Health Hazards of Obesity and Weight Control in Children: A Review of the Literature

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Abstract: A review of literature on the health hazards of obesity and weight control in children indicates: 1) methodological flaws tend to invalidate the assumption that obesity is a risk factor for this age group; 2) weight control by children and adolescents may cause a variety of health problems including retardation of growth, development, mental functioning, and reproductive capacity; and 3) preoccupation with weight control in this society makes it likely that weight control-related-health problems are common phenomena. Further research into the short and long-term consequences of obesity and weight control is necessary before enlightened clinical practice in this area is possible. (*Am J Public Health* 1983; 73:78–82.)

Concern for obesity and its attendant health problems has generally focused on adult populations. As more and more research points to the intractability of adult obesity, attention has been focused on prevention of the problem in infants, children and adolescents. [1-3] Preventive measures include restricted feeding and reducing regimes. [2,4,5]

Efforts to prevent or control obesity in infants, children and adolescents have been based on two assumptions: 1) because childhood obesity usually carries into adulthood, obese youths have increased risks of health problems in adulthood; and 2) except for a few acute side effects, weight control measures in young persons are safe. The purpose of this article is to review research literature which challenges such assumptions and to suggest further research into the risks of childhood obesity as well as the risks of childhood weight control measures. Populations at risk of developing weight-control-related problems will also be identified.

Risks of Obesity

Since obesity in childhood and adolescence has rarely been associated with mortality,[6] the risk of obesity in infants, children, and adolescents can be considered in terms of immediate and delayed physical and psychological morbidity. Several authors have reported increased morbidity among infants, children, and adolescents, but such studies have methodological or logical problems.

Hooper and Alexander[7] followed 151 children from birth on, comparing the incidence of illness relative to weight status. The most serious of several methodological problems with this often-cited study rests with data analysis. The authors calculated illness incidences for infants in three categories: breast fed, bottle fed, and obese. The concluded that since obese infants had an illness incidence rate of 2.3/infant compared to 1.9 for both breast fed and bottle fed infants, obesity was associated with greater morbidity. Since they did not calculate the incidence rate for non-obese infants, however, this comparison is not valid. Sufficient data are provided in the study report to make such a calculation. Of the 151 infants studied, 11 were obese and 140 were non-obese; of the 426 illness episodes, 26 occurred in the obese infants and 400 occurred in the non-obese. Therefore the incidence rate for the non-obese infants is 2.85, which is higher than the 2.3 rate for the obese infants.

Tracey and Harper[8] studied the incidence of respiratory infections among normal and above-average weighted children aged 3 months to 2 years. They report statistically significant differences between the rates of illnesses of children in the normal weight and overweight groups. Methodological problems, however, include: 1) normal weighted children were considered to be those between the 25th and 75th percentiles for their age while overweight subjects were in the 90th percentile or above; illness experiences of children in the 76th-89th percentiles were not analyzed, so that conclusions can only relate to extreme cases of obesity; 2) subjects were classed as having respiratory infections if their parents called the physician and reported respiratory symptoms lasting three days or more; definitive diagnosis by examination was not made, so that the results reflect only children in families who report episodes to physicians; 3) data regarding other intervening variables such as the number of other family members with respiratory symptoms were not collected, so that alternative explanations of the relationship between overweight and illness were not ruled out.

Obesity is perceived to be a particular risk factor for coronary diseases. New and Rauh[9] reviewed literature purporting to show a relationship between childhood obesity and hypertension. Their review was uncritical, however, and, upon close scrutiny, many of the cited studies present

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difficulties. For example, Londe, Bourgoine, Robson, *et al*,[10] reported that in 74 asymptomatic hypertensive children, only the presence of obesity and parental hypertension were significantly related to the presence of the elevated blood pressure. The authors gave no criteria for their classification of obese children, however.

Lauer, Connor, Leaverton, *et al*,[11] examined school children for the presence of coronary disease risk factors. They concluded that weight alone (independent of height) was related to elevated systolic and diastolic blood pressure. However, they failed to mention that the statistical correlation between measures of obesity and elevated blood pressure was lower than the relationship between *age* and elevated blood pressure, thus nullifying their conclusion.

Levine, Lewy, New, *et al*,[12] also studied the relationship between adolescent weight and hypertension. Participants in their study were drawn from a population of 1,863 high school students who were screened for hypertension. Of the 110 students found to be hypertensive, 28 consented to be admitted to a hospital for extensive examination by the authors. The researchers found family history of hypertension and obesity to be the most frequent positive findings. However, failure to compare the weight status of these subjects with the weight status of other hypertensives (and the non-hypertensives in the population from which this sample was drawn) presents a problem. The results of this study provide no assurance that obesity is always a concomitant of hypertension or vice versa.

Three recent studies provide equivocal evidence of the relationship between childhood obesity and hypertension. In a study of 248 "normal" adolescents, Ellison, Sosenko, and Harper[13] found a significant relationship between overweight and systolic blood pressure but not between overweight and diastolic blood pressure. Furthermore, none of the subjects studied had diastolic blood pressures exceeding 80 mm Hg and only four had systolic blood pressures exceeding 140 mm Hg. Siervogel, Frey, Kezdi, *et al*,[14] found a significant relationship between measures of body weight and both systolic and diastolic blood pressure in male and female children who were members of families with a male diagnosed as hypertensive, but the subjects in this study were not hypertensive. Finally, Court, Hill, Dunlop, *et al*,[15] studied the relationship between obesity and blood pressure by measuring blood pressures of 209 obese children referred to an obesity research clinic. While the authors found a relationship between estimates of body obesity and blood pressure, it is important to note that 77 per cent of the subjects were *not* hypertensive. These authors concluded that elevated blood pressure is not consistently associated with obesity in childhood.

Even if the limitations of the above-cited studies were to be overcome in subsequent studies, several problems in determining a relationship between obesity and hypertension would persist. Failure to develop an objective measure of obesity which can be efficiently and easily used during data collection is one such problem. Skinfold measures have been found to be a valid measure of body fat (which, in turn is seen as a crucial variable related to morbidity), but reliable and valid results require extensive measures by well-trained individuals.* Another problem is the lack of valid and reliable measures of blood pressure in children and adolescents. Hediger, Schall, Barker, *et al*,[16] found that postural position was an important contributor to variation in diastolic blood pressure during adolescence, while Phineas, Gillum, Horibe, *et al*,[17] found that observer variability, room temperature, time of day, and season of the year produced statistically significant differences in blood pressure readings. A final problem is the failure to establish norms for blood pressure among children and adolescents. Phineas, Gillum, Horibe, *et al*,[18] found that height in addition to age must be considered in establishing such norms. Given the methodological problems associated with particular studies and the generalized problems associated with blood pressure and obesity measurements in childhood, it seems reasonable to conclude that obesity in childhood has not been established as a risk factor for hypertension.

There appear to be few longitudinal studies relative to the *delayed* physical risks of childhood obesity. Abraham, Collins, and Nordsieck[19] conducted a study of the relationship between childhood weight status and morbidity in adults. These investigators located and examined 902 males whose childhood weight and health status had been monitored as part of the US Public Health Service study in Hagerstown, Maryland. The authors found no association between childhood weight status and adult status on fasting blood sugar and cholesterol. Furthermore, their was an inverse relationship between childhood weight status and hypertensive vascular disease. That is, those persons who were below average weight as children had the greatest incidence of hypertensive vascular disease as adults. There was no relationship between childhood weight status and cardiovascular renal disease, atherosclerosis, or diabetes.

Several studies have been conducted to determine childhood antecedents of adult hypertension.[20–22] Childhood blood pressure was found to be the best predictor of adult blood pressure status, but not necessarily of adult hypertension. In all of the studies, increase in weight/fatness between adolescence and age 35 was found to be only a weak predictor of adult blood pressure status; in one study the predictive ability applied only to males. None of the studies showed weight status in childhood to be related to hypertension in adulthood. Hoppa, Bengtsson, Bjorntorp, *et al*,[23] examined the effect of onset of overweight and the metabolic changes associated with obesity in women. They found no differences between women who were overweight in childhood and those who became overweight during adulthood. This finding seems to indicate that childhood obesity in women is not a particular risk factor for adult heart disease.

Obesity in childhood and adolescence may lead to psychological problems owing to the censure of overweight persons in modern industrial societies. While it is generally believed that emotional trauma leads to obesity, several studies have shown that the reverse is true.[24–26] That is, children who are overweight and ridiculed by adults and peers develop emotional reactions which persist through

*Personnel communication from Dr. Lombardo, Cleveland Clinic Hospital, Feb. 2, 1982.

adulthood.[27] One author has suggested that the resolution to weight-related neuroses lies not in weight loss by the overweight individual but in a change in societal attitudes toward acceptance of overweight individuals.[28]

Based on this review of evidence, the direct short and long-term risks of childhood obesity remain to be established. Studies with better designs should be conducted to determine whether obese youths experience more short-term illness episodes than normal weighted youth. More importantly, however, longitudinal studies like that conducted by Abraham, *et al*,[19] need to be carried out and repeated in both males and females. Such studies will provide a realistic assessment of the risks of childhood obesity to adult health status. Results will be relevant for programs designed to control weight in this age group.

Known Risks of Nutrient Restriction and Weight Control Measures

As discussed above, the first assumption underlying the prescription of weight control in youths is that obesity is a risk factor. The second assumption underlying the prescription of weight control efforts in infants, children, and adolescents is that, when prescribed and monitored by a physician, these efforts are relatively safe. The available evidence challenges this assumption.

Several researchers concerned with the effect on infants of dietary restrictions during pregnancy have conducted large scale studies. Simpson, Lawless, and Mitchell[29] studied 24,335 White and 2,133 Black women who delivered babies at Brooke General Hospital between January 1946 and April 1966. They found a linear correlation between weight gained during pregnancy and infant birthweight. Among White infants, the mortality rates were six times higher for low-birthweight infants (23.9/1000) than for normal weight infants (3.86/1000). Many of the pregnant women studied were weight conscious and voluntarily limited weight gain. The authors concluded that weight control during pregnancy was a danger to fetal and neonatal health.

Singer, Westphal, and Niswander[30] studied 10,000 infants, analyzing the relationship of maternal weight gain to birthweight, length of gestation, and subsequent growth and performance of the infants up to age one year. Infant growth and performance measurements included weight, height, mental functioning, motor functioning, and neurological performance. Data showed that the less the maternal weight gain, the poorer the infants' development and performance in all areas except neurological functioning.

Churchill and Berendes[31] conducted a prospective study of pregnant women in which they examined the effects of nondiabetic acetonuria (caused by caloric restriction) on the infant and child. Birthweight and mental/motor scores at birth, and IQ at age four years were examined. There were no differences in birthweight, or mental/motor scores at birth between offspring of acetonuric and nonacetonuric mothers. However, at four years of age, infants of nonacetonuric mothers had significantly higher IQs. Furthermore, infants whose mothers experienced acetonuria during the third trimester of pregnancy (when fetal mass increases significantly) had lower IQs than infants whose mothers experienced acetonuria during the first or second trimesters.

Stoch and Smythe[32] conducted a longitudinal study of youths who experienced severe undernutrition during infancy in order to determine permanency of effects. They found that despite improved subsequent nutrition, the study subjects experienced, at age 15, measurable retardation in weight and height and had smaller skulls relative to age norms. Brook, Lloyd, and Wolff[33] studied the effects of dietary restriction (to 350 K cal) in 20 obese youngsters aged 1.5 years to 16.5 years and found that they experienced a reduction in height velocity. Rayner and Court[34] found a similar decrease in linear growth velocity in overweight children who were being treated by dietary restrictions and/or anorectic drugs.

Whether retardation of growth and development extend beyond maturation is unresolved. Dreizen, Spirakis, and Stone[35] studied 60 adolescent girls, 30 of whom exhibited sustained nutritional deprivation and 30 of whom were adequately nourished. Skeletal development of the two groups was compared before and after menarche (which was delayed an average of 24 months in the undernourished group). They found that although skeletal growth was retarded prior to menarche, skeletal growth in the undernourished group accelerated after menarche. Thus in contrast to Stock and Smythe's findings, chronic undernutrition did not affect growth beyond puberty.

Heald and Hunt[36] studied four obese youngsters in an attempt to determine whether alterations in diets could reduce the proportions of proteins used for energy. Subjects between the ages of 12 2/12 and 15 7/12 years, all classed as obese, were given diets of varying caloric amounts and protein portions for periods of 24 days to 10 months. Researchers analyzed nitrogen retention during periods of adequate and reduced nutrient intake. They found that three subjects, who were in their growth spurt period, experienced negative nitrogen balance (i.e., conversion of protein to glucose) when caloric intake was restricted regardless of level of protein intake. Those subjects believed to be physiologically mature (i.e., having completed the growth spurt) did not experience severe or prolonged negative nitrogen balance. The investigators concluded that adolescents, even obese ones, experiencing the growth spurt could not safely be subjected to calorie restriction.

Although postponement of weight control until completion of the growth spurt has been recommended,[37] physicians continue to treat overweight children and teenagers[1,2] on the assumptions that they can prescribe diets which will reduce protein catabolism to a minimum, and adequately monitor the metabolic effects of the diet. These assumptions are questionable. First, since childhood and adolescence are basically anabolic periods, it is doubtful whether any degree of catabolism is acceptable.[38] Second, Van Itallie and Yang[39] have emphasized that "no convenient methods are available to the (general practitioner) that will enable him to estimate the composition of the patient's weight loss." Even the methods which are available to measure nitrogen excretion do not permit identification of the specific body tissues

which are experiencing catabolism. For these reasons, the assumption that the general practitioner can scientifically monitor a weight control program is fallacious. The best the physician can do is to monitor symptoms which may appear only after substantial damage has already been done.[40]

There is a real need for longitudinal studies that will examine the effects of weight control from infancy through adulthood. These studies should focus on the nature and severity of childhood nutrient restriction in relation to adult outcome in terms of growth, maturation and reproduction.

Population at Risk

Self-Directed Dieters

The *majority* of weight control activities are undertaken without direct supervision of health care personnel.[41–43] In addition to being the largest group of dieters, self-directed dieters probably increase significantly the magnitude of weight-control-related health problems. They are likely to be in their early teens and to be non-obese by objective standards.[43–45] Van Itallie and Yang[39] studied differences in nitrogen balance between obese and non-obese adults undergoing caloric restriction and found that the obese accomplished the conversion from use of proteins to use of fats more successfully than their lean counterparts. Since the metabolism of adolescents is more volatile than that of adults, it is logical to conclude that self-directed, non-obese teenage dieters are more susceptible to the adverse effects of weight control than their obese counterparts.

A second reason why self-directed adolescent dieters represent a group at special risk is that they are likely to try a variety of fad diets[43,45] or to try diets which are suited to adult metabolic needs.[24] Diets which severely reduce calorie intake or nutrient proportions are more likely to quickly produce serious symptoms.[42,46]

Little is known about the numbers of infants and children undergoing weight control, but a few surveys provide information about the numbers of adolescents undertaking weight control. Hueneman, Shapiro, Hampton, *et al*,[45] studied growth of 900 teenagers for a period of several years. They determined that in the 9th grade approximately one-half of the boys and two-thirds of the girls were "trying to do something about their weight." Only 15 per cent of the weight-conscious teens were objectively classed as obese. Dwyer, Feldman, and Mayer[44] surveyed 446 suburban, middle-class girls and found that 61.4 per cent had, at some time, dieted to lose weight.

Two surveys and several clinical reports indicate that adolescents on self-directed diets may be experiencing health problems. Nylander[47] found that 10 per cent of the teenagers on weight control programs reported experiencing three or more of the following symptoms: anxiety, depression, chilliness, constipation, amenorrhea, and mental sluggishness. Mallick[43] found that 80 per cent of respondents following diets prescribed in popular books and magazines (Atkins, Stillman, etc.) reported one or more of the following symptoms: hunger, weakness, preoccupation with food, headaches, fatigue, nausea, constipation, nervousness, dizziness, lack of concentration, change in menstrual functioning, and fainting. Both of these studies lacked specific data about duration or frequency of regimes, amount of weight lost, and predieting weight. Nevertheless they point to the need for additional research about the incidence and prevalence of health problems related to weight control in young persons.

Finally, several practitioners have reported serious cases of amenorrhea among young women who independently undertook weight control regimes.[48–50] Again, although these reports do not specify such variables as the type or duration of regime, amount of weight lost, the findings are consistent with other studies and with currently accepted theory. They suggest that some young dieters have serious health problems, and raise the question of how many unreported and unidentified cases remain. A reasonable first step in answering such a question might be to survey pediatricians and gynecologists to determine the number of young patients with menstrual or other problems related to weight control efforts.

Weight control efforts in infants, children, and adolescents have not previously been conceptualized as health hazards. A body of research data indicates that the negative aspects of weight control in this group may have been overlooked. In order to appropriately evaluate the seriousness of this issue further research is needed. It should include longitudinal study of the adverse effects of dietary restriction in young persons and cross-sectional and longitudinal study of the types, duration, and effects of self-directed weight-control regimes in young persons.

In summary, there are methodological flaws in research on the health hazards of obesity in infants, children, and adolescents. Research fails to substantiate the general belief that obesity in this age group increases the risk of health problems later in life. Results of a variety of studies on the health hazards of weight control in children and adolescents suggest that weight control in young persons may be a serious health hazard in itself. It appears appropriate to suggest that clinicians restrict weight control efforts in young patients and that researchers give priority to studies determining the short-term and long-term effects of weight control in this age group.

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