

# Economic Burden of Obesity in Youths Aged 6 to 17 Years: 1979–1999

Guijing Wang, PhD, and William H. Dietz, MD, PhD

**ABSTRACT.** *Objective.* To examine the trend of obesity-associated diseases in youths and related economic costs.

*Methods.* Using a multiyear data file of the National Hospital Discharge Survey, 1979–1999, we analyzed the changes in obesity-associated diseases and economic costs in youths (6–17 years of age) over time. Diabetes, obesity, sleep apnea, and gallbladder disease were examined to explore the trend of the disease burden. Other obesity-associated diseases for which obesity was listed as a secondary diagnosis were also analyzed. Obesity-associated hospital costs were estimated from the discharges with obesity listed as a principal or secondary diagnosis.

*Results.* From 1979–1981 to 1997–1999, the percentage of discharges with obesity-associated diseases increased. The discharges of diabetes nearly doubled (from 1.43% to 2.36%), obesity and gallbladder diseases tripled (0.36% to 1.07% and 0.18% to 0.59%, respectively), and sleep apnea increased fivefold (0.14% to 0.75%). Ninety-six percent of discharges with a diagnosis of obesity listed obesity as a secondary diagnosis. Asthma and some mental disorders were the most common principal diagnoses when obesity was listed as a secondary diagnosis. Obesity-associated annual hospital costs (based on 2001 constant US dollar value) increased more than threefold; from \$35 million (0.43% of total hospital costs) during 1979–1981 to \$127 million (1.70% of total hospital costs) during 1997–1999.

*Conclusions.* Among all hospital discharges, the proportion of discharges with obesity-associated diseases has increased dramatically in the past 20 years. This increase has led to a significant growth in economic costs. These findings may reflect the impact of increasing prevalence and severity of obesity. Diet and physical activity interventions should be developed for weight loss and prevention of weight gain in youths. *Pediatrics* 2002; 109(5). URL: <http://www.pediatrics.org/cgi/content/full/109/5/e81>; *children, adolescents, obesity, hospitalization, comorbidities, costs.*

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ABBREVIATIONS. NHDS, National Hospital Discharge Survey, ICD-9, *International Classification of Diseases, Ninth Revision.*

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The prevalence of overweight and obesity among children has been increasing rapidly worldwide.<sup>1</sup> In the United States, the age-adjusted prevalence of obesity based on the 95th percentile of body mass index nearly doubled from

1976–1980 to 1988–1994 for children in the 6 to 11 years and the 12 to 17 years age groups.<sup>2,3,4</sup> This trend has continued since 1994. Recent data have shown that prevalence of overweight among children (6–11 years old) and adolescents (12–19 years old) was 13% and 14%, respectively, in 1999.<sup>5</sup>

Obesity in children and adolescents has been associated with several important chronic diseases such as diabetes, asthma, sleep apnea, and gallbladder disease.<sup>6,7</sup> Several studies have documented that prevalence of type 2 diabetes mellitus is increasing among children and adolescents, and obesity may be a major contributor to the increase.<sup>8–11</sup> However, neither trends in the prevalence of diseases associated with obesity in youths nor their impact on health care costs have previously been examined. This study explores the trends of disease and economic burden of obesity in youths from 1979 to 1999 with use of a nationally representative population sample of hospital discharges, the National Hospital Discharge Survey (NHDS).

The term overweight is used to describe children and adolescents whose body mass index is  $\geq 95$ th percentile for youths of the same age and gender. The NHDS, however, lists obesity as a principal or a secondary diagnosis. Therefore, we will use the term obesity in this manuscript, although the use of the term reflects the provider's judgment and likely underestimates the true prevalence of overweight-associated conditions and costs.

## METHODS

### Data Source

We used a multiyear data file of the NHDS, 1979–1999, conducted by the National Center for Health Statistics. This survey collects data from inpatient records acquired from a national sample of hospitals. The NHDS records annual discharges from noninstitutional hospitals, exclusive of federal, military, Veterans' Administration hospitals, and hospital units of institutions, such as prison hospitals, located in the 50 States and the District of Columbia. Only short-stay hospitals (those with an average length of stay for all patients of  $< 30$  days), general (medical or surgical) hospitals, and children's hospitals are included in the survey. Because persons with multiple discharges during the year may be sampled more than once, and no personal identifiers were available, discharges rather than persons were used for this study.

The survey design, sampling, and estimation procedures were planned to produce calendar-year estimates of inpatient stays. A detailed description of the sample design of the survey is provided elsewhere.<sup>12</sup> In the survey, the medical information manually recorded on the sampled patients' abstract was coded by National Center for Health Statistics staff who used the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*. A maximum of 7 diagnostic codes was assigned for each abstract sampled. The diagnostic code listed first was used as the principal diagnosis, and subsequent diagnostic codes (second through seventh) were used as secondary diagnoses.

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The survey also provided demographic information, such as age, sex, and race. Data for race were missing for a total of about 13% of all discharges from all years, and no attempt was made to impute those missing values. In addition, because most obesity-related diseases occurred with a relatively low prevalence, we did not include race or other demographic variables in our analyses.

## Analyses

We analyzed the hospital discharges from 1979 to 1999 of children and adolescents 6 to 17 years of age. We selected diabetes (ICD-9 250), obesity (ICD-9 278), sleep apnea (ICD-9 780.5, 786.09, and 789.03–789.07 for the year 1999 because of code changes), and gallbladder disease (ICD-9 574 and 575) for the analyses of trends. Because type 1 and type 2 diabetes cannot be reliably differentiated in our analyses, we considered only the hospitalizations in which diabetes and obesity were both listed as diagnoses as the criteria for type 2 diabetes when we analyzed hospital costs. Sleep apnea included sleep disturbances and other symptoms involving the respiratory system, and other chest symptoms such as apnea, shortness of breath, and wheezing. Gallbladder disease included cholelithiasis and cholecystitis. To examine the trend of the frequency of these diseases over the study period, we used the total number of diagnoses, including principal and secondary diagnoses during a year, and then pooled discharges from 3 consecutive years for additional analyses.

To quantify the health burden of these obesity-associated diseases over time, we estimated the number of discharges in the earliest 3-year (1979–1981) and the most recent 3-year (1997–1999) periods by principal and secondary diagnoses, separately. To understand better the obesity-associated health burden, we examined the other frequent principal diagnoses for discharges where obesity was listed as a secondary diagnosis.

On the basis of the health burden, we derived annual hospital cost by multiplying the total number of hospital stays (days of care) by the average hospital cost per day. We used an average cost per day of \$249 for the community hospitals as the estimate of patient direct costs for hospital treatment during the period of 1979–1981.<sup>13</sup> The average cost per day during 1997–1999 was \$1066.<sup>14</sup> For comparison purposes, we derived the hospital costs using year 2001 constant US dollars. We used a 5% inflation rate for this purpose. In 2001 constant dollars, the average cost per day was \$694 for 1979–1981 and \$1234 for 1997–1999. Because of the potential for double counting and uncertainty about the linkage between obesity and obesity-associated diseases, we included only the discharges with a diagnosis of obesity for the estimate of economic burden.

Because the NHDS used a stratified, multistage probability design, for data analysis we used SUDAAN (Research Triangle Park, NC), a statistical software package to take the complex sample design effects into account.<sup>15</sup>

## RESULTS

The percentage of hospital discharges of youths increased for all obesity-associated diseases over the period of 1979–1999 (Fig 1). The percentage of dia-

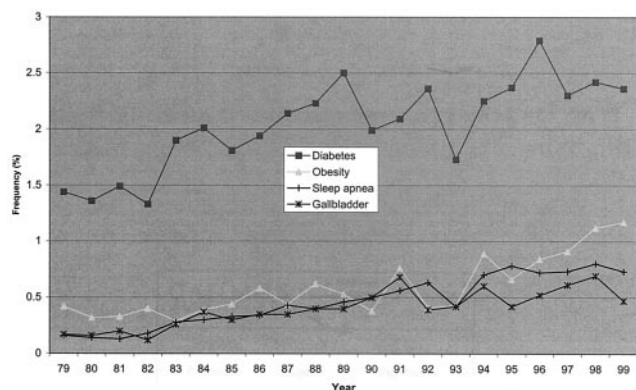


Fig 1. Discharge frequency of obesity-associated diseases in youths aged 6 to 17 years, 1979–1999.

betes diagnoses increased from below 1.5% in 1979 to nearly 2.5% in 1999. The percentage of obesity discharges increased from below 0.5% to nearly 1.2%, and the increase was consistent and rapid after 1995. The frequency of sleep apnea and gallbladder disease also increased over the years.

The pattern of increase was more apparent and consistent when we pooled the discharges over 3 consecutive years (Table 1). From the 1979–1981 to the 1997–1999 period, the prevalence of diabetes increased from 1.43% to 2.36%, obesity from 0.36% to 1.07%, sleep apnea from 0.14% to 0.75%, and gallbladder disease from 0.18% to 0.59%. The trends were similar in children 6 to 11 years old and adolescents 12 to 17 years old, although the prevalence was higher in adolescents than in children for all diseases except sleep apnea (Fig 2A–D).

Table 2 presents the number of national hospital discharges extrapolated from the NHDS by sample weight for the 4 diseases during the earliest 3-year (1979–1981) and the most recent 3-year (1997–1999) study period. Most discharges with a diagnosis of diabetes listed it as a principal diagnosis (83% during 1979–1981 and 75% during 1997–1999). Over 70% of discharges with a gallbladder disease diagnosis listed it as a principal diagnosis. Only 4% of discharges with an obesity diagnosis listed it as a principal diagnosis during 1997–1999, and in that same period only 4% of discharges with a sleep apnea diagnosis listed it as a principal diagnosis. From 1979–1981 to 1997–1999, the total number of discharges increased by 55% for obesity, 175% for sleep apnea, and 74% for gallbladder disease.

During 1997–1999, the most frequent principal diagnoses when obesity was listed as a secondary diagnosis were asthma, disturbance of conduct such as unsocialized conduct and depressive disorders, and diabetes (Table 3). The frequency of disturbance of conduct in the earliest period (1979–1981) was very low. The rate of asthma as an obesity-associated comorbidity increased from 5.9% in 1979–1981 to 8.1% in 1997–1999. Outcome of delivery was a common principal diagnosis in 1997–1999 (4.6% vs 1.3% in 1979–1981). This diagnosis applied to girls 15 to 17 years of age with a single liveborn.

For both principal and secondary diagnosis of obesity, the length of stays were longer in 1997–1999 (13.46 days and 6.76 days, respectively) than in 1979–1981 (6.35 days and 5.01 days, respectively; Table 4). The total days of care associated with obesity increased from about 152 000 days in 1979–1981 to about 310 000 days in 1997–1999. In 1997–1999, the length of stay was 7.0 days for discharges with an obesity diagnosis and 4.4 days for overall discharges (Fig 3). The length of stay for obesity-associated discharges increased from 5.32 days in 1979–1981 to 7 days in 1997–1999, and it slightly decreased for the overall discharges.

Based on hospital utilization and average hospital cost per day, the annual hospital cost of \$12.6 million during 1979–1981 increased to \$110 million during 1997–1999 (Table 4). A major proportion of the cost was for discharges that listed obesity as a secondary diagnosis. After adjusting for inflation, in 2001 con-

**TABLE 1.** Hospital Discharge Frequency (Weighted %) of Diseases Among Youths Aged 6 to 17 Years, 1979–1999 NHDS

Year Period	Diabetes (ICD-9 250)	Obesity (ICD-9 278)	Sleep Apnea† (ICD-9 780.5, 786.09, 789.03–789.07)	Gall Bladder Disease‡ (ICD-9 574, 575)
1979–1981 ( <i>n</i> = 42 540)§	1.43 (0.06)	0.36 (0.03)	0.14 (0.02)	0.18 (0.02)
1982–1984 ( <i>n</i> = 34 375)	1.73 (0.08)	0.36 (0.04)	0.25 (0.03)	0.24 (0.03)
1985–1987 ( <i>n</i> = 28 894)	1.96 (0.09)	0.49 (0.05)	0.37 (0.04)	0.33 (0.04)
1988–1990 ( <i>n</i> = 36 722)	2.25 (0.13)	0.52 (0.07)	0.45 (0.05)	0.43 (0.05)
1991–1993 ( <i>n</i> = 35 862)	2.07 (0.11)	0.54 (0.07)	0.54 (0.05)	0.50 (0.06)
1994–1996 ( <i>n</i> = 37 940)	2.46 (0.13)	0.80 (0.07)	0.74 (0.07)	0.51 (0.06)
1997–1999 ( <i>n</i> = 40 683)	2.36 (0.12)	1.07 (0.08)	0.75 (0.06)	0.59 (0.06)
Increase from 1979–1981 to 1997–1999	65%	197%	436%	228%

\* Percentages are weighted to be nationally representative.

† Sleep apnea includes sleep disturbance (ICD-9 780.5, excludes that of nonorganic origin) and other symptoms (ICD-9 786.09, 786.03–786.07 for year 1999 because of code changes) involving respiratory system and other chest symptoms (apnea, shortness of breath, cheyne-stokes respiration, tachypnea, wheezing, respiratory distress, or insufficiency).

‡ Gall bladder disease includes cholelithiasis (ICD-9 574) and cholecystitis (ICD-9 575).

§ *n* = total number of discharges in the sample.

|| Standard error.

stant dollars, annual hospital costs were about \$35 million (0.43% of total hospital costs) during 1979–1981 and increased more than threefold to about \$127 million (1.70% of total hospital costs) during 1997–1999.

## DISCUSSION

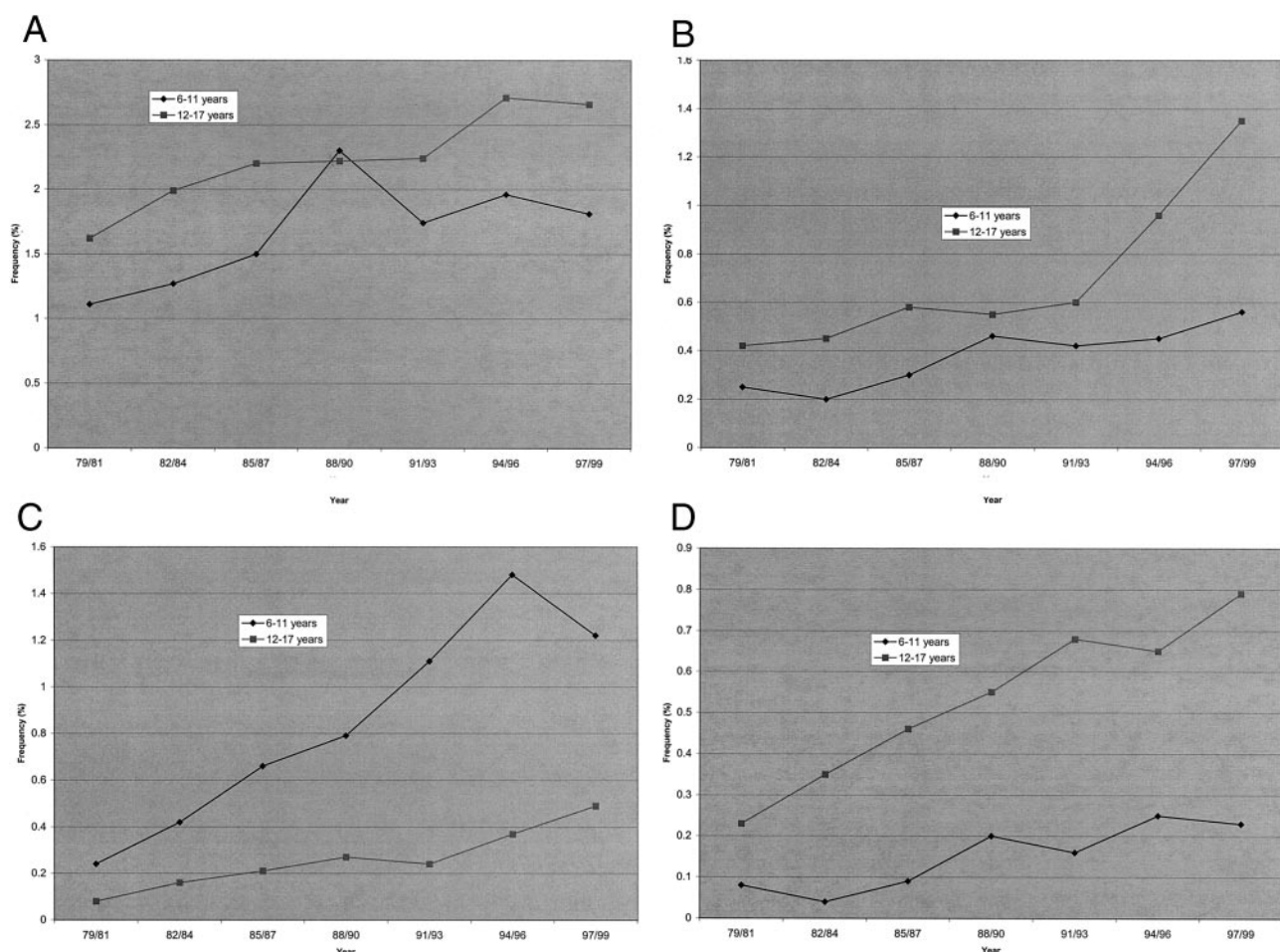
The increase in the percentage of discharges with obesity-associated diseases may reflect the medical consequences of the obesity epidemic. Although the numbers of percentage are small, the increases are substantial, especially for obesity (197% increase), sleep apnea (436%), and gallbladder disease (228%). These data may suggest that the increasing prevalence of obesity in children and adolescents has led to increased hospital stays related to obesity-associated diseases. The increasing proportion of hospital discharges with obesity-associated diseases in the last 20 years may also reflect the impact of increasing severity of obesity.<sup>2</sup> The higher proportion of hospital discharges of obesity-associated diseases in adolescents than in children for all of the diseases except sleep apnea may suggest further that obesity complications increase with age.

In the NHDS data reviewed for this study, obesity was usually listed as a secondary diagnosis. One potential explanation for this finding is that obesity is not generally a reimbursable diagnosis or medical health benefit. Health care payers may not reimburse for hospitalizations for obesity, even when obesity is the disease that causes diabetes, sleep apnea, or gallbladder disease. Therefore, doctors may not list obesity as a principal or even a secondary diagnosis. Lack of reimbursement may delay the treatment of obesity and lead to lost opportunities to prevent obesity-associated diseases. Reluctance to list obesity as a diagnosis may also make our estimates of disease burdens conservative.

The frequency with which other diseases have obesity listed as a secondary diagnosis suggests that obesity may lead to many other medical conditions. Asthma and some mental disorders have been linked to obesity.<sup>6,7,16–18</sup> The frequencies with which obesity was listed as a secondary diagnosis for asthma and for several mental disorders increased from 1979–1981 to 1997–1999. Especially for mental disorders, no discharges listed obesity as a co-morbidity during 1979–1981, but by 1997–1999, obesity had become a common co-morbidity. For asthma, the frequency of discharges associated with obesity increased nearly 40%. Outcome of delivery was another common discharge that listed obesity as a co-morbidity during 1997–1999. The diagnosis frequency increased from 1.3% in 1979–1981 to 4.6% in 1997–1999. All of the patients in this category were girls 15 to 17 years of age with single liveborn. This increase may reflect the contribution of obesity to pregnancy complications and adverse pregnancy outcomes, such as cesarean delivery and pregnancy-induced hypertension.<sup>19</sup>

The length of stay for discharges associated with obesity was longer than that for overall discharges. Discharges with a principal or secondary diagnosis of obesity yielded more days of hospital stay in recent years (1997–1999) than in earlier years (1979–1981), whereas the days of hospital stay decreased slightly for the overall discharges. When obesity was listed as a principal diagnosis, the average length of stay was twice that of discharges listing obesity as a secondary diagnosis (13.5 days vs 6.8 days). These data may reflect the time needed to treat obesity or to implement dietary or exercise strategies, or the time necessary to implement changes within families. The increased length of stay may also suggest that obesity treatment has become more complicated in recent years. For example, because of the increasing





**Fig 2.** A, Discharge frequency of diabetes diagnoses for children aged 6 to 11 years and adolescents aged 12 to 17 years. B, Discharge frequency of obesity diagnoses for children aged 6 to 11 years and adolescents aged 12 to 17 years. C, Discharge frequency of sleep apnea diagnoses for children aged 6 to 11 years and adolescents aged 12 to 17 years. D, Discharge frequency of gallbladder disease diagnoses for children aged 6 to 11 years and adolescents aged 12 to 17 years.

**TABLE 2.** National Estimates of Discharges of Diseases Among Youths Aged 6 to 17 Years During 1979–1981 and 1997–1999

Disease	1979–1981			1997–1999			Increase (Decrease) of Total From 1979–1981 to 1997–1999
	Principal Diagnosis	Secondary Diagnosis	Total	Principal Diagnosis	Secondary Diagnosis	Total	
Diabetes	94 914 (83%)	20 023 (17%)	114 937 (100%)	73 014 (75%)	24 511 (25%)	97 525 (100%)	(15%)
Obesity	6567 (23%)	22 044 (77%)	28 611 (100%)	1618 (4%)	42 597 (96%)	44 215 (100%)	55%
Sleep apnea	966 (9%)	10 319 (91%)	11 285 (100%)	1371 (4%)	29 671 (96%)	31 042 (100%)	175%
Gall bladder disease	9852 (70%)	4219 (30%)	14 071 (100%)	18 833 (77%)	5617 (23%)	24 450 (100%)	74%

severity of obesity, more obese individuals may require gastric surgery.

The hospital costs associated with obesity may have risen to more than \$127 million per year (in 2001 constant dollars) in recent years. These costs represent more than a threefold increase. As a percentage of costs for overall hospital discharges, obesity-associated costs increased from 0.43% in 1979–1981 to 1.7% in 1997–1999. The disparity between the changes in costs and the changes in prevalence of obesity may reflect the disproportionate increase in severe obesity from the 1970s to the 1990s.

This study had several limitations. First, the discharge frequency cannot be used to assess disease prevalence because a person with multiple discharges during a year may be sampled more than

once. Second, physicians' awareness of obesity or willingness to list obesity as a diagnosis may change over time. We did not consider this effect in analyzing discharge frequency because of lack of information. Third, only 4 obesity-associated diseases were examined for the trend analysis of diseases, and type 1 and type 2 diabetes were not differentiated, although we included only discharges that listed both obesity and diabetes for the analysis of economic costs. Fourth, we used only discharges with an obesity diagnosis to estimate the economic burden of obesity. Therefore, our estimates are probably conservative because many persons with obesity-associated diagnoses may not have a severe enough weight problem for obesity to be listed, or doctors may not have listed obesity as a diagnosis for reimbursement

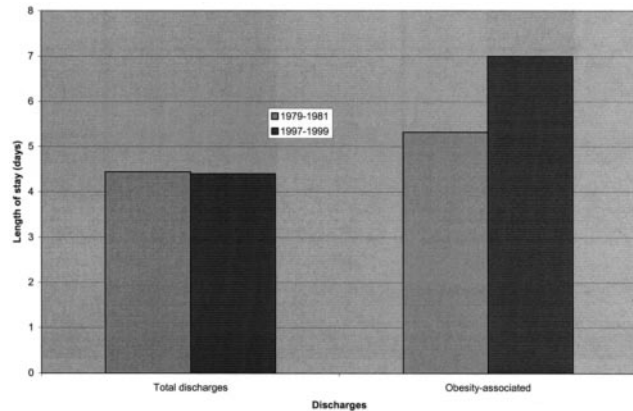
**TABLE 3.** Most Frequent Principal Diagnoses of Discharges Where Obesity Was Listed as Secondary Diagnosis in Youths in 1979–1981 and 1997–1999

Disease	ICD-9	Percentage (1979–1981)	Percentage (1997–1999)	Difference in Percentages From 1979–1981 to 1997–1999
1 Asthma	493	5.9	8.1	2.2
2 Disturbance of conduct	312	0.0	4.7	4.7
3 Diabetes	250	7.6	4.6	-3.0
4 Outcome of delivery	V27	1.3	4.6	3.3
5 Other cellulitis and abscess	682	0.0	4.2	4.2
6 Depressive disorder	311	0.0	3.9	3.9
7 Neurotic disorders	300	1.1	3.9	2.8
8 Adjustment reaction	309	0.0	2.7	2.7
9 Gall bladder disease	574, 575	1.1	2.3	1.2
10 Chronic disease of tonsils and adenoids	474	1.1	2.2	1.1
11 Disturbance of emotions specific to childhood and adolescence	313	0.0	1.5	1.5

**TABLE 4.** Length of Stay and Hospital Costs of Discharges With an Obesity Diagnosis Among Youths Aged 6 to 17 Years During 1979–1981 and 1997–1999

Items	1979–1981			1997–1999		
	Principal Diagnosis	Secondary Diagnosis	Total	Principal Diagnosis	Secondary Diagnosis	Total
Number of discharges	6567	22 044	28 611	1618	42 597	44 215
Length of stay (d/discharge)	6.35	5.01	5.32	13.46	6.76	7.00
Total days of care ( $\times 10^3$ d)	417.00	110.44	152.21	21.78	287.96	309.51
3-y hospital cost* (\$ million)	10.30	27.50	37.90	23.22	306.96	329.93
Annual hospital cost (\$ million)	3.43	9.17	12.60	7.74	102.32	110.09
Year 2001 value of annual hospital cost† (\$ million)	9.56	25.55	35.10	8.96	118.45	127.44

\* Based on the average cost per day of \$1066 during 1997–1999, from US Bureau of Census, Statistical Abstract of the United States, 2000, and based on the average cost per day of \$249 during 1979–1981, from US Bureau of Census, Statistical Abstract of the United States, 1990.  
 † Using 5% inflation rate. For the period of 1997–1999, dollar value inflated from 1998 to 2001, for the period of 1979–1981, dollar value inflated from 1980 to 2001.



**Fig 3.** Average length of hospital stay in 1979–1981 and 1997–1999.

reasons. Finally, we analyzed hospital costs only. Other costs—costs for physician visits, medication, and indirect costs such as the effect of obesity on future earnings—are considerable.<sup>20</sup> Inclusion of these costs would further increase the economic burden.

Several strengths of this study should also be noted. First, because this study used large, nationally representative samples collected over the past 20 years, we were able to examine trends and produce national estimates of hospital use and the economic burden of obesity. Although the proportion of obesity-associated discharges was low, the trend of the

proportion and its economic costs are accelerating. Second, because principal and secondary diagnoses were available, we were able to examine other major comorbidities associated with obesity. Finally, although our estimates of diseases and economic costs associated with obesity are likely to be conservative in absolute values, the data from this 20-year period portray a disturbing increase of hospital diagnoses of obesity-associated diseases and in health care costs.

## CONCLUSION

The increasing frequency of hospital discharges of obesity-associated diagnoses suggests a rising disease burden associated with obesity among children and adolescents. If the prevalence of obesity continues to grow, the disease burden will surely increase further. As overweight children become overweight adults,<sup>21–26</sup> the diseases associated with obesity and health care costs are likely to increase even more. Because disproportionate weight gains have occurred among heavier children,<sup>2</sup> the rate of obesity-associated diseases will rise even faster if the expanding prevalence of obesity continues. Clearly, both primary and secondary prevention of childhood obesity are required to address this epidemic.

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