Morbidity and mortality associated with elevated body weight in children and adolescents

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ABSTRACT The immediate and long-term risks associated with overweight in childhood and adolescence are best considered separately. Short-term mortality is rarely associated with overweight in the young. The greatest health burden of overweight in children and adolescents arises from long-term consequences. Long-term follow-up studies of children and adolescents indicate that the risk of adult overweight is about twofold greater for individuals who were overweight as children compared with individuals who were not overweight. Persistence is greatest for extreme overweight and when overweight is carried through later adolescence. The few studies of long-term health consequences in adolescent males find that even moderate overweight is associated with excess mortality in adulthood. Females have been studied infrequently; it appears that overweight confers long-term health risks, but these are less severe. However, because of concern about weight preoccupation in this age group and lack of data of sufficient precision to support specific recommendations, weight guidelines for children and adolescents are not now warranted. Am J Clin Nutr 1996;63(suppl):445S–7S.

KEY WORDS Morbidity, mortality, body weight, overweight, obesity, children, adolescents

SHORT-TERM CONSEQUENCES OF OBESITY IN CHILDHOOD

Serious physical complications of high weights occur during childhood but rarely. These include pickwickian syndrome (obstructive apnea), cardiomyopathy, and pancreatitis (2). Potentially nonlethal but serious complications include orthopedic disorders such as genu valgum, slipped capital femoral epiphysis, and tibia vara, and respiratory disorders such as upper airway obstruction and chest wall restriction (2). These pediatric comorbidities are largely restricted to the severely obese and are of low prevalence.

Obesity also confers significant cardiovascular risk for adolescents. Abnormal glucose tolerance (3, 4), hypertension (5, 6), and lipid profile abnormalities (7, 8) are conditions that in adulthood are associated with non-insulin-dependent diabetes mellitus, sustained hypertension, and increased risk of heart attack. Adverse cardiovascular risk factor profiles in adolescents improve with weight loss (9, 10). No conclusions can yet be drawn regarding the degree of weight loss required to produce sustained benefit for cardiovascular risk factor profiles.

The most prevalent immediate consequences of overweight during adolescence are psychosocial. At as early an age as 6 y, overweight children were described by their peers from a list of 39 descriptions as ugly, stupid, dishonest, and lazy (11). Social isolation and peer problems are not uncommon for obese children (12). Cultural messages regarding obesity become internalized by adolescence and may produce a lasting, distorted self-image (13). Societal rejection of overweight adolescents is reflected in lower college acceptance rates (14), lower marriage rates, and compromised economic attainment documented in young adults (15).

LONG-TERM CONSEQUENCES OF OBESITY IN CHILDHOOD

Of greatest concern and potential public health effect is the risk that adolescent overweight will persist into adulthood. Earlier longitudinal studies suggest moderate tracking of rela-
tive weight over this period and suggest that for many (25–50%), overweight in adolescence tends to persist into adulthood. A recent investigation indicates that 18-yr-old persons who are at or above the 95th percentile for body mass index (BMI, defined as weight in kilograms divided by height in meters squared) are at substantially increased risk of overweight at the age of 35 y, with probabilities of overweight estimated at 78% and 66% for males and females, respectively (16). Not surprisingly, later onset and severity at any age increase the likelihood that obesity will continue. Among the most obese adults one finds a disproportionate number who were obese in childhood. Longitudinal data from Great Britain suggest that the likelihood of persistence may be as much as three times greater for adolescent females than for adolescent males (17). Incidence of obesity during adolescence may also be higher for females than males, and remission rates lower.

Only a few studies have examined the long-term consequences of adolescent obesity. Danish men aged 18 y and with a BMI > 31 experienced excess mortality from all causes compared with Danish vital statistics (18). This extreme degree of overweight is associated with significant comorbidity in adolescents as well as adults. Unfortunately, lower degrees of overweight were not examined in this investigation, so no inference regarding more moderate overweight can be drawn. Mortality from all causes and from coronary heart disease was increased in Dutch men with a BMI > 25 (19). Dutch men were classified on the basis of height and weight measured at 18 y, and were followed for mortality outcomes for 32 y. The adverse effect of overweight did not become apparent until after 20 y of follow-up. Waaler (20) reported on the relation between BMI and mortality in the entire population of Norway aged > 15 y except for residents of the two largest cities. In those aged 15–19 y at the start of the study, mortality was increased for males with an initial BMI > 27 after 10 y of follow-up (H Waaler, personal communication, 1991). No association between BMI and mortality was seen for females in this age group.

Longitudinal studies of the relation between weight and mortality conducted in the United States are limited to special populations. Death from coronary heart disease was increased in male college alumni in the top quartile of relative weight compared with those in the lower three quartiles, especially for men dying before the age of 45 y (21). Associations between adolescent relative weight and mortality were studied in male and female participants in a school-based study conducted in Washington County, MD (22). Among the 46% of subjects who remained in the county for 30 y, all-cause mortality was elevated for females in the fifth relative weight quintile during adolescence. The internally derived Z score (relative weight expressed in SD units) used in this study as the index of relative weight makes it difficult to evaluate the amount of weight that was associated with increased mortality. It was estimated, however, that the top quintile in the Maryland study corresponds to a relative weight of only 106%, which suggests that there were few overweight youth in the sample (23).

In our recent follow-up of the Harvard Growth Study of 1922–1935, we assessed the morbidity and mortality experience of 508 of the original participants classified as adolescent lean or adolescent overweight on the basis of their BMIs during high school (24). After 55 y of follow-up, males classified as overweight in adolescence experienced excess mortality from all causes and from coronary heart disease compared with their lean classmates (Figure 1). The 75th percentile BMI from the First National Health and Nutrition Examination Survey (NHANES I) was selected as the criterion for overweight in this study. The cohort was relatively lean and the choice of the 75th percentile was made to ensure adequate numbers in the adolescent overweight group. Significantly increased mortality due to colon cancer and stroke in men was also observed, but the CIs around these relative risks were wide because there were few deaths from these causes. Relative risk of mortality was not elevated for death from any cause in females who had been overweight in adolescence compared with females who had been lean. Medical histories and current reported health status were obtained from study subjects who survived to 1988. Among these survivors, adolescent overweight increased the risk of heart disease for men and women, gout and colon cancer for males, and arthritis and reported difficulty with activities of daily living for females, compared with their respective lean counterparts. Elevated BMI may reflect increased bone or muscle mass; however, the close correlation between BMI (25) and body fat as determined by densitometry suggests that BMI represents a reasonable measure of fatness in adolescents and adults.

These results suggest an important long-term risk associated with moderate overweight during adolescence, especially for males. In addition, all of the aforementioned risks remained after statistical adjustment for midlife BMI reported at the age of ~50 y. A possible mechanism to explain a direct effect of obesity present in adolescence is the pattern of fat deposition that occurs at this time. The independent influence of adolescent weight on adult health and longevity, if confirmed in future studies, has important public health implications.

The rapid changes in fat distribution during the adolescent period add further uncertainty to the interpretation of specific weights. During maturation, fat is deposited centrally and lost peripherally, especially in males (1). Moreover, growth during

![Figure 1](image_url)
this period makes it at least theoretically possible for weight to normalize in the absence of weight loss. Estimates that 1–2 y of weight maintenance are required for each 20% increment in excess ideal weight (26) suggest that a weight loss prescription may be avoided when overweight is not extreme.

**SOCIETAL INFLUENCES**

Our discussion of healthy weights has purposely not considered conditions associated with the low weight extreme: anorexia nervosa and bulimia nervosa. Unfortunately, societal ideals for slimmness may be experienced as impossible standards for vulnerable adolescents, who are susceptible to eating disorders. Family members and health professionals may unwittingly reinforce disordered eating behavior in normal-weight or slightly overweight adolescents by the manner in which they counsel their patients regarding their body weight. Any weight guidelines for adolescents must reflect a concern for the stigmatization or incorrect labeling of this impressionable group. Until we have solid data on the health effects of different weights and weight change, the need to protect adolescents from undue additional pressure to lose weight is paramount and should preclude an emphasis on specific weight targets.

Routine preventive screening guidelines for adolescents were presented recently that are based on the 95th percentile BMI (27). A second level screen for BMIs that exceed the 85th percentile but not the 95th percentile includes family history, blood pressure, total serum cholesterol, large previous increment in BMI, and concern about weight. These adolescent criteria are appreciably more conservative than the current suggested acceptable weights for adults. This discrepancy reflects appropriate concerns for labeling and disordered eating behavior in this vulnerable age group. For adults, the lower risk of disordered eating behavior and the significant burden of comorbidity justifies the retention of the current more stringent weight ranges, which for adults correspond to the 75th-85th percentile BMI (a BMI of 25).

**SUMMARY**

Taken together, the studies reviewed all indicate that long-term health is compromised by overweight during adolescence. These effects are likely due to the persistence of overweight into adulthood and perhaps to a direct effect of adolescent overweight on subsequent fat distribution. However, these data do not make possible to precisely calibrate risk associated with specific adolescent BMIs. Furthermore, methodologic difficulties suggest that specific estimates from long-term studies are unlikely to be forthcoming. Short of such recommendations, a focus on prevention of childhood and adolescent obesity through increased physical activity, decreased sedentary activity, and better food choices offers the best opportunity to optimize health and longevity.

**REFERENCES**