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Healthy for Now? A Cross-Sectional Study of the Comorbidities in Obese Preschool Children in the United States

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Abstract

Objective—Examine health of preschoolers by BMI status.

Methods—A cross-sectional analysis of children 3 to 5 years old in the 1999–2008 National Health and Nutrition Examination Survey was carried out. The measured age- and sex-specific BMI percentiles were used to categorize children as very obese, obese, overweight, or healthy weight. The authors used logistic regression to examine the effect of weight status on 17 available measures of current child health potentially related to obesity.

Results—Except for very obese children, weight status had minimal effect on most measures of health for preschool-aged children (n = 2792). Parents of very obese children reported poorer general health and more activity limitations for their children. Additionally, very obese girls had more frequent/severe headaches, and overweight/obese boys had more asthma diagnoses.

Conclusions—Only severe obesity appears consistently related to immediate health problems in preschool-aged children. Parental perception that very obese children have worse health and more activity limitations may lead to decreases in physical activity, which would perpetuate obesity.

Keywords

cross-sectional design; comorbidities; obesity; overweight; BMI; preschool children

Introduction

Obesity in school-aged children and adolescents is associated with a variety of negative health outcomes, including worsened asthma, headaches, iron deficiency, and increased health care use.[1–6] However, the relationships between weight status and health has not been consistently established in preschool-aged children (3–5 years old).[7]

It is recommended that clinicians counsel families of overweight and obese preschool children to develop healthy habits and prevent future obesity and subsequent negative health outcomes.[8] Unfortunately, evidence demonstrating the long-term effectiveness of lifestyle change counseling to families with overweight children in this age group is limited.[9] However, if being overweight or obese among preschool-aged children were associated with immediate health problems, then counseling parents of children in this age group might reasonably focus on the opportunity to improve immediate health, instead of solely relying on a message preventing future health problems.

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There are a variety of reasons why overweight and obesity in preschool children might confer different or fewer medical complications than it does for older children, adolescents, and adults. First of all, infancy and early childhood is the time of the most rapid growth throughout the lifecycle, including a changing body habitus and changes in relative adiposity.[10] For example, the average BMI (in kg/m^2) decreases dramatically from age 2 to ages 4 through 7, when normal BMIs reach their nadir. Preschool-aged children (even those who are overweight or obese) have lower BMIs than younger toddlers and older children at the same BMI percentiles.[11] Based on these changes, the physiological impact of overweight and obesity for young children may be different from that in other age groups. Second, the effects of overweight or obesity may require prolonged exposure before complications are apparent. Young children with obesity, then, may be temporarily spared associated negative health effects.

Previous research on the relationship between obesity and health in young children has yielded mixed results.[7,12–14] In fact, one recent study suggested that being overweight (but not obese) may be associated with decreased hospitalization and outpatient visits in this age group.[13] What is important is that much of the research available in US populations is clinic-based and does not provide a nationally representative picture of the comorbidities of obese preschoolers.

Wake and colleagues provide an important picture of the comorbidities among young children in Australia[7] where there were few differences by weight in parental report of specific health problems and general health concern. Understanding whether these findings hold true in the diverse US population is essential to the development of appropriate obesity prevention and treatment strategies. Therefore, our objective is to formally evaluate the association of BMI status and health comorbidities among preschool-aged children. We hypothesized that only very obese preschool children would demonstrate immediate health problems related to their weight.

Methods

Data and Sample

We used the National Health and Nutrition Examination Survey (NHANES), years 1999–2008. NHANES is a stratified, multistage probability sample of the United States civilian, noninstitutionalized population. The survey comprises an in-home interview querying a wide variety of health and related topics, a physical examination, and laboratory testing. For young children, interviews are completed by a proxy, most frequently the mother.[15] For simplicity, we refer to these proxies as *parents*. The physical examination is conducted in a mobile examination center by a physician and includes body measurements and a dietary interview.

We include all children 3 to 5 years of age in the NHANES study sample with data on height and weight. Approximately 4% of the sample was missing such data.

Demographics

Race/ethnicity was categorized based on self-report as non-Hispanic white, non-Hispanic black, Hispanic, or “other” race. Income was categorized into 6 groups, all based on the poverty-to-income ratio. These categories range from below poverty to income greater than 5 times the poverty level. Health insurance status was categorized as ever uninsured in the previous 12 months, ever insured by Medicaid or other public insurance program, and ever insured with a private plan but never insured by a public program.

BMI Status

BMI was calculated from height and weight measured during the examination and was transformed to age- and sex-specific percentiles. Children were categorized as very obese (≥99th percentile), obese (<99th percentile and ≥95th percentile), overweight (<95th percentile and 85th percentile), and healthy weight (between 85th percentile and >5th percentile) according to expert consensus recommendations.[8] We used the categorization of 99th percentile to lend more specificity to the obese category and distinguish the children at the extreme of this category from those merely bordering it. Children below the 5th percentile for BMI were excluded from the analyses (n = 108) because underweight children may have problems uniquely associated with failure to thrive, and our goal was to examine the relative associations between excess body fat and health.

Health Measures

Our goal was to examine the associations among BMI status and the widest variety of measures of actual current health possible, including both parent-reported health concerns, proxies for overall health (such as health care use), and diagnoses or conditions based on the physical examination or laboratory values. Prior to analysis, 2 of the authors (MS and AS) reviewed the survey questions to parents and all the available direct health measures and selected those potentially associated with obesity or associated with obesity in prior literature. Some measures known to be associated with obesity such as sleep apnea and musculoskeletal injuries were not available in this data set. We included only reports or measures of *current* health, but we did not include those that are important mainly as risk factors for future health outcomes, such as lipid values. Our review yielded 17 health reports or measures (5 general health measures and 12 specific health conditions), which we organized into 2 categories: either overall health or specific health conditions for subsequent analysis. Because NHANES is continuously changing and portions of the most recent surveys have a staggered release, some of the outcomes are not available for the full sample.

Overall Health

Several variables describe children's overall health status. Parents rated general health status using a 5-point scale from *excellent* to *poor*. Parents also reported whether the child's health is better, worse, or about the same as it was 1 year ago. Two parent-reported items measured health care use. Health care visits were measured as the children's receipt of any health care visits in the previous 12 months; hospitalization was categorized as any hospitalization or not in the previous 12 months. Physical functioning was based on the parent's assessment of whether the child was limited in his or her play because of any physical, mental, or emotional illness, and whether the child had any walk, run, or play limitations.

Specific Health Conditions

Acute conditions—Measures included whether or not the parent reported the child as having had, in the past 30 days, a "head cold," a "stomach illness," or "an ear infection or flu." We also included indicators reporting whether or not the child had 3 or more ear infections and whether he or she had had frequent headaches in the past year.

Anemia—We used 2 indicators of anemia: whether or not the child was currently taking medication for anemia and laboratory values of hemoglobin <11 g/dL.[16]

Asthma—Parents reported whether a doctor had ever told them that their child had asthma, and for those with asthma, other indicators of severity were also collected and analyzed.

Allergies—Parents reported children's hay fever symptoms in the past year. A second measure of allergies is parental report of whether a doctor had ever told them that their child has allergies.

Respiratory—Parents reported whether their children had a dry cough at night and whether they had any wheezing in the past year.

Analysis

We used Pearson χ^2 tests adjusted with the second-order Rao-Scott correction to compare differences in the distribution of weight status among sociodemographic variables. We then used multivariate logistic regression models to estimate the effects of weight status on the health measures. Because of some significant differences in the prevalence of health conditions by sex, we also performed the multivariate model analysis by sex. Consistent with current recommendations, we did not adjust for multiple comparisons because we examined individual, predefined relationships.[17] All analyses were adjusted to account for the complex survey design of NHANES, making them representative of the pre-school-aged US population, and were performed using Stata 10.0 (College Station, TX).

Results

A total of 2792 participants were identified in the included NHANES years. Most (76%) of these young children were of healthy weight, but 11% were overweight, 8% were obese, and 5% were severely obese. Table 1 summarizes the demographic characteristics of the children based on BMI status. There were no significant differences in the prevalence of obesity by sex or poverty. There was a trend toward greater obesity among African American and Hispanic children, though this difference persisted only for boys when examining by sex (data not shown).

Overall Health

In general, there were no differences by sex for various measures of parent-reported overall health (Table 2), though parents were more likely to rate boys than girls of all weight statuses as having good, fair, or poor health (12.7% vs 9.3%; $P = .001$), compared with excellent or very good. In multivariate models, very obese children were more likely to have parents report good, fair, or poor health (adjusted odds ratio [aOR] = 1.68; $P = .05$), though these differences were not statistically significant in sex-stratified analyses. Parents of both very obese boys and girls and obese boys were more likely to report physical limitations (Table 3), whereas parents of very obese boys were more likely to report a health care visit in the previous year.

Specific Health Conditions

Most parent-reported specific health conditions were not different based on sex (Table 2), with allergic and respiratory conditions as notable exceptions, for which boys consistently had greater reported prevalence. In multivariate models for these conditions, sex differences were also apparent in the effect of weight status on specific health conditions (Table 4). Most of the associations seen in the full population (data not shown) were found to be sex dependent. All boys who were not of healthy weight had greater odds of parent-reported asthma diagnoses, and very obese boys had greater odds of parent reports of wheezing. On the other hand, the increased reporting of the nighttime symptom of dry cough among obese children appears isolated to very obese girls (aOR = 9.67; $P = .003$). Parents of very obese (aOR = 14.18; $P = .006$) and overweight (aOR = 2.99; $P = .045$) girls reported significantly more "frequent or severe headaches in the past year" than did parents of girls of healthy

weight. No associations were seen in any child or either sex individually for other concerns in the allergic triad, such as atopic dermatitis or allergies.

Discussion

Using a nationally representative sample of US children, we demonstrated that parents of overweight (BMI ≥85th percentile to <95th percentile) or obese (BMI ≥95th percentile to <99th percentile) children aged 3 to 5 years did not report worsened overall health. However, when children were very obese (BMI ≥ 99th percentile), parents were more likely to rate their children's overall health less highly and were more likely to report activity limitations. This difference in parental perception may be capturing qualitative health differences that are not easily measured with a single survey question. Additionally, very obese boys are more likely to have had a health care visit in the last year, which may indicate a general sense of poorer health or may reflect the greater prevalence of certain specific health conditions in these children.

We also examined the relationship of BMI status to specific individual health conditions reported by parents or measured directly in NHANES. Among 12 specific health conditions reported by parents, 5 were associated with increased weight in either girls or boys. Asthma in boys was the only condition associated with the overweight and obese categories (in addition to very obese). Very obese boys also had greater wheezing in the past year, with a nonsignificant trend for obese and overweight boys. Two additional health conditions were significantly greater in girls: parents of very obese and overweight girls reported increased headache frequency and nighttime coughing.

Asthma in Overweight Boys

The sex-based differences in asthma diagnosis or symptoms and wheezing in infancy and preschool years is consistent with data from other studies.[18–21] The proposed explanations for this finding are numerous—from behavioral differences of parents (such as better allergen reduction and longer breastfeeding in girls[21]), to altered immune regulation,[19] to sex-specific genetic modulation or differential expression of genetic and environmental interactions,[18] to physiological differences in lung size and function.[20] Also notable is that the male pulmonary symptoms were the only health concerns that significantly increased even for children at the threshold of overweight status, unlike other problems that did not worsen until children were obese or very obese. The increase in systemic inflammation in overweight and obese children has been previously documented, and this, in addition to physical chest wall weight and changes in respiratory dynamics during the day and night, may explain the effect BMI status has on the underlying sex differences.[22–24]

Headaches and Nighttime Cough in Very Obese Girls

Preschool girls with severe obesity had higher reports of both nighttime cough and frequent or severe headaches. In the setting of increased headache frequency and severity, it is interesting that very obese girls had nighttime cough but no other associated asthma symptoms. It is possible that the increased headaches and/or nighttime cough actually represent symptoms of sleep apnea, which was not measured in NHANES, thereby linking the cough and the headache associations.[25–27]

An interesting question stimulated by this research, and augmented by other recent studies, is whether there is immediate clinical significance to the 85th percentile BMI cutoff in growth charts for young children. This cutoff does not represent the distribution of the current population because the growth charts are based on historical averages from 1963 through 1994,[11] and current data show that 24% of all children aged 2 to 5 are now above

the 85th percentile of BMI for age.[28] Additionally, unlike adult BMI cutoffs, this level has not been validated based on long-term health outcomes for younger children, and recent studies linking childhood BMI to adult cardiovascular disease outcomes only included older children.[29] Our study suggests that there is no relationship between the immediate health of children and the 85th percentile BMI cutoff except for increased respiratory events in young male children.

The difficulty with definitions of obesity in this age group contributed to the US Preventive Services Task Force determination of "insufficient evidence" to recommend for or against screening for overweight in children under the age of 6 as a means to prevent adverse health outcomes.[30] However, in that same statement, the Task Force endorses BMI as the preferred measure to detect overweight, in part because at older ages of childhood, it tracks relatively well to future adiposity, particularly when accompanied by other risk factors.[30,31] Therefore, although BMI may have a role in estimating adiposity and identifying children at risk for future obesity, the importance of specific cutoffs of BMI in young children to indicate poor health has not been justified.

Limitations

There are limitations in our study. First, many of the direct health conditions in NHANES are based on parental report because the database is not directly linked to diagnoses by their regular physician, and the measured laboratory values more often represent risk for future health problems (eg, lipids). Parents are known, however, to be able to reliably report overall health and illness[32] and to accurately report symptoms, such as asthma symptoms.[33] Additionally, overall health is based on parent report. However, although limited, the single-item parent-reported health status question is considered appropriate for population surveys.[34] Second, as an exploratory study, we included all identified current health measures included in NHANES without necessarily having specific a priori hypotheses about the relationship between each health measure and BMI status for each condition. We were also limited to the availability of health measures in NHANES. NHANES does not include sleep apnea, which has been highly associated with obesity at older ages.[2] Thus, it is possible that there are additional health measures that would more strongly relate to obesity. Finally, in this cross-sectional analysis, we only tested associations, but we were not able to assess the cause or direction of relationships.

Despite these limitations, our study has multiple strengths, including a broad evaluation of the possible relationship between health and BMI status using a large, nationally representative sample of young US children. Additionally, we used the BMI category of "99th percentile," which allowed a more clear stratification of obesity than does the more commonly used "≥95th percentile." Our study findings reinforce the decision to stratify obesity beyond the 95th percentile BMI cutoff. The association between obesity and worse overall health measures and impaired activity was more definitive for children with BMI ≥ 99th percentile than for children with BMI from the 85th to the 99th percentiles.

In conclusion, our study demonstrates that only severe obesity in young children is associated with parental report of worse overall health status and limitations on activity. These activity limitations are particularly concerning because decreased physical activity may perpetuate a cycle of worsening weight trajectories. This observation should serve as a reminder to clinicians to encourage parents to help their obese children remain as active as possible. Young children with BMIs between the 85th and 99th percentiles did not demonstrate worse health by parental report or specific measures. So although it may help predict future BMI status and may be related to health measures we were unable to assess, the 85th percentile cutoff on current CDC growth charts does not relate to parent's

perception of their child's health and generally does not identify children who are more likely to suffer immediate health complications.

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Table 1

Percentage of Children in Each BMI Category by Demographic Characteristics

	Total Distribution	Very Obese	Obese	Overweight	Healthy Weight	P^a
Sex						
Male	50.63	5.37	7.42	12.06	75.15	.350
Female	49.37	3.94	8.22	10.84	76.99	
Age (years)						
3	33.21	2.44	7.34	11.71	78.51	.025
4	34.91	5.08	7.12	10.57	77.23	
5	31.88	6.45	9.05	12.16	72.34	
Race/Ethnicity						
White	56.36	3.44	7.22	10.49	78.85	.006
Black	14.52	5.34	7.35	12.98	74.33	
Hispanic	21.83	7.84	9.79	13.68	68.69	
Other race	7.30	3.29	7.52	9.17	80.03	
Poverty						
<100% of poverty level	24.10	5.63	8.76	11.50	74.12	.278
100%–200%	24.22	5.86	9.34	13.06	71.73	
200%–300%	15.65	4.33	7.88	11.50	76.30	
300%–400%	9.79	3.71	6.31	6.91	83.07	
400%–500%	7.47	2.04	4.45	13.25	80.26	
>500%	12.58	2.60	7.60	8.26	81.53	
Missing income data	6.19	5.81	4.68	16.54	72.97	
Insurance						
Ever uninsured	50.77	3.17	7.27	10.28	79.28	.007
Private insurance	32.03	6.91	8.18	12.72	72.19	
Public insurance	17.20	4.95	8.71	12.49	73.85	

[a] P values are from Pearson χ^2 tests adjusted with the second-order Rao-Scott correction.

Table 2

Percentage of Children with Selected Health Problems Among All Children, by Sex[a]

	n	Girls	Boys	*P*
Good, fair, or poor health	2796	9.32**	12.69	.001
Health worse than 1 year ago	2795	2.5	2.8	.717
Any crawl/walk/run/play limitation	2797	1.3	1.6	.430
Any health care visits in past year	2795	92.5	92.9	.770
Hospitalized in past year	2796	4.6	5.2	.515
Head cold last in 30 days	2658	35.9	35.3	.577
Stomach illness in past 30 days	2661	11.4	13.6	.225
Flu/Ear infection in past 30 days	2658	9.7	9.4	.826
3+ Ear infections in past year	1590	8.1	11.6	.071
Frequent/severe headaches in past year	1006	5.2	3.8	.381
Anemia	2797	2.7	2.6	.877
Hay fever in past year	2217	6.8	7.7	.580
Doctor said that they have allergies	634	14.3*	23.4	.050
Ever told that they have asthma	2794	10.5**	15.2	.006
Eczema	635	17.6	19.5	.695
Wheezing in past year	2226	12.5*	17.4	.014
Dry cough at night	2226	3.0	4.0	.305

[a]*$P < .05$,

**$P < .01$;

Pearson χ^2 tests adjusted with the second-order Rao-Scott correction.

Table 3

Logistic Regressions of the Effects of Weight Status on Parent-Reported Overall Health Conditions, for Boys and Girls[a]

	Girls			Boys		
ORs	**aOR**	**CI**	***P***	**aOR**	**CI**	***P***
Good, fair, or poor health						
Above 99th percentile	1.79	[0.76–4.22]	.184	1.59	[0.89–2.84]	.117
Obese	0.50**	[0.31–0.82]	.006	1.22	[0.63–2.34]	.551
Overweight	0.91	[0.53–1.55]	.723	1.13	[0.70–1.82]	.608
Health worse than 1 year ago						
Above 99th percentile	2.58	[0.39–16.97]	.322	1.42	[0.29–7.00]	.665
Obese	0.85	[0.20–3.57]	.829	0.50	[0.11–2.35]	.381
Overweight	0.55	[0.14–2.12]	.385	0.65	[0.15–2.82]	.559
Any crawl/walk/run/play limitation						
Above 99th percentile	8.50**	[2.20–32.85]	.002	5.80*	[1.25–26.98]	.025
Obese	1.39	[0.37–5.17]	.622	5.63*	[1.20–26.38]	.028
Overweight	0.88	[0.21–3.73]	.866	1.65	[0.37–7.43]	.512
Any health care visits in past year						
Above 99th percentile	1.44	[0.29–7.16]	.652	2.98*	[1.22–7.24]	.017
Obese	1.09	[0.40–2.96]	.867	2.22	[0.69–7.16]	.180
Overweight	0.87	[0.44–1.73]	.686	1.01	[0.46–2.23]	.981
Hospitalized in past year						
Above 99th percentile	1.42	[0.38–5.28]	.600	0.79	[0.28–2.26]	.658
Obese	0.61	[0.23–1.56]	.297	0.82	[0.19–3.50]	.791
Overweight	1.04	[0.40–2.74]	.929	0.74	[0.29–1.91]	.532

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval.

[a] *$P < .05$,

**$P < .01$;

adjusted for age, race/ethnicity, income, and insurance status.

Table 4

Logistic Regressions of the Effects of Weight Status on Parent-Reported Specific Health Conditions[a]

	Girls			Boys		
	aOR	**CI**	***P***	**aOR**	**CI**	***P***
Head cold in past 30 days						
Above 99th percentile	1.15	[0.49–2.72]	.741	0.78	[0.48–1.27]	.309
Obese	0.80	[0.46–1.39]	.429	1.23	[0.69–2.20]	.484
Overweight	0.82	[0.51–1.32]	.405	1.20	[0.77–1.85]	.419
Stomach illness in past 30 days						
Above 99th percentile	1.44	[0.43–4.84]	.554	0.87	[0.43–1.76]	.690
Obese	0.71	[0.26–1.95]	.502	0.46	[0.20–1.09]	.077
Overweight	1.19	[0.63–2.24]	.597	0.85	[0.44–1.61]	.612
Flu/ear infection in past 30 days						
Above 99th percentile	1.18	[0.35–3.96]	.782	1.26	[0.54–2.93]	.589
Obese	1.10	[0.52–2.33]	.808	1.16	[0.45–3.03]	.756
Overweight	1.28	[0.67–2.45]	.455	0.98	[0.47–2.03]	.953
3+ ear infections past year						
Above 99th percentile	3.48	[0.87–13.92]	.077	1.55	[0.49–4.89]	.453
Obese	0.72	[0.26–2.01]	.530	2.46	[0.68–8.87]	.165
Overweight	1.54	[0.69–3.45]	.291	0.89	[0.37–2.15]	.788
Frequent/severe headaches in past year						
Above 99th percentile	14.18**	[2.20–91.55]	.006	1.24	[0.20–7.75]	.818
Obese	0.52	[0.07–3.77]	.517	1.36	[0.31–6.00]	.679
Overweight	2.99*	[1.02–8.76]	.045	1.89	[0.47–7.55]	.365
Anemia						
Above 99th percentile	—	—	—	0.99	[0.29–3.39]	.983
Obese	1.02	[0.35–2.98]	.976	3.51*	[1.06–11.61]	.040
Overweight	1.31	[0.46–3.73]	.612	1.04	[0.46–2.34]	.921
Hay fever in past year						
Above 99th percentile	3.82	[0.95–15.27]	.058	0.90	[0.25–3.21]	.875
Obese	2.11	[0.85–5.20]	.105	1.08	[0.40–2.90]	.881

	Girls			Boys		
	aOR	**CI**	***P***	**aOR**	**CI**	***P***
Overweight	0.85	[0.23–3.14]	.809	1.04	[0.43–2.52]	.925
Doctor said that they have allergies						
Above 99th percentile	1.52	[0.23–10.20]	.657	1.27	[0.27–5.90]	.750
Obese	1.06	[0.24–4.68]	.941	1.10	[0.24–5.11]	.896
Overweight	2.20	[0.60–8.10]	.227	0.97	[0.41–2.31]	.950
Ever told that they have asthma						
Above 99th percentile	1.33	[0.46–3.84]	.593	2.51**	[1.36–4.64]	.004
Obese	1.15	[0.56–2.37]	.708	2.42*	[1.15–5.11]	.020
Overweight	1.27	[0.60–2.70]	.528	1.87*	[1.10–3.19]	.022
Eczema						
Above 99th percentile	3.02	[0.53–17.07]	.203	1.31	[0.32–5.43]	.699
Obese	1.96	[0.64–6.00]	.228	0.83	[0.22–3.16]	.778
Overweight	0.32	[0.09–1.12]	.074	0.85	[0.22–3.31]	.806
Wheezing in past year						
Above 99th percentile	1.35	[0.44–4.12]	.596	1.99*	[1.03–3.85]	.042
Obese	1.54	[0.74–3.20]	.243	1.88	[0.90–3.92]	.092
Overweight	1.67	[0.84–3.32]	.145	1.74	[1.00–3.04]	.051
Dry cough at night						
Above 99th percentile	9.67**	[2.24–41.74]	.003	2.22	[0.67–7.33]	.189
Obese	1.15	[0.15–8.64]	.892	0.40	[0.11–1.40]	.149
Overweight	1.83	[0.46–7.35]	.391	2.24	[0.73–6.83]	.156

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval.

[a]*$P < .05$,

**$P < .01$;

adjusted for age, race/ethnicity, income, and insurance status.

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