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Childhood obesity

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Abstract

In recent years the problem of child and adolescent obesity in the United States has received much attention. This growing concern is not only attributed to an increased prevalence and persistence of obesity in recent years but also to the probable side effects often attributed to obesity, including physical health and psychosocial difficulties.

CHILDHOOD OBESITY

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INTRODUCTION

In recent years the problem of child and adolescent obesity in the United States has received much attention. This growing concern is not only attributed to an increased prevalence and persistence of obesity in recent years but also to the probable side effects often attributed to obesity, including physical health and psychosocial difficulties.

Obesity has been defined as either a condition in which body weight exceeds ideal weight for height by 10-20% or more or, in recent years, in terms of skin fold thickness in excess of the 85th percentile (Wishon, 1990). Diverse criteria have complicated estimates of the prevalence of obesity, but according to a Harris Poll conducted for Prevention Magazine (1988), nearly two-thirds of Americans age 25 and over are too fat and more than a third are at least 10% over the recommended weights for their height, body build, and sex (Wishon, 1990). Other statistics indicate that obesity is present in 5-10% of preschool age children, 10% of school age children, 15% of adolescents, and in 30% of American adults (Maloney & Klykylo, 1983). In a review of obesity data by William Dietz (1987), of the New England Medical Center Hospitals in Boston, it was determined that the prevalence of obesity has increased by 54% among 6 to 11 year old children and by 39% among 12 to

17 year olds over the past 15 to 20 years. And in some population subgroups, such as females, blacks, children from low-income families, or children with obese parents and siblings, the rates of obesity are considerably higher (Wishon, 1990).

It has been estimated that 20% of Americans are enough overweight to be at risk for certain diet-related diseases (Wishon, 1990). Obesity is one of the most important risk factors associated with cardiovascular disease, diabetes, gall bladder problems, osteoarthritis, respiratory problems, and varicose veins. Obesity is also often present in association with certain kinds of cancer, elevated cholesterol, and glucose intolerance. In addition, people who are obese are greater surgical risks and have a notably shorter life expectancy. The President's Council on Physical Fitness (Wishon, 1990), has concluded that 40% of children, ages 5 to 8 years, show at least one heart disease risk factor, such as obesity, elevated cholesterol, or high blood pressure. And it has been established that sustained hypertension, which contributes to the development of coronary artery disease, congestive heart failure, cerebral vascular disease, and renal insufficiency, is nearly three times higher among the overweight, and it has been indicated that about two-thirds of mildly hypertensive adolescents will become hypertensive adults (Wishon, 1990).

Psychological consequences often associated with obesity include social stigmatization, rejection, withdrawal, isolation, and a diminished self-esteem (Wishon, 1990). In addition, obesity may also be related to underachievement.

PURPOSE AND ORGANIZATION

The purpose of this paper is to overview the etiological and consequential factors related to obesity in children and to draw inferences for school based programs to assist children and their families in weight reduction. Of particular focus will be the role a School Psychologist would play in assisting the program development.

Due to the increased prevalence and persistence of obesity, as well as the numerous physical health and psychosocial side effects attributed to obesity, strategies for prevention and treatment need to be developed. However, in order to be most effective, a knowledge and understanding of the various etiologies of obesity may be advantageous.

The paper starts with a review of the definitions and measurements involved in obesity, turns to a discussion of the persistence of obesity, reviews the etiological factors involved in obesity; the genetic environmental factors, developmental factors, factors of energy intake and energy expenditure, emotional factors, socio-economic status, psycho-social implications, and related brain influences on weight change. Lastly, implications for school based intervention programs and considerations for the role a school psychologist could perform are considered. The review starts with a consideration of obesity measurement.

ISSUES IN MEASURING OBESITY

Although body weight has been the most commonly used measurement for the assessment of obesity, it contains four major difficulties. The first relates particularly to children, in whom weight is a function of age and must be evaluated on an age-specific basis. The second difficulty is that weight is highly correlated with stature, independent of age. Thus, weight needs to be related to both age and height. The third difficulty is that sex differences are well substantiated and must also be included in the standards. And finally, there is the less well-defined problem of body build or body type. At any age or height, an individual can have a different lean body mass and, therefore, a different weight independent of the amount of body fat. Therefore, for weight to be a reliable measure of body fat, the variables of age, height, sex, and body build all need to be considered. Two additional problems inherent in the use of weight include what to use as a standard and what level of weight to consider excessive (Weil, 1977).

Weststrate and Deurenberg (1989) presented a method for assessing childhood obesity in a more objective way than most other routine methods used for diagnosing childhood obesity. They used the sum of bicipital, tricipital, subscapular, and suprailiacal skinfold thicknesses as related to total body density by use of theoretically defined prediction equations. Total body density was used to estimate the total body fat percentage by use of age- and sex-dependent equations on the relationship between body fat percentage and body density. These equations were constructed on the basis of published data on changes in the density of fat-free mass with age in children. With this method, childhood obesity could be assessed more consistently than with most other routine methods used to diagnose obesity in children.

Relating skin fold thicknesses to body fat percentage offers a more accurate, objective, and consistent method for diagnosing obesity in comparison to the traditional method of body fat percentage; where obesity may be defined as body density greater than 25% (for pubertal boys), greater than 30% (for prepubertal children), or greater than 35% (for pubertal girls). However, caution is recommended when assessing extremely obese children and adults, where skin fold thicknesses cannot be accurately measured (Weststrate & Deurenberg, 1989).

Marshall, Hazlett, Spady, and Quinney (1990) undertook a comparative study of obesity measurements with 533 male and female subjects, aged 11.8-15.9. Six adiposity measures were used, which included three skinfold indices, and three height-weight indices derived from measures of height, weight, and eight skinfold thickness measurements. Their analysis supported the interpretation that the underlying construct of these factors was adiposity, and that a factor score of greater than 1.5 SD above the mean was a suitable standard for labeling obesity. Utilizing this dichotomy of factor scores as a standard, the study of differential diagnostic capabilities of four adiposity scales commonly used in identifying obesity was undertaken. However, to ensure a valid measure of obesity, the pursuit of additional measures and larger sample sizes would be recommended in this methodology.

Another measure which can be used with skinfold thickness equations for more precise adiposity measures includes using a waist-hip circumference ratio. However, changes of waist-hip circumference ratio with age and excessive weight have not yet been established (Gibson, 1993).

PERSISTENCE OF OBESITY

A common observation made about obesity is its persistence. Although a majority of obese infants do not become obese children, Maloney and Klykylo (1983) argue that most obese children were obese infants, and at least 60%-80% of obese teenagers become and remain obese adults. Maloney and Klykylo, also cite Merritt (1979), who notes that "It is unusual for an obese child who becomes an obese teenager ever to attain normal weight status."

Several studies have shown a relationship between the number of obese parents and the prevalence of childhood obesity. In one study, Deutscher et al. (1966), cited in Epstein and Cluss (1986), showed that 52% of the offspring of two obese parents were obese, 23% of the children were obese if one parent was obese, and only 10% were obese if both parents were lean. Also, the percentage of children who were obese in families with one obese parent did not vary with the sex of the obese parent.

In another study, data from the U.S. Health Examination Surveys were analyzed to determine changes in body fatness between childhood and adolescence (Zack, Harlan, Leaverton, and Cornoni-Huntley, 1979). A national probability sample of 2,177 children was examined. Cycle II of the survey examined a national probability sample of children 6 to 11 years of age, and focused on growth and development. Cycle III of the survey examined youths 12 to 17 years of age, and studied measurements of sexual maturation and biochemical determinations. The interval between examinations was three to four years. Adiposity was measured as skinfold thickness by pediatricians and specially trained nurses. The correlations between childhood and adolescent adiposity were explored, and separate rankings were made for each age-sex-race group. Results of the study indicated that about three-fourths of obese children - those above the eightieth percentile for skinfold thickness - were classified as obese when re-examined three or four years later. They also found in their study that children of high socioeconomic class were reported to have higher levels of relative fatness than their less economically advantaged peers, and obese children of both sexes mature earlier than nonobese individuals. Further, in a multiple regression analysis of all potential factors, childhood fatness was the most important predictor of adolescent fatness. The prediction was relatively independent of physiological growth, sexual maturation, and economic status and was valid for both sexes, white and black (Zack et al., 1979).

A significant relationship was found between weight at age 9-13 years among 717 American children and their adult weight. Of the 19 children who were over 120% of their ideal weight, 61% were similarly overweight as adults, whereas only 4% of 223 children who were under 95% of ideal weight became very overweight as adults. However, he noted that 39% of very fat children did not become very fat adults, and there were far more fat adults who were normal weight children than who were very fat children (Garrow, 1978).

Charney (1976), found a similar pattern to Garrow when weight in infancy was compared with adult weight. In his survey, equal groups of children were chosen who were light, average or heavy during infancy and measured adult weight at age 20-30 years. Of these infants who exceeded the 90th percentile in the first 6 months of life, 36% were overweight adults, but only 14% of average or lightweight infants became overweight adults. Although the results were considered significant, caution is recommended in predictability (Garrow, 1978).

ETIOLOGICAL FACTORS IN OBESITY

The above reviewed studies reflect only a small sample of investigations targeting predictability in obesity with children. Obesity is considered a heterogeneous disorder with various etiologies. Stunkard (1980), cited in Maloney and Klykylo (1983), identified six major determinant areas of obesity. These areas include genetic versus environmental factors, development, energy intake and energy expenditure, emotional, socioeconomic status, and brain related influences on weight change.

Genetic versus Environmental Factors

Obesity may be affected by genetic factors, environmental influences, or the interaction between both. The relationship between the two variates can be expressed in a variety of ways. For example, hereditary factors may influence aspects of calorie intake, such as a preference for high calorie foods or differences in satiety, and may also influence various aspects of energy expenditure, such as activity levels, resting metabolic rate, or diet induced thermogenesis. Environments also vary in the extent to which they contribute to obesity. For example, environments may promote caloric intake by increasing food availability and by providing various prompts or reinforcement to eat, and may also influence the amount of activity level available (Epstein & Cluss, 1986).

By studying related pairs of individuals in a family, adopted siblings, or twins, the variance of the genetic and environmental components of obesity can be partitioned (Meyer & Stunkard, 1993). In nuclear family studies, data from parents and offspring, and from siblings have helped to identify the extent to which obesity is familial in nature. However, these studies it is difficult to determine whether the familial aggregation for obesity is due to shared genes or shared environments (Meyer & Stunkard, 1993). Adoption studies provide information about the genetic components between the adoptee and the biological parent, as well as environmental components of the adoptee with the adopted family (Meyer & Stunkard, 1993). And twin studies have compared the similarity of identical, or monozygotic (MZ), twins who share all of their genes as well as their early rearing environment, with fraternal, or dizygotic (DZ), twins who in contrast share, on the average, only half of their genes and all of their early rearing environment. By comparing the similarities of MZ twins to the DZ twins, assessment can be made of the relative contribution of genetics and environment (Meyer & Stunkard, 1993).

Most family studies of obesity have used the body mass index (BMI; weight (kg)/ height (m2) as a proxy for body fat (Meyer & Stunkard, 1993). The advantage of using this measure is that it is easier to collect data on a large sample. However, the disadvantage of using solely a BMI measure, is that it is inaccurate, as it is not really measuring body fat.

Ramirez (1993), conducted a study addressing the aggregation of total and relative fatness, as well as subcutaneous fat thickness in healthy nuclear families. The sample for this analysis included 529 Caucasian individuals, with 122 spouse pairs, 135 girls and 150 boys (from 212 sibling pairs). Both parents were less than 50 years old, with two or more children between 11 and 20 years old. Parents were also well educated, with middle to high incomes. Few of the adult participants smoke or drank alcoholic beverages, and engaged in some form of physical activity on a regular basis. Family members were living in the same household, and families with adopted or step children were not included in the study. Ramirez obtained this family and medical history from questionnaires completed by the participants. Subcutaneous fat thickness was measured using ultrasound images. Ramirez, also considered the variables of anthropometric measurements, body composition, and indices of relative fat distribution. The measurements were adjusted for age and body mass index, and the residuals were transformed to normalized z-scores by sex and age group. These z-scores were then used to calculate intraclass correlations between all family members.

The results of the Ramirez (1993) study showed significant familial correlations for the fat deposits on the upper abdomen, triceps, calf, and subscapula, as well as strong familial aggregation for the level of fatness and ponderosity. However, Ramirez, found that the subcutaneous fat on the lower abdomen and the corresponding indices were closely related to the level of fatness, and were significantly correlated between sisters, and between mothers and daughters. It was also found that the lower abdominal fat deposits were more likely to be influenced by environmental components such as diet, level of physical activity, current lifestyle, and childhood experiences.

In another study, the Quebec Study, Bouchard, Perusse, LeBlanc, Tremblay, and Theriault (1988) estimated the transmission of genetic and environmental influences on the amount and distribution of body fat in obesity. This study was conducted in an attempt to overcome former deficiencies in methodology from earlier familial studies. To overcome these deficiencies, their study included more refined measures of body composition, several kinds of relatives, and the use of a multivariate analysis technique to determine the amount of body fat and its distribution in biological inheritance.

Bouchard, et al.(1988) assessed the genetic and environmental transmission between generations by measuring body mass index, the sum of six skinfold measurements, the percentage of body fat, fatmass, fat-freemass, and two indicators of fat distribution. Their sample included 1,698 individuals of 409 families, which included the following nine pairs of family members: spouses (348), foster parent-adopted child (322), siblings by adoption (120), first-degree cousins (95), uncle/aunt-nephew/niece (88), parent-natural child (1239), full siblings (370), dizygotic twins (69), and monozygotic twins (87). Statistical procedures included multiple regression procedures to control for gender and age, and BETA path analysis to take into account both polygenic and cultural inheritance.

The total transmissible variance, in the Quebec Study, ranged from about 40 percent for the amount of subcutaneous fat to 60 percent for the pattern of subcutaneous fat distribution. It was also found that genetics accounted for only 5 percent of the variance for subcutaneous fat and the body mass index, but 20 to 30 percent for the percentage of body fat, fat mass, fat-free mass, and fat distribution. Bouchard, et al. (1988) therefore concluded that the amount of internal fat is influenced more by heredity more than the amount of subcutaneous fat, and that environmental influences are also important in determining the amount and distribution of body fat.

The results of adoption studies are mixed, due in part to the fact that all have limited their studies to children, have failed to explore the full range of body weight, and were handicapped by lack of information on the biological parents. The first adoption study to include information about the biological parents of the adoptees, was conducted by Stunkard, et al. (1986), who were therefore able to provide a clearer picture of the role of genetic factors in obesity. This study examined the contribution of genetic factors and family environment to human obesity in a sample of 540 adult Danish adoptees who were selected from a population of 3,580 adoptees. The sample was divided into four weight classes which included: thin, median weight, overweight, and obese weight. The data from self-reports on weight and height were used in this study, and compared with measured weights and heights from previous studies to assess the accuracy of the data. The comparison of these reports were found to correspond closely, and were therefore considered sufficient for the study. To determine the significance of the differences between mean parental body-mass index in relationship to the adoptee weight class, a separate one-way analyses of variance, including a test for linear trends in means, was conducted for the body-mass indexes of the biological mothers, the biological fathers, the adoptive mothers, and the adoptive fathers. In each case, the independent variable was the adoptee weight class. The results of this study found a strong relationship between the weight class of the adoptees and the body-mass index of their biological parents. However, no relationship was found between the weight class of the adoptees and the body-mass index of their adoptive parents. Cumulative distributions of the body-mass index of the parents showed similar results, where there was a strong relationship between the body-mass index of the biological parents and adoptee weight class and no relationship between the index of adoptive parents and adoptee weight class. Furthermore, the relationship between biological parents and adoptees was not confined to the obesity weight class, but was present across the whole range of body fatness; from very thin to very fat. These results were found to be consistent in all analytic tests. Therefore, Stunkard, et al. (1986), concluded that genetic influences have an important role in determining human fatness in adults, whereas, the family environment alone showed no apparent effect.

Sorensen (1992), analyzed the data from the Stunkard, et al. (1986) Danish adoption study, and quantified the findings. The biological correlation between parents and offspring was found to range from 11 to 15 percent, while the correlation for full siblings was 23 percent. The full correlation of body mass index for heritability was found to range from 20 to 40 percent. However, the correlation between adoptive parents and adult adoptees was close to zero. This quantifiable analysis confirmed the results of the Stunkard, et al. (1986) study, showing no apparent affect of the family environment on the body mass index of adoptees when they were adults.

From Sorensen's (1992) analysis, two questions were raised. Are genetic effects expressed in childhood, and, if so, at what age? And does the childhood rearing environments have an effect while the children are still living in the environment? To answer these questions, Sorensen, Holst, and Stunkard (1992), conducted an adoption study assessing the genetic and environmental influences of body mass index in children.

In the Sorensen, et al. (1992) adoption study, a sample of 269 Danish adult adoptees was selected for whom annual school measurements from the ages of 7 to 13 were available. Correlation coefficients, minimizing age and sex bias, were used to assess both current and maximum body mass indexes between the adoptees in childhood and both their biological and adoptive parents, and also between their age matched biological and adoptive siblings. The sample was divided into four groups, based on the measure of their current weight. These four groups included thin (below the fourth percentile), medium weight (estimated close to the median), overweight (between the 92nd and 96th percentile), and obese (above the 96th percentile). Sorensen et al., found correlations to be stable across the years of 7 to 13 years. Also, an average correlation of .17 was found between adoptees and biological mothers, a correlation of .16 with biological fathers, and a correlation of .59 with biological siblings of the same age. The correlations with members of the adoptive families were found to be lower, with a correlation of .10 with adoptive mothers, .03 with adoptive fathers, and .14 with adoptive siblings. Sorensen et al. concluded that these findings were consistent with previous studies, and that the genetic influence on body mass index as strong as that expressed in adult life is already expressed by the age of 7 years. It was also concluded that the rearing environment shared by the family has a weak influence during childhood.

Another complete adoption study by Price, Cadoret, Stunkard, and Troughton (1987), confirmed the major findings of the Danish study. This study examined the data from an adoptive registry in Iowa, where 357 adult adoptees (age 18 to 38 years) were identified through two Iowa adoption agencies: the Iowa Children's and Family Services agency and the Lutheran Social Services agency. The selected adoptees had been separated at birth from their biological parents, and data was collected through the use of adoption agency records, self-reports, reports by spouse, and interviews. The measure of fatness used in this study was the body mass index, which was examined both by correlation and regression analysis in which age was regressed out. The environmental variables considered in the study included rural versus urban upbringing, as well as disturbed rearing environments. Price, et al. (1987), found that the body mass index of the adoptees was correlated with that of their biological parents, but not of their adoptive parents. It was also found that the body mass index of the female adoptees was highly correlated with that of their biological mothers, but was less correlated with that of their biological fathers. And the correlations between the body mass index of sons and their biological parents were positive, however, were not statistically significant. In contrast to the significant biological parent/offspring correlations, adoptive parent/offspring correlations were found to be negligible and nonsignificant.

Twin studies have been used for nearly a century in an attempt to separate genetic and environmental influences on human obesity (Meyer & Stunkard, 1993). These studies are based on the fact that MZ twins share a genetic correlation of 1.0, and DZ twins share a genetic correlation of 0.5. Therefore, if the rearing environments of both twins are similar, any differences may be attributed to genetic factors.

The largest twin study of human obesity yet undertaken, was conducted by Stunkard, Foch, and Hrubec (1986), who assessed the height, weight, and body mass index in a sample of 1,974 monozygotic and 2,097 dizygotic male twin pairs. Their sample was drawn from a Twin Registry maintained by the National Academy of Sciences-National Research Council (NAS-NRC). Zygosity of the sample was determined through blood typing, fingerprinting, and questionnaires. And height and weight measures were taken of the sample at the approximate age of 20 years, and again 25 years later through self-reports. The measures of fatness used in the study included the body mass index and the percentage overweight, according to 'Fogerty' tables of recommended weights. However, corrections for age in the study were not necessary, due to the narrow range in age differences of the sample. The methods of assessment used in the study included the Bartlett-Box F test for homogeneity of variance, the Chi-square test for determining concordance rates of the twin pairs, Falconer's method for estimating heritability, and a path model calculating correlation coefficients to estimate genetic and environmental contributions.

In their study, Stunkard, Foch, and Hrubec (1986), found that the concordance rates of MZ twins were far higher than that of DZ twins at each of six levels of overweight studied. They also found large differences in the intraclass correlations of height, weight, and body mass index, between the pairs of MZ and DZ twins, which suggested a strong genetic link to obesity. The heritability for body mass index was estimated at .77 at the induction of the study, and at .84 at the 25 year follow-up. Through these statistics, it was concluded that approximately 80% of the variance in body mass index is accounted for by genetic factors. However, in estimating environmental influences, the large intrapair correlations between MZ twins suggested that environmental influences during early adulthood were small at 9%, 15%, and 19% for height, weight, and BMI, respectively. And twenty- five years later, these differences increased to 12%, 26%, and 33% for height, weight, and BMI, respectively. Stunkard, et al. (1986), concluded that height, weight, and body mass index are correlated across time, and that human fatness is under substantial genetic control.

Meyer (1992), cited in Meyer & Stunkard (1993), conducted a large twin study to investigate the role of genetics in human obesity. She studied the body mass index in 5,588 pairs of twins from the Virginia and American Association of Retired Persons adult twin registries. In her study, she found a high genetic variance of 69% for men and 75% for women. Her study not only indicated a strong genetic link to obesity, but also indicated a significant gender difference in the genetic contribution of body mass index.

Another twin study by Stunkard, Harris, Pedersen, and McClearn (1990), assessed the effects of genetic and environmental influences on the body mass index of identical and fraternal twins reared together and apart. Their analysis allowed for a more accurate assessment of the genetic contribution on obesity. Their sample consisted of 93 pairs of identical twins reared apart, 154 pairs of identical twins reared together, 218 pairs of fraternal twins reared apart, and 208 pairs of fraternal twins reared together. Their sample was taken from the Swedish

Adoption/Twin Study of Aging (SATSA). The mean age of the twins studied was 58.6 (+,-) 13.6 years. And sixty percent of the participants selected were women, conforming to the sex ratio for the last half of the life span. Measurements of height and weight were obtained through self-reports, questionnaires, and direct measurement. Analysis of intrapair correlations and maximum-likelihood model-fitting analysis were performed to evaluate the roles of genetic and environmental determinants of total phenotypic variance.

There were three principle findings in the Stunkard, Harris, Pedersen, and McClearn (1990) study on the determinants of body mass index. First, they found a strong correlation between heredity and body mass index. The intrapair correlations of the 93 pairs of monozygotic twins reared apart provided estimates of genetic influences that were independent of environmental contributions, with a .70 correlation for men, and a .66 correlation for women. And similar estimates were derived from the maximum-likelihood model-fitting analyses, with .74 for men and .69 for women. Second, the intrapair correlations of the monozygotic twins were more than twice those of the dizygotic twins. And third, they found that neither the shared rearing environment nor the correlated environments, had any contribution to the variation in body-mass index. They therefore concluded that genetics have a strong influence on body mass index, whereas the childhood environment has little or no influence on body mass index.

Development

Two types of adipose tissue cellular development have been recognized in the study of obesity (Maloney & Klykylo, 1983). The first type is hyperplastic, wherein the body has an abnormally high number of adipose cells, and the second type is hypertrophic, where the adipose cells are of normal number, but of increased fat volume. Thus, a subject who is obese, may have an increase in adipose cell number alone, or may be obese due to a combination of both increased cell number and cell size.

Questions that have been raised in the study of the development of adipose tissue in man, include each of the following. At what age is cell number and cell size achieved? At what age do obese subjects begin to deviate from normal cellular development? At what age do obese subjects exceed normal adult values for cell size and number? And at what age if any can cell number be altered by dietary means? The answers to these questions would not only provide additional information about the development of obesity, but would also be advantageous in providing interventions, such as dietary control, during critical periods of development.

Knittle (1972) studied subcutaneous samples of adipose tissue from obese and nonobese subjects in which adipose cell number and size was determined. His subjects ranged in age from 2 to 26 years of age, and all obese subjects were above the 97th percentile for weight and height, exceeding their ideal weights by 130% or more. In studying cellular size, it was found that obese children had, on the average, larger cells than nonobese children at all age levels studied, although some degree of overlap was observed. It was found that nonobese children had cell sizes below adult values. It was also found that three obese children studied, had attained adult size fat cells by the age of six. However, by the age of 11 years, the fat cells of all obese children had attained, but had not exceeded adult values. In studying cellular number, it was found that obese children had a greater number of adipose cells at all ages. It was even found that the adult range of cellular number was exceeded in one six year old girl. Also, all teen-age obese subjects had either attained or surpassed normal adult values, whereas, none of the non-obese children had attained adult values prior to the age of 12. Knittle observed that in some obese children a rapid increase in cellularity begins between the ages of 5 and 7 years, or earlier, whereas in nonobese children a similar occurrence is observed between the ages of 9 and 12, with little change in number between the ages of 2 and 10.

Knittle (1972) therefore concluded that cellular development proceeds at a more rapid weight in obese subjects, with deviations in 'normal' development being observed as early as 2 years of age. He also suggested that by the age of six, different groups can be distinguished within the obese population relative to cell number and size. These groups include subjects with cell numbers exceeding normal adult values, those with modest increases in cell number, those with increased cell size, and those with normal cell size. Knittle hypothesized that subjects who have exceeded normal adult values of cellularity will most likely retain their obesity, whereas those within the normal range or below may outgrow their 'baby fat'.

More recently, Sjostrom (1993), has reported that an increase in body fat from 1 month to 1 year of age is due only to an increasing fat cell weight (hypothrophic obesity), whereas the expansion of body fat from 1 to 22 years of age is due to an increase in fat cell number (hyperplastic obesity). Also, in adults, obesity up to 30 kg of body fat is usually associated with increased fat cell weight, whereas, in more severe cases of obesity, a combination of increased fat cell number and fat cell weight are usually observed. He also reports that in adulthood, short-term weight changes, of less than 2 years, are associated with changes in fat cell weight, while long-term changes are due to changes in fat cell number. And that increased fat cell weight is usually associated with a number of metabolic disturbances, while a high fat cell number is related to early onset of obesity and a poor maintenance of a reduced body weight.

Energy Intake and Energy Expenditure

Obesity results from an imbalance in energy intake and energy expenditure. Variables in energy intake may include the availability of energy-rich foods, ingestive behaviors, palatability (foods pleasing to the palate or taste), changes in nutrient composition, and metabolic processes (Sclafani, 1993). Variables in energy expenditure may include the resting metabolic rate, the thermic effect of food, and the energy cost of physical activity (Ravussin and Swinburn, 1993). However, the relative contribution of energy intake versus energy expenditure in the development of obesity is still controversial.

Differences in eating behavior between obese and lean subjects was studied by Bellisle (1988), who studied the food intake of 339 French children, aged 7-12 years, who lived in the Paris area. Daily energy consumption and distribution of intake over the waking hours was estimated from dietary histories. These dietary histories were compared in children of five corpulence categories, (lean, slim, average, fat, and obese), which were defined on the basis of weight/height index. Sex and age, in the study, were converted into standardized units. Bellisle found no difference in the estimated daily energy intake observed between the corpulence groups; however, the reported distribution of intake over the waking hours varied. Obese and fat children ate less at breakfast and more at dinner than their leaner peers. And the traditionally larger meals of the day, lunch and dinner, represented higher proportions of daily intake in fat and obese children. He also found that the energy value of the breakfast and afternoon snack was inversely related to corpulence. Bellisle (1988), therefore concluded that the results suggested a possible contribution of disturbed metabolic and/or behavioral daily cycles in the development of the overweight.

Drabman, Cordua, Hammer, Jarvie, and Horton (1979) assessed whether there was a difference in eating rates between normal and obese preschool children and whether noted patterns vary with increasing age. Their sample included 30 normal and 30 overweight children enrolled in 10 nursery schools and preschools, serving primarily white middle-class families in a metropolitan area in the South. Frequency data was obtained for four variables. These variables for eating rates included, number of bites, chews, sips of liquid, and talks with a neighbor, per 30 second observation intervals. An interobserver agreement method, and the Pearson product-moment correlation coefficient was used to assess the reliability of the data. A three-factor analysis of variance design (weight x age x sex), revealed that overweight preschool children demonstrated a somewhat higher rate of distinctly fewer chews per bite. And boys showed increasing chew rates with increasing age. Talk rates also increased with age but were unrelated to sex or weight status. Sip rates were not significantly associated with age, sex, or weight status. The results of the study supported the hypothesis that overweight persons are characterized by an increased eating rate, even at an early age.

In another study, Hammar, et al. (1972), of the University of Washington Adolescent Clinic, undertook an interdisciplinary study of adolescent obesity, focusing on the interrelation-ships of various aspects of obesity, rather than just isolated aspects of the problem. In their study, they evaluated the physical and physiologic changes, behavioral responses, and the psychological and social characteristics of obese teenagers, and compared these to a group of nonobese subjects. Their sample included twenty adolescent subjects, 10 obese and 10 nonobese, whose parents were recruited randomly from referrals for treatment to the Adolescent Clinic. Each subject in the sample was given a complete medical examination which included anthropometric measurements and sexual maturity ratings. They also received complete laboratory studies, were interviewed by a nutritionist, and were given a complete battery of questionnaires and psychological tests. Nutritional findings of the study included increased difficulties with infant feedings, food intolerances, formula changes, and an earlier introduction of solid foods among the obese group. Also, parents of obese adolescents commonly used food, particularly sweets, as reinforcement for good behavior. However, there were no differences found in the total daily caloric intake and eating patterns between the obese and nonobese adolescents. However, the obese subjects were less physically active and more interested in sedentary activity.

One hypotheses for the noted increase in obesity, due to inactivity, among children within the last 20 years, is that this increase is caused in part by watching television. Dietz, cited in Kolata (1986), reported that the strongest predictor of subsequent obesity, next to prior obesity, is television viewing. He found a relationship between obesity and television viewing consistently in three studies. Dietz's explanation of how television contributes to obesity includes the increased amount of food that children eat while watching television. He reports that they eat more of the foods advertised on television, and receive the message while watching television that they will be thin no matter what they eat, as nearly everyone on television is thin. He also reports that children who watch television are inactive. Dietz has started studies of the metabolic rates of children who watch television. For example, the first child Dietz observed was a 12 year old boy, who while watching cartoons had dropped his metabolic rate by 200 calories an hour.

Another study was conducted by Locard, et al. (1992), who studied the correlation of certain environmental factors and obesity in childhood, after taking the parental history of obesity into consideration. Their sample included 327 cases and 704 controls in a population of five year old children, from two French districts (Isere and Rhone). The anthropometric assessments were completed at school, which included medical examinations, including measures for height and weight, data from personal health records, and interviews with the parents. Obesity was defined as a weight for height greater than or equal to 2 standard deviations. The data collected included parental overweight and child birth overweight as 'constitutional' factors and family structure, socio-economic level, and daily lifestyle (sleep, TV viewing, after school care, etc.) as 'environmental' factors. The correlations between obesity at age five, constitutional factors, and environmental factors were statistically analyzed. The results of the study confirmed that parental overweight and birth overweight were closely related to the child's obesity at five years of age. The environmental factors which were found to correlate to childhood obesity included, southern European origin of the mother, snacks, excessive television viewing, and short sleep duration. They found that children who slept less than 10 hours a day were 4.9 times more likely to be obese by the age of five than children who slept more than 12 hours a day. Therefore, they concluded that the less a child sleeps, the higher the risk for obesity by the age of five. In respect to television viewing, they found that children who viewed television more than four times a day were 2.1 times more at risk of being obese. And they found that the more children watched television, the higher the risk for obesity by age five. They concluded from their study that modifications should be made in child care practices, in the prevention of obesity in children.

Emotional

For years obesity has been viewed as a disorder with strong behavioral determinants - 'psychopathology manifested as overeating' (Wadden & Stunkard, (1993). The obese were believed to overeat in a response to negative feelings, or in response to the lack of satisfactory interpersonal relationships. Food was seen as a source of comfort in the absence of other sources of solace. However, today these views have changed. Today when psychopathology is observed in obese individuals, it is seen as a consequence rather than a cause - a consequence of prejudice and discrimination to which the overweight are subjected to daily. This has also been supported by Rodin (1981), cited in Beck (1985), who has argued that "psychopathology, that may be associated with obesity, stems from society's reaction to fatness and the consequent rejection experienced by obese individuals, and not necessarily from psychological disturbances found within the individual"(p.55).

Families were obesity is prevalent have also been associated with psychological dysfunction. Beck (1985) conducted a study to assess the psychological characteristics of obese and normal-weight families. Beck recruited 8 obese families (parents and children) and 8 nonobese families (parents and children), with children aged from 8 to 12 years. In his study, Beck utilized home observations, the Family Environment Scale (FES), psychiatric evaluations, and interviews. In addition, a previously collected sample of 285 families' psychological characteristics (over 1,100 individuals), were included in the study to serve as a normative barometer from which to compare the obese and nonobese families. Beck found that the obese families generally perceived their families differently in comparison to the normal-weight families, and the representative families. The obese families appeared to be less supportive, more conflictual, less self-sufficient and active, and less organized, and more controlling than the nonobese families. These differences between the obese and nonobese families did not appear to be related to the parents marital status. Also, the identified overweight and lean children did not differ in their perceptions of their families when compared to their siblings. Beck therefore concluded from his study that obese families have problematic characteristics. However, these findings do not address the question of whether obesity creates problematic family characteristics or certain characteristics found in families promote obesity. These results are considered preliminary, and replicative studies are needed.

In the interdisciplinary study of adolescent obesity by Hammar, et al. (1972), different parental and family characteristics were found between the obese and nonobese adolescents. The obese adolescents appeared to occupy a unique position in their families. They were often a focus of parental conflicts, a source of embarrassment, and a scapegoat for their siblings. The parents did not feel that there was a warm, open, comfortable relationship between the obese adolescent and the family. The parents tended to view the prognosis for successful weight reduction as hopeless and offered minimal support to the adolescent in coping with his weight. Also, a low body image, low self-esteem, depression, and social isolation were noted among the obese group of adolescents.

Socioeconomic Status

Another variable of obesity which has just recently received attention is socioeconomic status (SES). Sobal & Stunkard (1989) reviewed 144 published studies of socioeconomic status and obesity in developed and undeveloped societies. They found that the relationship between SES and obesity differs between developed and developing societies, differs within developed societies, and differs between men and women. In developing societies, they found that obesity was positively related to SES among men, women, and children. Obesity is rare in these countries due to an insufficient food supply and high levels of energy expenditure, however, the prevalence of obesity increases with rising wealth and increased food availability. In developed societies, by contrast, a strong inverse relationship was found between weight and SES for women, but not for men or children.

Sobal & Stunkard (1989) also reviewed the social attitudes toward obesity and thinness in different societies, and found them to be congruent with the distribution of obesity by SES. They found four variables which may mediate the influence of attitudes toward obesity and thinness among women in developed societies, resulting in the inverse relationship between SES and obesity. These variables include dietary restraint, physical activity, social mobility, and inheritance.

The shift for a thinner ideal body shape in developed societies has led to negative attitudes and a pervasive stigmatization of obesity. These societal attitudes have led to an increased perception of body image, and have also raised question regarding the correlation between body image and self-esteem. Numerous studies have been conducted assessing probable correlations, but findings have shown mixed results. Stager & Burke (1982) conducted a study to determine the existence of body build stereotypes, the extent of identification with these stereotypes, and the effect of any identification upon a child's self-evaluation. Their sample included 406 Caucasian children, in grades four to eight, from a middle-class midwestern community. The children completed the Piers-Harris Children's Self Concept Scale, semantic differential ratings of the Global self-concept, and body build concepts of 'skinny girl', 'fat girl', 'skinny boy', and 'fat boy', and situationally specific self-concepts of 'myself in the classroom', 'myself at lunch/recess', and 'myself when looking in a mirror'. Measures of weight and height were obtained using a standard weighing scale and wall chart. And statistical techniques included differential and discriminant analysis. Their study verified the existence of a 'fat child', 'skinny child' stereotype, which was apparent across the sex groups and age groups studied. Fat children were described as stronger, braver, less good looking, more often teased, and having fewer friends than skinny children. They also found that actual fatness was generally related to identification, but not strongly so. This identification was even noted in children of a young age, suggesting an internalization of societal attitudes of body build even at a very young age. Also, low self-esteem was found to be concurrent with identification, regardless of the child's actual weight-to-height ratio.

In another study by Counts, Jones, Frame, Jarvie, and Strauss (1985), little difference was found between obese and normal weight children (third, fourth, and fifty grades) in their perceptions of obese individuals. Both groups of children endorsed negative attitudes of obese individuals when body type was the only available information. However, these stereotypes were negated when the obese person was physically attractive and/or in a position of authority.

In a study by Cohen, Klesges, Summerville and Meyers (1989), the influence of body weight on sociometric nominations and sociometric ratings by first, third, and fifth graders were assessed. Their sample included 43 first graders, 47 third graders, and 46 fifth graders, from a middle class public elementary school, with a racial balance of approximately 50% white and 50% nonwhite children. The children completed sociometric nominations and ratings. For the nominations task, the children were given a class roster and asked to nominate three children for each of six categories, which included: most liked and most disliked in the classroom, on the playground, and to sit with. For the ratings task, the children rated their liking of each classmate using a 5-point Likert scale. Through assessment of the nominations and ratings, they found less liking (but not disliking) of overweight peers among first and third grade males, while weight did not appear to influence the decisions of fifth graders. Cohen, et al., concluded that their results call into question the validity of a social stigma often assumed to be associated with overweight children. Even though they did not find sociometric choices to be related to weight status with increasing age, weight status may be found to influence the quantity and/or quality of social interactions among peers. However, further study would be needed.

Brain Related Influences on Weight Change

The neuroendocrinological foundations of appetite and satiety have been investigated in great detail. Multiple theories of appetite have been proposed, based upon the use of metabolic signals to the hypothalamus, such as metabolites of protein (aminostatic theory), fat (lipostatic), carbohydrate (glucostatic), or postprandail hypothalamic temperature increase (thermostatic). Work with stereotactic lesions has indicated that the venteromedial nucleaus is associated with satiety, while hunger is related to the lateral area of the hypothalamus. Psychopharmacologic research implicates serotoninergic transmission in the mediation of carbohydrate craving, and suggests the possibility of alteraction by administration of tryptophan (to enhance serotonin synthesis) or fenfluramine (to enhance release). It is speculated that this work will reveal subtypes of obesity related to various biochemical lesions of the hypothalamus (Maloney & Klykylo, 1983).

APPLICATIONS

The current state of knowledge in childhood obesity suggests a number of areas of promise for investigation in the six major determinant areas of obesity discussed above; i.e. genetics versus environment, development, energy intake and energy expenditure, emotional, socio-economic status, and related brain influences on weight change. Also, a knowledge of the various etiologies may prove advantageous in assessment and program treatment. Most weight treatment programs have focused on self and environmental change. These include diets, appetite suppressants, exercise programs, therapy, and behavior modification. Unfortunately, the majority of these programs have proven unsuccessful in weight loss maintenance. Current program strategies which prove most effective include those which integrate several program strategies. To date behavioral intervention has proven to be the most effective non-medical treatment to weight change. Although a multitude of strategies to educate parents and children about the value of a proper diet to ameliorate obesity have been attempted, most have proven unrewarding.

The school has increasingly been recognized as an ideal environment for the prevention and treatment of obesity. Unlike other generally accepted societal institutions, the school has daily contact with children over long periods of time, is cost-effective, facilitates early identification and treatment, has the potential for reaching large numbers of people, and includes important social aspects of the childs environment (Wolf, Cohen, & Rosenfeld, 1985). To date, school-based intervention strategies have primarily focused on three main areas, including behavioral modification, physical activity, and dietary management/nutrition education (Wolf, et al. 1985).

Behavioral approaches to childhood and adolescent obesity emphasize modification of eating and exercise behaviors in relation to the child's immediate environment. These approaches may include modeling, or instructing methods for modifying specific aspects of the child's personal, social, and physical environment as a means of modifying energy intake and expenditure, teaching self-monitoring skills, establishing contracts, providing reinforcement or incentives, and providing motivation and social support from peers, school personnel, and parents. These approaches are most beneficial when implemented early and consistently across environments. And it has been found that school-based programs which incorporate behavioral approaches emphasizing modification of eating and exercise behaviors have been notably successfully in promoting weight loss (Wolf, 1985).

Physical activity and dietary management/nutrition education are both crucial factors in determining whether students lose weight, and more importantly, whether they maintain their weight loss. However, it has been determined that implementing either of these approaches alone may be ineffective, promote minimal weight reduction, or provide short term results (Wolf, et al. 1985). Therefore, it is *recommended to include both components in a more* comprehensive approach, and to include both maintenance or relapse-prevention procedures as well as long-term follow-up, in the treatment and prevention of obesity.

School psychologists, along with school health personnel, are in an excellent position to promote effective weight change. They have frequent, systematic, and continual contact with children over an extended period of time. And they can enlist the assistance of important social support systems such as school personnel, the children's teachers, family, and friends in a collaborative effort. The school psychologist's role in this collaborative effort may include that of a facilitator, behavioral consultant, problem solver, counselor, and research analyst. These roles may be utilized at an administrative level, a staff level, or at a student level, and may also be utilized with parents and families. Although a multi-faceted approach has proven most effective in the prevention and treatment of weight loss, it is rarely considered or addressed within the school environment. A challenge for today's schools would be to first identify obesity as a serious problem with attributable health and psychological difficulties, educating school personnel and families, and teaching multiple strategies for effective weight management.

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