.87	29.32	1.32	−2.27	.42
Female	36.86	2.53	34.60	2.31	34.65	1.93	32.96	1.39	37.30	2.30	0.44	.42
Race or ethnicity												
Non-Hispanic white	35.20	3.35	29.30	2.20	32.60	2.17	25.02	1.83	30.58	2.44	−4.63	.04
Non-Hispanic black	28.02	1.69	28.16	2.03	28.65	1.36	33.06	2.21	29.06	2.75	1.04	.55
Mexican American	41.54	2.46	46.21	2.37	45.15	3.14	44.09	1.59	47.45	1.81	5.91	.27

Time trends in prevalence of abdominal obesity from 2003–2004 to 2011–2012 were examined with a multiple logistical regression model, with adjustment for age, gender, and race or ethnicity, when applicable.

obesity in US children aged 6 to 11 years significantly increased between 1988 to 1994 and 1999 to 2002.[8] The increasing trends were extended when NHANES 2003 to 2004 data were also examined.[6] The Australia national surveys conducted in 1985, 1995, and 2007 showed that abdominal obesity in children increased at a faster rate than obesity defined by BMI during the past 2 decades.[9] Liang et al[10] found significantly more obesity and abdominal obesity in Chinese school-aged children enrolled in the China Health and Nutrition Survey from 1993 to 2009. Notably, data from the Korean Nutrition Health and Nutrition Examination Survey indicated that abdominal obesity leveled off in boys but decreased in girls aged 10 to 19 years between 2001 and 2005.[11]

It is well accepted that consumption of high-calorie foods and sweetened beverages, lack of physical activity, and more time spent in sedentary behaviors (TV or video viewing, computer use) are main risk factors of obesity. Notably, between 2001 and 2010, TV viewing time and consumption of sweets and sweetened beverages decreased, while days with ≥1 hour of physical activity, intake of fruits and vegetables, and frequency of eating breakfast significantly increased among US adolescents aged 11 to 16 years.[12] These findings may in part explain why the prevalence of abdominal obesity did not increase but remained stable between 2003 to 2004 and 2011 to 2012.

The prevalence of abdominal obesity (WC ≥90th percentile for age and gender in NHANES III) was 18.87% among US children and adolescents aged 2 to 18 years in 2011 to 2012, which was similar to the prevalence of general obesity (BMI ≥95th percentile for age and gender according to the Centers for Disease Control and Prevention growth charts) in the same period (17%).[1] To date, there is no general consensus defining abdominal obesity at the national level. Therefore, we were unable to compare our results with those in other countries. In addition, the prevalence of abdominal obesity (WHtR ≥0.5) was 33.29% among adolescents aged 6 to 18 years in 2011 to 2012, which was comparable to the prevalence of overweight in the same period (34%).[1] WHtR is a simple measure of abdominal obesity, independent of age and gender. Based on results for the association between WHtR and cardiometabolic risk in adults, a cutoff for WHtR of 0.5 is recommended.[13] Indeed, WHtR has been reported as a better indicator of risk for CVD than BMI or WC.[3,4] Moreover, the message of "keep your waist to less than half your height" is attractive for public health policy.

The current study has 3 strengths. First, we used national data that are

TABLE 4 Demographic Factors Influencing Abdominal Obesity Among US Children and Adolescents Aged 2–18 y From 2003–2004 to 2011–2012

	OR	95% CI	*P*
WC ≥90th percentile			
Survey period			
2003–2004	1.0		
2005–2006	0.99	0.78–1.25	.93
2007–2008	1.05	0.84–1.31	.66
2009–2010	0.96	0.79–1.18	.70
2011–2012	1.07	0.84–1.36	.59
Age group			
2–5 y	1.0		
6–11 y	1.12	0.98–1.29	.11
12–18 y	1.31	1.16–1.47	<.0001
Gender			
Male	1.0		
Female	1.11	1.01–1.23	.04
Race or ethnicity			
Non-Hispanic white	1.0		
Non-Hispanic black	1.03	0.88–1.19	.75
Mexican American	1.49	1.32–1.70	<.0001
WHtR ≥0.5			
Survey period			
2003–2004	1.0		
2005–2006	0.88	0.68–1.14	.33
2007–2008	0.94	0.73–1.22	.64
2009–2010	0.83	0.66–1.04	.11
2011–2012	0.94	0.73–1.20	.60
Age group			
6–11 y	1.0		
12–18 y	1.27	1.15–1.39	<.0001
Gender			
Male	1.0		
Female	1.30	1.18–1.43	<.0001
Race or ethnicity			
Non-Hispanic white	1.0		
Non-Hispanic black	0.94	0.82–1.08	.39
Mexican American	1.90	1.65–2.18	<.0001

representative of US children and adolescents. Second, the data collectors were trained in standard procedures, and quality control measures guaranteed the reliability of study results. Third, although the trends for abdominal obesity in NHANES 1999 to 2004 were previously reported, we reported the trends for 4 additional survey cycles (2005–2006, 2007–2008, 2009–2010, and 2011–2012). However, 2 limitations should be noted. First, WC ≥90th percentile for age and gender in NHANES III was used to define abdominal obesity, which limited our ability to compare our results with those of other studies. Second, we did not analyze factors such as dietary and lifestyle habits that may affect trends in abdominal obesity, and additional studies are warranted to examine trends in environmental factors and determine whether they influence abdominal obesity.

CONCLUSIONS

The prevalence of abdominal obesity leveled off among US children and adolescents between 2003 to 2004 and 2011 to 2012, independent of age, gender, and race or ethnicity. However, the prevalence of abdominal obesity is still high; therefore, appropriate dietary intake and physical activity should be emphasized to combat the obesity epidemic.

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