Pediatric Overweight: A Weighty Mortality Concern

Daniel D. Zimmerman, MD, FAAP

Overweight children add a new dimension to pediatric underwriting due to their increasing numbers and unprecedented consideration in the risk stratification process. The lay and medical literature is rife with publications addressing the etiology, prevention, morbidity, and treatment of pediatric obesity. Less attention has been paid to long-term outcomes and mortality associated with pediatric overweight, although recent publications indicate that situation is changing. This review focuses specifically on mortality associated with pediatric overweight and its effect on the current and future insurability of children.

CASE PRESENTATION

The grandparents of a 13-year-old girl have applied for a $100,000 whole life policy insuring the girl. They own 4 life insurance policies with the company and have been clients for 30 years. The application is “clean,” and the agent expects it to be accepted as standard. However, because the girl’s build (weight, 210 lbs; height, 5’7”) places her above the reference chart, the risk assessment guidelines instruct the underwriter to refer the case to the medical director. The medical director uses the Centers for Disease Control and Prevention (CDC) BMI Calculator for Child and Teen, which provides the following response: “Based on the height and weight entered, the BMI is 32.9, placing the BMI-for-age at the 98th percentile for girls aged 13 years. This teen may be overweight and should be seen by a healthcare provider for further assessment.”

HISTORY

Before the 1970s, little attention was paid to pediatric overweight, probably because it affected a small percentage of children. In 1967, the American Academy of Pediatrics (AAP) published a policy statement indicating that “during the past 35 years the North American culture has become increasingly preoccupied with the problems of obesity.” This statement outlined the facts known at that time: (1) most overweight children remain overweight in adult life, (2) dietary treatment was less effective in patients who
had been overweight since childhood compared with those who became overweight later in life, and (3) hereditary factors may be more important than environmental influences as determinants of obesity.

When this statement was published, the AAP did not have long-term pediatric mortality data upon which to formulate policy. However, it did state that “mortality and morbidity rates for diabetes and cardiovascular disease are higher in obese adults than in those of average weight. Because the majority of obese children do tend to remain obese as adults, early treatment of obesity would seem to be a worthy objective.” Forty one years ago the AAP had identified the problem and concluded that pediatric obesity, at least theoretically, led to increased mortality rates.

**DEFINITIONS**

The body mass index (BMI) is used to define overweight and obesity in adults. However, BMI alone cannot be used for children due to normal growth and development and changing percentages of body fat. Instead, pediatric build is categorized using BMI-for-age percentiles, which are based on sex-specific growth charts developed by the CDC for ages 2 to 19 years. These charts were developed using national data from 1963 to 1994. The Table shows the pediatric build categories and their corresponding BMI-for-age percentiles.

<table>
<thead>
<tr>
<th>Category</th>
<th>BMI-for-age percentile</th>
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<tbody>
<tr>
<td>Underweight</td>
<td>&lt;5&lt;sup&gt;th&lt;/sup&gt;</td>
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<tr>
<td>Normal weight</td>
<td>5&lt;sup&gt;th&lt;/sup&gt; to &lt;85&lt;sup&gt;th&lt;/sup&gt;</td>
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<tr>
<td>At risk for overweight</td>
<td>85&lt;sup&gt;th&lt;/sup&gt; to &lt;95&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Overweight</td>
<td>≥95&lt;sup&gt;th&lt;/sup&gt;</td>
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The term *obesity* is not specifically defined in the pediatric literature, although the terms *obesity* and *overweight* are often used interchangeably.

**EPIDEMIOLOGY**

The National Health and Nutrition Examination Survey (NHANES) provides the data for monitoring the prevalence of weight distribution in children. The data for 2003–2004 revealed that 18.8% of children 6 through 11 years of age and 17.4% of adolescents 12 through 19 years of age were overweight. These results represent more than a tripling in the prevalence of childhood and adolescent overweight during the last 25 years.

These figures may raise some questions. For example, how could 18.8% of the children ages 6 through 11 be overweight since overweight is defined as BMI-for-age in the 95<sup>th</sup> percentile or greater? By definition, only 5% could be included in that group. The answer is relative. The CDC developed the BMI-for-age percentiles based on data over the last 3 decades. The *normal* baseline distribution of weight was established at that time. Thus, 18.8% of current 6 through 11 year olds meet or exceed the BMI-for-age cut points that established the 95<sup>th</sup> percentile during the baseline period.

**MORTALITY STUDIES**

Relatively few studies published in the last 20 years have directly examined long-term outcomes and mortality associated with pediatric overweight. These studies have garnered little attention from clinical or insurance medicine, although the current issue of *Brackenridge* has dedicated a full page to this topic. Recently several articles in the mainstream medical literature have again focused on the relationship between pediatric overweight and mortality.

Before reviewing the pediatric studies, it is instructive to review 3 articles that describe
the results of relevant non-pediatric studies, which all included participant data beginning at 18 years of age. Thus, they may contribute to a better understanding of overweight effects especially during the transitional years from adolescence to adulthood.

Non-pediatric Studies

In 1999, Bender reported that the risk of death increased with body weight, but obesity-related excess mortality declined with age at all levels of obesity. This study examined the standardized mortality ratios (SMRs) of 6193 obese subjects between the ages of 18 and 74 years who were divided into 4 age groups: 18–29, 30–39, 40–49, and 50–74. The cohort was studied for a median of 14.8 years. The reference population consisted of the general population from the same geographic area as the study participants. SMRs increased with BMI; but within each BMI group, the SMRs decreased with advancing age with the exception of only one sub-group. The highest SMRs were calculated for the subjects in the 18–29 age group with BMIs $\geq 40$.

Hoffmans et al reported in 1988 on the mortality impact of BMI on 18-year-old, Dutch men followed for 32 years. This study enrolled 79,657 men at the time of their military conscription exam in 1950 to 1951. The study population was divided into 4 groups based on their BMI: $\leq 18.99$, 19.00 to 19.99, 20.00 to 24.99, and $\geq 25.00$. Deaths were recorded and analyzed through December 31, 1981. Crude and adjusted risk ratios followed a U-shaped curve. The 19.00 to 19.99 BMI group experienced the lowest mortality rate and served as the reference category. The $\geq 25.00$ BMI group had no increased risk during the first 12 years of follow-up and a statistically significant increased risk ratio of 1.6 during the last 10 years of follow-up. The authors concluded that the negative effect of overweight did not become evident until after 20 years of follow-up and that the duration of overweight may play an important role in establishing the adverse effects.

In 2006, van Dam et al published a study based on data from 102,400 women 24–44 years of age in the Nurses’ Health Study II. In 1989, the current weight and height and the recalled weight at age 18 years were assessed by using validated questionnaires. During the 12-year follow-up period, 710 individuals died. The hazard ratios for premature death based on BMI relative to the internal reference group with a BMI from 18.5 to 21.9 were the following: 1.18 for BMI 22.0 to 24.9; 1.66 for BMI 25.0 to 29.9; and 2.79 for BMI $>30$. Weight gain between age 18 years and baseline was not associated with substantially increased rates of premature death from all causes. The authors concluded that moderately higher adiposity at age 18 years is associated with increased premature death in younger and middle-aged US women. They also stated that their findings support preventive action in children aimed at reducing their risk for becoming overweight.

Pediatric Studies

Mossberg published one of the first reports of increased mortality rates associated with pediatric overweight in 1989. He described the outcome of a cohort of 504 overweight children followed for 40 years in Sweden. This study defined overweight by a weight-for-height (W/H) standard deviation score (SDS). While the SDS does not correlate to the BMI-for-age percentiles currently used for children, it does correlate approximately to adult BMIs as follows: SDS $+1.0 = BMI 28$; SDS $+1.25 = BMI 29$; SDS $+2.0 = BMI 31$; etc. The overweight groups experienced 55 deaths, which was an excess over the 33 expected in the Swedish population reference group. The increased mortality was most demonstrable in the group with an SDS of greater than $+3.0$.

There are two significant criticisms regarding this study: (1) subjects were en-
rolled when admitted to hospital, but the admitting diagnosis was not disclosed other than “obesity,” and (2) the cohort contained 34 subjects with onset of obesity after certain or probable brain damage. Thus, these subjects may have been less healthy than the reference population. The author does attempt to separate the “cerebral obesity” population from the others by noting an increased relative mortality rate in this subgroup. Mossberg’s report concluded that the study confirms an association between obesity in childhood and high mortality in adulthood.

The best-known pediatric build study was published by Must et al\textsuperscript{10} in 1992. This study described 508 adolescents 13 to 18 years of age who participated in the Harvard Growth Study of 1922 to 1935. Subjects were interviewed in 1968 and 1988 to obtain information about their medical history. For deceased subjects, cause of death was obtained from death certificates. Overweight was defined as a BMI greater than the 75\textsuperscript{th} percentile (as defined by NHANES I) on two occasions. The reference population was defined as those with BMIs between the 25\textsuperscript{th} and 50\textsuperscript{th} percentiles. Fifty-two percent of the surviving subjects who had been overweight in adolescence were still overweight in 1988. The authors reported that overweight in men was associated with a relative risk of death from all causes of 1.8 compared with the lean population. The disease-specific relative risk of death among men was significantly higher for coronary heart disease (2.3), atherosclerotic cerebro-vascular disease (13.2), and colorectal cancer (9.1). These findings were not demonstrated among women; however, overweight women and men experienced more morbidity than their lean counterparts. The authors concluded that the prevention of overweight in childhood may be the most effective means of decreasing the associated mortality and morbidity in adults.

In 1992, Nieto et al\textsuperscript{11} published 50-year mortality results from a cohort of 13,146 children aged 5–18 years from Hagerstown, New Jersey. This study analyzed the relationship between weight, growth rates, and mortality. (Because growth rates were minimally related, they will not be discussed further.) Nieto’s group calculated quintiles in which relative weight was defined internally based on the distribution of weight for children of the same height, sex, and age. The researchers also divided the cohort into pre-pubertal and post-pubertal overweight. Children in the top quintiles of pre-pubertal relative weight showed an odds ratio 50\% higher for total mortality than those in the bottom quintile. Post-pubertally, this association was more evident in females. The authors concluded that these results indicate the avoidance of overweight in childhood might reduce mortality in middle age. They support the recommendation to conduct obesity assessments during the screening examinations of all children—not just those with a family history of cardiovascular disease.

Gunnell\textsuperscript{12} published the Boyd Orr cohort mortality results in 1998. This study examined the relationship between BMI measured in childhood and adult all-cause and cardiovascular mortality in a 57-year follow-up of a cohort of 2399 children from pre-war Britain (1937–1939). As in Mossberg’s study,\textsuperscript{9} the children’s measurements were converted to a standard deviation score or z-score. The z-score allows for a comparison that is independent of age and sex. Cohort members were categorized into 4 groups: <25\textsuperscript{th} centile, 25 to 49\textsuperscript{th} centile, 50 to 75\textsuperscript{th} centile, and >75\textsuperscript{th} centile with the 25 to 49\textsuperscript{th} centile serving as the reference category. Among those in the >75\textsuperscript{th} centile group, males experienced a hazard ratio for all-cause death of 1.5 and females had a ratio of 1.6. The study population was further subdivided into 2 groups: <8 years of age and >8 years of age. In the older group, a significant linear relationship between BMI and ischemic heart disease deaths was observed. The authors stated that: (1) correlations between childhood and adult obesity increase with age,
and (2) the significant relationship with overweight in the older group may be more strongly predictive of adult overweight. They concluded that this study supports an association between childhood overweight and increased mortality risk in later life.

In 2002, Engeland et al\textsuperscript{13} reported the results of a BMI study on 227,003 adolescents followed for an average of 31.5 years. From 1963 to 1975, Norwegian children between the ages of 14 and 19 were screened for tuberculosis, and their heights and weights were recorded at the same time. Almost all of the study participants were followed from the date of measurement until emigration, death, or June 30, 2001. This study classified the BMI as a sex- and age-specific percentile based on the US reference population. The internal reference population with a relative risk of 1.0 was defined as those in the 25\textsuperscript{th} to 74\textsuperscript{th} percentile. For males, the relative risk (RR) of death was 1.29 for the 85\textsuperscript{th} to 94\textsuperscript{th} percentile and 1.82 for the $\geq$95\textsuperscript{th} percentile. For females, the RR was 1.31 for the 85\textsuperscript{th} to 94\textsuperscript{th} percentile and 2.03 for the 95\textsuperscript{th} percentile and above. The authors noted that: (1) prior studies were often limited by size, and (2) since mortality is low during adolescence as well as young and middle-aged adulthood, a large number of study participants and long-term follow-up are required to observe enough deaths to obtain precise estimates. The group concluded that BMI in adolescence is predictive of adult mortality and overweight adolescents have increased long-term mortality.

Most recently, Baker et al\textsuperscript{14} reported in 2007 on the association between BMI in childhood and coronary heart disease (CHD) in adulthood. This study did not look at all-cause mortality, but focused on fatal and non-fatal coronary events. The group studied a cohort of 276,835 Danish children born from 1930 through 1976 who underwent mandatory annual health exams. Based on internal age- and sex-specific BMI references $z$ scores were calculated with positive values indicating BMI values above the average in the reference population. Individuals were followed after age 25 or in 1977, whichever came later through December 31, 2001. Information about CHD events was obtained through the National Cause of Death Register and the National Hospital Discharge Register. The data was analyzed to determine the association between BMI $z$ score at each age from 7 to 13 years and the risk of any CHD event, a nonfatal CHD event, or a fatal CHD event. Only the fatal events will be reviewed. Among men, 3,113 fatal events and among women, 991 fatal events were recorded during the study period. The risk associated with the $z$ score increased with the age of the child and within each age the association between $z$ score and adult fatal events was linear for boys and girls, with boys showing a slightly stronger association. The adjusted hazard ratios for the risk of a fatal CHD event for each 1-unit of $z$ score for boys ranged from 1.10 at age 7 to 1.24 at age 13 and for girls they ranged from 1.12 at age 10 to 1.23 at age 13. The authors concluded that, unlike the current BMI-for-age percentiles, which indicate increased risk with certain cut-points such as the 85\textsuperscript{th} percentile, risk actually increases linearly with even small amounts of excess weight.

**DISCUSSION**

The pediatric literature is not as extensive as the adult literature with regard to overweight and mortality outcomes. Yet, the studies reviewed represent a growing body of evidence, which supports the conclusion that pediatric overweight—especially in adolescence—is associated with increased mortality rates in adult life. The increased mortality outcomes are delayed and may require 20 or more years to become evident.

**CONCLUSION**

The issue of pediatric overweight is now omnipresent and based on current trends will remain so for a long time. Pediatric overweight adversely affects mortality rates;
the exact extent and degree have yet to be determined. Just as the adult obesity epidemic will affect projected mortality outcomes, so will pediatric overweight.

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REFERENCES


These findings are of particular concern, since life expectancy in CoA patients is limited mainly by atherosclerosis, and all the obesity-associated abnormalities found are harbingers of higher cardiovascular risk. Download full-text PDF. Source. Pediatric overweight: A weighty mortality concern Zimmerman et al. J Insur Med. 2008. @article{Zimmerman2008PediatricOA, title={Pediatric overweight: a weighty mortality concern.}, author={Daniel D Zimmerman}, journal={Journal of insurance medicine}, year={2008}, volume={40 3-4}, pages={. 204-9 } }. Daniel D Zimmerman. Overweight children add a new dimension to pediatric underwriting due to their increasing numbers and unprecedented consideration in the risk stratification process. The lay and medical literature is rife with publications addressing the etiology, prevention, morbidity, and treatment of pediatric obesity. Less attention has been paid to long-term outcomes and mortality associated with pediatric overweight, although recent publications indicate that situation is changing. This review focuses... CONTINUE READING. Child overweight was previously been defined as weight for height above the 90th centile on the NCHS growth charts or weight above 120% of the median for weight taking into account a childâ€™s sex, age and height [4] BMI is now commonly used as the standard measurement. BMI does not directly measure body fat but is a useful predictor of adiposity in children. Children being currently overweight. The proportion of all infants and toddlers plotting above the 85th centile weight for length is greater using WHO (21%) compared with CDC (16.6%) charts according to a recent comparative study. The greatest disparity between the 2 charts occurs in weight for length percentiles in children between 6 months and 2 years [7]. 96 (weight adj concern$).ti,ab. 97 ((stunt$ or suppress$) adj2 growth).ti,ab. 98 Nausea/ 99 Vomiting/ 100 (nausea$ or nauseous or vomit$).ti,ab. A height (percent ideal weight, percent overweight). Aim Studies that include a weight reduction focus. (primary aim may be targeting a comorbidity using, weight reduction). Park density impacts weight change in a behavioral intervention for overweight rural youth. Behav Med. 2015;41(3):123-30. Weight reduction is an effective treatment for NAFLD (37). Although a benign clinical course is typical of NAFLD, it may be associated with increasing fibrosis and, rarely, progression to cirrhosis (38). Obesity is a major risk factor for gallstones, which were found in 2% of obese children with a BMI greater than 30 kg/m2 compared with an incidence of only 0.6% in nonobese children (39). An increased BMI is related to morbidity and mortality in adults, even if there is imprecision as to the relationship of BMI values to body fat content. Following its widespread use in adults, BMI is now accepted as the standard in children (8). However, the use of BMI in children is more complex than in adults.