Pediatric Overweight: A Review of the Literature

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A. EXECUTIVE SUMMARY

This report on childhood overweight seeks to review the literature on prevalence of overweight, risk and protective factors for overweight in children, interventions that have been shown to be effective in children in school and community-based settings (as opposed to individual clinical treatment of established overweight), and barriers that challenge successful intervention implementation.

The significance of pediatric overweight as it contributes to adult overweight and chronic disease has been recognized by the US Department of Health and Human Services; monitoring the proportion of overweight children has been identified as 1 of the 10 leading health indicators in Healthy People 2010. Increasingly, pediatric overweight has been associated with increased disease risks during childhood including hypertension, dyslipidemia, hyperinsulinemia, and type 2 diabetes mellitus. In addition, it is known that the process of atherosclerosis is established during childhood. Onset of these morbidities in childhood predicts the presence of disease in adulthood. Alarmingly, one out of six overweight children age 6 and older has been reported to have one or more heart disease risk factors.

BMI has recently been recommended for use in population-based studies of overweight for both adults and children. Specific cut-off values determining adult overweight and obesity have been established based on associated increases in occurrence of chronic diseases, such as diabetes and heart disease, and mortality. Historically, cut-offs for children have varied and were not based on specific chronic disease risks. The newly revised US pediatric growth charts now include sex-specific BMI-for-age percentile distributions for ages 2-20 years and are currently applied across all racial and ethnic categories. Cut-off values in childhood are based on growth curve percentile values. Those values in late adolescence do correspond to adult overweight cut-offs. It remains to be determined if the new pediatric cut-offs will predict future chronic disease risk as children become adults.

Prevalence of Overweight

The current prevalence of pediatric overweight has increased from earlier national surveys of children. All ethnic, racial, gender and age groups have shown increases. For example, the prevalence of overweight among White 6- to 11-year-old girls doubled from 5.1% in the 1963-1970 National Health Examination Survey (NHES) to 10.2% in 1988-1991 (third National Health and Nutrition Examination Survey (NHANES III)). For the same aged African American girls examined during the same time frame, overweight more than tripled from 5.3% to 16.2%. Further, the most recent national data comparing overweight prevalence from NHANES III (1988-1994) to the preliminary 1999 NHANES indicate that overweight has continued to increase in recent years. It is estimated that 13% of children ages 6-11 years and 14% of adolescents ages 12-19 years are overweight, representing a 2-3 percentage point increase from NHANES III.

A recent compilation of 9 large epidemiological studies (including NHANES II and III) of 66,772 children age 5 to 17 years confirmed that the highest percentage of overweight exists among Hispanic boys and African American and Hispanic girls. Studies have also shown a striking increase in overweight rates among American Indian children and adults during the past 3 decades. Similarly, while data are sparse on Asian American children, first generation immigrants generally seem to be relatively protected while second and third generation children are more likely to be overweight, and certain Asian American and Pacific Islander groups have been noted to have higher overweight risks (Pacific Islanders, Koreans, Asian Indians) than other Asian Americans.

Based on the Centers for Disease Control and Prevention Pediatric Nutrition Surveillance System (PedNSS) data for low-income children, overweight was shown to increase among the less affluent segment of the US preschool population. In both the NHANES and PedNSS surveys, the most dramatic increases in overweight occurred among the older (4-5 year old) preschoolers. California state trends demonstrate increases in overweight as well. Data from PedNSS show consistently higher rates of overweight in California compared to the national average for low-income children (0-12 years of age) – regardless of race or ethnicity. Based on self-reported data from the 1998 California Teen Eating, Exercise, and Nutrition Survey (CalTEENS), approximately one-fourth of California's teens were "at risk for overweight", and 7% were "overweight". Boys were more likely to be at risk or overweight than girls. African-American and Hispanic teens were more likely to be at risk or overweight than White or Asian/other adolescents. Similar results were obtained for 9- to 11-year-olds based on parent-reported data from the 1999

California Children's Healthy Eating and Exercise Practices Survey (CalCHEEPS). Approximately 18% of California's 4th and 5th graders were "at risk for overweight", and 14% were "overweight". Differences noted in California data from different studies could be methodological (self-reported weight versus measured weight).

At no other time in human history has an epidemic of obesity of this magnitude been experienced. While differential rates of increase are observed, no racial, ethnic or age group escaped this trend. Because of the ethnic disparities in overweight and "risk for overweight" and in light of California's rapidly increasing Latino population, it is important to include African American and Latino children in overweight prevention strategies and to initiate efforts at an early age. However, it appears few are immune to the environmental influences responsible for weight gain. Adult obesity patterns are shifting as a consequence of the ever-increasing numbers of overweight adolescents entering adulthood. The degree and extent to which adults overweight from adolescence follow the pattern of the past, increasing their adiposity in middle age, is unknown. The possibility of this occurrence suggests a phenomenon heretofore not experienced in human history: a new category of extreme or super obesity initiated in childhood and exacerbated in the 4th or 5th decade of life, with enormous ramifications for increased morbidity and mortality.

Contributing Factors in Pediatric Overweight and Implications for Intervention

Overall, the risk for becoming an overweight adult was 2- to 6.5-fold higher for overweight children than for their non-overweight peers. Tracking of overweight into adulthood increases dramatically with age; some have shown effects beginning at age 6, others around age 9. Other potent risk factors for onset of overweight in childhood include overweight parents, early adiposity rebound (a phenomenon that generally occurs between ages 4 and 8), and early puberty. Intervening prior to age 9 or 10 seems essential for prevention of obesity and interventions beginning prior to adiposity rebound (age 4-8) may be even more promising.

While in developed countries, the inverse relationship between socioeconomic status (SES) and adult obesity has been confirmed by numerous studies using a variety of indicators of social class, among children the relationship between SES and weight status appears more complex and no clear relationship appears to predominate during childhood (see Summary Table). An inverse association between SES and childhood overweight is frequently reported in studies of White children and less frequently reported in children of other ethnicities. Other risk factors for childhood overweight include meal patterns and dietary intake, psychosocial factors including acculturation, parenting style and parental body habitus, declining rates of physical activity, and increasing time spent in sedentary behaviors including TV viewing, video games and movies, and computer use.

Children who are more physically active have a variety of health benefits. Fitness independent of overweight has been significantly related to lower blood pressure in children as young as 5-years-old. Other benefits of regular moderate to vigorous physical activity include improved fitness, and improvements in attitudes, discipline, and behavior. Improvement in academic performance was also observed in some, but not all, studies. Evidence also suggests a protective effect of physical activity during childhood on subsequent fatness in adulthood.

Children are less physically active than in the past both in school and out of school. While some measures of fitness, specifically coordination and strength, do not appear to have changed over time, physical endurance has markedly declined. Recently, approximately 80% of California students in grades five, seven and nine did not meet physical fitness goals. Further, less than half of California children met the physical activity recommendations of 60 minutes or more per day of moderate to vigorous exercise. As with prevalence of overweight, racial and ethnic disparities also exist for physical inactivity. African American and Hispanic children and adolescents have been reported to participate in fewer vigorous activities and/or more sedentary activities than Whites, with differences noted as early as elementary school. Ethnic differences in participation in moderate to vigorous physical activity as well as inactivity (TV viewing, playing video or computer games) have been noted among adolescents, with less physical energy expenditure reported by minority students than Whites. Numerous studies have now demonstrated that risk of overweight among children increases as TV viewing increases. For example, based on data from NHANES II and III, among children 12- 17 years of age the prevalence of overweight increased 2% for each additional hour of TV viewed daily.

Dietary change has been less well documented. However, at least one component of dietary change is clear: among young children, soft drink consumption increased by 23%, while fluid milk consumption decreased by 16% between

the late 1970's and early 1990's. Dramatic increases in soft drink intake by 2- to 17-year olds occurred between 1989 and 1995 alone. According to the Continuing Survey of Food Intakes by Individuals (CSFII), soft drinks were the sixth leading food source of energy and the second leading food source of carbohydrate among US children age 2 to 18 years in 1998. Recent studies are beginning to document an association between pediatric overweight and "liquid sugar". Other dietary factors associated with risk of overweight among children include high fat intake, low daily fruit and vegetable intake, fast food intake, snack food consumption, and meal skipping.

Diet and Physical Activity Interventions

The International Obesity Task Force (1999) concluded that prevention of weight gain is easier, less costly, and more effective than treating overweight after it has fully developed. It is recommended that interventions begin with children prior to the onset and consolidation of risk-related behaviors after which time lifestyle habits may be harder to influence. Prevention may also forestall the concomitant loss of self-esteem that may occur as children become overweight. It has been demonstrated that it is easier to increase activity in the non-overweight as compared to the already overweight child. Because of the refractory nature of overweight treatment, primary prevention in children is critical to stemming the current obesity epidemic.

While motivating children and their families to improve diet and activity practices, programs must avoid creating a negative reaction to overweight and segregation of overweight children. Education regarding the health risks of excess adiposity, poor diet and a sedentary lifestyle is also important. Family-based approaches to prevention provide the additional benefits of improving parental diet and physical activity patterns and reducing parental obesity. Findings suggest that children can be used as a conduit to alter family dietary behaviors.

A number of well-executed nutrition and physical activity interventions have targeted school children. While self-reported diet knowledge and intake and physical activity are often shown to improve, it has proven easier to influence outcomes such as changes in smoking, television viewing, physical fitness, diet and blood lipids, rather than overweight. There is little evidence so far that school-based programs have had a major or lasting impact on BMI or body adiposity. In addition, specific changes to in-school physical education, particularly when PE specialists are used, have been successful in improving time spent in moderate to vigorous activity during school. Unfortunately, many improvements have not been shown to be generalizable outside the school setting and follow-up studies often find a rapidly diminishing effect once the intervention is completed, which suggests that maintenance or "booster" interventions are necessary as well as sustainable changes in the environment. Further, complementary improvements in the activity and diet patterns of parents and families, factors inadequately addressed in most interventions, appear critical to successful health maintenance.

In light of the lack of success in interventions aimed at reduction or prevention of overweight, some may question the wisdom of large-scale programs for healthy school children. However, there are at least 4 reasons to promote interventions to improve nutrition and physical activity in children: the child may receive immediate benefits (such as better fitness or energy or micronutrient intake); intervention at critical periods may improve adult health (there may be specific periods that act as set points for later health); modifying chronic disease risks in childhood may lead to lower rates and risk factors in adults (e.g., the process of atherosclerotic plaque formation may slow); and modification of children's behaviors may lead to improved health behaviors in adulthood that would protect against chronic diseases.

Rather than weight loss, a reduced or stabilized BMI-for-age percentile or percentage overweight are appropriate outcomes for interventions in children. Other appropriate goals include increased physical activity levels and improved fitness levels, dietary habits, division of eating responsibility between parent and child, self-esteem, self-efficacy at physical activity, body image, and physiological measures (e.g., decreased lipids, blood glucose, blood pressure or breathing difficulties).

Social Marketing for Behavior Change

Many interventions described in this paper incorporated social marketing principals at several levels of intervention. Some successes have been achieved using social marketing. For example, specific behaviors, such as replacing whole milk with lower fat milk, have been shown to be amenable to social marketing approaches. However, the success of many social marketing interventions has been limited.

A recent state level report summarizes interventions that applied social marketing principals, the strategies used, and the associated outcomes. The report recommended that more attention be paid to setting realistic objectives when integrating social marketing concepts throughout intervention development and implementation. It also recommends ensuring that behavioral theories are actively applied to intervention design. Market segmentation should be better utilized in intervention implementation. Social marketing strategies can be utilized to design messages that appeal across multiple groups in order to reach all children in our state. In addition, it is recommended that social marketing campaigns should be used to alter the environment and to modify environmental policies. Social marketing strategies hold promise for delivery of population-based obesity prevention messages.

Policy and Legislative Approaches to Behavior Change

Though not well evaluated, policy initiatives may serve as important adjuncts to other intervention strategies. Environmental and policy change may be essential to the sustainable success of interventions to increase physical activity and improve dietary habits. In the schools, improving the content of school meals, reducing access to unhealthy snack foods, and employing pricing strategies to favor selection of healthy foods are examples of promising strategies. Qualitative assessments suggest that improving neighborhood safety and access to recreation areas could increase physical activity of residents in communities with low rates of physical activity. Similarly, improving neighborhood and traffic safety may provide critical support to other community physical activity interventions, such as low income areas or areas with large numbers of seniors.

Although sustainable environmental and policy change could potentially have a great impact on dietary intake and physical activity, there are limited data correlating successful environmental or legislative change to improved physical activity levels or changes in dietary intake. More rigorous evaluations of the independent impact of these types of interventions are therefore warranted.

Conclusions

A child is born with certain risk factors that are immutable, such as genetic predisposition, the body habitus of one's parents at the time of birth, and even the nutritional environment prior to birth, once that process has occurred. However, even in the face of these potent determinants of overweight and adiposity, the environment throughout childhood exerts strong effects on the development and maintenance of a child's body weight and habitus. Modifiable risk factors deserve broad-based intervention for both overweight children and the general populace, given the high likelihood in the US of developing overweight during the childhood years. Intervention should begin early, be multi-level, and be multi-age in design.

Early interventions targeting toddler and early childhood diet and physical activity should be followed by booster interventions in elementary years and beyond, seeking to increase length of time spent in PE, decrease sedentary behaviors such as TV viewing, decrease accessibility to high fat, high sugar, calorically dense foods and beverages, improve availability of physical activity programs, and ensure safe environments promoting physical activity. The pre-adolescent and adolescent years are accompanied by a fall-off in both PE and regular physical activity outside of schools and an increase in less healthy eating associated with dieting, particularly in girls.

School-based dietary interventions should include intervention in the school cafeteria and among food preparation staff for nutritional content change, as well as in the classroom. In addition, because the habits of children are largely developed and maintained in the home, parents and families must be involved if dietary and physical activity improvements are to be effective and sustainable. Social marketing and policy strategies and school-based campaigns, emphasizing to youth that nutrition and physical activity enhance physical, psychological and emotional health, seem to be promising approaches. Evaluation activities are important to assess the success of all interventions.

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Summary Table: Evidence of Associations with Childhood Overweight and Effects of Intervention.

Key to Symbols:
- *** *repeatedly documented association with overweight*
- ** *weak evidence of association with overweight*
- * *mixed or very weak evidence of association with overweight*
- ↓ *intervention studies tend to result in decrease in overweight*
- *0* *intervention studies tend to result in no effect on overweight*
- uk *not adequately evaluated by intervention studies*
- na *not readily modifiable by intervention studies*

Factor	Association With Overweight[1] Evidence	Direction[2]	Effect of Intervention	Comments
Sociodemographics				
Family income/parent education	**	inverse	na	Association strongest for white children and with overweight after childhood
Single parenthood	*	direct	na	
Smaller family size	*	direct	na	
First-born status	*	direct	na	
Acculturation	**	direct	na	
Familial and Psychosocial Influences				
Overly restrictive feeding practices	***	direct	uk	Evidence strong for influence on food choice, but weight not evaluated
Inadequate limit-setting	*	direct	uk	
Using food as reward	*	direct	uk	Evidence strong for influence on food choice, but weight not evaluated
Parental neglect	*	direct	uk	
Poor family communication	*	direct	uk	
Poor self-esteem	*	direct	uk	
Depression/psychiatric disorder	*	direct	uk	
Physical Activity Patterns				
PE participation	**	inverse	↓	
Recreational physical activity	**	inverse	↓	
Parental physical activity	*	inverse	uk	
Television and Media Factors				
Television viewing	***	direct	↓	Limited interventions have targeted either TV or video usage or both
Video/computer game playing/use	**	direct	↓	
Dietary Factors				
Total calories	*	direct	0	
Fat	**	direct	0	
Energy density	*	direct	uk	
Fruits and vegetables	**	inverse	uk	Interventions have increased reported intake, but weight not usually evaluated
Fruit juice	*	direct	uk	
Fast foods and restaurant use	**	direct	uk	Interventions have been done in conjunction with other recommendations for a healthy diet, but independent effect on weight not well evaluated
Snack foods	**	direct	uk	
Sugar-sweetened beverages	**	direct	uk	
Meal skipping	**	direct	uk	
Mild food insecurity	*	direct	uk	

[1] Presence of an association does not allow for discrimination between cause and effect (e.g., a direct association between poor self-esteem and overweight could be due to poor self-esteem resulting in overweight or poor self-esteem being a consequence of overweight or both). Intervention studies, however, can be used to determine the direction of causality.
[2] Direction of association indicates whether the association is *direct*, meaning that factors are related in the same direction (e.g., *increased* television viewing is related to *increased* weight) or *inverse*, meaning that factors are related in the opposite direction (e.g., *increased* PE participation is related to *decreased* weight).

B. INTRODUCTION

The goal of this literature review was to provide information to the California Department of Health Services for the design and implementation of an intervention program to address childhood overweight. The main objective of the first section was to determine the magnitude and scope of pediatric overweight and identify high-prevalence groups by reviewing the prevalence among children nationally and statewide. The prevalence of overweight among adults and a discussion of critical periods for the development of pediatric overweight were also briefly reviewed. The second section focuses on factors that may alter the risk of overweight among children, with a brief review of non-modifiable factors (to aid in group selection) and emphasis on modifiable factors (to aid in intervention planning). While the mother's health status (such as diabetes), diet, and metabolism affect fetal growth and may affect the development of metabolic mechanisms, we will not extensively cover background on risk factors such as low or high birth weight, nor the impact of breast-feeding on future overweight of the child. This decision was made based on our understanding that the DHS is not planning either a pre-natal or a breast-feeding intervention. The third section focuses on lessons learned and barriers noted from past interventions targeting children, with emphasis on healthy eating and physical activity. The last two sections review social marketing interventions and policy programs.

C. METHODS

Articles for review were identified based on: 1) on-line search of databases (Medline, PsycInfo) using the keyword method; 2) recommendations from project staff; and 3) sources cited by collected articles. Articles were selected based on the following criteria: 1) main topic was pediatric overweight or healthy eating and physical activity among children; and 2) study sample was comprised of or included children between the ages of 0 to 18 years. Articles published in the last decade and studies conducted in the United States were the focus, but relevant studies published earlier or conducted elsewhere were included where appropriate.

D. PREVALENCE OF OVERWEIGHT

1. INTRODUCTION

Historically, *definitions of child overweight and obesity* have varied considerably (Guillaume, 1999; Kuczmarski, 2000a). Ideally these criteria would include measures of body composition that distinguish between individuals with large amounts of muscle or lean tissue and individuals with elevated body fat (Hubbard, 2000). However, such a distinction is not routinely made. In practice, overweight is commonly determined by weight adjusted for height. The most widely used weight-for-height index is body mass index (BMI), which is calculated as weight in kilograms divided by the square of height in meters (Keys, 1972). Some researchers have advocated the use of alternative indices in children (Freedman, 2000b). In particular, the Rohrer index (kg/m^3) and weight/height$^{2.4}$ ($kg/m^{2.4}$) have been investigated in trials (Cole, 1991). However, BMI has recently been recommended for use in population-based studies of adults, as well as children (Cole, 1991; Dietz, 1999). The newly revised US pediatric growth charts now include sex-specific BMI-for-age percentile distributions for ages 2-20 years (Kuczmarski, 2000b). Specific cut-off values for adult overweight and obesity have been established based on associated increases in occurrence of chronic diseases, such as diabetes and heart disease (Guillaume, 1996). This approach is more problematic in children, who experience much lower rates of chronic diseases. Consequently, the cut-off values for pediatric overweight are more arbitrary. For children and adolescents the current suggested classifications based on BMI are: "at risk of overweight" for youths with BMI-for-age between the 85th and 95th percentiles and "overweight" for youths with BMI-for-age $\geq$ 95th percentile (Barlow, 1998). The amount of body fat constituting obesity in children has not been established and therefore, whenever possible in this manuscript, the terms "obese" and "obesity" are not used. Instead the terms "at risk of overweight" and "overweight" are used in accordance with the above definitions. The reader is cautioned, however, that the literature, both popular and scientific, abounds with the word "obesity" and that in describing this body of literature, the use of the word "obesity" is sometimes unavoidable.

The significance of pediatric overweight as it contributes to adult overweight and chronic disease has been recognized by the US Department of Health and Human Services; monitoring the proportion of overweight children has been identified as 1 of the 10 leading health indicators in Healthy People 2010 (USDHHS, 2000). Increasingly, *pediatric overweight has been associated with increased health risk* during childhood: increased stress on weight bearing joints (Bray, 1985), hypertension and dyslipidemia (Figueroa-Colon, 1997; Morrison 1999a/b; Freedman, 1999), hyperinsulinemia and type 2 diabetes mellitus (Pinhas-Hamiel, 1996; Freedman, 1999), and Pickwickian syndrome or breathing difficulties (Leung, 1990). Overweight during childhood has also been associated with the metabolic syndrome (characterized by a combination of hypertension, dyslipidemia, and insulin resistance) during adulthood (Vanhala, 1999). It has been estimated that by 5-10 years of age, 60% of overweight children have 1 associated biochemical or clinical cardiovascular risk factor and 25% have 2 or more (Freedman, 1999). While adiposity has been shown to be modestly correlated to the risk of various morbidities in childhood, body fat distribution (i.e. the ratio of upper to lower body fat) has been more predictive (Freedman, 1987). Further, Must (1999b), in a recent review on the consequences of pediatric obesity, concluded "few problems in childhood may have as significant an impact on childhood emotional development as obesity." Overweight adolescents have been found to suffer more emotional problems and consider themselves poorer students compared to their non-overweight counterparts (Falkner, 2001). Few studies have examined the long-term effect of pediatric overweight on adult morbidity, in part due to the inherent difficulty of maintaining a long-term cohort. Further, the relative contributions of pediatric and adult overweight to adult mortality are unclear because of the tracking (see discussion below) of weight status from childhood to adulthood (Gunnell, 1998). However, the data that do exist suggest that obesity-related disease can begin in childhood and that pediatric overweight increases the risk of adult morbidity and mortality (Dietz, 1998a/b; Must, 1999b). Specifically, longitudinal data from the Bogalusa Heart Study showed that overweight, hypertension, and dyslipidemia in childhood were predictive of the occurrence of these risk factors in young adults (Bao, 1997). Likewise, data from a 57-year follow-up of a British cohort indicated that children with a high BMI suffered increased risk as adults of mortality from heart disease as well as all-cause mortality (Gunnell, 1998).

Beginning in 1985, the cutoff points for adult overweight were commonly based on the sex-specific 85th percentile of the BMI distribution for persons aged 20-29 years in NHANES II, which corresponded to a BMI $\geq$ 27.8 for men and a BMI $\geq$ 27.3 for women (NIH, 1985). The rationale for selecting this age group as the reference population was that young adults are relatively lean and any weight gain with age is due primarily to the addition of body fat (Van Itallie, 1985). More recently, a BMI at or above 25.0 kg/m^2 was adopted in the Dietary Guidelines for Americans (USDA, 2000) and by the World Health Organization (WHO, 1998) as the criteria for overweight applied to both genders.

Using the most recent edition of the Dietary Guidelines (5th edition), *current definitions based on BMI for both male and female adults* are as follows: healthy weight 18.5-24.9 kg/m^2; overweight 25.0-29.9 kg/m^2; and obese ≥ 30 kg/m^2 (USDA, 2000). These definitions were selected based on the relationship between BMI and morbidity and mortality risk (Kuczmarski, 2000a).

According to data from NHANES III (1988-1994), the prevalence of type 2 diabetes mellitus, gallbladder disease, coronary heart disease, high blood cholesterol, hypertension, and osteoarthritis increased as BMI increased (Must, 1999a). Obesity is second only to smoking as the leading preventable cause of death in the United States; the annual number of deaths attributed to obesity among US adults was estimated to be 280,000 for the general population (McGinnis, 1993; Allison, 1999). The direct and indirect costs of obesity in the US have been estimated to approximate 10% of the national health care budget (Wolf, 1998).

2. PREVALENCE OF PEDIATRIC OVERWEIGHT

Representative samples of between 3,000 and 14,000 youths aged 6 through 17 years were examined in each of five national surveys conducted between 1963 and 1991 (Troiano, 1995). The surveys utilized complex, stratified, multistage, probability cluster design. *Childhood overweight prevalence increased among all gender and age groups* (Tables 1 and 2). The increase was particularly striking for African American 6- to 11-year-old girls. The prevalence of overweight among White 6- to 11-year-old girls doubled from 5.1% in the 1963-1970 National Health Examination Survey (NHES) to 10.2% in 1988-1991 from the third National Health and Nutrition Examination Survey (NHANES III). For the same aged African American girls examined during the same time frame overweight more than tripled from 5.3% to 16.2%. Assessment of subcutaneous fat by measuring skinfold thicknesses is another technique used to determine adiposity, although skinfold measurements can be hampered by large inter-observer variation. However, when skinfolds were used instead of BMI to assess overweight similar findings were observed (Gortmaker, 1987). Further, the most recent national data comparing overweight prevalence from NHANES III (1988-1994) to the preliminary NHANES IV (1999) indicate that overweight has continued to increase in recent years (CDC, 2001). Based on initial findings, it is estimated that 13% of children ages 6-11 years and 14% of adolescents ages 12-19 years are overweight, representing a 2-3 percentage point increase from NHANES III. The 1999 Youth Risk Behavior Surveillance System (YRBSS) data, based on self-reported rather than measured heights and weights as in NHANES, corroborated the increasing prevalence of overweight among adolescents. Nationwide, 16.0% of teens were at risk of becoming overweight (17.5% of males, 14.4% of females), while 9.9% of teens were overweight (11.9% of males, 7.9% of females) (Kann, 2000).

Table 1. Trends in age-adjusted percentage of "overweight"[1] among US youths of all races aged 6-11 years[2]. (Troiano, 1998)

Survey and years	Overweight (%)	
	Males	Females
NHES II (1963-1965)	3.9	4.3
NHANES I (1971-1974)	3.8	3.6
NHANES II (1976-1980)	6.5	5.5
NHANES III (1988-1994)	11.4	9.9

[1]BMI-for-age ≥ 95th percentile of the revised NCHS/CDC growth charts (preliminary data) constitutes "overweight".
[2] NHES, National Health Examination Survey; NHANES, National Health and Nutrition Examination Survey.

Table 2. Trends in age-adjusted percentage of "overweight"[1] among US youths of all races aged 12-17 years[2]. (Troiano, 1998)

Survey and years	Overweight (%)	
	Males	Females
NHES III (1966-1970)	4.6	4.5
NHANES I (1971-1974)	5.4	6.4
NHANES II (1976-1980)	4.7	4.9
NHANES III (1988-1994)	11.4	9.9

[1]BMI-for-age ≥ 95th percentile of the revised NCHS/CDC growth charts (preliminary data) constitutes "overweight".
[2] NHES, National Health Examination Survey; NHANES, National Health and Nutrition Examination Survey.

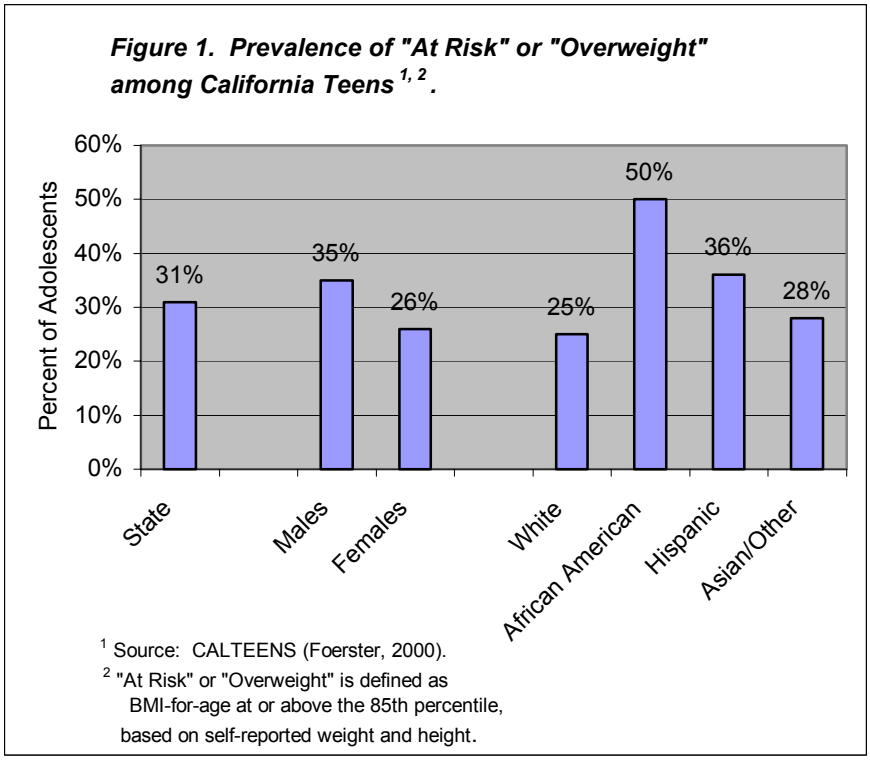
The most current national overweight prevalence estimates (from NHANES III, 1988-1994) by gender, age and race/ethnic groups for 6- to 17-year-old children are detailed in Table 3. A recent compilation of 9 large epidemiological studies (including NHANES II and III) of 66,772 children age 5 to 17 years confirmed that the *highest percentage of overweight exists among Hispanic boys and African American and Hispanic girls* (Rosner, 1998). Similar ethnic differences were observed among adolescents in the 1999 YRBSS (Kann, 2000). Morrison (1999c) and colleagues reported secular increases in BMI in a community study of Black and White children in the third to fifth grade between 1973-1975 and 1989-1990. The BMI increase was accompanied by a similar secular increase in hypercholesterolemia among young children and both of those trends were most marked for Black female children.

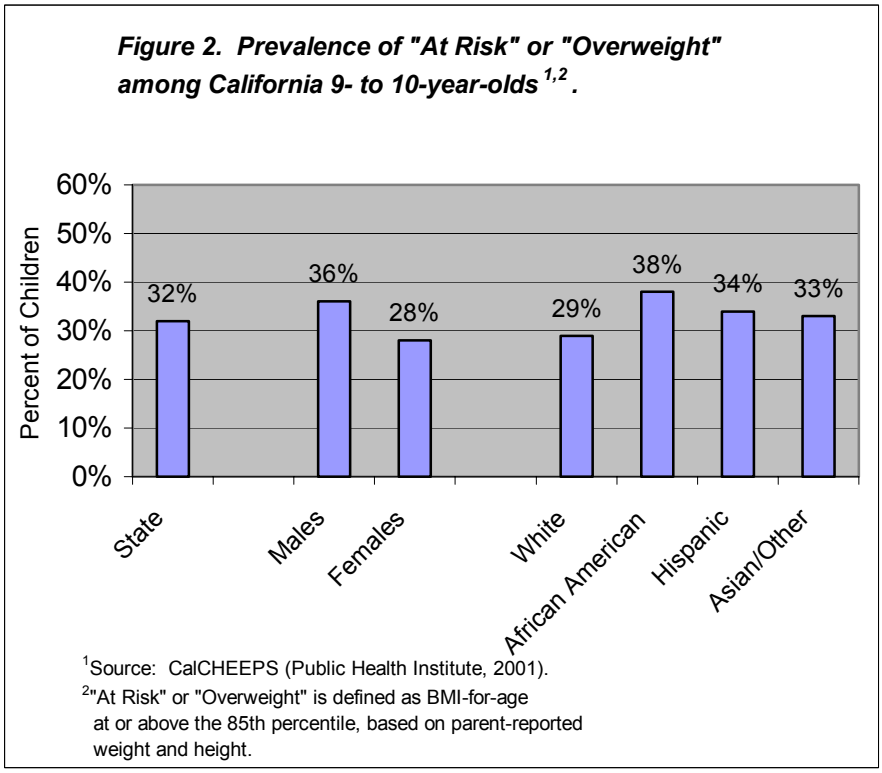
Based on self-reported data from the 1998 California Teen Eating, Exercise, and Nutrition Survey (CalTEENS), approximately one-fourth of California's teens were "at risk for overweight", and 7% were "overweight" (Foerster, 2000). Boys were more likely to be at risk or overweight than girls. African American and Hispanic teens were more likely to be at risk or overweight than White or Asian/other adolescents (Figure 1). Similar results were obtained for 9- to 11-year-olds based on parent-reported data from the 1999 California Children's Healthy Eating and Exercise Practices Survey (CalCHEEPS) (Figure 2). Approximately 18% of California's 4th and 5th graders were "at risk for overweight", and 14% were "overweight" (Public Health Institute, 2001). It is unclear whether disparities between national data and California data are a reflection of true regional differences or are a result of methodological differences (e.g., measured vs. self-reported weight).

Table 3. Prevalence of age-adjusted "overweight"[1] from NHANES III data (1988-1994). (Troiano, 1998)

Group	Overweight (%)
All children	
6 to 11 years	10.6
12 to 17 years	10.6
All males	
6 to 8 years	9.9
9 to 11 years	12.6
12 to 14 years	10.7
15 to 17 years	12.0
All females	
6 to 8 years	9.5
9 to 11 years	10.4
12 to 14 years	11.5
15 to 17 years	8.2
Males 6 to 11 by race/ethnicity	
Total	11.2
White (non-Hispanic)	10.3
African American (non-Hispanic)	11.9
Mexican-American	17.4
Males 12 to 17 by race/ethnicity	
Total	11.3
White (non-Hispanic)	11.1
African American (non-Hispanic)	10.7
Mexican-American	14.6
Females 6 to 11 by race/ethnicity	
Total	10.0
White (non-Hispanic)	9.2
African American (non-Hispanic)	16.4
Mexican-American	14.3
Females 12 to 17 by race/ethnicity	
Total	9.8
White (non-Hispanic)	8.5
African American (non-Hispanic)	15.7
Mexican-American	13.7

[1] BMI-for-age ≥ 95th percentile based on the revised NCHS/CDC growth charts (preliminary data) constitutes "overweight".





Fewer nationally representative data are presently available on the prevalence of overweight among very young children. National survey data based on between 1200 and 7500 children under 6 years of age indicated that prevalence of overweight increased between NHANES I, II and III for girls in all age groups (6-11 months [data not available in NHANES I], 12-23 months, 2-3 years, 4-5 years) (Table 4). For boys, the results were less consistent (Ogden, 1997).

Based on the Centers for Disease Control and Prevention Pediatric Nutrition Surveillance System (PedNSS) data for low-income children, overweight was shown to increase among the less affluent segment of the US preschool population (Mei, 1998) (Table 5). In both the NHANES and PedNSS surveys, *the most dramatic increases in overweight occurred among the older (4-5 year old) preschoolers*. Like the US, other industrialized nations have also experienced a growing prevalence of overweight. Recently, data from the UK showed that the prevalence of overweight increased among younger British children (Bundred, 2001). Between 1989 and 1998 there was a 60% increase in the prevalence of overweight (BMI > 85th percentile of the British Growth Reference Charts) and a 70% increase in the prevalence of obesity (BMI > 95th percentile) among 3-4 year olds. Data from PedNSS show consistently higher rates of overweight in California compared to the national average for low-income children (0-12 years of age) – regardless of race or ethnicity (Figure 3).

Table 4. Trends in age-adjusted percentage of "overweight"[1] among US youths of all races aged 6 months to 5 years[2]. (Ogden, 1997)

Survey and years	6-11 months		12-23 months		2-3 years		4-5 years	
	Males	Females	Males	Females	Males	Females	Males	Females
NHANES I (1971-1974)	†	†	7.5	6.1	3.1	2.0	4.4	5.8
NHANES II (1976-1980)	4.0	6.2	7.2	7.2	2.0	2.5	4.4	7.6
NHANES III (1988-1994)	7.5	10.8	7.5	9.5	2.1	4.8	5.0	10.8

[1] Weight-for-length (for children ≤ 2 years old) or weight-for-stature (for children > 2 years old) above the 95th percentiles of NCHS reference curves (Hamill, 1979) constitute "overweight".
[2] NHANES, National Health and Nutrition Examination Survey.
† NHANES I did not include children younger than 1 year.

Table 5. Prevalence of age-adjusted "at risk of overweight" and "overweight" among low-income children 0 to 59 months from 1983 to 1995. (Mei, 1998; Data source: PedNSS)

Age (months)	At Risk of Overweight			Overweight		
	1983	1995	Relative Increase (%)	1983	1995	Relative Increase (%)
Total (0-59)	18.6	21.6	16.1	8.5	10.2	20.0
0-11	22.7	25.5	12.3	9.9	11.3	14.1
12-23	23.3	26.0	11.6	12.1	13.7	13.2
24-35	14.2	16.8	18.3	5.6	7.0	25.0
36-47	15.8	18.6	17.7	7.0	8.5	21.4
48-59	17.2	21.2	23.3	8.2	10.6	29.2

[1] Weight-for-length (for children ≤ 2 years old) or weight-for-stature (for children > 2 years old) between the 85th and 95th percentiles or above the 95th percentiles of NCHS reference curves (Hamill, 1979) constitute "at risk of overweight" and "overweight", respectively.

Figure 3. Prevalence of "overweight" in low-income children (0-12 years) in the US & California, 1997-1999. (CDC, 1997a/1998/1999; Data source: PedNSS)

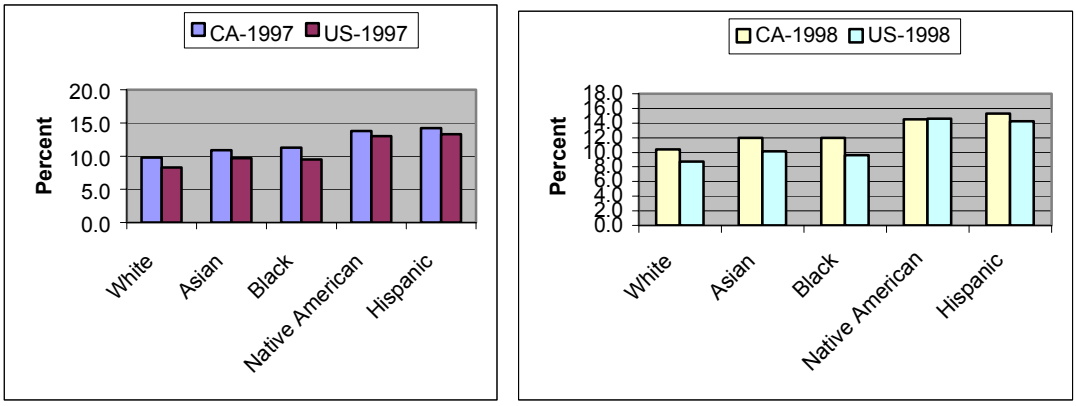
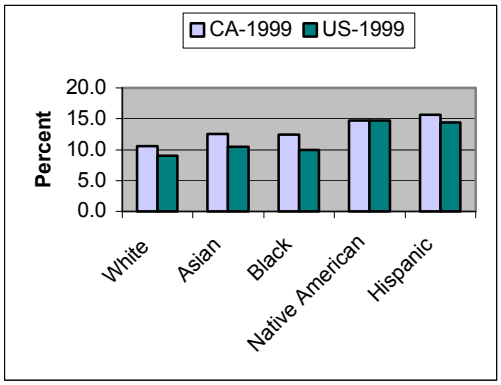
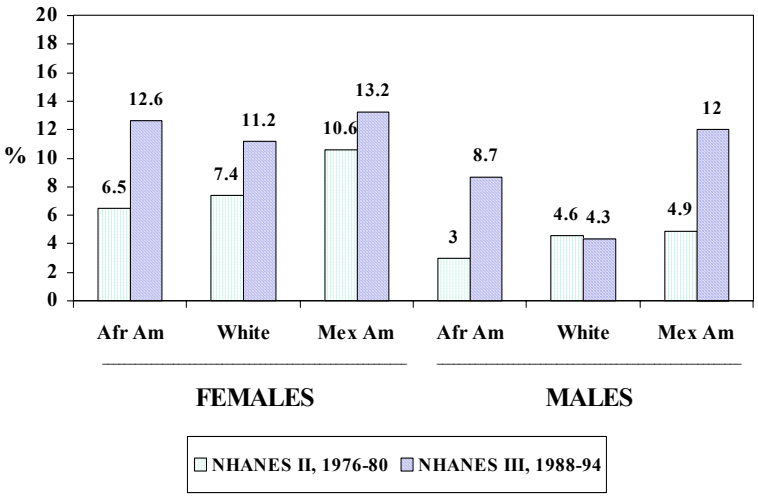


Figure 3 (continued).



Figures 4, 5 and 6 illustrate the dramatic increases in overweight that have occurred for all age and race groups of children, with the exception of White preschool-age boys. At 6-11 and 12-17 years of age no data are available for Hispanic children in NHANES II. However, Hispanic HANES data (1982-1984) showed that Mexican American children consistently have the highest rates of overweight, with the exception of school-age African American girls (Kaplowitz, 1989). It should be noted that *differences among populations designated as Hispanic have been documented*. For example, based on Hispanic HANES data, overweight was more prevalent in Puerto Rican adolescents compared to Mexican Americans and Cubans (Pawson, 1991). However, recent data from the National Longitudinal Study of Adolescent Health (Add Health Study), the largest nationally representative survey of teens completed to date (N ≈ 14,000), indicated that prevalence of BMI ≥ 85th percentile was similar (32.2% to 33.1%) for Mexican American, Puerto Rican, and Cuban adolescents, aged 13-18 years. It is noteworthy that significant generational differences were observed. Twenty-six percent of first generation Hispanic adolescents were at risk of overweight or overweight compared to 33% of second and third generation Hispanics (Popkin, 1998).

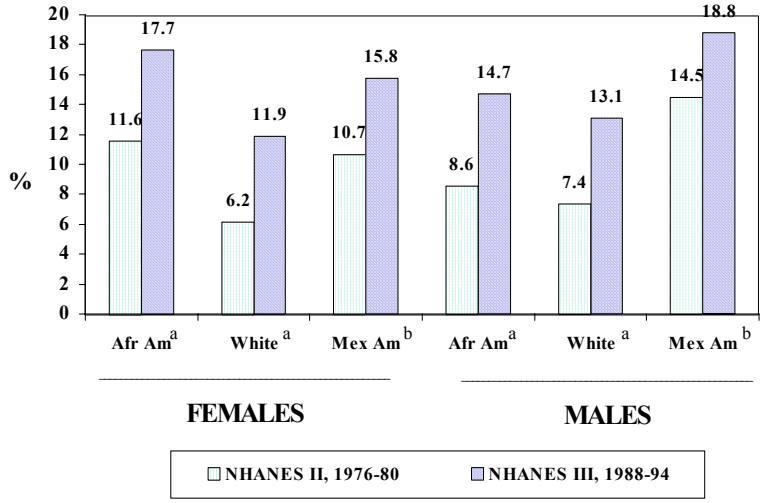
Figure 4. National prevalence of overweight in children, aged 4-5 years, NHANES II and III.



Source: Ogden et al, 1997

Data for Mexican Americans are from Hispanic HANES, 1982-84

Figure 5. National prevalence of overweight in children, aged 6-11 years, NHANES II and III.

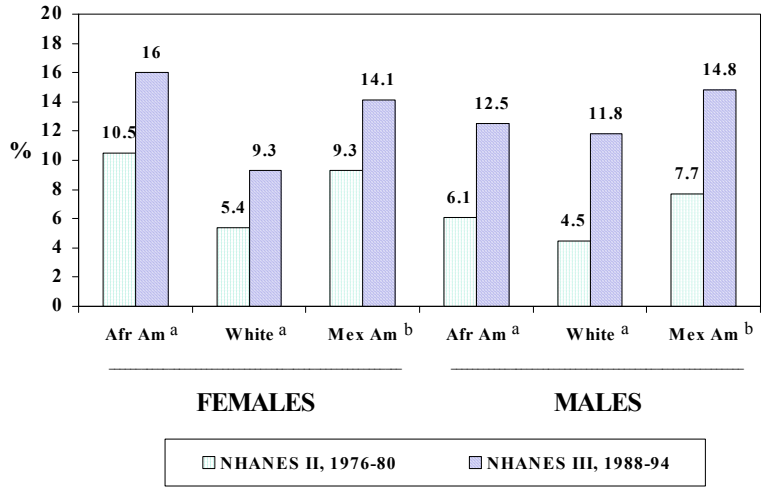


Source: MacKay et al, 2000 (age-adjusted prevalence rates; cutoff for defining overweight was age-specific 95th percentile of BMI from the 1963-65 NHES)

[a]African American and White are non-Hispanic

[b]Initial data for Mexican Americans are from Hispanic HANES, 1982-84

Figure 6. National prevalence of overweight in children, aged 12-17 years, NHANES II and III.



Source: MacKay et al, 2000 (age-adjusted prevalence rates; cutoff for defining overweight was age-specific 95th percentile of BMI from the 1966-70 NHES)

[a]African American and White are non-Hispanic

[b]Initial data for Mexican Americans are from Hispanic HANES, 1982-84

There is a paucity of national data on the health and weight status of Asian Americans in general and among Asian American children in particular, in comparison to other ethnic groups. For example, while African Americans and Mexican Americans were over sampled in NHANES III to improve data reliability, Asian Americans were not. Further, the PedNSS publishes overweight prevalence rates for Asian Americans in combination with Pacific Islanders, a population with a high prevalence of overweight in comparison to most Asian populations (Bindon, 1986). In 1997, 9.6% of Asian American/Pacific Islander children from PedNSS, aged 2-5 years, were considered overweight, compared to 7-8% of Whites and African Americans, and 12% of Hispanics (Mei, 1998). *Among populations currently classified as "Asian American", considerable heterogeneity appears to exist in the prevalence of overweight, attributable possibly to differences in ethnic origin and acculturation effects.* For example, in an investigation of 307 first-generation low-income young children followed longitudinally from birth to 5 years of age, Hmong, but not Lao, children showed evidence of overweight (Hyslop, 1996). In the Add Health Study, Chinese and Filipino adolescents showed substantially lower prevalence of overweight and risk of overweight than Whites (15.3% and 18.5% respectively vs. 24.2%). However, for a combination of other Asians in the US, notably Koreans, Japanese, Southeast Asian, and Indian-Asians, the rate was high (28.2%). Interestingly, although the prevalence rate of overweight among first generation Asians (16%) was lower than among first generation Hispanics (26%), second and third generation Asian Americans (31%, 35%) experienced rates of overweight comparable to their Hispanic counterparts (Popkin, 1998).

Studies have shown a striking increase in overweight rates among American Indian children and adults during the past 35 years (Story, 1999; Eisenmann, 2000). *While variation exists in rates of overweight across tribes, all studies indicate that overweight is widespread in American Indian youth*. Data from the 1994 PedNSS on over 50,000 American Indian children aged 2-4 years showed that 12% were overweight compared to only 6% of White children (CDC, 1996). Two large studies of American Indian school-aged children conducted during the 1990s showed that age-adjusted prevalence of overweight risk (BMI ≥ 85th percentile for NHANES II) was 39% for males and 38-39% for females. The age-adjusted prevalence of overweight (BMI ≥ 95th percentile) for males and females were 22% and 18%, respectively. Even at the youngest school ages, overweight was more than twice as likely as for US youth in general (Jackson, 1993; Zephier, 1999).

3. PREVALENCE OF ADULT OVERWEIGHT

The secular trends in overweight among children and adolescents mirror that observed for US adults (Table 6). Further, results from recent surveys suggest that adulthood obesity continues to increase rapidly in the US. For example, based on self-reported weights and heights from adults in the Behavioral Risk Factor Surveillance System (BRFSS), the prevalence of obesity (defined as BMI ≥ 30.0 kg/m^2) increased from 12.0% in 1991 to 17.9% in 1998, representing a 51.5% increase in men and a 47.4% increase in women in 7 years. In California, the increase in obesity was greater than for the nation as a whole; the prevalence increased 66.7% from 10.0% in 1991 to 16.8% in 1998 (Mokdad, 1999). According to 1997 BRFSS data, the prevalence of overweight (defined as BMI ≥ 25.0 kg/m^2) adults ranged from 46.4% in Colorado to 58.2% in Georgia. *The prevalence of overweight in California (51.6%) was slightly lower than the nationwide median of 53.6%, with more overweight men (60.2%) than women (43.1%)* in California, a gender difference similar to that observed in the nation as a whole (Holtzman, 2000).

Table 6. Trends in age-adjusted percentage of "overweight" (BMI ≥ 25.0) among US adults of all races aged 20-74 years[1]. (Kuczmarski, 2000a)

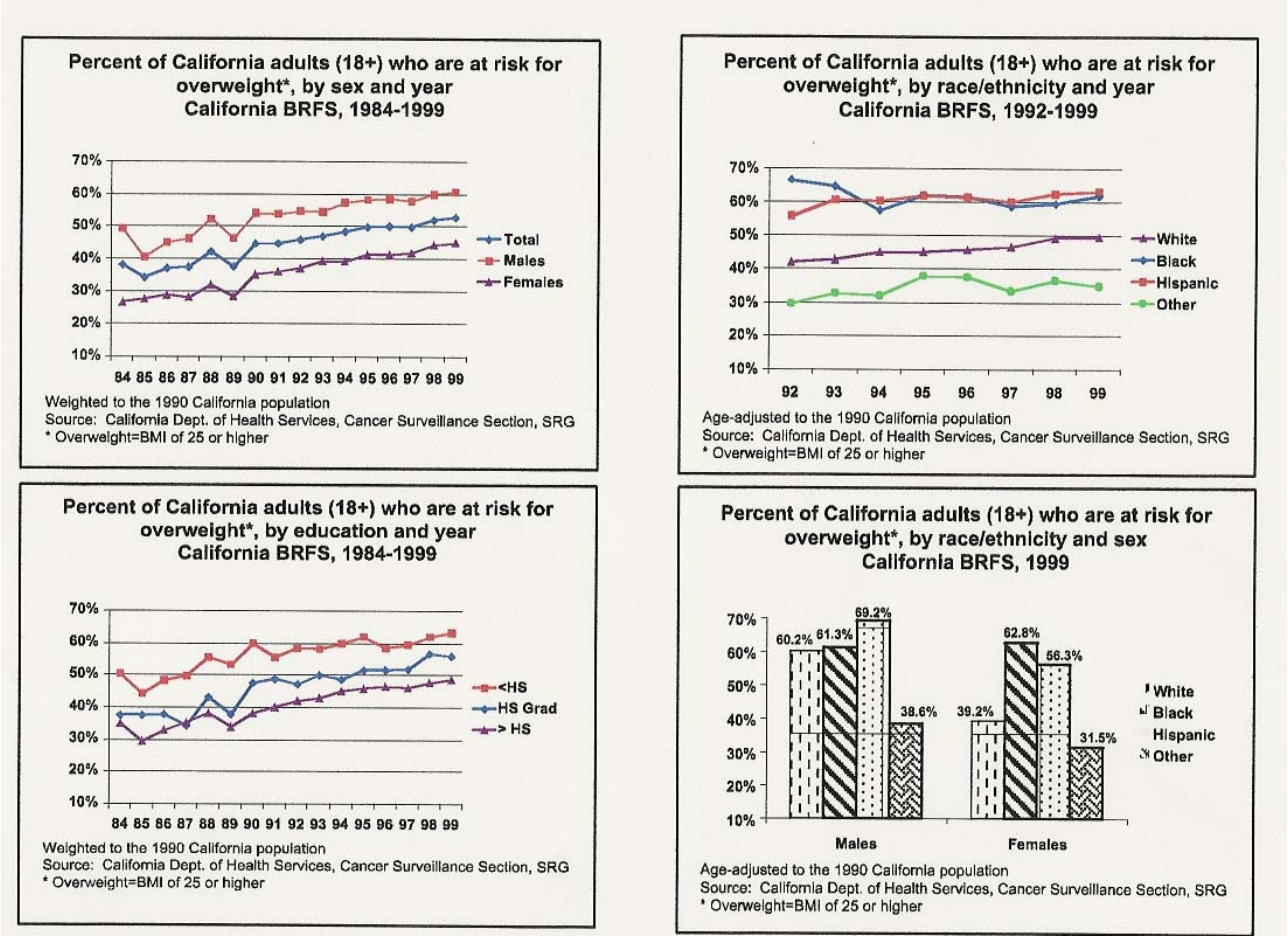
Survey and years	Men	Women	Total
		%	
NHES I (1960-1962)	48.2	38.7	43.3
NHANES I (1971-1974)	52.9	39.7	46.1
NHANES II (1976-1980)	51.4	40.8	46.0
NHANES III (1988-1994)	59.3	49.6	54.4

[1] NHES, National Health Examination Survey; NHANES, National Health and Nutrition Examination Survey.

As with children, differences by race/ethnicity have been observed among adults for overweight and obesity prevalence. From the 1994 BRFSS results, based on fewer than 50 states due to small sample sizes in some states, the median state prevalences of overweight were higher among African Americans than among Whites. While there was no clear geographic pattern among White or African American men in this analysis, among White and African American women, the higher prevalence states were found in the northeastern areas of the country. In this same analysis, there

were significant geographic patterns for physical inactivity as well (Hahn, 1998). From the 1997 BRFSS data, the median percentage of respondents who were obese was 15.6% for Whites, 26.4% for African Americans, 18.2% for Hispanics, 30.1% for American Indians or Alaska Natives, and 4.8% for Asians and Pacific Islanders (Bolen, 2000). Likewise the age-adjusted prevalence of overweight among adults from NHANES III was higher for Mexican American men and women and for African American women than for Whites (Kuczmarski, 1994). Data from the 1999 BRFSS for California adults indicated that the increasing prevalence of overweight mirrors that observed for the nation as a whole, and that no age, race/ethnicity, income or education group is immune (California Dept. of Health Service, 2000) (Figure 7).

Figure 7. Prevalence of overweight in California adults. (Ca Dept. Health Services, 2000; Data source: BRFSS)



Key to legends:

First graph above (overweight by sex and year) – top line (red squares) = 'Males', middle line (blue diamonds) = 'Total', bottom line (purple triangles) = 'Females'.

Second graph above (overweight by race/ethnicity and year) – top line (blue diamonds) = 'Black', second line (red squares) = 'Hispanic', third line (purple triangles) = 'White', bottom line (green squares) = 'Other'.

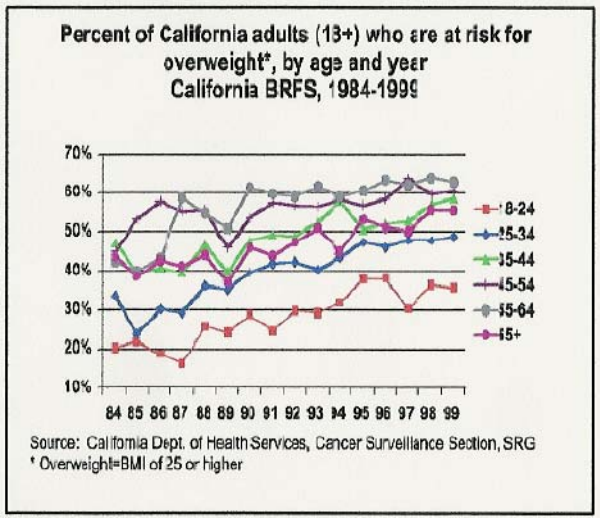
Third graph above (overweight by education and year) – top line (red squares) = '< High School', middle line (blue diamonds) = 'High School Graduate', bottom line (purple triangles) = '> High School'.

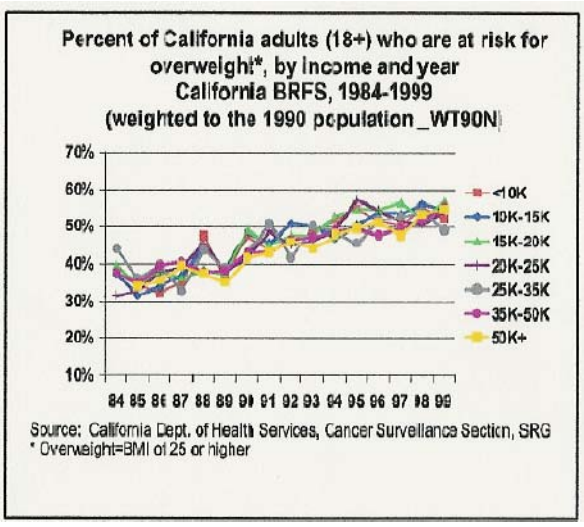
Fourth graph above (overweight by race/ethnicity and sex) – first bar = 'White', second bar = 'Black', third bar = 'Hispanic', fourth bar = 'Other'.

Fifth graph below (overweight by age and year) – top line (gray squares) = '55-64 years', second line (purple pluses) = '45-54 years', third line (green triangles) = '35-44 years', fourth line (pink squares) = '65+ years', fifth line (blue diamonds) = '25-34 years', sixth line (red squares) = '18-24 years'.

Sixth graph below (overweight by annual income and year) - red squares = '<10K', blue diamonds = '10K-15K', green triangles = '15K-20K', purple pluses = '20K-25K', gray squares = '25K-35K', pink squares = '35K-50K', yellow squares = '50K+'.

Figure 7. (continued)





4. CRITICAL PERIODS AND PERSISTENCE OF OVERWEIGHT INTO ADULTHOOD

Persistence of overweight into adulthood may be the greatest risk for overweight children. Not all overweight children grow into overweight adults and not all overweight adults were overweight as children. Based on a review of epidemiological literature published between 1970 and 1992, Serdula (1993) estimated that about one-third (26 to 41%) of overweight (definitions varied between studies) preschool children and one-half (42 to 63%) of overweight school-age children became overweight as adults. Overall, the risk for becoming an overweight adult was 2- to 6.5-fold higher for overweight children than for their non-overweight peers (Serdula, 1993). The greatest risk of adult overweight occurred among children who were fatter and older (e.g., adolescents). Several recent studies have confirmed these findings (Guo, 1994; Whitaker, 1997). For example, Whitaker (1997) found that the odds ratio for overweight in adulthood associated with "at risk for overweight" in childhood ranged from 1.3 at 1-2 years of age to 17.5 at 15-17 years of age, after adjusting for parental obesity. Figure 8 illustrates how the chances of being an obese adult increased as the degree of overweight and age increased among children. The predictive value of overweight in childhood as a risk factor for adult obesity was highest in 10-15 year olds. This study also showed that parental obesity was a potent predictor of adult obesity across the same age groups (odds ratio of 2.2 at 15-17 years and 3.2 at age 1-2 years) after adjusting for the child's weight status. Lake (1997) reported that while child to adult BMI correlations were low to moderate ($r \approx 0.3$) if both parents were categorized as having a "normal" weight, tracking of BMI was stronger ($r \approx 0.5$) if both parents were obese. Figure 9 illustrates the likelihood of being overweight at age 35 years based on BMI percentile among White children (Guo, 1999). Children above the 95th percentile, as compared to those above the 75th and 85th percentiles, were more likely to be at increased risk of adult overweight at earlier childhood ages. High risk for adult overweight began between 9-10 years for girls and between 8-9 years for boys. Little is known about the tracking of overweight for children of other racial and ethnic groups. Further, the pattern that will prevail in the future is unknown as a result of current increases in the magnitude and extent of childhood overweight.

Figure 8. Tracking BMI-for-age from birth to 18 years with percent of overweight children who are obese at age 25 (vertical axis signifies the % obese as adults). (Source: Whitaker, 1997)

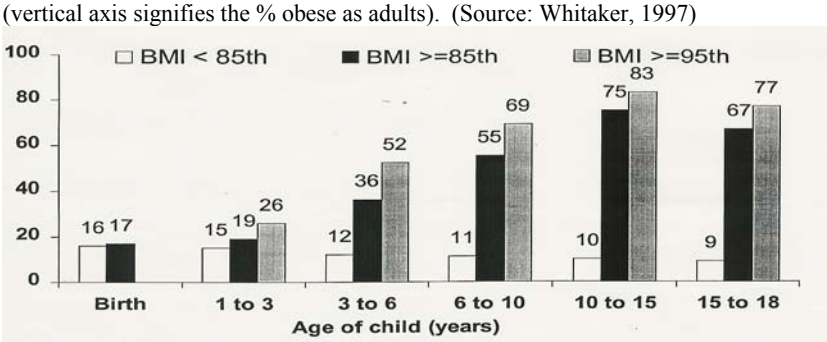
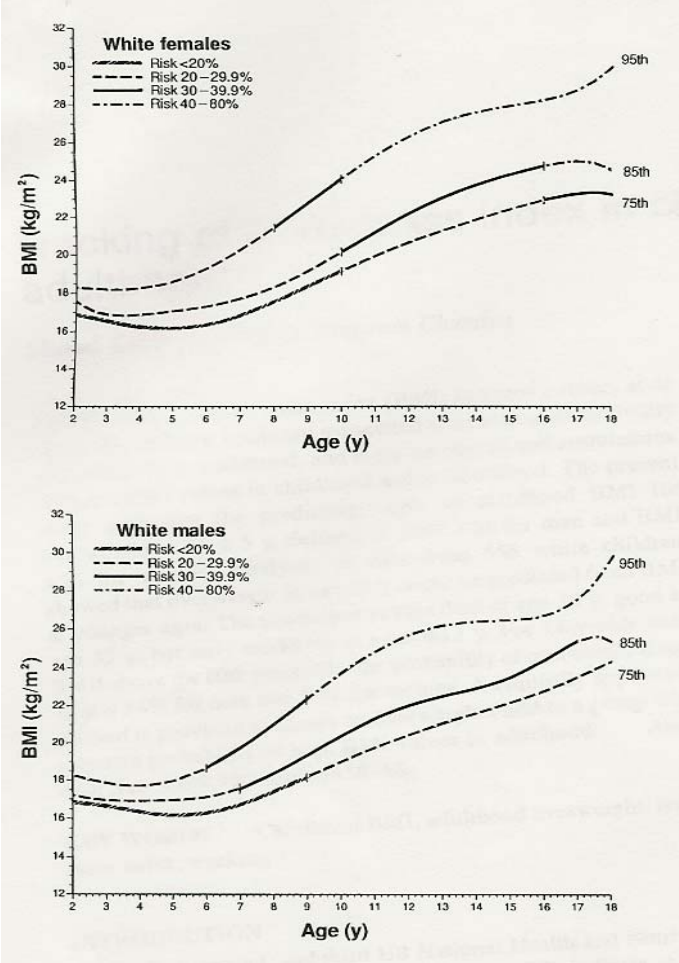


Figure 9. Risk of overweight (BMI ≥ 26 for females; BMI ≥ 28 in males) at age 35 years based on selected percentiles of BMI (NHANES II) for children. (Source: Guo, 1999)



Early sexual maturation has been related to relative weight and overweight (Abraham, 2001). Freedman (2000a) found that postmenarcheal girls were 1.4 to 2.9 kg/m^2 heavier than premenarcheal girls at the same age. The increase in BMI with maturation was greater for African American than White girls. Power (1997), using longitudinal data from 5700 females and 5512 males from a 1958 British birth cohort, found a strong association between timing of puberty and BMI; earlier maturers had higher BMIs at ages 7-33 years. It is possible that the larger weight gain among early maturers may contribute to some of the racial differences in overweight observed among adult women.

In addition to early adolescence, there appear to be at least 2 other periods during childhood characterized by an increased risk of developing overweight which persists into adulthood: prenatally and during adiposity rebound which generally occurs between 4 and 8 years of age (during which time adiposity, after a decline from infancy, reaches a nadir and begins to increase again) (as reviewed by Dietz, 1997). Children that reach their nadir earlier experience higher risk of adulthood obesity (Serdula, 1993; Whitaker, 1998). Based on long-term serial data from the Fels Longitudinal Study, BMI was significantly greater among adults who experienced early onset of overweight (before 25 years of age) in comparison to adults whose overweight occurred after age 25. This difference became apparent beginning at the time of adiposity rebound (Wisemandle, 2000). Among 911 Mexican-American children in a school district in south central US, the largest increase in overweight for girls was seen between kindergarten and 1st grades and for boys between the 1st and 2nd grades. In this study, a kindergartener with a BMI at or above 23.7 kg/m2 has a 91% + chance of being an overweight 5th grader; most children who entered kindergarten overweight left elementary school overweight (Suminski, 1999). Taken together these *studies suggest that adiposity rebound is a critical period at which to institute overweight interventions*. In addition, intervening prior to age 10 may introduce critical lifestyle and behavior influences prior to changes in resting metabolic rate (RMR) that have been shown to occur in obese and non-

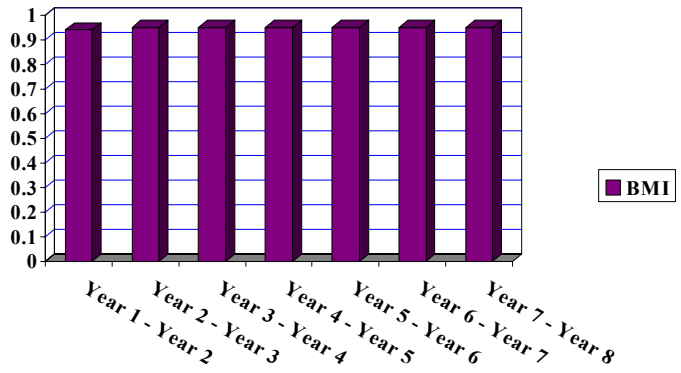
obese children (Laessle, 1997). In this study, there were significant age-dependent differences in RMR only among 10-year-old children, with obese children showing lower values. Such a reduced RMR could contribute to increased body weight, even in the absence of excessive energy intakes. Other researchers have postulated that the pre-pubertal period is a critical one for overweight development (Dietz, 1994).

In the largest longitudinal study to date of a cohort of girls (White and African American), the National Heart, Lung and Blood Institute Growth and Health Study (NGHS), the majority of 16- to 17-year-old at risk and overweight girls were already at risk or overweight by age 9 or 10 when the study was initiated (Crawford, 2001) (Table 7). The correlations between the yearly BMI measurements of the girls followed in the NGHS study were remarkably high (0.94 – 0.95), indicating that girls that were heavy relative to their peers at age 9 years, continued to be heavy adolescents at age 17 years (Figure 10). These data suggest that *BMI is extremely stable between 9 and 17 years of age and primary prevention of overweight should begin prior to 9 years of age*.

Table 7. Age at onset of development of overweight status (BMI-for-age > 85th percentile) in 16- to 17-year old girls by race. (Crawford, 2001; Data source: NHLBI Growth & Health Study, 1988-1995; n = 1883)

Age (years)	Percent of At Risk or Overweight Girls at 16 to 17 Years	
	African American	White
9/10 or earlier	65	62
10/11	9	7
11/12	6	6
12/13	5	7
13/14	4	5
14/15	6	7
15/16	4	4
16/17	2	3

Figure 10. Correlations (Spearman) between yearly BMI measurements among African American and White girls in the NHLBI Growth and Health Study.
(Crawford, 2001)



There are several possible models for the increase in the prevalence of overweight in recent years. For example, one subgroup of the population may be heavier now than in the past, with little change in the remainder of the population. Alternatively, the entire BMI distribution may be shifted upward. Among younger children, the former appears to be the case. However, to some extent for older children and particularly for adults, the entire distribution is shifted upward in NHANES III compared to NHANES II (Flegal, 2000). As the results were similar when the analyses were limited to White children and adults, *secular changes in the race/ethnic composition of the US population is an unlikely explanation for the secular increase in BMI-for-age and prevalence of overweight*. Instead, these findings suggest that few are immune to the environmental influences responsible for weight gain and accordingly interventions should be broad and population-based, rather than targeted at individuals (Flegal, 2000).

5. CONCLUSION

It is difficult to predict the magnitude of the adult consequences of the recent rises in overweight among children from the past tracking data. The best currently available estimates of the persistence of pediatric overweight to adult overweight and health risks were based on studies done at a time when pediatric overweight was significantly less prevalent. It has long been observed that well nourished young adults tend to gain weight as they age, peaking in middle age and then declining during the elderly years (Troiano, 2000). The question remains as to the long-term consequences of the earlier age of onset and rapid rise in prevalence of pediatric overweight. At no other time in human history has an epidemic of overweight of this magnitude been experienced. Whether the BMIs of the ever younger and the ever larger number of overweight children will level off in adulthood or continue to rise, as has been the pattern in the past, remains to be seen. The mere possibility of the latter consequence makes primary prevention of pediatric overweight all the more urgent.

The percentage of obese adults who were obese as children has been estimated to range between 5 and 44% (Serdula, 1993). While these estimates may increase as a result of currently increasing numbers of overweight children, it seems clear that *preventive strategies among children need to be population-based rather than targeted at specific individuals* (Power, 1997). While African American female children in particular and Mexican American and Native American children of both genders currently experience the highest risk of overweight, as do children of obese parents, rather than limiting prevention strategies to specific groups, broad-based campaigns will likely be more effective if interventions are culturally tailored and language accessible to promote healthy behaviors among those targeted groups.

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E. CONTRIBUTING FACTORS IN PEDIATRIC OVERWEIGHT AND IMPLICATIONS FOR INTERVENTION

1. INTRODUCTION

Pediatric overweight is caused by a complex interplay of both genetic and environmental factors. The extent to which these factors contribute to overweight within a population has not been established and it is likely that the identity and relative contribution of risk factors differ among individuals. Many of these factors cannot easily be modified. For example, at present one's genetic endowment is unalterable. However, expression of one's genes can be influenced by environmental factors. Further, numerous factors involved in the etiology of overweight are more or less amenable to modification. In as much as the purpose of this review is to design effective interventions for pediatric overweight, primary focus is placed on those factors in the environment that can be most readily altered. Others are briefly reviewed, however, to support the identification of high-risk groups.

2. GENETIC FACTORS

2.1 Genetic Loci Studies:

Although *over 200 specific genetic factors related to overweight risk in humans have been identified* as of the year 2000 (Chagnon, 2000; Pérusse, 2001), a single genetic test of risk is not yet available. Using families participating in the Muscatine Study, Moll (1991) estimated that 35% of the age and gender adjusted variability in BMI can be explained by genetic variation at two specific gene sites, while an additional 42% of the variability can be explained by background genetic variation. Others have estimated that between 30-50% (Bouchard, 1996; Allison, 1996) and 65-75% (Stunkard, 1986a) of the variance in BMI or adiposity within a population can be explained by genetic differences.

Ongoing research into genetic loci responsible for predisposition to overweight may use either random sampling of individuals, which is convenient but has low statistical power, or investigation of specific populations (either siblings/families or special populations), which may suffer from problems with generalization, but offers high statistical power. These studies seek to calculate a genetic linkage score (called the LOD) with a score of 3 taken as strong evidence of linkage (Comuzzie, 1998). Several of the candidate genes under study at present affect thermogenesis and resting energy expenditure (REE), with at least 2 studies showing LOD scores over 3. However, it is unlikely that persons who are homozygous for these candidate genes account for the most common forms of obesity, since homozygocity occurs at very low frequencies (Comuzzie, 1998). This is consistent with the finding that only a small sub-population of children has overweight caused by a specific genetic disorder (such as Prader-Willi or Bardet-Biedl syndromes). While several human genetic abnormalities have been identified which result in excessive weight gain in virtually all but very extreme environments, in most cases environmental factors make a significant contribution (Maffeis, 1999). It has been suggested that those who are genetically susceptible to overweight are particularly at high risk without early environmental manipulation (Rosenbaum, 1998).

2.2 Anthropometric Parent, Sibling and Twin Studies:

The evidence that genetics contributes to weight gain and overweight is compelling. Whitaker (1997) found that among young children (under 3 years of age) *the strongest predictor of adulthood obesity was parental obesity status*. The risk of becoming an obese adult increased 3-fold if one parent was obese and 13-fold if both parents were obese. In addition to confirming this relationship, Lake (1997) also reported a stronger pattern of overweight tracking from childhood to adulthood among subjects with two obese parents. The correlation in body mass index (BMI) between mothers and their 9- to 10-year-old daughters was found to be 0.27 in White girls and 0.30 in Black girls (Morrison, 1994). Stunkard (1986b) examined body weight in adult offspring of obese parents who lived from birth with non-obese adoptive parents. A significant association in BMI was found between adoptees and their biologic parents, but not between adoptees and their adoptive parents. A study of controlled overfeeding of 12 pairs of non-obese young adult male monozygotic twins also indicated a strong genetic role in obesity development (Bouchard, 1990). Similarity of body weight and fat increase as a result of overfeeding 1000 kilocalories per day, six days per week for 100 days was significant within each pair, with 3 times more variance among pairs than within pairs. Within-pair similarity of fat distribution was significant when individual differences in gain in total fat mass

were accounted for, suggesting that even location of fat deposition is likely to be genetically determined (Bouchard, 1990). In Allison's study (1996) of monozygotic twins reared apart, the correlation of twins' BMIs was 0.79 in a sample of twins that included data from Finnish, Japanese and American twins. The authors found that 50% of total variance in BMI could be accounted for by genetic variation after controlling for relevant covariates (such as age, gender, and source of data) in a regression model (Allison, 1996).

While generally it has been assumed that these genetic predispositions are not of recent origin, at least one research group has investigated whether the recent increase in prevalence of overweight and the stigma attached to overweight could have resulted in increases in mating between obese individuals. By studying children with extreme obesity and investigating parental weight, the authors found that the most overweight children were also more likely to have parents from the highest decile of parental weights. This could be consistent with the hypothesis that assortative mating within the past few generations might increase the rates of extreme obesity (Hebebrand, 2000).

2.3 Physiologic Studies:

Data from studies of young children suggest multiple mechanisms are responsible for regulation of body fatness. Genes may be associated with metabolic rates, dietary induced thermogenesis, appetite and food preferences, satiety, fat storage, and physical activity expression. Along these lines of research, fat oxidation has been examined between overweight and non-overweight children to assess whether *increased fat stores might promote fat oxidation and allow for weight equilibrium at a higher level*. Maffeis (1995) found that for prepubertal overweight and non-overweight White children fat mass and fat oxidation were positively and significantly correlated, and concluded that the higher post-absorptive rate of fat oxidation of overweight children may favor a new weight equilibrium, maintaining that weight, but opposing further adipose weight gain. For these children, the researchers then hypothesized that decreasing fat intake while stimulating physical activity would favor fat loss.

Differences in human energy expenditure have also been examined for familial patterns. Resting metabolic rate (RMR) is a measure of resting energy expenditure (REE). Most studies cited here have used resting metabolic rates instead of basal metabolic rates, since the latter measurement requires measurements taken first thing in the morning in a reclining position after an overnight fast of at least 12 hours (including no coffee/tea/smoking), before engaging in any physical activity and in a thermoneutral environment (i.e., without shivering or sweating). For the purposes of this review, we have used RMR and REE interchangeably. A lower REE has been hypothesized to predispose genetically susceptible individuals to weight gain. Griffiths and Payne (1976) used continuous heart rate monitoring techniques to measure the energy expenditure of very young children born to obese and non-obese parents. At the time of measurement there was no significant difference in body weight between the two groups of children. However, children of obese parents had lower daily energy expenditure than children of non-obese parents. Roberts (1988) corroborated these findings using the doubly labeled water method to measure energy expenditure of a group of normal weight infants. Infants whose mothers were overweight had 21% lower energy expenditure at 3 months of age than infants whose mothers were not overweight. The authors suggested that the energy differential was attributable to differences in physical activity during the infant's first year of life. Testing has also been performed on normal weight 3- to 4-year-old children with either obese or non-obese parents. Griffiths (1987) found that *children of obese parents had lower intakes of kilocalories, lower non-resting energy expenditure, and lower REE*.

To further examine this finding of RMR differences, Wurmer (1998) examined a group of girls 8-12 years sorted into groups based on the obesity status of both parents. Thus there were overweight girls with one or two overweight parents and normal weight girls with two or no overweight parents. Based on retrospective BMI data, all of the children had similar courses for weight gain during the first 12 months of life. However, by 24 months of age BMI was significantly different between the 4 groups, with overweight girls of 2 overweight parents having the highest BMI values at both 24 months and 48 months of age. Further, when adjustments for fat-free mass and fat mass, as well as age and pubertal status were made, the lowest value for RMR was found in the overweight girls with 2 overweight parents. However, there was not a significant difference from controls (normal weight girls without overweight parents). The authors concluded that, since RMR did vary between the groups, further studies should continue towards determining sub-groups of overweight children based on metabolic differences and reiterated the higher risk of overweight for children of two obese parents.

Not all studies have confirmed the findings of metabolic differences between overweight and non-overweight. In several cross-sectional (Bandini, 1990; DeLany, 1995; Laessle, 1997) and longitudinal (Goran, 1998; Figueroa-Colon, 2000) studies RMR was not different between overweight and non-overweight elementary school-aged or adolescent children, after adjusting for differences in total body weight. Further, a recent meta-analysis in adults indicated that REE is similar between the obese and lean after adjustment for differences in body composition (Carpenter, 1995). In the study by Laessle (1997), however, there **was** a significant difference in RMR among 10 year olds only and the authors suggested the possibility of a "critical period" during which decreases in RMR, and thus energy expenditure, in overweight children could lead to further increases in body weight even without excess energy intake.

In a recent review, Goran (2000a) concluded that there are *several explanations for the ambiguous findings with respect to the role of energy metabolism in obesity: 1) differences in energy expenditure have different impacts on weight status at the various stages of maturation; 2) differential responses could also occur among different individuals as a function of factors such as race and gender; 3) differences in energy metabolism may be too small for existing measurement techniques to detect; and 4) individual differences in energy metabolism may be so great that only exorbitantly large studies could detect differences between susceptible and non-susceptible groups.* For example, because the majority of these studies have been performed in Whites, race-related differences in REE cannot be precluded. In a recent review Gannon (2000) concluded that the majority of studies indicate that African American adults have lower daily total energy expenditure and REE. Fewer studies have been done among children. However, the preponderance of evidence suggests that African American children, like their elders, also tend to have lower REE expenditure than White children (Treuth, 2000b; Yanovski, 2001). What remains to be proven is that a lower REE translates into elevated risk of adiposity. In one study comparing Black adults from the U.S. and Nigeria, no differences were observed in REE adjusted for body composition, suggesting that the differences in body adiposity between the groups were due to environmental influences (Luke, 2000).

Energy expenditure and appetite may both be at least partially under the control of hormones. Differences in human growth hormone (HGH; a hormone which stimulates lipolysis) and leptin (a neuroregulatory hormone produced by fat cells) have been investigated for links with development of obesity or variation in the type of adipose distribution (subcutaneous versus visceral adipose). This variation is also consistent with variation in genetic coding within the body for hormone and pro-hormone levels and at least one mutation in the gene that codes for leptin produces a rare form of obesity in homozygotes (Goran, 2001). Laessle's study (1997) showed significant decreases in HGH levels in overweight (compared with non-overweight) children. Serum leptin appears to correlate best with sub-cutaneous adipose, although there has been conflicting data on the role of this hormone in fat distribution (Ronnemaa, 1997; Banerji, 1999). One discordant weight twin study has shown leptin to correlate most strongly with BMI, not twinship (Ronnemaa, 1997), a finding supported by population studies of children which showed that leptin was highly correlated with adiposity (Garcia-Major, 1997).

Experiencing an early adiposity rebound, the age at which body mass index (BMI) increases after its nadir in early childhood, has been shown to be a risk factor for subsequent adiposity. Experiencing an early adiposity rebound may also be genetically influenced. Among a British cohort of nearly 900 children followed from birth to 5 years of age, parental obesity was associated with early adiposity rebound, while no relation was observed between adiposity rebound and diet composition or socioeconomic status (Dorosty, 2000). However, children provided with high protein diets at age 2 had higher BMIs at age 8 (Rolland-Cachera, 1995). This suggests that adiposity rebound may depend on both genetic and environmental influences.

A secular trend toward earlier age of menarche has been observed over the last several decades, particularly among African American and Hispanic girls (Wattigney, 1999; Adair, 2001). The direction of causality has presumably been that increased weight results in earlier onset of menarche. However this relationship has not been proven and it is plausible that early maturation may also predispose girls to subsequent weight gain. Early maturation has been associated with increased fatness among children in cross-sectional and longitudinal studies (Wattigney, 1999; Adair, 2001). *Early maturation nearly doubled the risk of overweight among adolescents* (Adair, 2001). Based on an exhaustive review of longitudinal studies, Parsons (1999) concluded that earlier maturation is also associated with greater subsequent fatness in adulthood. However, the longitudinal studies done to date have not thoroughly investigated potential confounding of this relationship by other factors such as parental fatness, SES, earlier adiposity rebound, timing of pediatric overweight, and dietary and physical activity behaviors.

3. ENVIRONMENTAL FACTORS

The rapid changes in the prevalence of childhood overweight over the last few decades highlight the importance of the environment in gene expression. Evidence indicates that early environment greatly impacts the development of eating and activity patterns of children that can track into adulthood. Further, these modifiable variables have been shown to account for more of the variance in changes in BMI in young children than nonmodifiable factors (e.g., number of obese parents) (Klesges, 1995). In addition to eating and activity patterns, environmental factors relevant to weight status include the prenatal environment, familial patterns, and socio-demographic factors.

3.1 *In Utero* Environment:

While not a genetic factor, the prenatal environment is unique in that it affects fetal metabolic processes in a manner that appears to establish set-points that may be very difficult, if not impossible, to change once the processes are "switched on" or programmed. While this type of programming has not yet been conclusively demonstrated for weight, it has been shown to be apparent in other health outcomes (Lucas, 1998). Development *in utero* can create either environments in which little skeletal muscle is formed (*in utero* growth retardation) or in which high fat mass is created (high weight gain *in utero*). Either of these situations seemingly can create a lifelong imbalance between lean body mass and fat mass. It is known that *low birth weight (LBW) and high birth weight (HBW) both emerge as potential risk factors for overweight and development of chronic diseases in adulthood* (e.g., diabetes, cardiovascular diseases). Multiple studies have confirmed the relation of low birth weight (LBW) and coronary artery disease (CAD), including studies of women (Fall, 1995), biethnic studies in the US (Valdez, 1994) and a large cohort of men studied in Finland over a 65-year period (Eriksson, 2001). Fall's study of women in England showed that LBW children who became overweight had the highest level of CAD risk. Eriksson's study also demonstrated that LBW men who had rapid growth from the ages of 1-3 years had an even greater risk of CAD than other Finnish men in the study who had LBWs without rapid growth. Similarly, studies of LBW children in India demonstrated that poor intrauterine growth predicted higher central adiposity at age 8 years. Central adiposity is a marker for visceral adiposity that is highly related to insulin resistance and later CAD. Children born small who had grown heavy were the most insulin resistant (Yajnik, 2000). On the other hand, infants of diabetic mothers weigh more at birth and have higher risk for overweight by age 14 years (Metzger, 2000). In a recent review, Martorell (2001) concluded that although the evidence is suggestive, it is not yet definitive that undernutrition in early life is a risk factor for subsequent overweight. The evidence is very conclusive, however, that overnutrition in early life or HBW is a risk factor for excess adiposity in adulthood. The risk of subsequent adiposity may be even greater for HBW infants born to overweight parents (Frisancho, 2000). Thus a critical consideration for prevention of overweight should be targeting women for proper nutrition before and during pregnancy, improved care of pregnancy related diabetes, and attention to all causes of low and high birth weight.

3.2 Sociodemographic Factors:

Socioeconomic status (SES) is a useful indicator of a constellation of environmental and familial influences potentially related to overweight. In developed countries the inverse relationship between SES and adult obesity, particularly among women, has been confirmed by numerous studies using a variety of indicators of social class—income, education, and occupation (Goldblatt, 1965; Silverstone, 1969; Rimm, 1974; Garn, 1977; Jeffery, 1989; Sobal, 1989). Among children the relationship between SES and weight status appears more complex. Based on an exhaustive review of the literature, Sobal (1989) concluded that no clear relationship predominates during childhood. Among White children, several studies have found that poverty was associated with less fatness in very young children, but that during adolescence, at least among girls, this trend reversed (Garn, 1981; Jones, 1985; Troiano, 1998). Among adolescents in the National Longitudinal Study of Adolescent Health (Add Health), the largest nationally representative study of adolescents conducted to date, parental education and household income were independently and inversely associated with overweight (Goodman, 1999). However, the age at which SES is inversely related to overweight status may be decreasing. Recent studies suggest that low SES may be a risk factor for overweight among children as young as preschool age (Gerald, 1994; Sherman, 1995). The prevalence of overweight among 4-year-olds in the Supplemental Feeding Program for Women, Infants and Children (WIC) was 10.6% (Mei, 1998), compared to a rate of 7.9% for a nationally representative sample of 4- to 5-year-olds (Ogden, 1997). Similarly several studies of low-income preschool children attending Head Start programs have found a high prevalence of overweight, ranging from 10% (Wiecha, 1994) up to 32% (Hernandez, 1998). Further, baseline national data from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99, indicates that familial

risk factors for overweight among kindergarten-aged children include low maternal level of education, and English as a second language (Department of Education, 1998). Corroboration of some of these findings comes from the National Longitudinal Study of Youth, which showed that children who lived with nonworking parents, nonprofessional parents, and/or mothers who did not complete high school all had an increased likelihood of overweight at the 6 year follow-up study of a cohort of normal weight children ages 0 to 8 years (Strauss, 1999). The inverse linear relationship between household income and increased risk of childhood overweight was also confirmed.

Differences in the relationship between SES and weight status have been observed among children from different racial/ethnic groups (Crawford, 2001). For example, an inverse association between SES and overweight prevalence was found in a large cohort of pre-adolescent White girls, but was absent in an equally large cohort of pre-adolescent Black girls from the NHLBI Growth and Health Study (Patterson, 1997). This difference may be attributable, in part, to cultural differences in body image perception and weight control behaviors. Parker (1995) identified differences between Black and White girls in the conceptualization of beauty and style, which may also contribute to the observed racial differences in overweight prevalence. In the NHLBI Growth and Health Study, the observed decrease in self-rating of self-esteem, physical appearance and social acceptance with increasing BMI was smaller for Black girls than for White girls (Kimm, 1997; Brown, 1998). Compared to White children, Black 4th and 7th graders selected a significantly larger body size for ideal adult body size and also perceived less personal, family and peer concern about body weight (Adams, 2000). In another study White adolescent girls were nearly twice as likely to perceive themselves as overweight than Black adolescent girls (Neff, 1997). Evidence from NHANES III also suggests the absence of a relationship between overweight prevalence and income or education among African American and Mexican American children, aged 6-11 years, and adolescents, aged 12-17 years. However, these data should be cautiously interpreted because several of the estimates have large coefficients of variation (Troiano, 1998). Other studies of African American adolescents have shown an inverse relationship between SES and weight status (Jones, 1985; McMurray, 2000). In a study of 549 African American and White youth, race was not found to be a moderator of relationships between SES and increased BMI, central adiposity, and other cardiovascular risk factors (Treiber, 1999).

Other sociodemographic factors besides social class have been investigated with respect to pediatric adiposity. For example, single parenthood has been related to increased risk of childhood overweight in several studies (Garman, 1982; Gerald, 1994; Strauss, 1999; Tanasescu, 2000). Living in a smaller family (Patterson, 1997; Anand, 1999) and being first-born (Stettler, 2000) have also been shown to increase risk of childhood overweight. Being raised in a home with quality amounts of cognitive stimulation has been related to a lower risk of childhood overweight (Strauss, 1999). However, based on a comprehensive review of the literature, Parsons (1999) concluded that due to lack of adequate study, no definitive conclusions could be drawn presently regarding the influence of these social factors on pediatric overweight.

Acculturation may also mediate the relationship between weight and sociodemographic factors. Specifically, the risk of obesity has been reported to be 3.5- to 4-fold greater between U.S.- versus foreign-born Asian American adults. Further, living longer in the US has been associated with higher risk for Asian American adults of being overweight or obese (Lauderdale, 2000). This finding also extends to adolescents in the Add Health Study, conducted in 1995 with a 1-year follow-up. These adolescents were classified by race/ethnicity as well as interviewed about country of origin and recency of migration for immigrant children. The highest levels of overweight were found among Black non-Hispanic females and Hispanic males, but Asian Americans who were neither Chinese nor Filipino were also more likely to be overweight. Among Asian Americans and Hispanics, there were also significant differences seen by gender and for generation post-migration. The overweight level more than doubled between the first and second generation Asian Americans. Chinese Americans were the only group of the ethnic groups studied that did not demonstrate a large and significant change in level of overweight in the second or third generation. However, it should be noted that non-Chinese, non-Filipinos were grouped as "other Asian" due to small sample sizes that prevents separation of children into specific country of origin groups (Popkin, 1998). A small study of Asian students recruited from colleges showed that several differences were reported in these students post-migration (Pan, 1999). Students eating only 2 meals a day increased, more students skipped breakfast because of school schedules, more salty and sweet snack items were being consumed and more were selecting American-style fast food when they ate out. However there was no significant change in frequency of snack consumption and the frequency of eating out was actually less. Students consumed more fats, dairy products and fruit but fewer vegetables and less meat after immigration. This study is preliminary but emphasizes that immigrant youth should

be targeted with messages that encourage them to retain healthful dietary habits from their country of origin (Pan, 1999).

Finally, *there is evidence to suggest that childhood SES influences adulthood weight status, independent of adult SES* (Brunner, 1999). Analysis of a British cohort followed from birth in 1946 revealed that childhood social class, based on paternal occupation, was inversely associated with adult BMI after controlling for educational attainment and adult social class (Hardy, 2000). In a recent systematic review of the literature, Parsons (1999) confirmed the lack of a clear relationship between SES in early life and childhood overweight. However, a strong and consistent relationship was observed across studies between low SES in childhood and overweight in adulthood. In contrast to cross-sectional studies that have predominantly shown an association between SES and overweight for women only, the association between childhood SES and adult overweight applied to both men and women. Three major processes whereby childhood environment affects adult overweight were proposed by Power (2000): 1) nutrition in childhood, either over- or undernutrition, followed subsequently by overnutrition; 2) psychological factors, such as emotional deprivation in childhood; and 3) sociocultural norms acquired during childhood regarding dietary restraint and attitudes toward fatness.

3.3 Familial and Psychosocial Influences:

While the familial aspects of body weight status have been well documented, the contributions of genetics, culture, SES, and parenting and psychosocial patterns are not always easy to separate. Parents serve not only as a gene source, but also as companions to children as they engage in family activities and as role models of health-related behaviors. The attitudes and behaviors that predominate in our culture, filtered through the family, affect how parents and their children behave in relation to food and exercise. A recent focus group study of low-income mothers found that mothers believed that heavier infants were healthier, that their infants were not getting enough to eat and required introduction of solid foods at ages earlier than recommended, and that it was appropriate to use foods to stimulate good behavior (Baughcum, 1998). Further, parents may not correctly assess the weight status of their children. In one study, only a minority (6%) of mothers with an overweight preschool child correctly identified their child as overweight (Jackson, 1990). In a study of WIC mothers with "at risk" pre-schoolers, mothers did not assess a child's weight status by the charted weight and height used by health care providers, but rather were more likely to see weight as a problem only if peers teased the child about weight or the child became inactive (Jain, 2001). Further, girls (aged 9-14 years) were more likely than their parents to perceive themselves as overweight, even when their weight was within normal range (Field, 1999).

Research has shown that most young children are inherently able to regulate their energy intake when challenged with a high energy pre-load (Birch, 1995). However, about 10% of children seem to be less able to self-regulate (Maffeis, 1999). In addition, very small but prolonged positive energy imbalances in children can result in significant weight gain. Family interrelationships are one area that may alter a child's ability to respond to energy density and timing of meals. *Inability of children to self-regulate food intake may be related to overly restrictive child feeding practices* (Birch, 1986), *inadequate parental limit setting* (Christoffel, 1989), *or parental neglect* (Lissau, 1994). The inability to self-regulate dietary intake has similarly been identified as one causal factor in adult obesity. Mothers who were more controlling of their 3- to 5-year-old's food intake had children who showed higher rates of eating, less ability to self-regulate energy intake, and increased adiposity (Johnson, 1994; Drucker, 1999; Fisher, 1999a). Both out of control eating (Johnson, 1994) and dieting (Hill, 1990) were more common among children whose mothers also practiced these behaviors. In a study of 18 families with discordant weight siblings, there were similar levels of maternal control over feeding, however the mother's own weight status related to concerns about both her overweight and non-overweight child's weight and health (Saelens, 1998). Mothers who were most concerned about their own weight and the weight of their 5-year-old daughter were most restrictive of their child's eating, which in turn, was associated with increased inability of the child to self-regulate food intake (Birch, 2000). Higher levels of maternal restriction predicted higher levels of snacking in girls 3-5 years of age (Fisher, 1999a, 2000a). *Restricting access to palatable foods has been shown to increase children's attention on and desire for that food* (Fisher, 1999b). Further, children whose food intake was restricted exhibited behaviors associated with severe scarcity of food, such as scavenging and stealing of food (Ikeda, 1995). Parents have been shown to impose more control in domains of their children's development when: 1) the parents have problems regulating their own behavior, 2) when the child is perceived as at risk for developing some behavior, or 3) when the child appears to lack self-regulatory behavior (Costanzo, 1985). In one study, mothers who breast-fed their child for a year were less controlling of their toddlers diet, perhaps allowing for better development of self-regulating feeding

(Fisher, 2000b). Breast-feeding has been shown in some studies to be protective against overweight at age 5-6 years (von Kries, 1999) and during older childhood and adolescence (Gillman, 2001).

On the other hand, *excessively permissive child-feeding practices may also have deleterious consequences*. Children allowed to snack *ad libitum* had higher caloric intakes than children provided nutritious snacks at designated times (Birch, 1995). In a Japanese study (Takahashi, 1999), snacking irregularity were behavioral factors that increased risk of overweight over host factor risks (overweight parent or overweight at birth). In another study, mothers of overweight pre-schoolers expressed emotional difficulty in denying additional food to a child who professed hunger despite having just eaten (Jain, 2001).

Children have a predilection for sweetness and saltiness, and choose high-fat and energy-dense foods if provided (Cowart, 1981). Willingness to eat a wide variety of foods is greatest at 1-2 years of age and declines by age 4 years (Cashdan, 1994). However, *parental involvement can alter the number of non-nutritious food choices and the caloric content of meals eaten by children regardless of overweight status* (Klesges, 1991). Parents' child-feeding practices shape children's food preferences and these preferences in turn affect the percent of energy from fat in children's diets (Birch, 1996). Common parenting strategies may induce effects opposite to those intended. Foods (usually less nutritious foods high in fat and/or sugar) used as a reward (e.g., "you can have a cookie if you get into the car") tend to increase child preference for that food. In contrast, having children eat a food (usually a more nutritious food) in order to obtain a reward (e.g., "you must eat your dinner before having dessert") tends to decrease child preference for that food (Birch, 1999). Among adolescents food choice and fat intake have been shown to be more highly associated within family networks than with friends, with associations slightly higher for mother-child than for father-child (Feunekes, 1998).

Since both over-regulated and chaotic settings have been faulted as potentially leading to eating problems, the most well-meaning of parents may be at a loss to find an appropriate and healthful balance. *Positive feeding relationships have been found when parents actively use cues and information from children on the timing, amount, preference, and pacing of foods* (Satter, 1986). It is recommended that parents be responsible for what healthy foods are presented and the manner in which foods are presented, and children be allowed to select from the food choices and determine the quantity consumed (Satter, 1987). *It has also been recommended that overweight prevention programs include more information to improve general parenting skills and focus less on an individual child's growth* (Jain, 2001).

In addition to food-centered activities, other parental factors have been examined with respect to child adiposity. In a study of 30 families with an overweight adolescent and 30 families of a non-overweight adolescent, no differences were seen in family communication, family climate, or support (Valtolina, 1998). While the role of support and communication with the mother was perceived as important, this was similar in both groups of adolescents. Besides parental factors, adolescents have been studied for those factors that offer protection from high-risk behaviors of many types and foster adoption of healthy behaviors. A study of multi-ethnic middle school and high school students in Denver noted that a composite *index of health enhancing behaviors which included healthy diet and regular physical activity was related to religiosity, commitment to school, having friends engaged in conventional activities, orientation towards parents, positive relationships with adults, and involvement in social activities* (Jessor, 1998). Thus strengthening these factors among youth may also be important to intervention designs. Unhealthy dieting behaviors (use of diet pills and purging or self-induced vomiting) have been shown to be associated with the intake of fewer fruits and vegetables, and higher fat intake in adolescent girls, as well as with higher fat intake and lower levels of vigorous physical activity in adolescent boys (Story, 1998). While an extensive examination of the literature on eating disorders was not undertaken for this review, it is clear that interventions need to avoid delivering messages that might encourage extreme dieting behaviors.

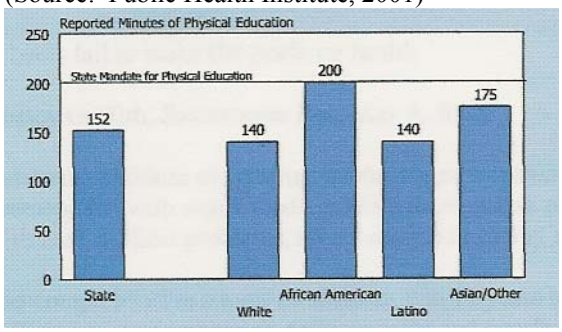
Several studies have examined the relationship of emotional and mental health with overweight. In epidemiologic studies of obese and non-obese adults, Friedman and Brownell (1995) found no difference in prevalence of psychiatric illnesses. However, some studies of overweight children have reported both more depression and social problems with peers (Erickson, 2000; Banis, 1988), as well as more parent-reported descriptions of psychopathology (Braet, 1997). In addition, conduct disorders among adolescents have been shown to be predictive of both increased adult BMI and adult depressive symptoms in women, but not men (Pine, 1997). Erickson's study also found that the relationship was stronger between depression and overweight in pre-adolescent girls than boys, and that BMI was no longer associated with depressive symptoms in girls once the level of overweight concerns were controlled for in the

model (Erickson, 2000). The role of the mother-daughter relationship has featured prominently in explaining weight concern among young girls, however it is unclear if this is related to modeling or to low autonomy beliefs in the mother (Ogden, 2000). Kaplan and Wadden (1986) found minimal correlation between BMI and self-esteem in a study of Black children. These types of studies suggest that *the pathway for the relationship between overweight and emotional status is complex, probably bi-directional, and perhaps different for different cultural and ethnic groups*. Factors such as smoking status, presence of eating disorders (both binge eating and anorexia/bulimia nervosa types), and self-worth or self-esteem also create potential mechanisms for relations of either underweight or overweight status to psychopathology and likely account for some of the conflicting data on these relationships.

3.4 Physical Activity Patterns:

Inactivity is very common among American youth (Harrell, 1997; Gordon-Larsen, 2000). In a study of 2,200 3rd and 4th grade students, the most common leisure time activities reported by boys were playing video games (33%), playing football (32%), bicycling (31%), watching television (28%), and playing basketball (26%) (Harrell, 1997). Doing homework (39%), bicycling (31%), watching television (30%), dancing (27%), and reading (23%) were the most common leisure time activities reported by girls. In the 1996 Add Health study only 21% of adolescents participated in 1 or more days per week of school-based physical education (PE), and one-third of adolescents (25% of males and 40% of females) failed to achieve the recommended minimum of 30 minutes of moderate to vigorous physical activity three times per week (Gordon-Larsen, 1999, 2000). Similarly one-third of adolescents (28% of males and 47% of females in 1997; 28% of males and 43% of females in 1999) surveyed in the nationally representative 1997 and 1999 Youth Risk Behavior Surveillance System Surveys (YRBSS) failed to participate in vigorous exercise (defined as those that made them sweat and breathe hard for at least 20 minutes on 3 or more days in the week preceding the survey) (Kann, 1998, 2000). At current levels, high school students will have to double their activity level in order to meet the minimum requirement of 30 minutes of PE daily for students in grades K-12 recommended by the President's Council on Physical Fitness and Sports (USDHHS, 1985). Among children 9 to 11 years of age in California, the average time spent in PE was nearly an hour short of the state mandate of 200 minutes of PE every 10 days for 1st through 6th graders (Figure 1). Further, less than half of California children met the physical activity recommendations of 60 minutes or more per day of moderate to vigorous exercise (Public Health Institute, 2001). According to results from the 1999 California Physical Fitness Test, approximately 80% of the over one million students tested in grades five, seven and nine did not meet fitness standards in all six examined areas: aerobic capacity, body composition, abdominal strength and endurance, trunk strength and flexibility, upper body strength and endurance, and overall flexibility (California Department of Education, 2000). Among children 6 to 9 years of age, only 53% of children surveyed said that they played outside after school and on Saturdays, while 80% reported watching TV (International Food Information Council, 1992).

Figure 1. Minutes of PE over ten school days reported by California 4th – 5th grade students.
(Source: Public Health Institute, 2001)



Also of concern is the age-related decline in physical activity (Figure 2) and participation in school PE programs (Figure 3) that has been observed in numerous cross-sectional studies (Sallis, 1993b; CDC, 1996; Kemper, 1999; Pratt, 1999; Bradley, 2000; Gordon-Larsen, 2000). Goran (1998) noted an age-related decline in physical activity in girls as young as 6-9 years of age. Sallis (1993b) reported that boys' physical activity decreased about 2.7% per year, while girls' activity decreased at the substantially greater rate of 7.4% per year in the 4th and 5th grades. The age-related decline in physical activity observed in cross-sectional studies has also been confirmed in longitudinal studies (Verschuur, 1985; Kimm, 2000). In the longitudinal NGHS study of African American and White girls,

daily activity and habitual activity declined by 35% and 83%, respectively, from ages 9-10 to 18-19 years (Kimm, 2000). Adolescence appears to be a developmental time during which physical activity declines are particularly evident. Some of the factors reported to influence the age-related decline in physical activity included: peer influences (e.g., "not as cool" to do certain activities); greater time demands (e.g., homework, job, dating); more driving (e.g., getting driver's license); working parents (e.g., difficulty getting children to programs); team sports becoming less participatory and more competitive; and lack of availability of structured community programs (Sallis, 1992). Lower levels of social support for exercise and more scarcity of exercise role models have also been reported by adolescents in comparison to pre-adolescents (Garcia, 1995). In addition, the finding that adolescent African-American girls have lower mean concentrations of hemoglobin than White girls (Pivarnik, 1993) suggests there could be a variety of both physiologic and psychosocial mechanisms influencing the drop-off in girls' physical activity.

Figure 2. Age-related decline in moderate and vigorous physical activity. (Source: CDC, 1996)

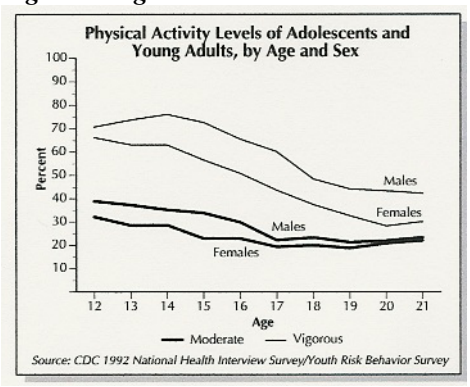
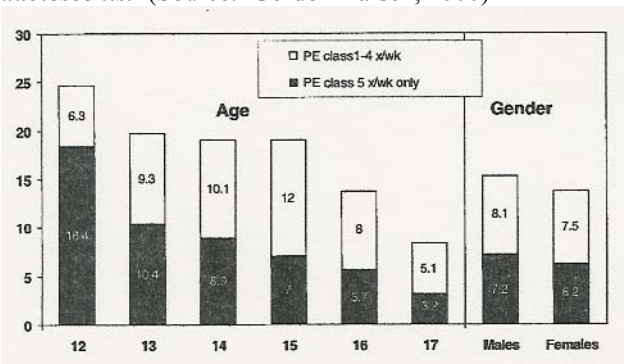


Figure 3. Age-related decline in school PE participation among a nationally representative sample of US adolescents. (Source: Gordon-Larsen, 2000)



In numerous studies, *physical activity among girls was less than among boys* (Garcia, 1995; CDC, 1996; Sallis, 1996; Guillaume, 1997; Harrell, 1997; Pate, 1997; Garcia, 1998; Goran, 1998; Allison, 1999b; Gordon-Larsen, 1999; Lindquist, 1999; Pratt, 1999; Bradley, 2000). Bradley (2000) also reported that *girls with more advanced pubertal status were more sedentary than less physically mature girls of the same age*. The decline in physical activity, however, appears to occur prior to puberty among girls, at a time during which boys generally remain active (Goran, 2001). In one study there was an increase in total energy expenditure between the ages of 5.5 and 9.5 in boys while there was a decrease from the age of 6.5 to 9.5 years in girls (Goran, 2001). This measure included the underlying REE as well as the activity-related energy expenditure, but the authors concluded the drop-off for girls was related to decreased activity related energy expenditure. Trost (1997) demonstrated that girls who were involved in community sports programs in 5th grade were more likely to remain involved in moderate and vigorous activity one year later. It has been suggested that organized sports may represent a public health opportunity that has not been fully realized, particularly for girls (Bungum, 1997; Pratt, 1999). In addition, stage of change research among 5th and 6th graders has revealed that boys were not only more likely to be active, but were more likely to be in a maintenance stage than were girls. This suggests that it may be easier to get boys to exercise regularly during that

age period than girls and that different strategies may be required to motivate girls to change if they are in an earlier stage of change (more girls were in a preparation stage of change). The authors recommended that PE for girls focus on learning enjoyable lifetime physical activity skills to prevent the decline in girls' activity and to target those in contemplation and preparation phases (Walton, 1999). Similar to Trost's findings in girls, boys who participated in community sports in 5th grade and had a sense of self-efficacy in overcoming barriers to exercise were more likely to engage in moderate and vigorous physical activity in 6th grade (Trost, 1997). In a study by Garcia (1995), 5th, 6th and 8th grade girls reported poorer perceived health status, lower self-esteem, and a more frequent behavioral history of minimal exercise than boys, factors that may contribute to more sedentary habits. According to a national survey of elementary school children, fathers spent an average of 50 days per year exercising with sons as compared to only 35 days per year with daughters. This imbalance becomes increasingly pronounced as girls grow older (Ross, 1987). While mothers exercised with sons and daughters equally, it is possible that paternal influences are a factor in the lower level of physical activity observed among girls. Taken together, these findings indicate that physical activity intervention in girls would optimally occur prior to age 10.

Among older girls, a similar pattern of declining physical activity has emerged. *While enrollment in PE declined between 9th and 12 grades among both girls and boys, this decline was particularly marked for girls* (Table 1). The participation in organized sports was also less at all high school grades and the drop more precipitous for girls compared to boys (Kann, 1998) (Table 2). Based on focus groups among African American and Latino adolescent girls, motivators for physical activity participation included having fun, social support, and concern with body image and health. Barriers to physical activity included negative experiences in PE classes, concern about appearance after activity, and lack of opportunity (Taylor, 1999b).

Table 1. Percentage of U.S. high school students enrolled in PE class from the 1997 YRBSS. (Kann, 1998; similar data were reported in the 1999 YRBSS)

Grade	Female	Male	Total
9th	68.7	69.6	69.2
10th	50.1	56.0	53.3
11th	34.2	43.5	39.3
12th	28.4	42.3	36.1

Table 2. Percentage of U. S. high school students playing on organized sports teams sponsored by schools or unaffiliated with schools from the 1997 YRBSS. (Kann, 1998; similar data were reported in the 1999 YRBSS)

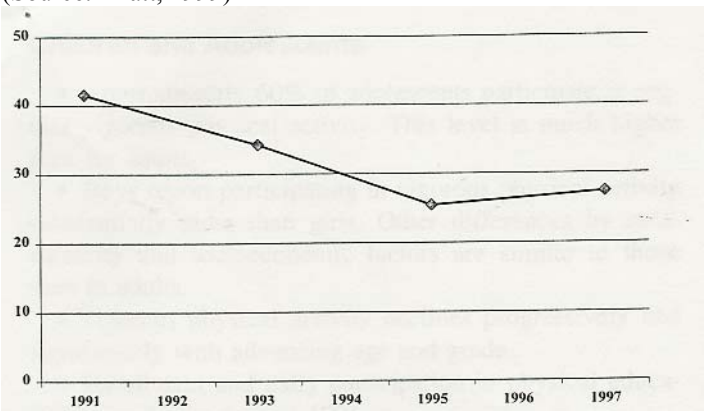
Grade	Played on Sports Teams Run by the School			Played on Sports Teams Unaffiliated with the School		
	Female	Male	Total	Female	Male	Total
9th	48.5	57.2	53.1	36.8	51.3	44.4
10th	45.0	58.0	52.2	34.7	47.3	41.7
11th	40.7	54.0	48.0	26.4	41.6	34.7
12th	35.7	53.4	45.5	21.9	42.6	33.5

In addition to differences in physical activity by age and gender, differences have also been observed by race. Specifically, *African American and Hispanic children and adolescents have been reported to participate in fewer vigorous activities and/or more sedentary activities than Whites, with differences noted as early as elementary school* (Sallis, 1996; Bungum, 1997; Andersen, 1998;Gordon-Larsen, 1999; Pratt, 1999; Bradley, 2000; Gordon-Larsen, 2000). Ethnic differences in times per week of moderate to vigorous physical activity as well as hours per week of inactivity (TV viewing, playing video or computer games) have been noted among adolescents, with less physical energy expenditure reported by minority students than Whites (Gordon-Larsen, 1999). Interestingly, the ethnic differences in physical *inactivity* were far greater than for physical *activity*. Analogous results have been observed for PE participation among college-age students (Finkenberg, 1990). It should be noted, however, that not all results of race-related physical activity have been consistent. For example, Harrell (1997) found that while White girls reported more high-intensity activities than African American and other girls, the opposite trend was observed among boys.

National survey data are inadequate to fully assess trends in physical activity and fitness among children and adolescents. Firstly, there is a lack of data collected. Fitness data of children on a national scale have not been

collected since the completion of the National Children and Youth Fitness study (1984-1986). The YRBSS does not assess fitness, and leisure time physical activity questions have been standardized only since 1993 and provide information only on high school students. Secondly, the use of differences in populations accessed, season and method of survey administration, and questionnaire wording between surveys make comparisons of the limited data available problematic (Pratt, 1999). According to YRBSS data, there has been no significant change in reported vigorous physical activity between 1993 and 1999: 1993, 66%; 1995, 64%; 1997, 64%; 1999, 65% (Pratt, 1999; Kann, 2000). Nevertheless, evidence appears to be accumulating that *certain components of physical activity and fitness among US youth have declined in recent decades*. In the 1984 National Children and Youth Fitness study, 65% of 9th- to 12-grade students were enrolled in PE classes (Ross, 1985). According to the YRBSS, the number of high school students enrolled in PE dropped to 52% in 1990, 49% in 1997 (Pratt, 1999), and 56% in 1999 (Kann, 2000). Nationally, the percentage of high school students attending daily PE has also dropped in recent years (Figure 4). In 1999, the percentage of adolescent students attending PE class daily remained at 29% (not illustrated in figure) (Kann, 2000). While some measures of fitness, specifically coordination and strength, do not appear to have changed over time, physical endurance has markedly declined (Luepker, 1999). According to the President's Council on Physical Fitness and Sports (PCPFS), scores on the mile run, a measure of endurance, declined between 1979-1981 and 1985. Among boys aged 6-15, mile run times increased by more than 20 seconds in 6 of the 10 age groups (USDHHS, 1985). While national trend data on physical activity is inadequate, even less available are comparable data on the related but distinct behavior, physical *in*activity. However, experts on pediatric overweight are becoming concerned that sedentary behaviors, namely TV/video watching and video/computer game playing, are becoming increasingly prevalent (Dietz, 1985) (see section on TV below).

Figure 4. Percentage of US high school students attending daily PE class, 1991-1997 YRBSS.
(Source: Pratt, 1999)



Low levels of physical activity have been related to increased childhood overweight (Waxman, 1980; Ross, 1987; Sallis, 1988; Eck, 1992; Obarzanek, 1994; Raitakari, 1994; DeLany, 1995; Harsha, 1995; Klesges, 1995; Harrell, 1997; Maffeis, 1997; Kemper, 1999; Takahashi, 1999; Berkey, 2000; Garaulet, 2000; Tanasescu, 2000; Public Health Institute, 2001). Overweight children have been shown to expend less energy while participating in the same activities for the same length of time as their non-overweight counterparts (Bullen, 1964). In the longitudinal Framingham Children's Study, preschool children with low levels of physical activity gained substantially more subcutaneous fat by first grade than did more active children (Moore, 1995). Deheeger (1997) found active children, in a study of 86 healthy 10-year-old children of similar BMI, to have higher proportions of fat-free mass and later adiposity rebound than less active children. Family patterns of exercise, including parents' exercise patterns, were inversely related to fatness in children (Dietz, 1991). In a recent study by McMurray (2000), regular participation in as little as one high-intensity activity 3-5 days a week decreased the risk of overweight among 10- to 16-year-old males, but not among females. Further, in a recent review of the literature, Parsons (1999) found inconsistent but suggestive evidence for a protective of effect of physical activity during childhood on subsequent fatness in adulthood. Finally, exercise, even in the absence of dietary changes, has been shown to be an effective strategy for reduction of overweight among adults (Ross, 2000) and children (Gutin, 1999; Owens, 1999).

However, not all studies have demonstrated a clear association between physical activity and body weight (Huenemann, 1966; Durnin, 1974; Bradfield, 1971; Harrell, 1997; Muecke, 1992; Salbe, 1997; Dwyer, 1998;

Maffeis, 1998). Ward and Evans (1995), based on a review of existing studies at the time, concluded that *there is inadequate evidence to support the hypothesis that overweight children are less active than non-overweight children*. Further, in a study of prepubertal girls (mean age 8.5 years), physical activity and fitness did not differ according to parental obesity status (Treuth, 2000a). Even among some of the studies that did show a significant association between physical activity and adiposity, the relationship was complex. For example, in the study by Garaulet (2000), overweight was negatively related to level of physical activity only among boys. In the study by Berkey (2000), the opposite was true: a significant relationship was observed only among girls. In the study by Kemper (1999) adiposity was negatively related to level of physical activity only when measured by skinfolds, but not if assessed by BMI. In the study by Harrell (1997), total physical activity score was not related to skinfold thickness or BMI. However, significantly fewer overweight than non-overweight children reported a vigorous activity as one of their top three activities (Harrell, 1997). Among 1st through 4th graders in the National Children and Youth Fitness Study, there were no differences in PE participation between lean and overweight children. However, lean children tended to participate in more community-based physical activities (Ross, 1987). Differences between study results may occur in part because methods varied; some used open-ended activity questions, others used scaled questionnaires, diaries of variable length and activity recalls, or indirect calorimetry. Further, it is not known which of the elements of physical activity are most important in body weight regulation or health, e.g., intensity, duration, metabolic efficiency, type of physical activity, or overall energy cost (Goran, 1997). Treatment studies by Epstein (1994) comparing types of exercise suggest that lifestyle exercise (e.g., walking to school) had the greatest impact on weight loss, followed by aerobic exercise. Lacking are analogous studies of prevention of overweight among children. Finally, in the majority of studies it is not possible to differentiate between cause and effect; it is not clear whether adiposity preceded or resulted from low levels of physical activity.

It has been suggested that *metabolic fitness may be a better predictor of overweight risk than total or activity-related energy expenditure*. Skeletal muscle activity promotes fat oxidation (as well as insulin sensitivity) and studies in a high-risk population, Pima Indian adults, showed high fat oxidation rates were protective against weight gain (Zurlo, 1990). While studies in children have been less clear (Maffeis, 1995), there is evidence that higher post-absorptive rates of fat oxidation in overweight prepubertal children may oppose further adipose gain. In a cross-sectional study, no differences were noted in total energy expenditure, activity-related energy expenditure or physical activity level between overweight and non-overweight 5- to 11-year-old children. However, the most aerobically fit group was the least fat and among older children (8-11 years), those with the greatest muscle strength were also the least fat (Grund, 2000). Other cross-sectional studies have confirmed that overweight children tend to be less physically fit than their non-overweight counterparts (Goran, 2000b; Hanley, 2000). Further, in a longitudinal study of 95 Black and White children, while initial fat mass was the dominant factor associated with increased adiposity, aerobic fitness was also a significant independent predictor (Johnson MS, 2000), suggesting that lack of fitness contributes to overweight as opposed to simply being a consequence of overweight. In a recent review of the literature, Ward and Evans (1995) concluded that when physical fitness was assessed in relation to body weight or lean body mass, the majority of studies found that overweight children were less physically fit. According to data from the National Children and Youth Fitness Study, factors associated with increased fitness among 5th through 12th-grade students included: access to year-round physical activities (i.e., during the summer as well as the school year); not merely enrollment in PE, but exposure to a wide variety of PE activities (i.e., as opposed to a more restricted exposure); and physical activity in settings outside of PE (i.e., a variety of community physical activity programs) (Ross, 1985).

Regardless of weight status and impact on adiposity, regular participation in physical activity is critical to health. The Columbia Study of Childhood Activity and Nutrition demonstrated that fitness independent of overweight was significantly related to diastolic blood pressure in 5-year-old children (Gutin, 1990). Further, improvements in fitness independent of overweight status have been related to lower rates of age-related increases in systolic and diastolic blood pressure in 5- and 6-year-old children (Shea, 1994). Based on a comprehensive review of studies among school-age students published since 1980, Keays (1995) concluded that *benefits of regular moderate to vigorous physical activity include improved fitness, improved blood pressure, and improvements in attitudes, discipline, and behavior*. Improvement in academic performance was also observed in some, but not all, studies. Physical activity has also been associated with improved blood lipids and coronary risk profile (Raitakari, 1994). *Among adults, physical activity and cardiorespiratory fitness have been shown to be of equal or more importance than BMI as predictors or all-cause morbidity and mortality* (Barlow, 1995; Lee, 1999; Blair, 1999). Taken together, these results suggest that physical activity and fitness should be promoted, regardless of effect on adiposity.

Potential determinants of children's physical activity behaviors can be grouped into three categories: physiologic/developmental, environmental, and psychological/socio-demographic (Kohl, 1998). Each of the three can then be further divided into a multitude of specific determinants (Table 3). However, the relative contribution and effect of these various factors has not been clearly established. A case in point is SES. In a cross-sectional study of 2,200 third and fourth grade students, high SES was associated with a more sedentary level of physical activity among boys, but not girls (Harrell, 1997). In a cross-sectional Belgium study, children with more educated fathers participated in more sports activities. However, children with stay-at-home mothers reported lower levels of physical activity and more television viewing (Guillaume, 1997). In a longitudinal study of 107 7- to 13-year old children lower levels of PE activity and more television viewing was found among children from single parent homes. However, among these same children more vigorous exercise and higher physical fitness was observed (Lindquist, 1999). In a multiethnic study of adolescents, high SES was related to more participation in physical activities in school PE as well as programs outside of school (Sallis, 1996). In the 1992 National Health Interview Survey, high SES among adolescents was related to increased participation in vigorous physical activity, a relationship that persisted after controlling for age, gender, and race/ethnicity (Lowry, 1996).

Table 3: Potential determinants of physical activity behaviors among children. (Kohl, 1998)

Physiologic/developmental:
- Growth and maturation
- Physical fitness
- Physical limitations

Environmental:
- Facilities/equipment access
- Seasonality
- Safety

Psychological/socio-demographic:
- Self-efficacy
- Knowledge, attitudes
- Parental influences
- Role modeling
- Peer influences
- Education/socioeconomic status
- Gender
- Age

Parental influences appear to be an important, albeit complex, determinant of children's physical activity. In a longitudinal analysis of children from 111 families, early age participation in physical activity was related to the child's enjoyment of physical activity (DiLorenzo, 1998). However, during the later phase of the study child's exercise knowledge, mother's physical activity and both the child's and the mother's friends modeling physical activity and/or support of physical activity emerged as important determinants for girls. For boys, knowledge of exercise, parental modeling, interest in sports media and the child's own self-efficacy for physical activity emerged as important. In all children, information about father's level of activity added explanatory power in both genders, however all children without information on fathers were excluded from the study, potentially biasing the results. Similarly, a study of 222 preschoolers demonstrated a significant relationship between a child's weight, parent weight status and percent time spent outdoors with children's activity levels and parental participation in children's activities interacted significantly with levels of parental obesity in predicting physical activity levels. Children with a calculated risk of overweight of greater than 50% (based on number of obese parents) benefited by the most gain in physical activity as levels of parent-child interaction increased (Klesges, 1990). Other authors have found strong associations between parent activity level and child activity level (Moore, 1991) and associations between parental rules regarding active play and parental prompts for active play (Sallis, 1993a). Sallis (1993a) also noted ethnic differences between Mexican-American and non-Hispanic White families in activity rules and prompts. Among 1st through 5th graders in the National Children and Youth Fitness Study, parents of leaner children were more physically active and exercised more often with their children than parents of overweight children (Ross, 1987).

Parental beliefs in the benefits of physical activity have been associated with physical activity among children (Kimiecik, 1998). In other studies, however, the activity level of parents or peers has not been found to be a significant correlate of children's physical activity level (Pate, 1997; Kimiecik, 1998). Further, in a retrospective study of 105 adult males, *both being forced and being encouraged to exercise during preadolescence appeared to have a negative impact on adulthood physical activity, suggesting that children should be given latitude in their choice of type and extent of activity* (Taylor, 1999a).

Physical activity self-efficacy may be another influential, yet incompletely understood, factor. A study of 5th grade predominantly African American children demonstrated that psychosocial factors such as physical activity self-efficacy and positive beliefs about the outcomes of physical activity were important predictors of either self-reported moderate or vigorous activity 1 year later (Trost, 1997). This finding was confirmed using an objective measure of physical activity, the accelerometer. In a later study by Trost (1999), in a diverse group of 6th grade children, physical activity self-efficacy was a significant predictor of vigorous physical activity in both boys and girls. Physical activity self-efficacy was also a predictor of moderate physical activity in girls (along with beliefs regarding physical activity outcomes and access to sporting equipment at home), while involvement in community-based physical activity organizations, social norms regarding physical activity and father's activity level were significantly correlated with moderate physical activity in boys. In a study of high school students, physical activity self-efficacy was predictive of vigorous physical activity, but explained less variance in physical education classes than in out of school physical activity (Allison, 1999b). However, in a study by Sallis, psychological factors (e.g., preferences for activity) and parent variables (e.g., parents transporting children to activity locations) explained only a small percentage of physical activity change in a 20-month study of 4th and 5th graders (Sallis, 1999).

Based on a comprehensive review of the correlates of physical activity (108 studies published between 1970 and 1998), Sallis (2000) found that *the following variables were consistently associated with physical activity among children (ages 3-12 years): gender (male), parental overweight status, physical activity preferences, intention to be active, perceived barriers (inverse), previous physical activity, healthy diet, program/facility access, and time spent outdoors. Among adolescents (ages 13-18 years) variables consistently associated with physical activity included: gender (male), ethnicity (White), age (inverse), perceived activity competence, intentions, depression (inverse), previous physical activity, community sports, sensation seeking, sedentary after school and on weekends (inverse), parent support, support from others, sibling physical activity, direct help from parents, and opportunities to exercise.* It should be noted that some variables were studied too infrequently, may not have been adequately measured, or provided conflicting results so that conclusions could not be made (e.g., parent physical activity, child body weight, socioeconomic status, benefits, peer modeling).

Researchers have also studied perceived barriers to physical activity, which may be categorized as either external/environmental or internal/individual barriers. In a sample of high school students, Allison (1999a) noted time constraints from schoolwork, conflicting interests and family activities were commonly cited as barriers. Females reported higher perceived barriers than did males in this study. There were also differences between 9th and 11th graders on rankings of barriers. According to the focus group research conducted with California children and parents in the Children's Healthy Lifestyle project, factors which limited participation in physical activities were high cost, limited accessibility and lack of transportation, competitive nature of most programs designed for children, and lack of safe places for children to play without parent supervision (Cohen, 2000). Researchers have recommended priority be given to programs that seek to reduce barriers for older students and female students (Allison, 1999b).

Finally, it has been suggested that physical activity and inactivity may be influenced by different determinants. Among a nationally representative sample of adolescents *physical activity was most associated with environmental factors, while physical inactivity was most associated with socio-demographic factors* (Gordon-Larsen, 2000). Specifically, participation in daily PE classes and use of a community recreation center were associated with increased moderate to vigorous physical activity. A high level of serious crime in the neighborhood was associated with decreased moderate to vigorous physical activity. High family income and advanced maternal education were associated with lower levels of inactivity.

Correlations of physical activity between early and later childhood and between childhood and adulthood have generally been low to moderate (Sallis, 1995; Pate, 1996; Taylor, 1999a), suggesting that physical activity habits developed in children may not persist to a great extent in later life. However, most studies of adults have been based

on recall of childhood physical activity, introducing potential bias from inherent memory limitations and poor recall. Also lacking are studies investigating whether certain physical activity habits are more persistent than others and to what extent tracking is mediated by environmental and psychosocial influences. One of the few prospective studies to date of tracking of physical activity found that daily PE in elementary school had a positive impact on exercise habits among adult women, despite similar perceived barriers, attitudes and intention to exercise between the experimental and control groups. While exercise habits did not differ among men in the two groups (daily PE and control), significant health effects were observed (i.e., reduced risk of becoming a regular smoker in group with daily PE) (Trudeau, 1999). In another prospective study, physical inactivity tracked better from adolescence to young adulthood than did physical activity. Approximately 57% of inactive teens remained inactive after a 6-year follow-up, while only 44% of active teens remained active as young adults (Raitakari, 1994). Physically active adult men have been found to have significantly greater physical fitness test scores as children than did inactive adults (Dennison, 1988). Taken together, these data suggest that healthy physical activity habits require reinforcement throughout the lifecycle.

Finally, *interactions between physical activity and diet may exist*. Physically active children of similar BMI at age 10 were found in one study to ingest more energy than less active children, predominantly by increasing their carbohydrate intake and thus reducing their percentage of calories derived from fat. These children were also more likely to have higher intake at breakfast and in the afternoon, suggesting that physical activity may exert positive modifying effects on children's diets (Deheeger, 1997). Energy balance is not determined by diet or activity alone, but by the interaction of the two. For example, physical activity may mitigate the effects of an energy dense, high fat diet. Likewise consumption of a diet low in energy density can mitigate the effects of a sedentary lifestyle (Hill, 1998).

3.5 Television and Media Factors:

Television viewing has become a common activity among US children. Ninety-nine percent of children live in a home with at least one TV set and 97% have a VCR; 32% of 2- to 7-year-olds and 65% of 8- to 18-year-olds have a TV set in their bedroom (Roberts, 1999). Data indicate that television viewing among adolescents has increased from the 1960's to 1980's (Figure 5). The average child or adolescent watches an estimated average of nearly 3 hours of television per day, not including time spent watching videotapes or playing video games (Nielsen, 1998). It has been estimated that young children 2 to 5 years of age watch an average of 3.6 hours of television daily (AAP, 1992) and that one-quarter of all US children watch over 4 hours of television daily (Johnson RK, 2000). A 1999 study of a large nationally representative sample found that 2- to 18-year-olds spend an average of 5 hours and 29 minutes per day with various media combined (Roberts, 1999) (Figure 6). Only 5% of this media use time was spent on computer and video game use. In a sample of 2,389 adolescents 10 to 16 years of age from the Cardiovascular Health in Children Study (CHIC), 75% of children watched 2 or more hours of television on non-school days and just over 50% watched 2 or more hours on school days (McMurray, 2000). Among children 8 to 16 years of age assessed in NHANES III, 61% reported watching 2 or more hours of TV daily (Andersen, 1998).

Figure 5. Total weekly TV viewing by 12- to 17-year olds in the US. (Source: Gortmaker, 1990)

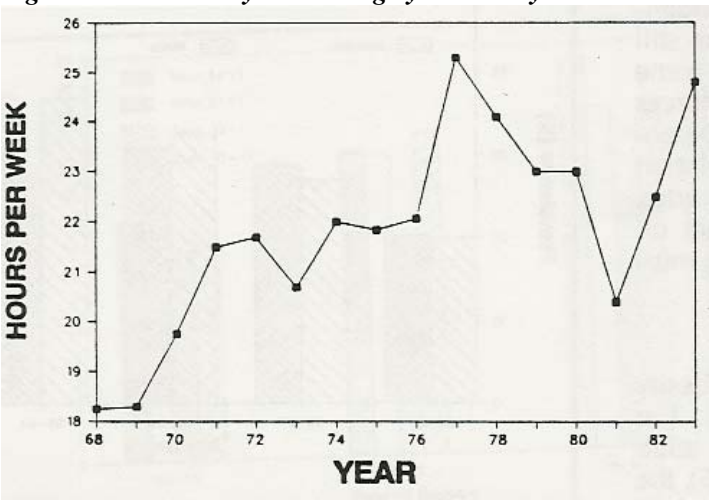
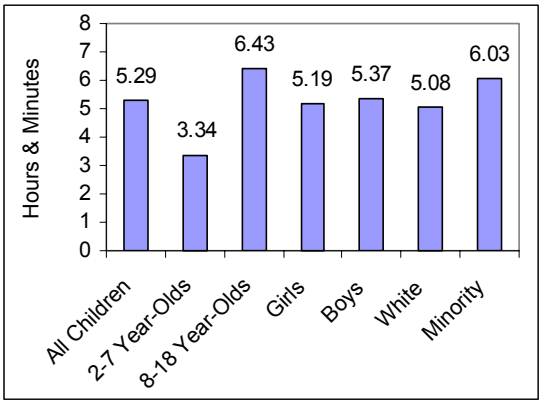


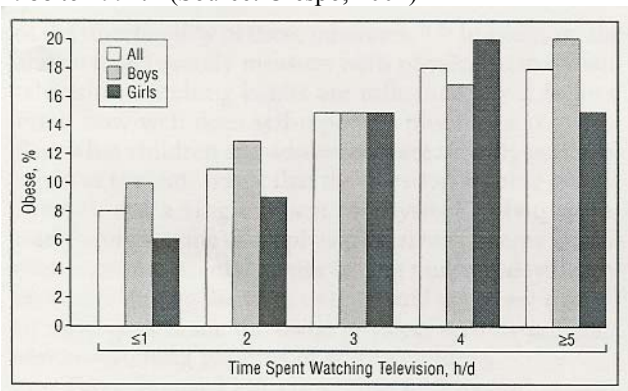
Figure 6. Average total daily media use by children and adolescents. Total media use includes television/video, video game, computer, and CD/cassette player use, listening to the radio, and reading printed media. (Roberts, 1999).



In the CHIC study, adolescents from lower SES households and African American adolescents watched more television and played more video games than adolescents from higher SES households and White adolescents. NHANES III data indicate that more non-Hispanic Black (65%) and Mexican American (53%) children (8 to 16 years) watched television for 3 or more hours compared to non-Hispanic White children (37%). Non-Hispanic Black children had the highest rates of watching 4 or more hours of television per day (42%) (Andersen, 1998). Other studies have also found *TV viewing to be higher among African Americans and Hispanics than Whites* (Klein, 1993; Bungum, 1997; Kann, 2000).

Time spent viewing television has consistently been shown to be associated with overweight status (Dietz, 1985; Ross; 1987; Durant, 1994; Sallis, 1995; Gortmaker, 1996; Guillaume; 1997; Deheeger, 1997; Andersen, 1998; Maffeis, 1998; Hernandez, 1999; Müller, 1999; Berkey, 2000; Grund, 2000; Hanley, 2000). Based on data from the National Health Examination Surveys (NHES cycle II – 1963-1965 and cycle III – 1966-1970), among children 12 to 17 years of age the prevalence of overweight increased 2% for each additional hour of TV viewed daily (Dietz, 1985). Data from NHANES III (1988-1994) also found an increase in overweight prevalence with increased television viewing among 8- to 16-year-olds (Figure 7), however, after adjusting for other correlates, significance was only found for girls (Crespo, 2001). Among 9- to 11-year-old children from proxy data obtained from parents in the California Behavioral Risk Factor Surveillance Survey System (BRFSS), at risk or overweight children spent more time than children not at risk (101 vs. 81 minutes per school day) watching TV or playing computer and video games (Public Health Institute, 2001). While provocative, it should be noted that these results did not take into account race/ethnicity and SES. Interestingly, in another study the significant relationship between TV viewing and BMI disappeared after adjusting for ethnicity and SES, suggesting that these variables may be important mediators of the relationship between TV watching and overweight (McMurray, 2000). Gortmaker (1996) reported that children who watched more than 5 hours per day have a nearly 5-fold increased risk of overweight compared with those who watched 0-2 hours. In a study of Mexican children, Hernandez (1999) found that odds ratios of overweight were 12% higher for each hour of television program viewing per day, and 10% lower for each hour of moderate/vigorous physical activities. In Spanish 13- and 14-year-olds, time spent watching television was related significantly with BMI in girls and with body fat percentage in both boys and girls (Moreno, 1998). Crawford (1994) examined factors prior to the onset of overweight in a large group of Black and White pre-adolescent girls and found hours of television viewing to be predictive of overweight development. More video and computer play has also been noted among overweight versus non-overweight children in some (Deheeger, 1997; Crooks, 2000; Public Health Institute, 2001), but not all (Tanasescu, 2000; Hernandez, 1999) studies.

Figure 7. Prevalence of obesity by daily hours of television watched among US children aged 8 to 16 years, from 1988 to 1994. (Source: Crespo, 2001)



Researchers have suggested two primary mechanisms by which television viewing contributes to overweight. These mechanisms are reduced energy expenditure from reduction in physical activity and increased dietary energy intake, either during viewing or as a result of food advertising (Robinson, 1999). The extent and relative contribution of these mediating effects is unclear. In some cases REE was lower during television viewing than during quiet rest; in normal weight 8- to 12-year-old girls REE dropped by 12% and in overweight girls REE dropped by 16% (Klesges, 1993). Further, the energy expended while watching television or videos has been shown to be less than most if not all other sedentary activities (e.g., video games, schoolwork, and arts and crafts) (Treuth, 2000b). In a study of predominantly African American 5th grade students, television viewing was found to be one of the most important correlates of physical inactivity; students who watched TV or played video games for 3 or more hours after school were over 2 times more likely to have low activity status than children who watched less than 3 hours per day (Pate, 1997). Furthermore, in a study of 14- to 18-year old African American girls, following sports through the media was associated with low levels of participatory activity (Bungum, 1997). While several studies have found significant inverse associations between TV watching and physical activity or fitness (Tucker, 1986; Durant, 1994; Bungum, 1997; Pate, 1997), others have failed to confirm this association (Taras, 1989; Robinson, 1993).

Television viewing may influence weight status over time by influencing the type and/or amount of foods consumed by viewing children. The advertising of calorically dense food products during children's television programming is of particular concern. Foods are some of the most heavily advertised items on children's television programs, and most food advertising on television is funded by brand-name food manufacturers and fast food chains (USDA, 1998). In a study of the advertising content of 50 hours of nationally broadcast Saturday morning children's television (ABC, CBS, NBC, Fox, and Nickelodeon), 47.8% of the ads were for food, airing an average of one every 5 minutes (Kotz, 1994). Most (91%) of these ads were for foods high in fat, sugar, and/or salt; none of the ads promoted fruits and vegetables. Figure 8 contrasts the USDA Food Guide Pyramid with a pyramid depicting the foods advertised on Saturday morning children's television (Kotz, 1994). Food advertising is also high during prime time hours, when children's television viewing is heaviest (Nielsen, 1998). In an analysis of the commercials aired during 17.5 hours of top-ranked prime-time network shows for the age 2- to 11-year-old category, 40% of the food advertisements were for fast food items (Byrd-Bredbenner, 1999a,b). Low-nutrient density foods and foods in the fats, sweets, and alcohol group constituted 41% of all foods referenced, while medium- and high-nutrient density foods constituted 36%. French fries, a low-nutrient density food, represented 80% of the vegetables advertised. Nearly half of the foods that fall into the breads/grains group were high in fat or sugar, and none were whole grain. Figure 9 compares the Food Guide Pyramid to one constructed of the foods advertised during this study.

Studies have suggested that the attention level of children as young as three or four increases at the onset of a commercial and that 50-90% of children under age six cannot articulate that ads are intended to influence purchasing (Wartella, 1980). In small study of preschool children, those exposed to a videotape with embedded commercials were significantly more likely to choose the advertised items than children who saw the same videotape without commercials (Borzekowski, 2001). Only 1 or 2 exposures to short (< 30 seconds) commercials for specific food products influenced 2 to 6 year olds' short-term preferences for those products. Longer-term effects on preferences were not measured. In a study of 209 4th and 5th grade students, Signorielli (1992) found that heavy TV viewers were more likely than light viewers to hold unhealthy conceptions about food and incorrect

knowledge about principles of nutrition. In a later study, Signorielli (1997) again found a strong positive relationship between TV viewing and unhealthy perceptions of nutrition in 4th and 5th graders. Lewis (1998) found that food commercials more strongly influenced self-perceptions of well-being and appetite for sweets in overweight 9-year-old children than non-overweight children. This suggests that there may be differences in the way children interpret messages associated with food ads.

Figure 8. Comparison of USDA Food Guide Pyramid and pyramid of foods advertised on Saturday morning children's television. (Source: Katz, 1994)

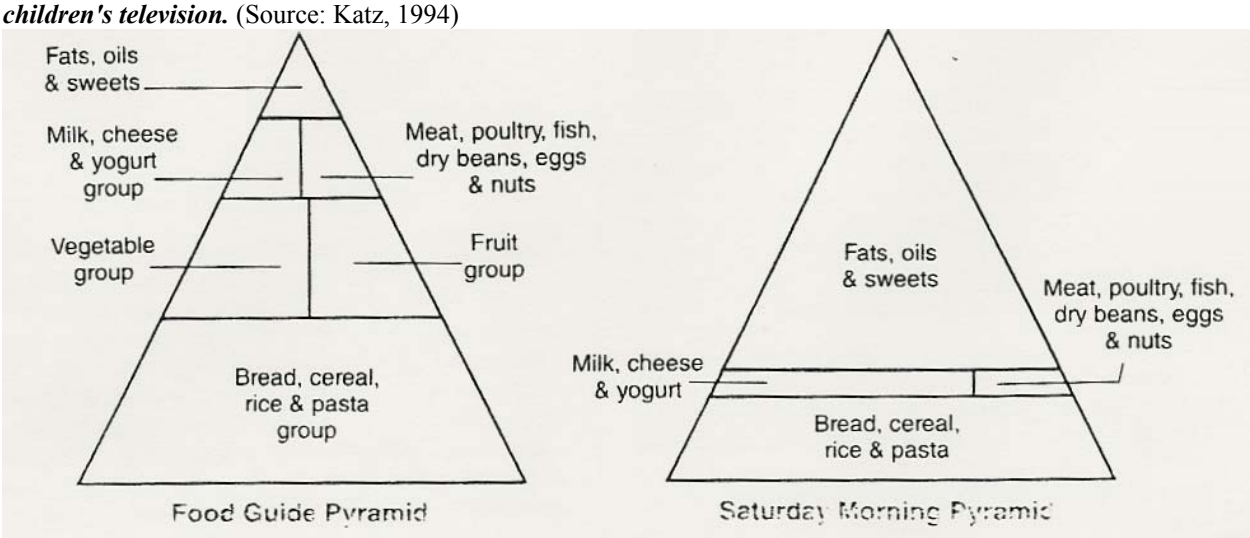
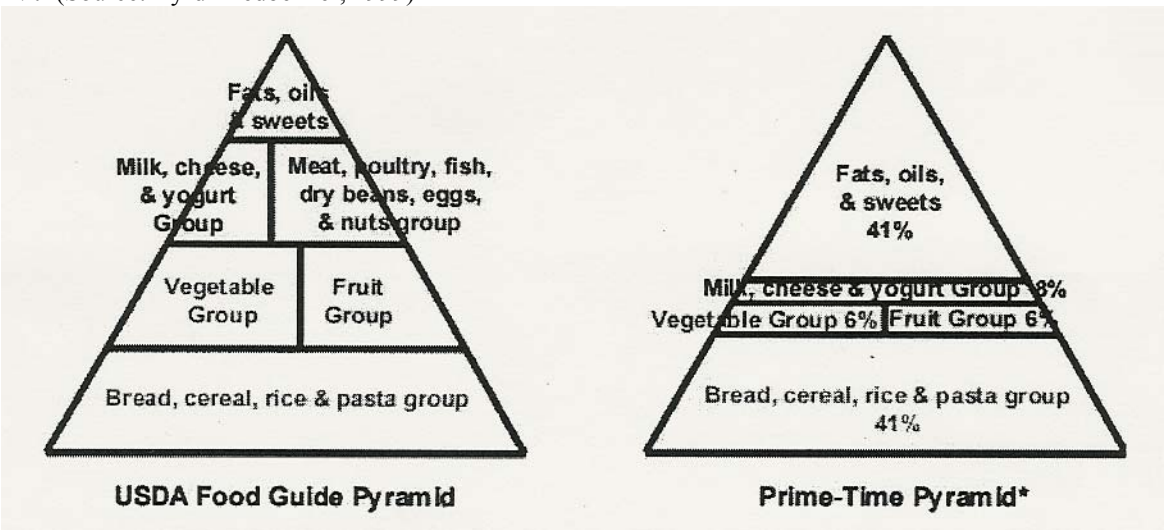


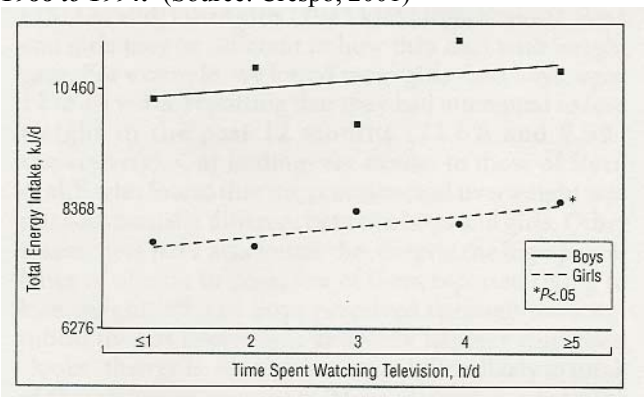
Figure 9. Comparison of USDA Food Guide Pyramid and pyramid of foods advertised on children's prime time TV. (Source: Byrd-Bredbenner, 1999)



Total energy intake and type of foods consumed have both been shown to be associated with increased television watching. NHANES III data reflect a positive association between total energy intake and hours of television watched among both boys and girls aged 8 to 16 (Figure 10) (Crespo, 2001). Tanasescu (2000) found that TV viewing was associated with physical inactivity and was not associated with sweets and snack intake among girls. However, among boys, TV viewing was not associated with activity level, but was positively correlated with consumption of sweets and snacks. Taras (1989) also found that time spent watching television was positively related to children's requests for and parents' purchase of advertised foods, and to children's overall caloric intake. Müller (1999) found that television viewing in excess of one hour per day was associated with higher consumption

of fast food, sweets, chips and pizza and lower consumption of fruits and vegetables among 5- to 7-year-old children. The Signorielli (1992) study of 4th and 5th graders also found that TV viewing was an extremely strong predictor of poor nutritional eating habits. A series of studies by Jeffrey (1982) suggested that low-nutrition ads were most effective in increasing total caloric consumption and were not mediated by cognitive development.

Figure 10. Total energy intake and daily hours of television watching among US children aged 8 to 16 years, 1988 to 1994. (Source: Crespo, 2001)



Food commercials may influence food purchasing and consumption for the entire family as mediated through the child. Kraak (1998) reviewed findings and trends from marketing literature to gain perspective on the food purchasing influence and habits of children and adolescents. Nearly 75% of 7- to 9-year-olds made an average of 2 independent trips to the store each week. A 10-year-old averages 5 visits each week to 5 different stores, representing 250 store visits each year. Findings from the 1989 USA Weekend/Roper Report on Consumer Decision-Making in American Families suggest that 78% of children and adolescents influence where the family goes for fast food; 55%, the choice of restaurant for dinner; 50%, the type of food the family eats at home; and 31%, the specific product brands that families purchase. It has been observed that in families where adolescents exert more control over food decisions, the food choices are less healthy (De Bourdeaudhuij, 1998). Parents are 2-3 times more likely to name a child rather than themselves as the family expert for selection of fast food, snack food, restaurants, and new breakfast cereals. When asked to describe the barriers that interfere with their family changing to a healthful diet, parents identified two: varying food preferences of family members and children's desire to eat advertised foods. At least 1/3 of the industry sales of fast foods, candy and gum, packaged cookies, hot cereals, juices and juice drinks, peanut butter, frozen pizza, and toaster products are influenced by children.

Coon (2001) theorized that *the practice of eating meals with the television on may influence families' food consumption patterns*. An estimated 58% of children have the TV on during mealtime (Roberts, 1999). In a study of ninety-one families of 4th, 5th, or 6th grade students, households with lower incomes, less educated mothers, or single parents were more likely to have a television on during meals (Coon, 2001). The presence of television during meals was inversely related to parents' general knowledge and concern about nutrition and diet. When other factors were controlled for, children from families with high television use derived an average of 6% more of their total daily energy intake from meats; 5% more from pizza, salty snacks, and soda; and almost 5% less from fruits, vegetables and juices than children from families with low television use. It has also been reported that girls who frequently eat while watching TV more likely to have higher caloric intakes than girls of comparable weight who did not report these behaviors (McNutt, 1997). Distraction (e.g., listening to a recorded story) during meals, among women at least, has been associated with increased food consumption (Bellisle, 2001). Thus *it is likely that excessive TV watching influences both energy expenditure and energy intake.*

3.6 Dietary Factors:

Research over many decades has been aimed at identifying associations between dietary factors and childhood overweight. Associations exist for maternal diet and preconception underweight status and infant weight and health, as well as for breast-feeding and infant weight and health. Thus attention to the earliest facets of "diet" is pertinent to any discussion of child overweight. How this early phase in a child's life impacts future health is still being investigated (Lucas, 1998; Hediger, 2000; von Kries, 1999) and data are sometimes conflicting. The Office of the

US Surgeon General has called for an effort to increase rates of breast-feeding which are also disparate across communities, with extremely low rates among African-Americans. Healthy People 2010 lists objectives to address this disparity (Office of the US Surgeon General, 2000).

Most research regarding diet in the etiology of overweight has focused on caloric intake, yet with few exceptions (Berkey, 2000), *there is not clear evidence of a relationship between total energy intake and overweight from either cross-sectional or longitudinal studies of children* (Huenemann, 1974; Vobecky, 1983; Shapiro, 1984; Rolland-Cachera, 1988; Cinciripini, 1984; Valoski, 1990; Obarzanek, 1994; Klesges, 1995; Johnson-Down, 1997; Dwyer, 1998; Maffeis, 1998; Tanasescu, 2000). It has even been reported that fatter children consume fewer calories than thinner children (Stewart, 1999). Further, dietary surveys have generally reported similar mean energy intakes for children in each of the last three decades (Albertson, 1992; Nicklas, 1993; Stephen, 1990; Kennedy, 1997; Troiano, 2000). In contrast to dietary survey data, recent US ecologic data (determinations of food availability) suggest that per capita energy intake has increased by 15% between 1970 and 1994 (Harnack, 2000). However, ecologic data, by its nature, is not specific to children and also changes in food waste cannot be accounted for. One explanation for an inability to elucidate the expected relationship between calories and weight gain or overweight is that dietary methods lack sensitivity to detect small caloric differences. Increasing caloric intake by as little as 150 kilocalories per day above the requirement for weight maintenance can result in substantial weight gain over a year (Rosenbaum, 1998). Some have also proposed that lack of an observable relationship is a result of children's underreporting of foods and serving sizes (Johnson-Down, 1997). Adolescents were found to underreport kilocalories by 20% to 41%, with variation depending on overweight status (Bandini, 1990).

The fact that studies have shown that energy intake of children and adolescent have remained relatively stable over the recent past suggests that the current overweight epidemic is more a function of decreased energy expenditure than dietary changes (Schlicker, 1994). However, metabolic studies of the efficiency with which macronutrients are converted to body fat suggest that not all sources of calories are equivalent (Parsons, 1999). Specifically, *dietary fat may be more obesigenic than other macronutrients*. Fat is energy dense (containing 9 kilocalories/gram compared to 4 kilocalories/gram for carbohydrate and protein) and highly palatable. Children provided with high fat diets may experience lower meal-induced thermogenesis than those who have diets higher in carbohydrate or protein (Maffeis, 1999). Energy intakes and BMIs have been shown to be lower among adults consuming low fat (high carbohydrate) diets (Kennedy, 2001). Several studies of children have also found a relationship between dietary fat intake and body adiposity (Gazzaniga, 1993; Obarzanek, 1994; Klesges, 1995; Tucker, 1997; Anand, 1999; Robertson, 1999; Garaulet, 2000). Klesges (1995) found that higher baseline percent fat intake, as well as increased fat intake over time, were associated with increased BMI among a cohort of 3- to 5-year-old children followed over a 3-year period. Crawford (1994) similarly demonstrated an association between percent fat in the diet of 9- to 10-year-old girls and likelihood of overweight development 2 years later. Sawaya (1998), in a longitudinal study of school-aged girls in a poor area of Brazil, found that a high dietary fat intake was associated with high weight gain among growth stunted, but not non-stunted girls, suggesting a variable response to dietary fat. These researchers have also demonstrated that nutritional stunting was associated with impaired fat oxidation (Hoffman, 2000a), while no association existed with REE (Hoffman, 2000b). Further, the effects of a high fat diet on energy balance may be more deleterious in combination with physical inactivity (Shepard, 2001). Finally, the degree to which a child prefers high-fat foods (Fisher, 1995), and the percentage of kilocalories consumed from fat (Eck, 1992) have been positively associated with parental adiposity. In summary, Hill and Peters (1998) in a recent review reported that laboratory studies in rodents and humans have consistently shown that high levels of dietary fat can induce weight gain. What is lacking, they say, are large prospective trials testing whether a diet with reduced fat and energy density can prevent overweight.

Although more children are meeting the dietary guidelines for fat (<30% of total kilocalories) and saturated fat (<10% of total kilocalories) presently than in past decades, the majority of children still consume excess amounts of fat, according to national surveys (Kennedy, 1997; Troiano, 2000). In 1988-1994, among children and adolescents overall means of energy from fat and saturated fat were 33.5% and 12.2%, respectively. Only 1 in 4 youths met the recommendations for fat intake (Troiano, 2000). Among the 9- to 10-year-old girls in the NHLBI Growth and Health study, 90% of Black girls and 84% of White girls consumed more than the recommended 30% of kilocalories from fat (Crawford, 1995). Further, while energy intakes varied little across household income strata, there was an inverse association among children between SES and dietary total and saturated fat (Kennedy, 1997). One of the most obvious differences in food intake patterns between children of low and high household incomes was pattern of milk intake. Even though milk intake tends to increase with increased SES, higher SES children consume more low

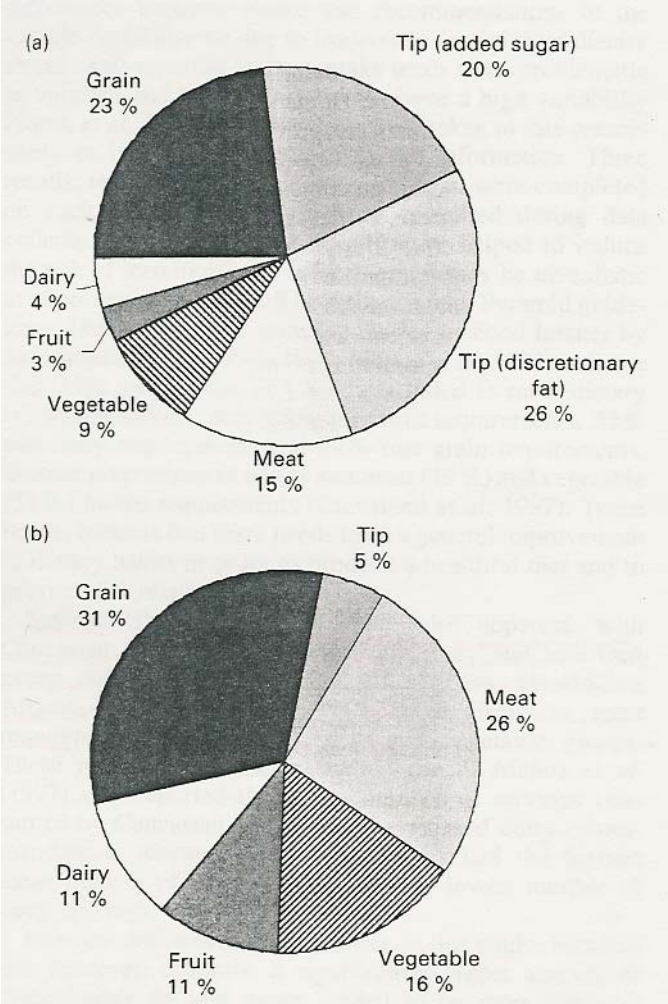
and nonfat milk and less whole milk; consumption of whole milk drops from 51% for the lowest income group to 31% for the middle-income group to 19% for the highest income group (Kennedy, 1997). Nevertheless, while targeting type of milk consumption may be an important public health strategy to improve lipid profile and cardiovascular risk, a relationship between whole milk consumption and weight status remains to be established.

The fact that other studies have failed to find a relationship between fat intake and overweight (Muecke, 1992; Johnson-Down, 1997; Dwyer, 1998; Maffeis, 1998; van Lenthe, 1998; Atkin, 2000; Berkey, 2000; Maffeis, 2000), and that the national prevalence of overweight has risen while the percentage of dietary energy derived from fat has decreased (Stephen, 1990; Nicklas, 1993; Kennedy, 1997; Cavadini, 2000), suggest that other dietary mediators may also be involved. For example, the *energy density of foods may influence food regulation more so than macronutrient content*. In a study of obese and lean women, the fat content of foods did not affect total caloric intake. However, higher caloric intakes were observed when subjects were fed a diet rich in high-energy-dense as opposed to low-energy-dense foods (Rolls, 1999). Similarly Cox (1999) found that non-dieting obese and non-obese adults did not consume diets that differed substantially in macronutrient content or sensory (i.e., taste and texture) or hedonic (i.e., perceived pleasantness) characteristics. However, the obese group did have a diet with a significantly higher energy density, particularly associated with salty or savory (rather than sweet) foods. Unfortunately, analogous studies among children are lacking.

The glycemic index (GI) of foods, that is the rapidity with which the gastrointestinal tract absorbs glucose from a food, has also been investigated with respect to regulation of food intake and overweight (Ludwig, 2000). In a study of overweight adolescent boys, voluntary energy intake was significantly higher after a high GI meal than after medium or low GI meals (Ludwig, 1999). However, a non-overweight control group was not included in this study and additional research in this area is needed before any definitive relationship between GI and adiposity can be ascertained.

Although not yet well documented, links have also been observed between eating pattern and overweight. Reported associations of food groups with childhood overweight include: low intake of fruit and vegetables (Neumark-Sztainer, 1996; Müller, 1999; Public Health Institute, 2001), high intake of fast foods and sweets (Müller, 1999), and high intake of sugar-sweetened beverages, such as soft drinks (Ludwig, 2001). It is estimated that only 30% of children currently meet the goals for daily intake of grains, meats, fruits and vegetables according to the Food Guide Pyramid (USDA, 1992) and that discretionary fat and added sugars represented over 40% on the energy intake of 2- to 17-year-old children in the 1989-1991 CSFII (Muñoz, 1997). Figure 11 illustrates a typical comparison of the composition of the reported diet of children (in this case, 7-14 years of age) with the hypothetical diet meeting the Food Guide recommendations (Brady, 2000). Of all the food groups, children are most likely to have low consumption of vegetables and fruit (Kennedy, 1997). Further, fruit consumption declines as children grow older (USDA, 1996). According to the 1999 YRBSS, less than one quarter of adolescents had eaten ≥ 5 servings/day of fruits and vegetables during the 7 days preceding the survey (Kann, 2000). Although vegetable consumption appears to be stable as children become teens, the most popular vegetable choices are potatoes (including french fries and potato chips), followed by tomato products (including spaghetti-type sauces and salsa). Among adolescents, white potatoes accounted for half of vegetable consumption in 1996, up from a third in 1965, much of the increase due to high-fat potatoes such as fries and chips (Cavadini, 2000). Lacking in the diets of children are the nutrient-rich dark green and deep yellow vegetables (USDA, 1996). Further, it has been shown that when fruits and vegetables are added to the diet, fat intake tends to decrease (Murphy, 1992; Kennedy, 2001). Among adolescents in the YRBSS the most common risk behaviors for chronic disease were unhealthy dietary patterns, such as low intake of fruits and vegetables and high intake of fat (Lowry, 1996).

Figure 11. Comparison of reported (a) vs. recommended (b) consumption of food groups by children.
(Source: Brady, 2000)



Data from national surveys indicate that in recent decades *consumption of soft drinks has increased dramatically among US children and adolescents*, with a concomitant decrease in milk consumption (Borrud, 1996; Gerrior, 1998; Morton, 1998; Cavadini, 2000) (Figure 12). Among young children soft drink consumption increased by 23%, while fluid milk consumption decreased by 16% between the late 1970's and early 1990's (USDA, 1996). Figure 13 shows the increases in beverage intake by 2- to 17-year olds between 1989 and 1995 alone. Of all beverages examined, the most dramatic increase has occurred for soft drinks (Morton, 1998). According to the 1989-91 Continuing Survey of Food Intakes by Individuals (CSFII), soft drinks were the sixth leading food source of energy and the second leading food source of carbohydrate among US children age 2 to 18 years (Subar, 1998). In the 1994-95 CSFII carbonated soft drink consumption represented 55% (lowest income group) to 64% (highest income group) of total beverages consumed by children (Kennedy, 1997). According to data from NHANES III, soft drinks were the major beverage contributor to energy among adolescents, providing 8% of total energy (Troiano, 2000). Further, high consumption of soft drinks by adolescents has been associated with higher intake of energy (Guenther, 1986; Harnack, 1999).

Figure 12. Per capita soft drink and milk consumption in the US, 1945—1997. (Source: Gerrior, 1998)

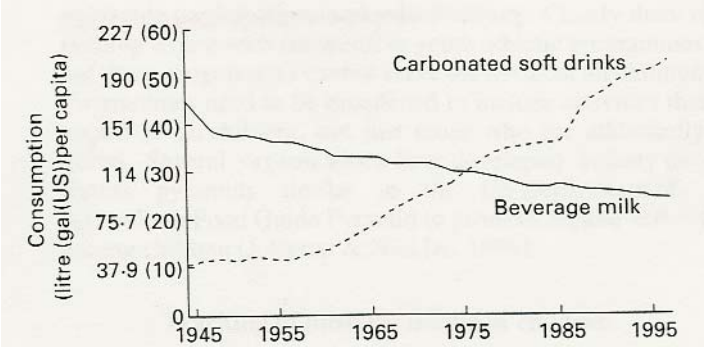
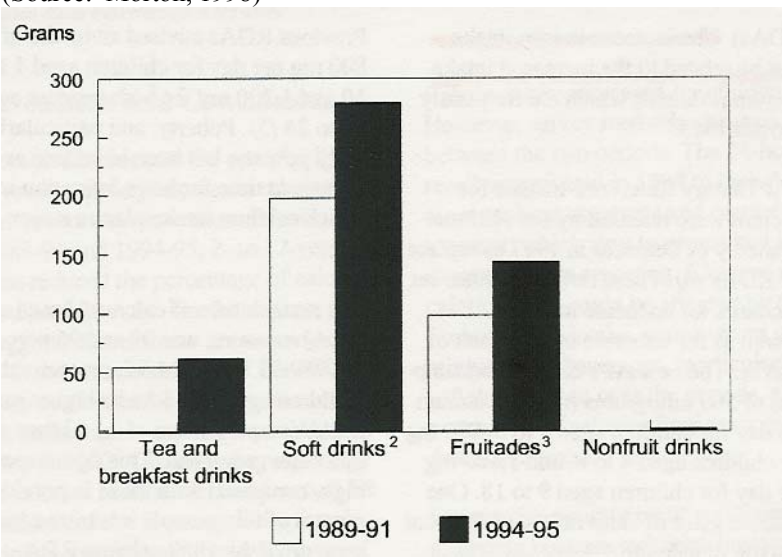


Figure 13. Changes in beverage intake among 2- to 17-year-olds from CSFII 1989-1991 versus 1994-1995. (Source: Morton, 1998)



Several studies suggest that consumption of excessive soft drink or other sugar-sweetened beverages is related to pediatric overweight. For each additional serving of a sugar-sweetened beverage consumed daily over a 1 ½-year period among school-aged children, the risk of becoming overweight increased 60% after controlling for other potentially confounding variables (Ludwig, 2001). Further, based on national surveys, beverage consumption in general, and soft drink consumption in particular, were generally higher among overweight than non-overweight children and adolescents (Troiano, 2000). Among California 9- to 11-year-old children, overweight or at risk children drank more soft drinks and fruit drinks compared to children who were not at risk (1.4 vs. 1.1 servings/day), though these results were not adjusted for differences in race/ethnicity or SES (Public Health Institute, 2001). While there is no clear evidence that consumption of sugar *per se* affects food intake and weight gain (Hill, 1995), there is some evidence to suggest that "liquid sugar" or energy consumed as a liquid may be less well regulated than energy consumed in a solid form (Mattes, 1996). It should be noted, however, that consumption of high-calorie, low-nutrient-dense foods has been observed to be high among children and adolescents, regardless of weight status (Bandini, 1999; Brady, 2000).

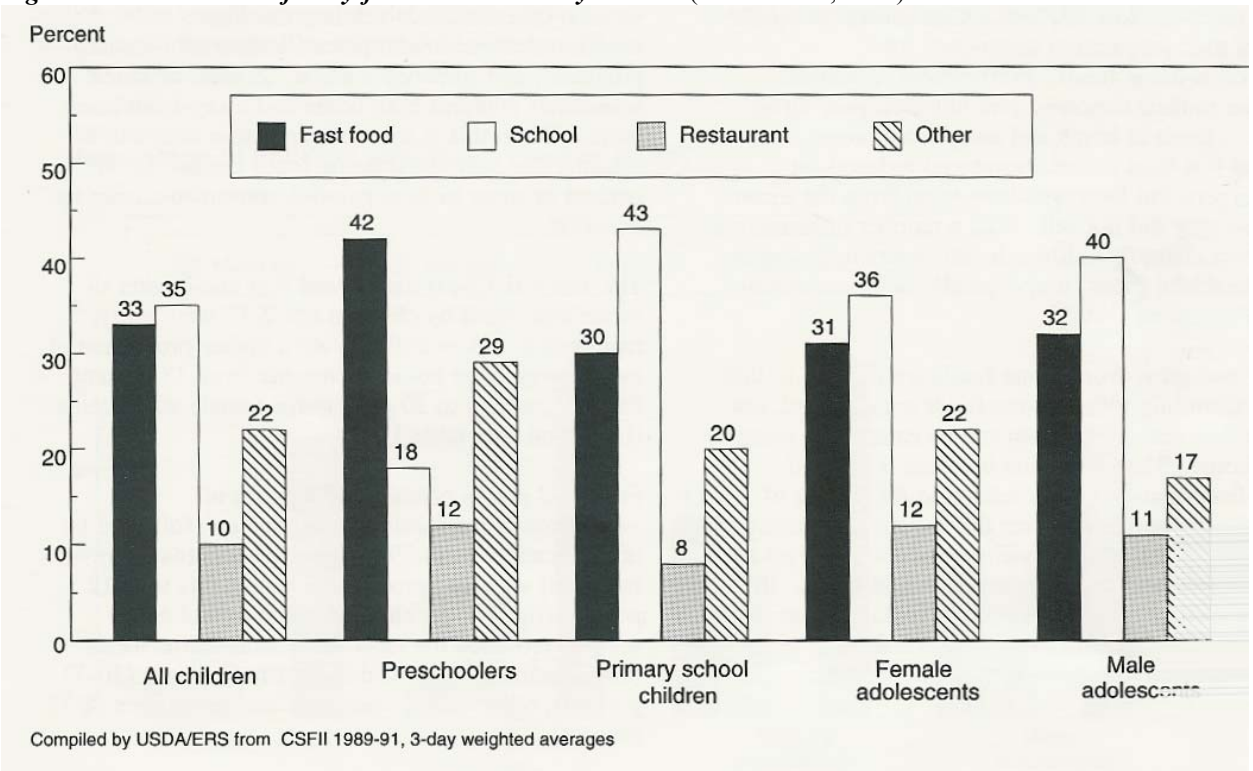
There is conflicting data about the role of high intakes of fruit juice in children. Dennison (1997) and Tanasescu (2000) found that high intakes of 100% fruit juice were correlated with childhood overweight, while others (Riddick, 1997; Skinner, 1999; Alexy, 1999) reported no relation between 100% fruit juice and overweight among preschool children. Dennison found that preschool children who consumed more than 12 oz/day (n=19) of 100% fruit juice were at increased risk of short stature and overweight. Skinner (2001) was unable to replicate this finding in a recent study of preschool-aged children. Unlike previous studies, Skinner followed the children longitudinally (from 24 to 72 months of age). No relation was seen between 100% juice intake and anthropometric measures. One

criticism of the Skinner study is that only 3 children in this study consumed ≥ 12 oz/day over time and only 1 of these had ≥ 12 oz/day at all 7 dietary interviews. However, in a USDA study with 78 2- to 5-year-olds in the sample who reported 12 oz or more of 100% juice daily for 2 days, no relation was seen between fruit juice consumption of 12 or more oz per day and BMI (Riddick, 1997). Among young children the consumption of non-citrus juices (e.g., grape and apple juice and mixtures) rose by 304% between the late 1970's and early 1990's (USDA, 1996). The American Academy of Pediatrics recently recommended that fruit juice consumption be limited to 4-5 oz/day for children 1-6 years of age and 8-12 oz/day for children 7-18 years of age. (AAP, 2001). These recommendations, however, were based on consideration of nutrient and gastrointestinal problems; more research was viewed necessary before overweight could be considered a consequence of excess fruit juice consumption (Conlon, 2001). Other agencies, however, have stressed the important contribution to nutrient intake that 100% fruit juices can make and advise that fruit juice consumed in quantities consistent with the Dietary Guidelines for Americans is advantageous for healthy children (Riddick, 1997).

Food eaten away from home is increasing in the US. In 1992, households spent 38% of their food dollar on foods eaten away from home, an increase from about 20% in the 1970s. Between 1992 and 1993 alone, there was a 9% increase to $197.8 billion dollars spent on meals eaten out (Schwenk, 1995). During the past 2 decades, percentage of meals and snacks eaten away from home increased from 16% in 1977-78 to 27% in 1995 (Harnack, 2000). According to the 1994 CSFII, nearly half of 3- to 5-year-old children consumed food or drink purchased from restaurants, compared to one-third in the 1977-1978 survey. Foods eaten away from home now constitute 20% of total energy intake in young children. Among older children (6-19 years of age), outside food consumption increased from about 55% of food in 1977-1978 to about 66% in 1994, currently representing 25% of total calories among 6- to 11-year-olds and 33% of total calories among 12- to 19-year-olds. One in three school-age children gets more than 40% of total calories from away-from-home food (USDA, 1996). Not surprisingly, *frequent consumption of foods at fast food and other restaurants has been associated with a diet high in fat and low in nutrient density* (Dausch, 1995; Cusatis, 1996; Zoumas-Morse, 2001). Meanwhile, the number of fast food restaurants is increasing at an annual rate of 7%, compared to 3% for the restaurant industry as a whole (Perman, 1998). Data on secular trends in restaurant portion sizes and implications for weight gain are scant and primarily anecdotal (Harnack, 2000). However, according to a study by the National Restaurant Association, which collected menus from the same 66 restaurants in 1988 and again in 1993, the number of menus offering more than one portion size, such as "super" sizes, increased by 12% (NRA, 1993). In the 1994-1996 CSFII, eating food away from home was associated with higher weight among men, after controlling for other variables. Eating restaurant foods or fast foods (foods typically high in fat and calories and low in nutritional value) has also been associated with higher weight and energy intake among women (Jeffery, 1998; McCrory, 1999; Binkley, 2000). Further, 9- to 11-year-old children from the California BRFSS who were at risk or overweight reported eating more fast food than children who were not at risk of overweight (1.4 vs. 1.1 times/week), although these results did not take into account differences by race/ethnicity or SES (Public Health Institute, 2001).

While a substantial percentage of away-from-home food comes from fast food restaurants, school meals represent another major source for school-aged children (Lin, 1996) (Figure 14). Meals provided through the National School Lunch Program are required by law to be balanced and nutritious. Despite the many nutritional benefits of school meals (Public Health Institute, 2001; USDA, 2001), *meals offered in the National School Lunch Program and the School Breakfast Program have, on average, been shown to exceed the Dietary Guidelines' goals for total fat and saturated fat as a percentage of food energy* (Burghardt, 1995). Correspondingly, students who participate in the School Breakfast and School Lunch Programs have been shown to have higher mean intakes of energy, fat and saturated fat than children who participate in neither program (USDA, 2001). Moreover, fast foods sold separately from the National School Lunch Program are exempt from dietary guidelines. According to California school district food service directors that responded to a mailed survey, 90% of high schools sold fast foods and 72% permitted advertising of brand-name fast foods and beverages on campus (Samuels, 2000). On a national basis, in 1990-1991 brand-name fast foods were sold in only 2% of public schools in the National School Lunch Program; in 1995-1996 this number had increased to 13% (US General Accounting Office, 1996). In California, 16% and 8% of 9- to 11-year-olds reported having access to vending machines selling either soda or candy, chips and cookies, respectively, and 24% reported that their school cafeterias served fast food (Public Health Institute, 2001). Compared to children not at risk, at risk or overweight children were twice as likely to attend a school with vending machines selling chips and candy and reported eating more fast food, although these figures were not adjusted for racial/ethnic or SES differences (Public Health Institute, 2001).

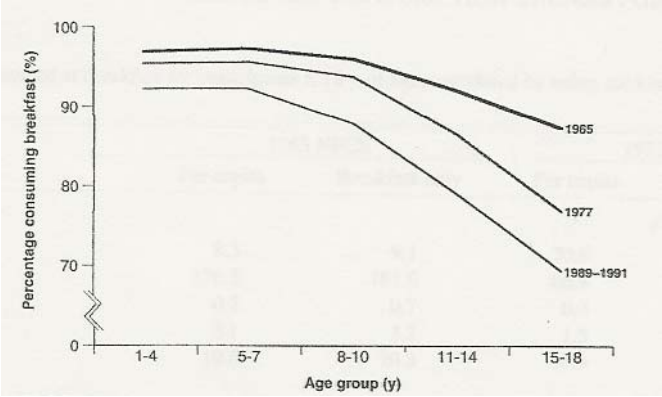
Figure 14. Distribution of away-from-home meals by source. (Source: Lin, 1996).



In support of the data which suggest that eating meals away from home is a risk factor for a less healthy diet and possibly overweight, *eating dinner with family has been associated with a more healthy diet*: more fruits and vegetables, less fried foods and soda, less fat, and more micronutrients (Gillman, 2000). As expected, fewer adolescents eat dinner with family than younger children (Gillman, 2000). Compared with other children, female teens have been reported to have the highest tendency to skip breakfast, eat the smallest number of meals, and eat the most food away from home (Lin, 1996). Thakur (1999), in a study of high school students, found that overweight adolescents were more likely to report infrequent meals consumed with family than their non-overweight peers.

Population-based surveys have revealed that many children, particularly adolescents, skip breakfast and other meals and eat more food later in the day and that this pattern has increased in recent years (Singleton, 1982; Siega-Riz, 1998b) (Figure 15). In the Child and Adolescent Trial for Cardiovascular Health (CATCH), both African American and Hispanic adolescents were more likely to skip breakfast than Caucasian adolescents (Dwyer, 2001). According to 1989-1991 CSFII data, meal skipping was more common among African Americans, older teens, and children from a single-parent household (Siega-Riz, 1998a). Interestingly, children from low-income households were 60% less likely to skip meals. This finding may be attributed to the fact that low-income children have higher rates of participation in school breakfast and lunch programs, which in turn is associated with a more consistent meal pattern (Siega-Riz, 1998a). *Overweight children and adolescents have been shown to be more likely to skip breakfast and consume a few large meals per day than their leaner counterparts* who are more likely to consume smaller frequent meals (Huenemann, 1968; Fabry, 1964, 1966; Metzner, 1977; Crawford, 1994; Wolfe 1994; Ortega, 1998; Siega-Riz, 1998b; Dwyer, 2001). Overweight children have also been reported to eat smaller breakfasts than their non-overweight peers (Ortega, 1998). It has been suggested that eating breakfast reduces fat intake and limits snacking over the remainder of the day (Schlundt, 1992). In a study of 7- to 11-year-old children, Maffeis and colleagues (2000) found that while diet composition was not related to adiposity, the distribution of energy intake among the different meals was. Specifically, a higher proportion of energy intake at the dinner meal was associated with greater adiposity.

Figure 15. Trends in breakfast consumption among US children from 1965 to 1991. Weighted results are from the Nationwide Food Consumption Surveys of 1965 and 977 and the Continuing Survey of Food Intakes by Individuals of 1989-1991. (Source: Siega-Riz, 1998b).



The type of foods consumed may mitigate the physiologic benefit, if any, of frequent snacking. According to nationally representative data, *while the average size of snacks and the energy per snack has remained relatively constant, the frequency of self-defined snacking has increased from 1977 to 1996* among children in all age groups between 2 to 18 years (Kennedy, 1997; Jahns, 2001). Further, snacks tend to be higher in energy density and fat content than meals (Jahns, 2001) and high snack consumption has been associated with high intakes of fat and sugar (Cusatis, 1996). The top snacks selected by teens from the 1976-80 NHANES II and the 1987 National Adolescent Student Health Survey included: potato chips, ice cream, candy, cookies, breakfast cereal, popcorn, crackers, soup, cake, and carbonated beverages. Fruits and vegetables were infrequent choices. Between one fourth and one third of the energy intake of adolescents has been reported to be derived from snacks (Dausch, 1995). It has been reported that girls who frequently buy snacks were more likely to have higher caloric intakes than girls of comparable weight who did not report this behavior (McNutt, 1997). High intake of snack foods (i.e., chips, peanuts, peanut butter and popcorn) was positively correlated with BMI among prepubertal children (Tanasescu, 2000). Likewise high fat snacking, unadjusted for race/ethnicity or SES factors, has been associated with at risk or overweight among 9- to 11-year-old children (Public Health Institute, 2001).

Paradoxically, moderate to mild food insecurity (i.e., not having enough of the kinds and amounts of food) may play a role in the etiology of overweight. Nationwide approximately 3% of all households with children and 7.5% of low-income families with children have been reported to experience food insecurity (Casey, 2001). Food deprivation (either in the form of starvation or self-imposed dieting) appears to result in preoccupation with food and eating binges once food is again available (Polivy, 1996). It has been hypothesized that cyclical food shortages (e.g., when money for food runs out before payday or food stamps run out before the end of the month) may increase reliance on high fat or empty calorie foods, resulting in weight gain over time (Dietz, 1995; Olson, 1999). An increased reliance on high fat or empty calorie foods may represent a strategy to cope with constrained finances as such foods are often a less expensive, yet satiating, source of calories. In the 1989-91 and 1994-95 CSFII, while total dietary energy decreased for children from food insecure compared to food secure households, the distribution of calories from fat and saturated fat increased (Kennedy, 1997). In an another analysis of the 1994-96 CSFII, low-income, food-insecure households included more overweight children than higher-income food-secure households. Further, the food insecure group consumed less fruit and spent more time watching television, although their caloric intake was lower (Casey, 2001). In another study, preschool children classified as “hungry” or “at risk of hunger” consumed more empty calories by drinking more fruit drinks and juice than non-hungry children (Cutts, 1998). Household food insecurity has also been associated with a low intake of nutrient dense, low kilocalorie foods such as fruits and vegetables (Cristofar, 1992; Kendall, 1996; Neumark-Sztainer, 1996). Several studies have demonstrated a positive association between mild to moderate household food insecurity and overweight in adult women, an association that remained after controlling for SES (Frongillo, 1997; Townsend, 2001). However, in a study of US children of Puerto Rican descent, moderate food insecurity was higher in non-overweight than overweight children (Tanasescu, 2000). Additional studies of the impact of food insecurity among children are needed to clarify these conflicting results.

Numerous barriers to following a healthy diet have been identified. Among adults, factors cited included: lack of time (Anderson, 1998; Lopez-Azpiazu, 1999); expense (Anderson, 1998; Margetts, 1998; Lopez-Azpiazu, 1999); lack of willpower to give up favorite foods and difficulty changing ingrained habits (Lopez-Azpiazu, 1999; Saba, 1999); lack of support from family and friends (Anderson, 1998); lack of availability of healthy choices (Airhihenbuwa, 1996); and lack of agreement on the part of experts regarding which foods are healthy (Margetts, 1998). Cultural perceptions toward foods may be an additional barrier to change (Airhihenbuwa, 1996). Generally lack of knowledge was not reported as a barrier. Preventing disease, maintaining health and reducing weight have been the main benefits reported by adults for eating healthy (Zunft, 1997; Lopez-Azpiazu, 1999; Zunft, 1997).

Deterrents to healthy eating behaviors among children have been less well documented. Preference for palatable foods has been noted as a barrier to diet change among both young children (Cowart, 1981; Murphy, 1995) and adolescents (Freeman, 1997). Sociocultural influences, such as media and fashion, have been reported to be among the most influential factors in adolescents' decision to make dietary changes (Brook, 1997; Wertheim, 1997). According to the focus group research among California children and their parents in the Children's Healthy Lifestyle project, notable *barriers to adopting healthy diets included: lack of time for food preparation; lack of convenience; expense; lack of availability; and children's refusal to eat healthy foods* (Cohen, 2000).

Tracking of nutrient intake from childhood into adulthood may begin as early as 3-4 years of age (Singer, 1995). Energy intake per kilogram of body weight has been shown to demonstrate moderate correlation between the ages of 13 to 27 years of age, consistent with moderate stability in overweight risk over that period of time (Kemper, 1999). Kelder (1994) found that food preferences tracked well from age 11 to 17 years of age and suggested that interventions should begin before 6th grade at which time dietary patterns appear already ingrained and therefore may be more difficult to change than at younger ages.

4. CONCLUSION

In conclusion, genetic factors lay the groundwork for overweight and over 200 specific genetic factors related to overweight risk in humans had been identified as of 2000. Although genetic influences on adiposity patterns are well established, the environment has a great influence on how genes are expressed. The first environment for development is the uterus. Low birth weight (LBW) and high birth weight (HBW) both emerge as potential risk factors for overweight and development of chronic diseases in adulthood, although the data is less conclusive that LBW is a risk for future overweight. Thus an important consideration for prevention of overweight is targeting women for proper nutrition before and during pregnancy, improved care of pregnancy related diabetes, and attention to all causes of LBW and HBW.

From studies of families, one of the strongest predictors of adulthood obesity in children appears to be parental obesity status. The risk of becoming an obese adult increases approximately 3-fold if one parent is obese and 13-fold if both parents are obese. While some studies have found that metabolic rates may be lower in overweight children after controlling for body weight, not all studies have supported this finding. At least one study found that in children examined by year of age, there appeared to be periods when metabolic rate is lower (such as age 10), suggesting that risk reduction intervention prior to this age may be optimal. In addition, experiencing an early adiposity rebound, the age at which body mass index (BMI) increases after its nadir in early childhood, may be a risk factor for subsequent adiposity. Since adiposity rebound normally occurs between the ages of 4 and 8, early childhood is prime for prevention interventions.

Another physiologic factor related to risk of adulthood adiposity is age of maturation; early maturation nearly doubled the risk of overweight among adolescents in one recent study. A secular trend toward earlier age of menarche has been observed over the last several decades, particularly among African American and Hispanic girls. While the factors that underlie this trend are not completely understood, this evidence suggests that prevention interventions prior to menarche are important to obesity prevention in girls.

Socioeconomic status (SES) emerges as a risk factor (low SES as a risk factor for higher BMI), though the data for childhood is not conclusive. No one factor (income, single parent household, parental education level) can be clearly shown as a determinant. Differences in the relationship between SES and weight status have been observed among children from different racial/ethnic groups with black children being more similar in weight between lower

and higher income households than White children. More research is needed, but the constellation of traits that may be found in a low income household suggest that at the broadest level, education and economic empowerment will be key policy level interventions.

Specific family characteristics are associated with child overweight. Family interrelationships may alter a child's ability to respond to energy density and timing of meals. Inability of children to self-regulate food intake may be related to overly restrictive child feeding practices as well as inadequate parental limit setting. It has been recommended that overweight prevention programs include information on general parenting skills and focus less on an individual child's growth. Some data suggest that eating meals away from home is a risk factor for a less healthy diet and possibly overweight, while eating dinner with family has been associated with a more healthy diet: more fruits and vegetables, less fried foods and soda, less fat, and more micronutrients.

Low levels of physical activity during childhood have been related to increased risk of childhood overweight as well as subsequent fatness in adulthood. Inactivity is very common among American youth and is more prevalent than in the past. Declines have occurred in both PE participation and out of school physical activity in recent years with declines more marked for girls than boys. Unfortunately, in the majority of studies of physical activity, it is not possible to differentiate between cause and effect; it is not clear whether adiposity preceded or resulted from low levels of physical activity. Still the dropping level of physical activity at a time when mean overweight is increasing in childhood is of concern. In addition, benefits of regular moderate to vigorous physical activity include improved fitness, improved blood pressure, and improvements in attitudes, discipline, and behavior. Thus it is appropriate to target all children for messages about the benefits of regular physical activity. The best type(s) of physical activity for prevention of overweight among children have not been determined, but treatment studies of established overweight suggest that lifestyle exercise (e.g., walking to school) had the greatest impact on weight loss, followed by aerobic exercise.

Greater amounts of time spent viewing television have consistently been shown to be associated with overweight status, while the data is less conclusive for other media (computer use, electronic game use, etc). Children who watched more than 5 hours per day in one study had a nearly 5-fold increased risk of overweight compared with those who watched 0-2 hours. Two primary mechanisms suggested for the contribution of television viewing to overweight are reduced energy expenditure and increased dietary energy intake, either during TV viewing or as a result of food advertising.

Most research regarding diet in the etiology of overweight has focused on caloric intake, yet with few exceptions, there is not clear evidence of a relationship between total energy intake and overweight from either cross-sectional or longitudinal studies of children. Reported associations of food groups with childhood overweight include: low intake of fruit and vegetables, high intake of fast foods and sweets, and high intake of sugar-sweetened beverages, such as soft drinks. Among young children soft drink consumption increased by 23%, while fluid milk consumption decreased by 16% between the late 1970's and early 1990's.

While theoretically multiple risk factors are amenable to prevention interventions, focusing on a few behaviors may be most efficacious. Physical activity promotion (in light of falling levels), strategic dietary changes (such as lower fat milk and decreased soda consumption), and promotion of family mealtime and activity represent examples of risk/protective factors that could be targeted. Childhood overweight increases span all age, gender and race/ethnicity groups indicating universality in need for intervention, yet variation in risk behaviors by demographic group must be considered in intervention design.

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F. DIET AND PHYSICAL ACTIVITY INTERVENTIONS AMONG CHILDREN

1. INTRODUCTION

Articles reviewed included two general types of overweight intervention: 1) treatment and 2) prevention. Recent review articles cover the individual-level treatment approach (Williams, 1997; Barlow, 1998; Epstein, 1998). Further, programs developed for adults, although components of some of those programs target family dietary change, will not be reviewed. Recent reviews also exist of these areas (Brownell, 1991; Glenny, 1997). For the purpose of this review, treatment trials were not emphasized, but rather emphasis was placed on lessons learned from overweight prevention programs with an emphasis on primary preventive interventions that would best inform state prevention planning. However, key findings from treatment studies will be provided where relevant. Although there is considerable heterogeneity with respect to emphasis and technique, both prevention and treatment programs frequently involve similar components, for example, behavior modification, diet improvement, and promotion of physical activity. In as much as a primary aim of any successful treatment program is long-term weight maintenance and prevention of the return of overweight status, there is also considerable overlap between treatment and prevention strategies, particularly in structural components such as parent participation and changes in the home environment (Robinson, 1999a).

The interventions reviewed include: family-based programs, school-based programs, and community-based programs. Duplicative trials that reinforced but did not add to the information already gained were not emphasized in the discussion. In addition, we attempted to avoid duplication of previous comprehensive reviews of pediatric overweight prevention (the reader is referred to Jackson, 1991, McGraw, 2000, and Schmitz, 2000), by focusing on the most recent and relevant studies. Within that framework, programs may either focus on specific affected or at-risk youth, or may be primary prevention oriented. In addition, for many school-based intervention strategies, programs include multiple components such as individually targeted physical activity improvements paired with organizational change in food purchasing or food delivery. We will discuss the results of all the components under the section covering school-based interventions.

2. BACKGROUND AND RATIONALE

While one advantage of *treatment* for overweight is that those most in need are targeted for intervention and treatment can be tailored to meet the unique needs of each individual, several disadvantages exist. Experts recommend that *interventions ideally begin with children prior to the onset and consolidation of risk-related behaviors after which time lifestyle habits may be harder to influence* (Perry, 1990). Further, the International Obesity Task Force (1999) concluded that *prevention of weight gain is easier, less costly, and more effective than treating obesity after it has fully developed*. Prevention may also forestall the concomitant loss of self-esteem that may occur as children become overweight (Pierce, 1997). Further, it has been demonstrated that it is easier to increase activity in the non-obese as compared to the already obese child (Epstein, 1996b). *Because of the refractory nature of obesity treatment, consensus is growing that primary prevention in children is key to stemming the current obesity epidemic* (NHLBI, 1998). While motivating children and their families may require education regarding the health risks of excess adiposity, poor diet and a sedentary lifestyle, programs should foster community cohesiveness, and avoid creating negative reactions to overweight and segregation of overweight children (Rosenbloom, 1999). Isolating only those who are overweight may further stigmatize children in a society that idealizes thinness. Children perceive what is the socially acceptable body image at a young age (Feldman, 1988). Edelman (1982) studied a group of children from ages 5 to 12 years and found that even the youngest children conceptualized the idea of being overweight as something negative. Harris (1983) found that school-age children identified thin figures as having more friends and being better looking, smarter, and neater than fat figures. Numerous studies have identified deleterious consequences of the quest for ideal weight among children and adults (for review see Lindeman, 1999).

Although weight loss is the conventional goal for adult interventions, it is generally not an appropriate target for growing children. In the case of children, whose weight normally increases as a function of growth, hypocaloric dieting to induce weight loss can lead to stunting of linear growth (Figueroa-Colon, 1993). In contrast, promotion of

a balanced diet within the 900 to 1200 calorie range among overweight children who were followed for 10 years showed no impact on height compared to controls (Epstein, 1990). Weight loss efforts may be counterproductive and ultimately increase overweight risk. According to a 3-year longitudinal study of nearly 700 9th grade girls from three high schools in northern California, those who reported more strenuous dieting and radical weight loss efforts (such as use of laxatives, diet pills, vomiting, and fasting) gained more weight than girls who did not follow such practices. Regardless of initial weight status (underweight, normal weight or overweight), the risk for overweight was over 3 times greater for dieters than non-dieters (Stice, 1999). Sixty-one percent of adolescent girls surveyed in the 1993 national Youth Risk Behavior Survey reported dieting in the previous year. Girls engaging in extreme weight loss strategies were less likely to have adequate fruit and vegetable intake than moderate dieters and were more likely to have consumed 2 or more servings of high fat food (Story, 1998). Further, preoccupation with weight may lead to body dissatisfaction, poor self-esteem, and eating disorders (Neumark-Sztainer, 1996). Dieting for weight loss may also compromise bone mineral content and increase risk of subsequent osteoporosis (Van Loan, 2001). In addition to physical and psychosocial development, dieting may compromise intellectual development. In a British study of 11- to 18-year-old girls, dieting and resultant poor iron status were associated with a drop in IQ (Kenyon, 2000). Rather than weight loss, a reduced or stabilized BMI-for-age percentile or percentage overweight are appropriate outcomes for interventions in children. Other appropriate goals include increased physical activity/fitness level, healthier dietary habits, improved division of eating responsibility between parent and child, improved self-esteem, more positive body image, and improved physiological measures (e.g., decreased lipids, blood glucose, blood pressure or breathing difficulties) (Barlow, 1998; Neumark-Sztainer, 1999).

While some may question the need for a large-scale intervention on essentially healthy children, there are at least 4 reasons to promote interventions to improve nutrition and physical activity in children (Baranowski, 2000a): the child may receive immediate benefits (such as better fitness or energy or micronutrient intake); intervention at critical periods may improve adult health (there may be specific periods that act as set points for later health); modifying chronic disease risks in childhood may lead to lower rates and risk factors in adults (for instance, the process of atherosclerotic plaque formation is slowed); and modification of children's behaviors may lead to improved behaviors in adulthood that would protect against chronic diseases. A strong case has been made by Baranowski for obesity and overweight interventions based on tracking coefficients for adiposity being higher than for other behavioral risk behaviors (such as physical activity) and physiologic risk factors such as lipid abnormalities (only LDL showed moderate levels of tracking).

Several learning theories have served as the basis for nutrition and physical activity interventions. Behavioral-choice theory involves the concept that behavior modification can be achieved by reducing access to an unwanted behavior (e.g., TV watching) and improving access to a desirable behavior (e.g., physical activity), a theory which has been employed clinically to treat overweight youth (Epstein, 2000). Social cognitive theory focuses on the importance of social and environmental factors in influencing behavior (Bandura, 1986). Social learning theory promotes change via several constructs such as role modeling, social support, opportunities, knowledge, self-efficacy, skill building, behavioral contracting, self-monitoring and reinforcement (Williams, 1998; Davis, 1999). For example, some interventions aimed to change children's knowledge, values and sense of personal control over health, teach behavioral skills such as self-monitoring and goal setting for physical activity and food selection, and seek environmental changes via promotion of new role models, providing opportunities, influencing parents and creating peer support (Davis, 1999). The transtheoretical stages of change model describes five stages denoting readiness for behavioral change: precontemplation, contemplation, preparation, action and maintenance (Prochaska, 1992; Prochaska, 1997). Some commonalities among these theories include reduction of barriers to change and reinforcement of positive changes. While the identity and extent to which various learning theories were employed in the selected interventions will not be reviewed, it should be noted that most, if not all, were based on one or more established theories of learning.

3. CATEGORIES OF PREVENTION PROGRAMS

One method of *grouping prevention programs is according to their primary focus or avenue of delivery such as via individuals, families, schools, community groups, or the environment* (Jackson, 1991). While programs may involve more than one of these modes, the main emphasis of the intervention provided the means for grouping in this review.

Most of the individual-based interventions identified were treatment programs, a few of which are included herein. While most individual-level programs target the affected child, at least one successful program targeted the parent as the sole agent of change and found that approach to be superior to one that targets the child, and also offered protection against the self-esteem issues that arise when the child is singled out for therapy (Golan, 1998). Family-based interventions focused on families as a unit or on a child and a parent.

Since the majority of California children attend public or private schools (in the 1999-2000 school year there were over 6.5 million K-12 students in California (California Department of Education, 2000a/b)), schools are a logical and convenient place to conduct overweight prevention programs. The school-based interventions were roughly grouped according to the age of the students involved: preschool (age 2 – 5 years), elementary school (age 5 – 12 years), middle school (age 12 – 14 years), and high school (age 14 – 18 years).

Community-based and environmental strategies promote healthy practices and/or discourage unhealthy practices for the population-at-large rather than specific individuals in established settings (Jackson, 1991). Included in the category of environment-based approaches are broad-based social marketing campaigns and legislative policy efforts. The school-lunch program is also an environmental intervention as it influences the diet of children without any knowledge or training on their part, however this will be covered under school-based programs. A comprehensive review of social marketing promotions of nutrition and physical activity was recently conducted by the Center for Advanced Studies in Nutrition and Social Marketing at UC Davis (Alcalay, 2000; Carroll, 2000) and will therefore not be duplicated here. However, an update of social marketing campaigns conducted since the completion of that review and a summary is provided in section F of this document. Policy efforts are reviewed in section G.

4. LESSONS LEARNED FROM INTERVENTIONS

4.1 Individual and Family-Based Treatments:

The basis of much of our current understanding of treating pediatric overweight comes from four long-term family-based studies conducted by Epstein (1996a). Epstein's studies targeted children between 6 and 12 years of age. Common program features included: counseling sessions for parents and children (treatment length varied from 8 to 26 weeks); the "stoplight" diet wherein no foods are forbidden, but low calorie ("green") and moderate calorie ("yellow") foods are encouraged over high calorie ("red") foods; and a physical activity program. Behavior modification strategies involved: self-monitoring of activity and eating habits; use of praise and contracts with non-food and non-monetary rewards; stimulus control to make the home environment more conducive to a healthy lifestyle; role-modeling of healthy behaviors by parents; and avoidance of over-regulation of children's food consumption. Key findings from Epstein's 10 year follow-up on treatment of overweight adults and children from 143 families included findings that child outcomes were improved when both parents and children were targeted for behavior change, that increased physical activity was critical to long-term maintenance of weight control in children, and that it was easier for children to decrease their percent overweight and maintain weight control than for adults. While both parents and children lost weight in these family-based studies, the parents had significantly less success maintaining weight loss (Epstein, 1996a).

Promising short- and long-term weight management for children and adolescents has been demonstrated using a multidisciplinary approach. SHAPEDOWN, a 10-week family-based intervention program employed cognitive, behavioral, affective and interactional techniques to effect self-directed change in diet, exercise, communications, and attitudes. Restrictive diets were not used. The program's goals were not simply to lose weight, improve diet and exercise, but rather to reduce psychosocial and medical problems associated with overweight. After one year, mean weight loss of the intervention group was 3.9 kg as compared to a weight gain of 1.3 kg for the control group (Mellin, 1987). It should be noted, however, that this evaluation involved relatively few subjects. Other multidisciplinary approaches have been beneficial as well (Sothern, 1999). Based on a meta-analysis of 41 studies to treat pediatric overweight, Haddock (1994) found that interventions that incorporate both behavioral and knowledge components, particularly those that include exercise in the intervention, are likely to be successful. Nutrition intervention alone did not prove to be a successful strategy for reducing pediatric overweight (Pinelli, 1999), unless the treatment was very intensive (Nuutinen, 1991). In contrast, physical training alone, without dietary intervention, has resulted in improved body composition (Owens, 1999). There also appears to be some

benefit in weight control programs of encouraging children to decrease sedentary activity as opposed to simply increasing participation in physical activities (Epstein, 2000). Nevertheless, experts recommend incorporation of physical activity and dietary modification with emphasis on improving overall health rather than on effecting change only in body fatness (Barlow, 1998).

It is important that parents be involved in overweight interventions (Wadden, 1990; Barlow, 1998). This begins with early interventions that target new mothers for information on breast-feeding and delaying introduction of solid foods. Even a short targeted educational intervention of first-time adolescent mothers demonstrated efficacy in decreasing introduction of foods before 3 months of age (Black, 2001). In a study involving treatment of overweight children 8-12 years of age, parental involvement was one of the best predictors of both short and long term weight regulation (Epstein, 1996a). Families in which parents expressed a positive attitude that their child would be less likely to be overweight in the future were more likely to have children with successful weight loss in an overweight treatment program (Uzark, 1988). Intervention groups without maternal involvement have been significantly less successful than interventions with separate mother and child involvement (Brownell, 1983). Similarly, in a clinic-based study of Black adolescent girls, girls treated in the same or separate sessions with their mothers lost more weight than girls treated without any parental participation, although the differences were not significant in this small study (Wadden, 1990). Treatment of childhood overweight with a family-based approach in which only the parents received group sessions on behavior change was more successful than when only children received counseling (Golan, 1998). During the one-year study, for the "parent" groups, attrition rate was significantly lower (3% vs. 30%) and mean percentile weight reduction among children was significantly greater (14.6% vs 8.1%).

Based on data from the U.S. Department of Agriculture's 1989-91 Continuing Survey of Food Intakes by Individuals and the companion Diet and Health Knowledge Survey, Blaylock (1999) concluded that "*the more a mother knows about health and nutrition the better is the overall quality of her children's diet, for preschoolers more so than older children*". Recent research has revealed the need for additional parental education. In a recent study, three-quarters of parents did not think that overweight or obesity represented a health problem and half did not recognize that their child was overweight (Bass, 2001). In a study of WIC mothers with pre-schoolers at risk for overweight, mothers did not incorporate information on weight for height given by providers when assessing overweight in their children. Rather, they were more likely to depend on factors such as a child being teased about weight or becoming inactive because of weight (Jain, 2001). Mothers in this study also expressed distrust of information given to them about overweight. Such beliefs may act as barriers to effective intervention.

Further, family-based approaches provide the additional benefits of improving parental diet and physical activity patterns and reducing parental obesity (Golan, 1999). African-American mothers who participated in a mother-daughter health education program showed reductions in saturated fat intake, daily cholesterol intake and daily percentage of calories from fat, a stronger outcome than for the daughters (Stolley, 1997).

In a comparison of health promotion between a school-based approach and a home-based approach, it was found that students in the school-based program gained more knowledge, but students in the home-based program reported more behavior change (Perry, 1988). Along this vein, one study reported increased levels of physical activity for children identified as "low fitness" through their elementary school when they participated in a home-based activity program that used contingent rewards from parents for increased levels of physical activity. However, the children received the intervention for only 12 weeks and only 3 children received a follow-up evaluation post-intervention (Taggert, 1986). Another study of overweight children referred by schools for treatment between ages 10 and 11 showed that addition of family therapy to routine dietary counseling and medical check-ups prevented progression to severe obesity in adolescence compared to control children (Flodmark, 1993). Duration of Flodmark's treatment was 14 – 18 months with follow-up one year post-intervention. Based on a process evaluation to determine the strengths and weaknesses of the 5-a-Day Power Plus school-based program, Story (2000) concluded that increased parental involvement was needed to further improve fruit and vegetable consumption among 4th and 5th grade students (additional details of study provided under school-based section below). Family-based cardiovascular risk reduction interventions have been shown to improve eating habits and improve blood pressure (Nader, 1989).

In summary, particularly among young children, parents may control access to as well as model behaviors involving food purchasing, preparation and consumption, television viewing, and physical activity participation. *Because the family provides the primary environment in which a child's weight management and healthy lifestyle developments*

will either be hindered or helped, the involvement of the family in interventions with children is crucially important. A systems approach integrating the child, family, physician and allied health care professionals has been recommended for overweight children (Pronk, 1999).

Programs of short duration such as an intensive 1-month lifestyle modification program are considered too short for children (Cohen, 1991). However, some adolescent weight reduction programs have reported little weight loss even after 20 weeks of exercise, diet, and behavior intervention (Becque, 1988). One reason that current treatment for overweight may fail to reliably sustain weight loss is that weight loss is typically accompanied by compensatory metabolic changes (Leibel, 1995). For example, reduction in body weight is associated with decreased resting and non-resting energy expenditure per kilogram of fat free mass. *This highlights the importance for children of focusing on: 1) reducing weight gain, rather than promoting weight loss; and 2) attaining a reasonable weight, rather than an ideal weight.* Another potential reason for program failure is the high rate of recidivism (as high as 80%) reported in research trials with overweight children and adults (Wadden, 1993).

In a recent review, Robinson (1999a) identified a host of *strategies employed in the most effective behavioral treatments for pediatric overweight*. These included the following: a group format with individualized behavioral counseling, parent participation, frequent sessions, a long treatment duration, a simple and explicit diet, a physical activity program which emphasizes choice and reduces sedentary activities, reducing cues in the family environment associated with calorie intake and inactivity, increasing cues that promote physical activity, self-monitoring, goal setting and contracting, parenting training, developing skills for weight maintenance and prevention of relapse. Recommendations from professional organizations are summarized in Appendix 1 (Ikeda, 2001).

Barriers to successful individual therapy and family therapeutic and preventive strategies include the child's self-perception, child's perception of family members and parents' perceptions of children. Obese children who viewed themselves as having more control over their diet and weight lose more weight, while those who perceived more stress or problems in the family lost less weight (Uzark, 1988). Children who express a sense of self-efficacy and empowerment in attitudes towards physical activity have been shown to be more active (Trost, 1999). Many family traits can contribute to a loss of dietary self-regulation in children (Birch, 1986; Christoffel, 1989; Lissau, 1994) and are compounded by factors such as easy availability of non-nutritious foods and sedentary activities. In addition, while there are studies that demonstrate inadequate knowledge about healthy diet and the relationship of inactivity to overweight (Johnson, 1994), another barrier to successful intervention is the lack of congruity between *knowledge* about healthy eating and *actual* eating habits. This has been seen in kindergarteners (Murphy, 1995), adolescents (CDC, 2000), and adults. In addition, in studies of both children (IFIC, 1995) and adults (Patterson, 2001), consumers reported they are tired of messages about unhealthy food or felt that eating low-fat food took the pleasure out of eating. Thus careful crafting of messages to highlight statements about positive food choices rather than focusing on foods to avoid may bolster healthy food choices.

4.2 School-Based Interventions:

<u>*Day care and Preschool:*</u>
Few interventions in the preschool and daycare settings have been developed. *Healthy Start is a primary intervention program* conducted in 9 New York Head Start Centers *to reduce cardiovascular risk*. The program has *dual targets: food service to reduce total and saturated fat in preschool meals and snacks, and a comprehensive health and nutrition education curriculum* (Williams, 1998). One intervention group is receiving a family education component targeting nutrition while the other intervention and control group are receiving a family safety curriculum. Initial Healthy Start enrollment numbers included 827 children with a mean age of 3.6 years, equal percentages of males and females, and racial/ethnic mix of 42.6 % non-Hispanic Black, 31.6% Hispanic, 22.9% non-Hispanic White, 1.4% Asian, and 2.2% other ethnicities. Body fatness is one of numerous outcome measures. However, results from this 3-year trial are not yet available.

Intervention work in the daycare setting has shown that children's diet quality can be improved and food acceptance improved by increasing familiarity with new foods and modeling appropriate behavior by peers, parents, and teachers (Swadener, 1995). Additional innovative strategies for preschool aged and younger children need to be developed and tested before firm conclusions can be drawn regarding the efficacy of primary and secondary interventions for overweight. However, it has been demonstrated that preschoolers are more likely than school-age children to modify lifestyle behaviors (Davis, 1994).

Elementary, Middle and High School:
Research shows that *some school-age children are clearly in need of sound sources of health information* and that teachers can be trained to provide that information. In a study of over 300 African American and White adolescent students from two inner-city schools in the Midwest, the leading sources of information on weight control from a list of 12 sources were television, magazines and family members (Desmond, 1989). In a study of 232 predominantly African American elementary school-age children, the most frequently mentioned (by 86% of children) cause of obesity was eating "all the time" or "too much food" (Johnson, 1994). Approximately 20% of children attributed obesity to eating junk foods or eating too much fat, although their definitions of junk food and fat were frequently incorrect (e.g., such foods as bread, pasta, potatoes, bananas and chicken were cited as junk food and cholesterol as a type of food). Very few children (7%) cited lack of exercise as a cause of obesity. From a recent Gallup telephone survey of a national sample of 410 children between the ages of 9 and 15 years, it was found that several nutrition misperceptions were widespread including that all high fat needs to be avoided to eat a healthy diet (81%) and that healthy foods don't taste good (64%). Only about half (52%) of those surveyed were aware of the Food Guide Pyramid (Natchipolsky, 1995).

Most school-based overweight treatment interventions have resulted in positive, though modest and short-term, effects (Resnicow, 1993; Story, 1999). Based on a review of publications between 1965 and 1996, Story (1999) identified 12 controlled school-based treatment studies of overweight children. Of these, four involved children 5-10 years old, six involved adolescents aged 12-15 years old, and 2 involved children 8-16 years old. Interventions aimed at younger children were generally more successful than interventions targeting adolescents. Lacking were interventions among children younger than 5 years of age. Intervention duration ranged from 9 weeks to 6 months, with sessions ranging from 1 to 5 times per week. Most involved nutrition education, physical activity and behavior modification. In all but one of these studies, the intervention group had a significantly greater reduction in percentage of overweight compared to the control group, with a mean reduction in percentage overweight of 10%, with a range of 5 to 11% (Table 1). Treatment effects were generally larger for heavier children. Also, interventions targeting younger children were more successful than those aimed at adolescents. Unfortunately, only 2 of the studies included long-term follow-up; in only one of these (Zakas, 1981) was weight loss maintained at 6 months post-intervention. Interestingly, few school-based treatment trials have been published since 1985. Sallis and colleagues (1995) speculate that the reason for the reduction may be increased sensitivity to the stigma associated with participation in such programs.

In contrast to school-based treatment studies, school-wide prevention interventions have generally focused on reducing cardiovascular disease (CVD) risk rather than prevention of overweight and have had little impact on overweight (Resnicow, 1993). A comprehensive review of school-based physical activity interventions was recently published by Stone (1998). Based on a review of the literature, Resnicow and Robinson (1997) identified 16 school-based CVD risk prevention trials published between 1985 and 1995. Using a semi-quantitative meta-analysis of the combined results, positive effect ratios (percent of programs that showed positive effects) were observed more frequently for smoking (80%), physical fitness (36%), diet (34%), and lipid (31%) outcomes than for blood pressure (18%) and overweight (16%) outcomes. Of all the outcomes, the lowest rates were observed for adiposity measures. These results suggest that broad-based intervention programs aimed at promoting healthy lifestyles are not effective at reducing pediatric overweight. In confirmation of this result, most broad-based pediatric CVD prevention studies conducted since 1995 have not included adiposity measurements or, when measured, have not shown positive results (Table 2).

Controversy exists among experts regarding the independent effects on health of weight status versus improvement in diet and level of physical activity. The Columbia Study of Childhood Activity and Nutrition demonstrated that fitness independent of weight status was significantly related to diastolic blood pressure in 5 and 6 year old children (Gutin, 1990). While little research in this area has been done in children, studies with adults indicate that health benefits can result from improved diet and fitness, regardless of weight change. For example, the Dietary Approaches to Stop Hypertension (DASH) trial demonstrated that adults could reduce blood pressure in the absence of weight loss by eating more fruits and vegetables and low-fat dairy foods (Appel, 1997). In a study of more than 21,000 men, mortality was significantly higher for unfit, normal weight men than for fit overweight men (Barlow, 1995).

Table 1. Summary of school-based overweight treatment studies.
(Source: Story, 1999)

Study	Subjects	Intervention Components					Duration	Design	Major findings
		NE	BM	PA	PI	FS			
Botvin *et al.*, 1979[9]	T: 50 C: 69 (12–14 y)	x	—	x	—	—	10 weekly classes	Random assignment of 4 schools	70% of treatment *vs* 43% control students decreased skinfolds.
Brownell and Kaye, 1982[10]	T: 63 C: 14 (5–12 y)	x	x	x	x	x	10 weeks	Self-selection	T: 95% lost weight mean = – 4.4 kg C: 21% lost weight (mean = [illegible] kg)
Christakis *et al.*, 1966[11]	T: 49 C: 33 (boys, 13–14 y)	x	—	x	—	—	18 months	Random selection	T: net wt change 3.5 kg; treatment effects limited to obese (> 130%)
Collipp, 1975[12]	T: 25 (9–10 y)	x	—	x	—	—	12 weeks	Phase I: 6 weeks PA Phase II: 6 weeks PA and diet	Phase I: no effect Phase II: weight loss (mean = 10 lbs)
Figueroa-Colon *et al.*, 1996[13]	T: 12 C: 7 (8–13 y)	x	x	x	x	—	6 months	Random assignment of 2 schools	at 6 months the superobese children on protein-sparing modified fast diet had lost – 5.6 kg, and the control group gained weight (mean 2.8 kg)
Foster *et al.*, 1985[14]	T: 48 C: 41 (7–11 y)	x	x	x	x	—	12 weeks	Random assignment of 2 schools	T: lost 0.15 kg and reduced % overweight by 5.3% C: gained 1.3 kg and increased % overweight by 0.3%
Jette *et al.*, 1979[15]	T: 11 C: 10 (15 y)	—	—	—	x	—	Twice/week for 5 months	Random assignment of 2 schools	No significant changes in skinfold measures or body composition
Lansky and Brownell, 1982[16]	T: 71 (12–15 y)	x	x	x	—	—	15 weeks	3 schools BM or PA and NE No untreated controls	64% of children in the BM group and 63% of PA and NE groups decreased % overweight
Lansky and Vance, 1983[17]	T: 30 C: 84 (12–14 y)	x	x	x	x	—	12 weeks	Random assignment	T: decreased % overweight mean = 5.7% C: decreased % overweight mean = 2%
Ruppenthal and Gibbs, 1979[18]	T: 14 C: 28 (5–10 y	x	—	x	—	—	5 months	Self-selected	T: 13/14 decreased % overweight C: 3/28 decreased % overweight
Seltzer and Mayer, 1970[19]	T: 189 C: 161 (8–15 y)	x	x	x	—	—	5–6 months	Self-selected	T: – 11% overweight C: – 2% overweight
Zakus *et al*, 1981[20]	T: 10 C: 12 (girls, 14 y)	x	x	x	—	—	9 weeks	Random assignment of 2 schools	T: – 9% overweight C: – 1% overweight

NE = nutrition education; BM = behavior modification; PA = physical activity; PI = parent involvement; FS = food service; T = treatment group; C = control group.
[a]Modified from Parcel GS, Green LW, Bettes BA. School-based programs to prevent or reduce obesity. In: Krasnegor NA, Grave GD, Kretchmer N (eds). Childhood obesity: a biobehavioral perspective. Jedford Press, Inc.: Caldwell, 1988.[24]

Noticeably lacking in the literature are primary intervention studies designed to prevent pediatric overweight. One of the largest randomized-controlled school-based overweight prevention trials conducted to date is the Pathways Study of Native American children (Story, 1999). While results from the 3-year feasibility phase of this study have been published, the full-scale 5-year study of 2000 3rd grade children in 21 intervention and 20 control schools involving 7 Native American tribes is ongoing and will not be completed until later this year. It is hoped that the results of this integrated curriculum, physical education (PE), home and school food service approach provide much-needed information regarding the effectiveness of school-based overweight prevention programs. However, early results are not encouraging: no significant difference in percent body fat or BMI was observed between intervention and control groups. As so many children (roughly one-third) were overweight or at-risk by the 3rd grade, it has been suggested that the program would have been more successful if instituted among younger children (Broussard, 2001).

Table 2. Selected School-based Interventions[1].

Study	Design	Duration	Sample	Ethnicity	Relevant Results
PRESCHOOL					
Healthy Start (Williams, 1998)	▪ Randomized, controlled field trial ▪ Classroom curriculum ▪ Taught by trained Head Start teachers ▪ 11 units per year ▪ Topics: ? ▪ Adjunct: home-based activities, newsletter & parent meetings, and food service change (low fat)	3 years (in progress)	▪ ≈800 3- & 4-year olds ▪ 6 Head Start Centers (2 controls, 2 nutrition education + food service, 2 food service only)	▪ 43% African Amer. ▪ 32% Hispanic ▪ 23% White	▪ Overweight: na ▪ Diet: na ▪ Nutrition knowledge: na
ELEMENTARY SCHOOL					
(Donnelly, 1996)*	▪ Quasi-experimental field trial ▪ Classroom curriculum & PE ▪ Taught by classroom & PE teachers ▪ Topics: reducing dietary energy & fat, increasing fruit & vegetable intake, increasing PA ▪ Adjuncts: food service change	2 years	▪ 338 3rd, 4th & 5th graders ▪ 2 school districts	▪ 94% Caucasian	▪ Overweight: no effect ▪ Diet: ↓ energy/total fat & ↑ carbohy-drate/fiber at school lunch, but not over 24-hour period ▪ PA: ↑ PE activity, but ↓ activity outside of school
Go for Health (Simons-Morton, 1991)	▪ Similar schools within same district matched for ethnicity and available facilities (food service and PE) ▪ Classroom curriculum & PE ▪ Taught by classroom and PE teachers with GFH staff supporting ▪ 5 modules ▪ Topics: food purchasing & preparation ▪ Adjuncts: food service change & enhanced PE curriculum	5 X 6-8 week units	▪ 129 3rd & 4th graders at baseline ▪ 4 schools (2 intervention, 2 control)	▪ 62% Caucasian ▪ 21% Mexican-American ▪ 15% African Amer.	▪ Overweight: na ▪ Diet: ↓ total/sat. fat at school lunch ↓ total/sat. fat & energy daily ↓ total sodium content in school lunch ▪ PA: ↑ moderate-vigorous, ↑ PE time
5 A Day for Better Health (Harris, 1998)	▪ Pilot stage, these schools had history of participating in CV risk reduction activities ▪ Classroom curriculum ▪ Taught by classroom teachers ▪ Topics: reducing dietary fat, increasing fruit & vegetable intake, increasing PA ▪ Adjuncts: food service change, take-home fliers & community events	5 months	▪ 772 elementary students asked to participate, actual n not reported ▪ 3 schools, 82% of teachers participated	▪ Not specified	▪ Results: Most students participated in tastings and cost for school lunches did not increase with food service change. Only formative and process measures reported. No final report available.

Study	Design	Duration	Sample	Ethnicity	Relevant Results
Cardiovascular Health In Children study (Harrell, 1998)	▪ Randomized, controlled field trial ▪ Classroom curriculum & physical activity program taught by trained teachers/physical educators (classroom-based) or ▪ Classes taught by nurses to small groups of at risk children (risk-based) ▪ Topics: heart healthy nutrition & regular exercise to reduce CVD risk ▪ Adjuncts: none	8 weeks	▪ 422 3rd & 4th graders ▪ with at least 2 CVD risk factors (low aerobic power & either high serum cholesterol or overweight) ▪ 18 schools/school clusters	▪ 73% white ▪ 22% African Amer.	▪ Health knowledge: ↑ ▪ Overweight: BMI - no effect Sum of triceps & subscapular Skinfolds - ↓
Jump Into Action (Holcomb, 1998)	▪ Non-experimental field trial ▪ Interdisciplinary integrated curriculum ▪ Topics: low-fat foods & regular exercise to reduce NIDDM risk ▪ Adjuncts: none	4 months	▪ 1114 5th graders ▪ 14 schools	▪ >90% Hispanic	▪ Health knowledge: ↑ ▪ Dietary & exercise self-efficacy: ↑ ▪ Overweight: na ▪ Diet: no effect ▪ PA: ↑ ▪ Some changes at 4 weeks follow-up
5-a-Day Power Plus Program (Perry, 1998)	▪ Randomized, controlled field trial ▪ Classroom curriculum ▪ Taught by trained classroom teachers ▪ 16 lessons per grade ▪ Topics: promotion of fruit & vegetables ▪ Adjuncts: home-based activities, food service change, industry support	2 years	▪ 1750 4th & 5th graders ▪ 10 intervention & 10 control schools	▪ 48% White ▪ 25% Asian American ▪ 19% African Amer. ▪ 6% Hispanic ▪ 1% Native American	▪ Overweight: na ▪ Diet: Fruit intake - ↑ at lunch & daily Vegetable intake - ↑ at lunch in ♀ % total fat - ↓ daily
High 5 Project (Reynolds, 2000)	▪ Randomized, controlled field trial ▪ Classroom curriculum ▪ Taught by High 5 Curriculum Coordinators with assistance from classroom teachers ▪ ? lessons ▪ Topics: promotion of fruit & vegetables ▪ Adjuncts: home-based activities with parents, food service change	1 year (+ 1 year & 2 year follow-up)	▪ 1698 4th graders ▪ 14 intervention and 14 control schools	▪ 83% White ▪ 16% African Amer.	▪ Overweight: na ▪ Diet of children (yrs 1 & 2 follow-up) Fruit intake – ↑ daily; no lunch effect Vegetable intake - ↑ daily; no lunch effect % total/saturated fat - ↓ daily calories – no effect ▪ Diet of parents: (yr 1 follow-up; at year 2 no effect) Fruit intake – no effect Vegetable intake - ↑ daily
(Robinson, 1999b)*	▪ Randomized, controlled field trial ▪ Classroom curriculum ▪ Taught by classroom teachers ▪ 18 lessons ▪ Topics: monitoring, managing and reducing television, videotape and video game usage ▪ Adjuncts: newsletters to parents, electronic television time manager sent home	6 months	▪ 192 3rd & 4th graders ▪ 1 intervention and 1 control school	▪ na	▪ Overweight: ↓ ▪ TV viewing: ↓ ▪ Meals eaten in front of TV: ↓ ▪ Diet: no effect on high-fat or highly advertised food intake ▪ Fitness: no effect ▪ PA (moderate-vigorous): no effect

Study	Design	Duration	Sample	Ethnicity	Relevant Results
SPARK (Sallis, 1997)	▪ Quasi-experimental field trial ▪ PE ▪ Taught by certified PE specialists (A), or classroom teachers with special training (B), or untrained classroom teachers (Control) ▪ Adjuncts: self-management curriculum & home-based activities	2 years	▪ 1538 4th & 5th graders participated, analysis on 955 students who had complete results ▪ 7 schools – 3 in each of 2 experimental groups, 1 control	▪ Schools ranged from 8% to 19% minority Baseline group were 82% Caucasian, 12% Asian/Pacific Islander, 2% African American	▪ Overweight: nonsig ↓ ▪ PA: At school - ↑ in A & B groups Outside of school – no effect ▪ Fitness: ↑ in A in ♀
CATCH (Nader, 1999; Webber, 1996; McKenzie, 1996; Nader, 1996; Lytle, 1996; Edmundson, 1996; Luepker, 1996, Osganian, 1996)	▪ Randomized, controlled field trial ▪ Classroom curriculum & PE classes ▪ Taught by classroom teachers ▪ Topics: Healthy eating and PA ▪ Adjuncts: food-service modification and home-based activities and family fun nights	Entire trial was 4 years, Eat Smart food service intervention was 2 ½ years	▪ Baseline cohort 5,106 3rd – 5th graders ▪ 96 schools (4 states; 56 intervention, 40 control, stratified by state/site)	Baseline: ▪ 69% Caucasian ▪ 13% Africam Amer. ▪ 14% Hispanic ▪ 4% other	▪ Health knowledge: ↑ ▪ Overweight: no effect ▪ Diet: ↓ total/sat. fat ▪ PA: ↑ PE intensity ▪ Follow-up 3 years later: significant effects in self-reported food intake and minutes of physical activity continued but less pronounced than post- trial
Pathways* (Davis, 1999)	▪ Feasibility study ▪ Classroom curriculum & PE classes ▪ Taught by trained classroom/PE teachers ▪ 2 class lessons/week for 12 weeks & ≥ 3 PE lessons/week ▪ Topics: health, nutrition, PA ▪ Adjuncts: family & school food service interventions	3 years (full-scale study in progress)	▪ 3rd, 4th, & 5th graders ▪ 4 schools	▪ Native American	▪ Mostly positive teacher and student response to lessons ▪ Teachers desired more flexibility in how lessons were taught, shorter lessons & localized teacher training. ▪ Results of full-scale intervention are not available, but early results show no effect on overweight.
Eat Well & Keep Moving* (Gortmaker, 1999a)	▪ Quasi-experimental field trial ▪ Interdisciplinary integrated curriculum ▪ Taught by trained classroom teachers ▪ 13-18 lessons per grade ▪ Topics: TV, PA, diet (low fat & F/V) ▪ Adjuncts: home-based activities & community support	2 years	▪ 4th & 5th graders ▪ 479 longitudinal ▪ 2103 cross-sectional ▪ 6 intervention & 8 matched control schools	▪ 91% African Amer.	▪ Overweight: na ▪ TV viewing: nonsig. ↓ ▪ PA: no effect ▪ Diet: ↓ total/sat. fat & ↑ F/V
MIDDLE SCHOOL					
Dance for Health (Flores, 1995)	▪ Randomized, controlled field trial ▪ Health education curriculum & aerobic dance (in place of regular PE) ▪ Taught by researcher ▪ 25 lessons total; 3 PE classes/week ▪ Topics: nutrition, exercise, overweight, smoking & substance abuse, stress management, peer pressure	12 weeks	▪ 81 7th graders in 1 school (randomized by classroom)	▪ 44% African Amer. ▪ 43% Hispanic	▪ Overweight: ↓ in ♀ ▪ PA: improved attitude in ♀

Study	Design	Duration	Sample	Ethnicity	Relevant Results
Planet Health* (Gortmaker, 1999b)	▪ Randomized, controlled field trial ▪ Interdisciplinary integrated curriculum and PE classes ▪ Taught by trained classroom/PE teachers ▪ 16 lessons per grade ▪ Topics: TV, PA, diet (low fat & F/V) ▪ Adjuncts: none	2 years	▪ 1295 6th & 7th graders ▪ 5 intervention & 5 control schools	▪ ≈ 2/3 White	▪ Overweight: ↓ in ♀ ▪ TV/video: ↓ in ♀ & ♂ ▪ PA: no effect ▪ Diet: ↓ energy increase & ↑ F/V in ♀
Teen Activity Project (Leslie, 1998)	▪ Non-experimental field trial ▪ After school elective class ▪ Taught by peer leaders & an RD ▪ 3 classes per week for 10 weeks ▪ Topics: nutrition, fitness, body image, aerobic dance and strength training ▪ Adjuncts: school committee to change school food service & promote healthy activities & family/community sessions	1.5 years	▪ ≈ 50 girls ▪ (no control group; comparisons pre vs post-intervention)	▪ African American ▪ Hispanic	▪ Overweight: na ▪ Nutrition knowledge: ↑ ▪ Diet: no effect ▪ PA: no effect ▪ Self-esteem: no effect
HIGH SCHOOL					
(French, 1997)	▪ Non-experimental field trial ▪ Reduction (by 50%) of school cafeteria pricing of fruits and vegetables & public address announcements of reduced pricing	Several months	▪ ≈600 9th–12th graders ▪ 2 schools	▪ Primarily white	▪ Overweight: na ▪ Fruit & vegetable sales: ↑
Gimme 5: A Fresh Nutrition concept (Nicklas, 1998)	▪ Randomized, controlled field trial ▪ Classroom curriculum ▪ Taught by classroom teachers ▪ Topics: increase F/V intake ▪ Adjuncts: school media material, mailed brochures, newsletters, discount coupons, & food service modification	3-4 years	▪ 2.213 students in a cohort followed from 9th to 12th graders ▪ 19 schools (6 intervention, 6 matched control & 7 pilot schools)	▪ 84% Caucasian ▪ 4% African Amer. ▪ 9% Hispanic ▪ 3% other	▪ Health knowledge: ↑ ▪ Overweight: na ▪ Diet: ↑ F/V intake (in first 2 years only)
Zuni Diabetes Prevention Program (Teufel, 1998)	▪ Non-experimental field trial ▪ Integrated curriculum ▪ Taught by classroom teachers ▪ Topics: diabetes education, healthy food choices, physical activity ▪ Adjuncts: school wellness facility for physical activity; supportive social networks, modification of the vending machine food supply and school lunches & provision of water coolers	4 years (in progress)	▪ ≈400 9th–12th graders ▪ 2 schools	▪ Native American	Midpoint (year 3) results: ▪ Overweight: ↓ ▪ Diet: nonsig ↑ dietary fiber ↓ high-sugar beverages ▪ Fitness: ↑

*Prevention programs designed specifically to address overweight; others are cardiovascular disease prevention, non-insulin dependent diabetes (NIDDM) prevention or general health promotion programs.

[1]Key to abbreviations: African American (African Amer.), body mass index (BMI), cardiovascular disease (CVD), fruit/vegetables (F/V), nonsignificant (nonsig.), not available/not measured (na), physical activity (PA), physical education (PE), saturated fat (sat. fat).

In the meantime, results from several other smaller-scale overweight-specific prevention programs have shown promising results. One school-based approach that focused on reducing television, videotape, and video game usage among children averaging 9 years of age resulted in significant decreases in body fatness, as assessed by BMI, triceps skinfold thickness, waist circumference and waist-to-hip circumference ratio. The intervention involved 18 classroom-based lessons taught by classroom teachers over a 6-month period. To assist in monitoring and managing television usage, each family was provided with one or more electronic television time managers, a device which plugs into the television and measures the time each member of the household watches television, videocassettes or video games. This improvement in overweight occurred in the absence of measurable changes in snacking while watching TV, high-fat or highly advertised food consumption, moderate-to-vigorous physical activity level, and cardiorespiratory fitness (Robinson, 1999b). In a 12 week overweight treatment study, TV viewing for the experimental group was contingent on pedaling a stationary cycle ergometer. In comparison to the controls, children in the experimental group pedaled significantly more (64.4 vs. 8.3 minutes per week), watched less TV (1.5 vs. 21.0 hours per week), and lost significantly more total body and percent leg fat. Total pedaling time was correlated with greater body fat reductions (Faith, 2001). Further, epidemiological studies have found positive associations between television viewing and children's fat and energy intake (Robinson, 1995; Taras, 1989) and experimental studies have found that food advertising affects children's snack choices (Gorn, 1982; Jeffrey, 1982). Replication of the Robinson intervention study among larger and more sociodemographically diverse samples and an investigation of sustainability are needed before these results can be generalized, but the promising results suggest that a simple, targeted intervention can translate into positive effects on pediatric weight – at least in the short-term.

The prevalence of overweight among 11- to 13- year old girls (but not boys) was reduced by a 2-year interdisciplinary intervention, Planet Health, involving curricula in 4 major subject areas and physical education. Sessions focused on decreasing television viewing and consumption of high-fat foods, and increasing physical activity and consumption of fruits and vegetables. The intervention was successful in reducing the age-associated increase in energy intake, as well as in increasing fruit and vegetable consumption, but again this was observed only in girls. Only television viewing was reduced in both genders, while changes in moderate to strenuous physical activity were not observed among either boys or girls. The differential response of girls and boys suggests that different causal factors operate with respect to weight gain. It is possible that girls were more receptive to the way in which the health message was delivered in this trial (Gortmaker, 1999b).

The *SPARK study* was a health-related physical education program targeting elementary school children in 7 schools in Southern California. The schools were assigned to one of 3 conditions in a quasi-experimental fashion. One group of schools received physical education from certified physical education specialists, the second received physical education from classroom teachers who received some special training on implementing the physical education program, while control schools had "usual physical education" as implemented by untrained classroom teachers. Students participated in the program in 4th and 5th grades. A total of 1,538 students were considered subjects. Students in the two intervention conditions spent more time in physical activity while in school. The specialist-led students participated in twice as much moderate to vigorous activity as control students with teacher-led students in between. However, there was no significant difference in weekday and weekend recall of physical activity performed outside of school. Girls in the specialist-led condition improved substantially in their mile-run time. There was no significant intervention effect at post-test for boys, but they had better fitness at baseline (Sallis, 1997). *Although there was a trend toward reduced body fatness, the differences in body fatness between 4th and 5th graders in the intervention and control groups were not significant after 2 years* (Sallis, 1993). Another component of the SPARK program was a self-management program taught in the classroom and homework sent home to be done with parents. This component was not felt to be effective in increasing out of school activity (Sallis, 1997). Encouraging are the results from another physical activity school-wide intervention for overweight prevention from South Australia (Dwyer, 1983). Implementation of a 50-minute daily physical activity program resulted in a significant decrease in adiposity (based on sum of skinfolds) among 5th grade students. Despite the loss of 50 minutes of classroom teaching time per day, academic scores for math and language skills did not change over time.

Another health-based physical education program, Dance for Health, targeted middle school-age minority children. This creative aerobic dance physical activity intervention program (substituted for traditional PE classes) also included a culturally-sensitive health curriculum. Innovative strategies included: dance routines that were fun; use of popular music that appealed to students; non-competitive activity that could be performed by all students, regardless of skill level or weight; and minimal equipment requirements. *After only 12 weeks of intervention*

significant reductions were observed in BMI, heart rate, and mile run times among girls. Also girls reported more positive attitudes about physical activity. Differences among boys were not significant (possibly due to the small sample size of approximately 20) but favored the intervention group (Flores, 1995).

The largest school-based study to date, now in a third phase of follow-up, is CATCH, the Child and Adolescent Trial for Cardiovascular Health, which involved over 6,000 3rd through 5th graders in 96 schools from sites in 4 states. This randomized controlled trial had 56 intervention and 40 control elementary schools. Twenty-eight schools participated in an intervention of school-based food service modification, enhanced PE, and classroom health curriculum. Twenty-eight other schools received all of these and additionally a family education component. This multi-level, multi-component intervention seeks to promote both a healthy school environment as well as to improve eating behaviors and physical activity levels in children. Evaluations have been published of many of the components of this trial. The CATCH Eat Smart program was designed to target the food service staff in 56 intervention schools over a 2 ½ year period to lower fat, and saturated fat in school lunches. There was a significantly greater reduction in the mean percentage of calories from total fat and saturated fat in intervention schools. There was no difference for total cholesterol or BMI. Average total calories in school lunches decreased while remaining above the RDA for this age group (Osganian, 1996).

The family intervention component was evaluated in the sub-set of schools that received that component. Analysis of students who attended a CATCH family intervention school during all 3 years of the study showed statistically significant changes in knowledge and attitudes related to diet and physical activity which were more pronounced for minority and male students (Nader, 1996). Students in the intervention schools showed decreases in total energy, proportion of energy from total fat, proportion of energy from saturated fat, as well as other dietary components that were statistically significant. There were no ethnic, gender, or site differences (Lytle, 1996). In the intervention schools, percentage energy intake from fat fell more (change of 6.8 % decrease compared to 2.7% decrease ($p< .001$) for control schools). Intensity of PE activity increased significantly in intervention schools. No deleterious effect was observed (Leupker, 1996). *CATCH is one of the largest interventions with a number of successes in behavior change, yet it found no significant change in overweight, blood pressure or serum cholesterol* after improvements were made in school food service and physical activity participation (Luepker, 1996; Webber, 1996). However, improvements in dietary fat intake and intensity of physical activity did occur (Lytle, 1996; McKenzie, 1996), with intervention children reporting 12 more minutes of daily vigorous activity. Differences in type, duration, and timing of interventions as well as compensation in both energy intake and physical activity outside of school may in part be responsible for differences between study findings. There were also sustained improvements after 3 years in knowledge, intentions, self-efficacy, and perceived social reinforcement at intervention schools as measured by a health behavior questionnaires (Edmundson, 1996). It is noteworthy that follow-up of a cohort from CATCH showed sustained but weakening changes in self-reported diet and level of physical activity among early adolescents (Nader, 1999), suggesting that a sustained program is necessary to maintain intervention effects.

Gimme 5 was a theory-based multi-component intervention to increase consumption of fruit, juice, and vegetables (FJV). This randomized controlled trial of 16 elementary schools included a cohort of 3rd grade students in its first year followed by the addition of 4th and 5th grade students who joined the original cohort in year 2 and 3. Schools were matched for size, percent students on free or reduced price lunch and percentage annual student turnover. There was random assignment within pairs and random selection of parents to interview for parent perception of home changes. Intervention included an education curriculum that featured role-playing, recipe tasting, snack and meal preparation skills for kids, goal setting and problem solving. Each year's curriculum was increasingly more sophisticated in content and skills. Children also took home a health newsletter and 3 videotapes for parents, had home assignments for fruit, juice or vegetable preparation under parental supervision, and received prizes for completing home assignments. A point-of-purchase education intervention was conducted at 2 grocery stores frequented by parents at these schools. The evaluation used 7-day food records for children and from the school menus, psychosocial measures for children, results of interviews with parents and attendance at point-of-purchase events. Completed food records were obtained from 1,253 children for all 3 years. Only African-Americans and Caucasians were compared in the analysis (Baranowsi, 2000b). There was a significant group by time effect favoring the treatment group for FJV combined ($p= 0.038$) and vegetables alone ($p= 0.004$), but not for fruit. Two psychosocial measures improved (asking for FJV at home and knowledge of FJV). *Increases in overall consumption improved only among the lowest 2 quintiles of intake at baseline.* Other groups had decreased intakes of FJV but this was greater for the control groups. This was interpreted as a mitigating effect of the intervention

over the decreases in fruit intake normally observed among this age group. No change in offerings in the school lunches was noted over time and less than 15% of participating students attended point-of-purchase events.

Gimme 5: A Fresh Nutrition concept was a second program under the national program to promote per capita intake of 5 servings of fruits and vegetables daily. This trial, based in New Orleans, recruited 19 of 22 schools in the New Orleans' school system. Twelve schools (6 pairs matched on gender, race, enrollment and geography) were randomized to intervention or control, while the other 7 schools served as pilot sites. Of interest in this study is that there were 3 pairs of female-only schools, 2 pairs of male-only schools, and one pair of coed schools. The interventions followed a cohort of students from 9th to 12th grades. At follow-up in Spring, 1997, 81% of the cohort had received the Gimme 5 intervention for 4 years. An additional 15% had received 3 years of the program. The intervention was multi-component utilizing educational workshops, lessons included in required academic courses, school media materials (posters, taste-testings, marketing stations) to target students, mailed brochures, newsletters, and discount coupons for produce to target parents, and school meal modifications including food service staff training. *Intervention students had greater improved knowledge of fruit and vegetable intake ($p<0.05$ at year 2 and 3), increased awareness of the Gimme 5 program (although control schools increased too), improvements in stage of change, and increased consumption of fruits and vegetables at year 1 and 2 (although this difference was not sustained at the year 3 follow-up, due to improvements in the control schools).* It is noted that intervention was more aggressive during the first 2 years of the campaign (Nicklas, 1998). In addition, it is possible that control schools received inadvertent contamination intervention since their knowledge of the Gimme 5 campaign increased over time and there was concomitant marketing of the national 5-A-Day for Better Health during this time period.

The 5-A-Day Power Plus program was 2-year school-based intervention in St. Paul, MN, in which 20 inner-city elementary schools (10 matched pairs) participated in a 4th and 5th grade multi-component intervention targeting a multi-ethnic population (19.1% were African-American, 25.2% were Asian American (primarily Hmong), 48.0% were Caucasian, 1.3% were Native American, and 6.4% were Hispanic). Randomization occurred within school pairs. This intervention used a behavioral change curriculum in the 4th and 5th grade classrooms, parental involvement and education, school food service changes, and industry support. The curricula had 16 sessions over an 8-week period. Sessions included snack preparation, taste testing, skill-building and problem-solving. Comic books and adventure stories were used to promote healthy role models, and team competition used to reward fruit and vegetable consumption during lunch. Parents participated in 5 information/activity packets with entry into a prize drawing as the reward for participation. Evaluation measures included lunchroom observation of fruit and vegetable consumption, 24-hour food recall, parent telephone surveys and a health behavior questionnaire (Perry, 1998). *The evaluation showed that the effect of the intervention was significant for improvement of vegetable consumption at lunch for girls but not boys. Significant improvements were seen for lunchtime fruit consumption (by ≈ 1/3 of a serving) and combined fruit and vegetable consumption (by ≈ 1/2 of a serving) for all children.* No differences were noted by racial or ethnic group. Using 24-hour recalls, there was a significant effect of the intervention on servings of fruits and vegetable per 1000 kcal. There was also a significant reduction in percentage of calories as fat (from 32% to 30%). Further analysis showed that favorable trends were seen for percentage of calories as fat and saturated fat for Asian and African Americans, while unfavorable changes were seen for Hispanics and no change for Whites. This finding highlights that an intervention found to be effective for one or more groups may not be effective for other ethnic groups. The intervention was only delivered in English and parents were only interviewed if they were English speakers. There were 4 significant changes in the health behaviors questions: more perceived support from teachers for eating fruits and vegetables, more perceived need to eat fruits and vegetables, more reports of asking for fruits and vegetables, and more usual daily servings of fruits and vegetables. Overall the program was felt to provide additional evidence that multi-component school-based behavioral programs can improve dietary behavior even among schools and communities with considerable ethnic and socioeconomic status variation (Perry, 1998). Girls appeared more receptive to the dietary intervention than boys, a finding that has been seen in other studies of eating patterns and physical activity (Perry, 1994). Based on a process evaluation of the results and feedback from students and teachers, taste-testing activities were among the most effective parts of the curricula (Story, 2000). Although the long-term sustainability of this dietary intervention remains to be established, the St. Paul school district has provided the Power Plus program for classroom use by all 4th grade teachers for the 3 years since the study ended, suggesting that such programs can be successfully maintained (Story, 2000).

A similar intervention targeting increased fruit and vegetable consumption among 4th grade students was the High 5 Project in 10 matched pairs of elementary schools in Alabama. In contrast to the 5-A-Day Power Plus program, the

students in this field trial were primarily White of relatively high socioeconomic backgrounds (parental mean education of 14 years, median annual household income between $40,000 and $50,000). Although the effect diminished over time, *even at two years post-intervention, fruit and vegetable intake as assessed by 24-hour recall was significantly greater in intervention compared to control children. No intervention effects were found in the lunchtime cafeteria observation data.* An interesting component of this study was the significant parental involvement and assessment. Parents were asked to assist their children to increase fruit and vegetable intake and complete homework assignments. Brochures, recipes and promotional materials were also sent home. In addition parents were asked to complete questionnaires regarding their own fruit and vegetable intake. At one year follow-up, intervention parents consumed more fruits and vegetables combined than control parents. No differences were observed at 2 years follow-up for parent consumption. These findings suggest that children can be used as a conduit to alter family dietary behaviors, at least in the short-term. The program appeared to be most effective in families with married parents, but the intervention was successful in most subgroups (by gender, race/ethnicity, family income, parental education) (Reynolds, 2000).

Go for Health was a school-based intervention in 3rd and 4th graders in 2 Texas schools using 3 components based on social cognitive theory. Six classroom-based modules were used for health education in knowledge and skills necessary to incorporate lifelong diet and physical activity behaviors. The New School Lunch program was a program to modify food purchasing, menus, and food preparation practices in the school cafeteria setting. A final component was a physical education component consisting of five 6-8 week units, designed to promote enjoyable moderate-to-vigorous physical activity (MVPA) among children during PE classes. Evaluation measures included school lunch nutrient content, 24-hour dietary recall, and observation of students in PE classes for levels of moderate-vigorous physical activity. Mean percent decrease in fat in school lunches in the intervention schools were 15.5% and 10.3%, average percent saturated fat declined 31.7% and 18.8% (Simons-Morton, 1991). *Students in the intervention group reported fewer calories, less total fat, and less saturated fat than the control group* for total day intake, and less total fat, saturated fat for tray and bag lunches while in school. Intervention schools had improvements in median MVPA to 28% in third graders at one school and to 39% of class time or greater in the other intervention groups. No changes were seen at control schools, with medians no higher than 5% of class time. A critical observation in this study was that extremely low MVPA during PE was observed at all schools at baseline with the author noting that his previous work has shown that PE accounts for nearly half of children's total physical activity in the US (Simons-Morton, 1987).

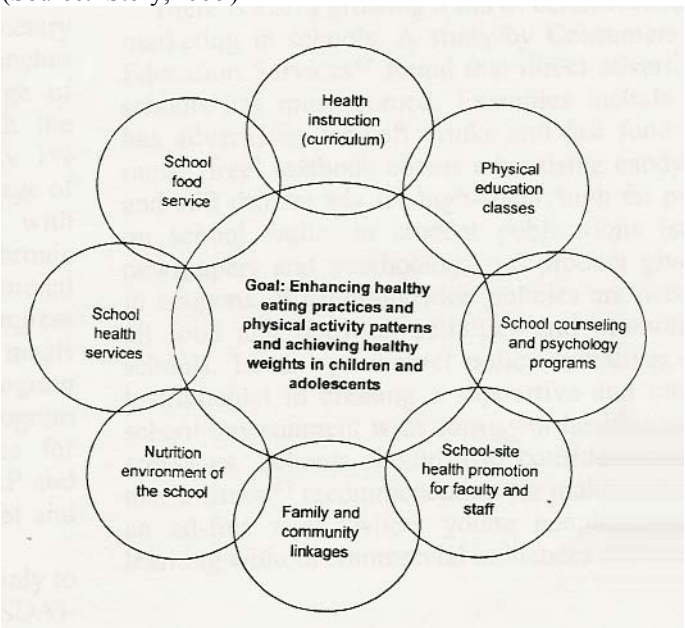
5 A Day for Better Health is a two-phase intervention in 3 Kansas elementary schools. The first phase was devoted to reduction of dietary fat and increasing physical activity, while the second phase focused on increasing children's consumption of fruits and vegetables. Reports from the early and intermediate phases of the project reported that the school food service served samples of 96% of the recipes in the food service intervention and that per lunch cost did not increase. In addition, most students (96%) at 2 schools in the same community participated in recipe tastings while only about 50% participated in the other school in a different community. Both communities held kick-off events which were noted as one strength of the project in focus groups conducted in the communities. Use of coupons for local supermarkets and awareness of parents of specific foods promoted in take-home fliers were not felt to be very successful components based on focus groups and coupon return rates. There were no control schools and final outcomes have not yet been reported (Harris, 1998).

The comparative benefit of teaching all children in the classroom versus targeting only overweight or obese children has not been determined. To our knowledge, only one study has attempted to address this issue, the Cardiovascular Health in Children study. In this randomized, controlled school-based field trial of over 400 3rd and 4th graders in 20 schools or school clusters in North Carolina, Harrell (1998) found that both the classroom-based intervention directed at all children and the risk-based intervention targeted only at children with identified CVD risk factors produced significant reductions in serum cholesterol concentration, a small reduction in body fat as assessed by triceps and subscapular skinfolds, and higher health knowledge after 8 weeks. However*, the population approach was easier to implement into existing curricula, required less teaching resources, minimized stigmatization of at-risk children, avoided the potential problem of misclassifying children at risk, and benefited children from all risk groups* (Harrell, 1998). Focus group research with adolescents has shown that students would prefer weight control programs that are inclusive of all students, irrespective of the weight status (Neumark-Sztainer, 2000).

Research suggests that *school-based interventions may be acceptable among ethnically diverse populations, such as Native Americans, provided that they are culturally relevant and community integrated* (LeMaster, 1994; Broussard, 1995). Results from the Pathways study of American Indian schoolchildren, has shown that targeting children through the food service programs was effective in reducing the percentage of kilocalories consumed from fat (Snyder, 1999). Culturally appropriate curriculums on healthy eating and promotion of physical activity, as well as family interventions, were also developed for the Pathways study (Davis, 1999; Teufel, 1999). Similarly results from the Jump Into Action program to reduce the risk of type 2 diabetes in a primarily Hispanic school district have shown success in encouraging students to eat low-fat foods and exercise regularly (Holcomb, 1998).

Components of Successful School-Based Interventions:
The results of the reviewed studies suggest that for interventions to be successful, modifications to the school environment (e.g., changes to school food services or access to physical activity programs) may be as important as classroom-based curricula. Based on a review of the literature, Story (1999) recommended a comprehensive school health program model for primary prevention of overweight. *Integrated components of a school health model to prevent overweight include: health instruction, health services, school environment, food service, school-site health promotion for faculty and staff, social support services, physical education classes, and linked family and community health promotion efforts* (Figure 1 & Table 3). Consistent with the proposed model, one aim of the Pathways intervention was the creation of a school environment wherein teachers, food service workers, and families were united in inducing healthy behavior change (Davis, 1999). Having teachers and other staff well trained in the components of the intervention is also critical to success (Sallis, 1997).

Figure 1. Components of an integrated comprehensive model for school-based overweight prevention.
(Source: Story, 1999)



Given the current dimensions of the pediatric overweight problem, however, and the limited success exhibited to date in stemming the tide of this epidemic, it may be necessary to find new and creative solutions. For example, one innovative school-based approach was to reduce the school food service price of fruits and vegetables, resulting in a significant increase in fruit and vegetable consumption among high school students (French, 1997). A new school-based approach used to successfully reduce the risk of disordered eating among adolescents focused on improving self-esteem and self-efficacy of students, as opposed to simply educating about anorexia nervosa and bulimea (O'Dea, 2000b). Empowering children is an example of a strategy that needs to be investigated for its effect on additional elements of children's health. Experts have voiced concern that programs addressing overweight and eating problems may inadvertently harm children psychologically or emotionally (Barlow, 1998; O'Dea, 2000a). In one overweight treatment study, for example, children aged 10-15 years had decreased self-esteem after enrollment in a 12-week weight management program compared to controls (Cameron, 1999). O'Dea (2000a) recommended

that "Changing the focus from highlighting negative, problem-based issues to helping young people build self-esteem and enjoy healthy eating and regular enjoyable physical activity without developing a fear of food is the first step in establishing positive nutrition messages and school-based education programs which will do no harm."

Table 3. Components of the school-based overweight prevention model. (Source: Story, 1999)

Key Component	Subcomponents
Health curriculum	Benefits of, social influences on, and components of healthy eating & physical fitness; healthy weight management techniques; body size acceptance; healthy and individualized physical activity programs; self-monitoring, goal-setting and behavioral change.
PE classes	Health-related physical activities; activities enjoyable to children of all sizes and abilities.
Counseling	Access to psychological counseling for disordered and emotional eating and body weight and self-esteem issues.
Health promotion for faculty/staff	Healthy eating, participation in physical activity and weight management to benefit personnel health and knowledge and provide role modeling.
Links to family/community	Take-home activities; school-based events.
Nutrition environment	Vending machines & school stores; fund-raising events; classroom snacks and parties; use of food to reward or discipline; corporate-sponsored nutrition education materials; in-school advertising of food products.
Health services	Screening for overweight; preventive counseling; weight management treatment or referral.
Food service	Healthy school meals and snacks.

Advantages of School-Based Approaches:
One advantage of interventions based in schools is that the majority of US children attend school, most children eat one or two meals a day at school, and schools provide opportunities for physical activity. Another advantage is the cost and time-effectiveness derived from utilizing existing classroom teachers as the source of information and integrating lessons on nutrition and exercise into existing curricula. Also, to maximize breadth and depth, successful school-based approaches could be replicated at similar schools, could be sustained indefinitely, and could be used to reinforce and expand behavior modification initiated in the younger grades through the upper grades. Further, *schools can provide integration between cafeteria, classroom, home and community*. Recently, the "Fleurbaix-Laventie-Ville-Santé" Study of 6- to 12-year-old schoolchildren was undertaken in northern France to assess the hypothesis that not only will a school intervention influence the behavior of children, but of parents and other family members as well. Encouraging are preliminary results of this ongoing study indicating a decrease in fat intake by families as a result of a school-based intervention (Basdevant, 1999). Finally school-based approaches that address the health behaviors of all students may avoid the stigmatization that may be experienced when overweight children are singled out for treatment. In the Planet Health school-wide study, for example, there was no evidence of unintentional "dieting" side-effects of the intervention among 6th and 7th graders (Gortmaker, 1999b).

Disadvantages and Barriers of School-Based Approaches:
A lack of a dietary and/or physical activity effect from some interventions may be due to the lack of easily available, desirable, or culture and age-appropriate nutrition and physical education classes, after school programs and community facilities (Gortmaker, 1999a). In comparison to children who were not overweight or at risk of overweight, at risk children in the California Children's Healthy Eating and Exercise Practices Survey (CalCHEEPS) were less likely to play sports outside of school PE class (48% vs. 60%) and less likely to have taken

part in nutrition education (50% vs 64%) (Public Health Institute, 2001). It should be noted, however, that racial/ethnic or SES differences were not accounted for in this analysis.

However, merely *teaching the importance of improved diet and increased physical activity may not have a behavioral impact and translate into weight outcomes*, without the availability of appropriate means of executing that learned behavior (Holcomb, 1998). Reviews of major school-based nutrition education research studies, while confirming the positive effect of education on nutrition knowledge and attitudes, have found that the behavior impact of most programs to be minimal (Contento, 1992; Schlicker, 1994). Overweight and non-overweight adolescents have been shown to have similar knowledge of nutrition (Thakur, 1999). It has been proposed that nutrition education alone may not be effective in inducing behavior change because of the strong impact of food preference on food choice among both young children (Murphy, 1995) and adolescents (Freeman, 1997). Therefore, repeated exposure to new and healthy alternative foods may be necessary in order to change what children like to eat (Harvey-Berino, 1997).

Further, *when behavior changes are achieved, children may compensate outside of school for the changes during school hours*. In a 2-year intervention study of physical activity and modified school lunch program which failed to find an effect on body fatness among 3rd through 5th graders, the intervention group reported 6% more physical activity in school, but 16% less physical activity outside of school compared to the control group. Likewise, although children in the intervention schools consumed significantly less energy, fat, and sodium and more fiber during school lunch than children in control schools, only the difference in sodium remained in the analysis of intake over the entire day (Donnelly, 1996).

Behavior modification may require skills-training, attitude changes and environmental modification. *Cultural and gender-specific barriers to modifying diet and physical activity should be addressed when designing an intervention.* For example, concern about physical appearance was noted as a major barrier of physical activity among middle school African American and Hispanic girls; the primary reason for avoiding exercise was to avoid messing hair and make-up (Leslie, 1998). Additional barriers included self-consciousness when exercising in the presence of boys and feeling that boys, because of their size and athletic abilities, received preferential treatment from male PE teachers. Barriers may be overcome and motivators employed by designing activities that are desirable and acceptable to children. For example, in the study of middle-school-aged girls by Leslie (1998), school dance activities incorporating popular music and dance steps, and work outs with light weights (as long as it did not promote an excessively muscular, "unfeminine" appearance) were identified during focus group interviews as activities girls would pursue. The circumstances and needs of the individual should be addressed and the age, gender, educational level, socioeconomic status, and cultural sensitivity of the intervention should be considered. Further, in studies with long-term follow-up, mitigating effects of interventions were observed, suggesting that short-term interventions are not effective and that interventions may need to be continuous through upper grades in order to achieve sustained results.

Several *institutional barriers to the implementation and success of the intervention strategies* were noted. For example, in a study aimed to reduce NIDDM risk factors among Native American high school students, the high turnover of school faculty and administration was a challenge in maintaining program continuity (Teufel, 1998). A unique feature of the intervention by Teufel (1998) was the development of a school wellness facility that could be used by students for physical activity and recreation. However, employing qualified staff without high turnover (typically students) to manage this center was also troublesome. While teacher training was a component of most school-based interventions, the optimal degree and type of health education training was not evaluated. A program for continual training and retraining of teachers and staff may be necessary. Specifically, results from SPARK would suggest that well-trained specialty teachers may be important to successful implementation of changes in PE classes that will increase physical activity and promote fitness (Sallis, 1997). Further, convincing school faculty and staff to devote time to additional curricula may be a challenge given the current focus on improving academic performance on standards-based assessments. Barriers can include the additional documentation and time requirements placed on staff (Auld, 1999). One method used to reduce the extra workload of teachers used in a school-based nutrition education program designed for 2nd through 5th grade students, was to alternate instruction between classroom teachers and special resource teachers (Auld, 1999). Careful attention to fidelity of implementation and type of measures used to assess implementation success is also important (McGraw, 2000). Effective liaison building within the school community is required for most interventions to be successfully implemented and maintained.

Family involvement has been shown to increase student knowledge and positive attitudes toward healthy habits in a dose response manner (Nader, 1996). Improving parent involvement and support in the intervention was identified as a critical element for improved success of many studies; inadequate parental involvement was often cited as a reason for failure (Perry, 1998; Teufel, 1998; Story, 2000). Translated materials may be necessary to reach targeted parent populations. Further, take-home materials alone may not be powerful enough to produce long-term changes (Perry, 1988). Finally, individual, family-based, and school-based interventions may be more successful in conjunction with reinforcing community-based programs (Teufel, 1998).

<u>Summary:</u>
In summary, most of the school-based programs we reviewed used a knowledge-based approach with emphasis on modification of attitudes and behaviors related to diet and physical activity. Although all of the studies reported some change in knowledge, attitudes, or behavior, the magnitude of the changes was not large and most of the outcomes were assessed by self-reports. Acquisition of health-related knowledge did not always translate into healthy behaviors (Holcomb, 1998). Some of the school-based programs incorporated the family, food service personnel, the community, or the media in the intervention. To sustain behavior change it may be necessary to facilitate reinforcement from the family, social and media environments. Additionally, follow-up *studies often find a rapidly diminishing effect once the intervention is completed, which suggests that maintenance or "booster" interventions must be considered over time* (Holcomb, 1998; Nader, 1999).

Long-term outcomes of school-based approaches have not been determined. Most studies had no follow-up or included only short-term monitoring. The 3-year follow-up from CATCH indicates persisting changes in knowledge and reported behaviors but with less difference between intervention and control schools over that time period. The only interventions that have proven long-term effectiveness in reducing overweight among children have been intensive clinical individual/family-based programs (Epstein, 1990). It has been recommended that interventions among children and adolescents, regardless of approach, are most effective if family-oriented (Washington, 1999). Longitudinal and sustainability studies of school-based interventions are needed. Further, few randomized controlled trials of overweight prevention among children have been conducted to date. In a comprehensive review of the literature from 1985 to 1999, Campbell (2001) identified only 7 studies, 3 long-term (≥ 1 year follow-up) (Simonetti, 1986; Donnelly, 1996; Gortmaker, 1999) and 4 short-term (Flores, 1995; Stolley, 1997; Mo-suwan, 1998; Robinson, 1999), all but one of which (Stolley, 1997) was school-based and all but two of which (Simonetti, 1986; Mo-suwan, 1998) were conducted in the US. They concluded that ". . . currently there is limited quality data on the effectiveness of overweight prevention programs and as such, no generalisable conclusions can be drawn. The need for well-designed studies which examine a range of interventions remains a priority."

4.3 Community-Based Interventions:

The major large-scale community-based interventions in the US that targeted change in cardiovascular risks including nutrition and physical activity were the Stanford 5-City Project, the Pawtucket Heart Health Program and the Minnesota Heart Health program (MHHP). None of these trials focused exclusively on overweight as an outcome. Typically these types of programs did not specifically target children, although they may have included family-based interventions. Some included social marketing strategies that were presumably accessible to children. In addition, we cover here the results of two studies that advocated for lower fat content in milk using community-level methods. Many of the community-based studies are reviewed in Pate (2000).

MHHP evaluated the influence of school and community wide interventions in a cohort of students as they progressed from 6th to 12th grades. This component of MHHP was called the Class of 1989. While MHHP involved 6 communities, only 2 communities (one intervention and one control) participated in the Class of 1989. These communities were similar in size, socioeconomic status, and were predominantly Caucasian. The Fargo-Moorhead community received a community-wide intervention to improve eating and exercise, reduce smoking, and this school-based CVD prevention program. The comparison community (Sioux-Falls, SD) received none of the components. The intervention design was based on social learning theory and based on findings of needs assessment surveys of 4th to 11th grade students and focus groups of each target age group (Perry, 1989). Sixth graders were enrolled in baseline surveys in 1983 and followed as a cohort until 12th grade. Each wave of the survey, though, included new students who had entered the grade of the cohort. A separate analysis was done just for those students present at baseline and in each subsequent survey wave. These students would have received 5

years of behavioral health curricula that covered smoking, physical activity, and nutrition. There was a focus on healthy lunches at sixth grade and on healthy eating and physical activity at tenth grade. The tenth grade program was peer-led. This was all delivered within the context of the community-wide strategies including nutritional food labeling at restaurants and grocery stores, annual risk factor campaigns, continuing education for health care providers about CVD risk reduction, and worksite, church, and other organization programs related to CVD risk (Kelder, 1995). There were significant differences between the intervention and control communities at baseline on fat intake (from healthy foods list) as assessed by common foods eaten. Differences for intake of healthy foods were significant for males from the intervention community at 6th, 7th, 8th, 9th and 10th grades. There was no difference between males for 11th and 12th grades. Differences in intake of healthy foods were significant for females in all years except 12th grade (Kelder, 1995). Knowledge of healthy food choices was more sensitive to the intervention than actual food choice, suggesting that use of food knowledge as an outcome indicator may not be as sensitive or specific as examining food choices. In this study also, females were more sensitive to nutrition intervention than males. Similarly, the physical activity intervention appeared to impact females more than males, with females having significantly greater physical activity scores at 8th, 9th, and 11th grades, while males had only higher post-intervention means that did not meet significance. Females also had greater hours of exercise in all grades except 11th, while males reported exercising more frequently than controls with values significant only in 7th and 11th grades (Kelder, 1993). The Class of 1989 study design did not allow for separation of the effects of the community intervention from the school level intervention.

Another community-based program, conducted in South Carolina, targeted 5th grade youth. Active Winners was designed to promote physical activity in rural, African American youth. It consisted of an after school and summer program to promote physical activity self-efficacy, fitness, and knowledge about positive aspects of exercise. There were take-home activities for the children's families and media features on physical activity. Community walking trails were developed during the same time period. There was no significant difference between intervention and control community students, however girls showed increased intentions to exercise and there was a statistically insignificant trend toward more vigorous activity among those students who participated more frequently in the after school program (Pate, 2000).

Washington Heights-Inwood Healthy Heart program promoted low fat milk consumption in an inner city Latino neighborhood using bilingual low-literacy flyers and posters, presentations at community meetings, and use of low fat taste tests at busy intersections. Public service announcements were placed on Spanish radio and cable television shows. Discount coupons were distributed for purchase of low-fat milk. Advocacy was used to encourage childcare centers, senior centers and parochial schools to serve low fat milk. Before the campaign, only 6 of 28 childcare centers examined used low-fat milk; after the campaign, 20 of 28 served low-fat milk, nearly all of them using low fat milk exclusively (Wechsler, 1992; Shea, 1996).

A pilot campaign for 1% or less milk in 2 West Virginia cities used television, radio, and print media along with taste tests in supermarkets, schools and worksites to promote low-fat milk. The outcome measure was sales of low-fat milk that showed an increase from 18% to 41% of total milk sales both immediately and 6 months post-intervention. Total volume of milk also increased. The control community had no change in total milk or low-fat mild percentage (Reger, 1998).

CANFit is an ongoing nutrition intervention designed specifically to target adolescents from low-income communities in California. The needs assessment preceding project design revealed an adolescent population of whom 40% were overweight, 21% met minimum physical fitness standards, and over one quarter had iron deficiency anemia. Planning was done through community-based organizations and involved youth in planning. One caveat for all organizations involved is that programs should attempt to alter the environment of low-income adolescent youth including promotion of positive role models who practice healthy eating and regular physical activity. Projects funded under this program include school-based, after school, sports organization based, public housing related, and Indian reservation based programs (Hinkle, 1997). Published evaluations of these projects are not yet available.

As Schmitz and Jeffery (2000) have pointed out in their review of public health interventions, the relatively minor successes of community-based interventions are likely attributable to two key limitations. Firstly, the educational messages from the programs such as those reviewed may be diluted by the current success of for-profit advertisements of less healthy diet and physical activity choices. For example, in 1995 alone, $2.5 billion was spend

in advertising by the top six fast food franchises in the US, an amount equivalent to approximately $10 for every citizen (Jeffery, 1998). This expenditure represents only the tip of the advertising barrel and yet dwarfs the total public health monies spent to promote healthy eating and exercise behaviors. Secondly, the main focus of the reviewed interventions was dissemination of information. In order for educational programs to result in healthy eating and exercise habits that are adopted and sustained by a large segment of the population, environmental changes, such as wide accessibility of physical activity sites and healthy food, as well as affordability, may be integral. Ultimately though, *permanent change on a broad scale is best accomplished by changing behavior, and community-based interventions, supported by policy changes, have the best potential to enact that level of change* (Pate, 2000).

5. CONCLUSION

Primary prevention of overweight in children should begin at early ages. Parents are particularly effective agents for change in the health habits of children and should be incorporated into prevention interventions. Focus groups may be useful in gaining a better understanding of characteristics of a target population (e.g., readiness to change, sociodemographics, and cultural background) in order to maximize efficacy. It is recommended that interventions be interdisciplinary, sustainable, and of long duration. In addition, to avoid stigmatization pediatric prevention interventions should target improving health (e.g., reducing dietary fat and sedentary behaviors; increasing fruit and vegetable intake and vigorous physical activity) without primary emphasis on body size or fatness. Many interventions show success in knowledge and reported behaviors, but little effect on BMI or prevalence of overweight, most notably the large and expensive CATCH and Pathways trials. In general primary prevention efforts have been limited and short-term. There is an urgent need for innovative approaches targeting children.

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G. SOCIAL MARKETING FOR HEALTH BEHAVIOR CHANGE

1. INTRODUCTION

Social marketing is a practical approach to creating health behavior changes among specific targeted audience segments. This approach attempts to influence beliefs and practices of a group through expansion on the traditional commercial marketing strategies of market research, product positioning and access, pricing and other costs involved with obtaining the product, physical distribution, and promotion. According to Alcalay and Bell, social marketing strives to create conditions in the social structure, environment, and/or system to facilitate the promoted behavioral changes (Alcalay, 2000). Consideration of the political environment needed to support change efforts is another important aspect of this approach (Sutton, 1999). Social marketing techniques may be combined with media advocacy and applied to a broader range of "consumers" who are in positions to deliver messages, change policies, pass legislation, revise regulations, and implement programs. Social marketing differs from the traditional health education model in that "consumer" or target audience input is integral throughout the intervention process, whereas the health education model does not usually involve consumer input (Thackeray, 2000). However, the social marketing framework is sometimes used to apply one or more of the behavioral change theories associated with health education.

In June 2000, the Center for Advanced Studies in Nutrition and Social Marketing (CASNSM) released an in-depth and comprehensive review of social marketing concepts and campaigns that have focused on health promotion (Alcalay, 2000). Included in this review were published interventions considered to be campaigns, using the employment of multiple health promotion activities as a criteria. Single-activity interventions based at a single site were not included, resulting in exclusion of most school health education programs. Alcalay and Bell found *little evidence among the campaigns reviewed that social marketing has induced adults with well-established eating patterns and activity routines to alter those habits dramatically.* The authors note that public campaigns may be more effective at preventing the adoption of unhealthy patterns of behavior than modifying ingrained practices of adults and that social marketing has been most effectively used to promote prevention to individuals who have not yet formed unhealthy eating habits (i.e. children).

2. SOCIAL MARKETING INTERVENTIONS TARGETING CHILDREN

Significant behavioral and cognitive changes were seen in an evaluation of the California Children's 5 a Day-Power Play!, a large-scale social marketing initiative to increase fruit and vegetable consumption among children and their parents (Foerster, 1998). The initiative, designed around three theories of behavior change and formative research, employed school- and community-based nutrition education and mass media techniques. During a one-year experimental cohort study, behavioral and cognitive changes among 2,684 4th and 5th grade students were measured by self-reports. There were two intervention groups (school-only intervention and school-plus-community intervention) and one control group. The school intervention activities included independent schoolwork, small group work, classroom activities, family activities, the school cafeteria, and the entire school environment. Community channels used were the media, community youth organizations, supermarkets, and farmers' markets. Statistically significant increases from baseline in fruit and vegetable consumption were seen in both the school-only intervention group (+7%) and the school-plus-community intervention group (+14%). A 12% decrease was found in the control group, a finding theorized to be related to an unexpected change in the availability of produce during the study. Although the difference between the intervention groups was not statistically significant, a dose-response effect was seen. Significant increases in consumption occurred during eating episodes where the children had the most control, daytime snacks and lunch, but not during breakfast and dinner. Both intervention groups also showed significant increases in the number of children who believed they should eat 5 or more servings of fruits and vegetables per day.

A similar program in Minnesota, *5-a-Day Power Plus*, was also guided by behavior change theory and obtained similar results (Perry, 1998). In a randomized experimental community trial with a nested cohort design, ten matched pairs of schools were obtained for a multi-component behavioral intervention among ethnically diverse 4th and 5th grade students. The program included classroom curricula, parental involvement, school food service changes, and industry support and involvement. The social marketing aspects of the program included point-of-

purchase promotion, enhancing attractiveness of fruits and vegetables served at school lunch, increasing the variety and choice, taste testing, home snack preparation activities, video presentations, and educational and incentive materials. Effects were evaluated using lunchroom observations, 24-hour recalls, health behavior questionnaires, and parent surveys. *The intervention increased lunchtime fruit consumption and combined fruit and vegetable consumption, lunchtime vegetable consumption among girls, daily fruit consumption, and proportion of total daily calories attributable to fruits and vegetables.* The changes in the children's diet were most likely to occur during lunch. Although the intervention included home activities intended to involve parents, the study authors noted the difficulty of making changes in the home and involving parents (Perry, 1998).

The *Eat Well and Keep Moving Program* was a 2-year quasi-experimental school-based intervention designed to improve the diets and decrease television viewing of 4th and 5th grade students (Gortmaker, 1999). The program was designed around social cognitive theory and used social marketing techniques, including multiple channels of communication and extensive formative research. In addition to classroom lessons, three other campaigns were used to reduce TV viewing, increase walking and encourage practice of recommended behaviors at home. Effects of the program were assessed using 24-hour recalls and food/activity frequency surveys. *The evaluation found a significant, though modest, increase in fruit and vegetable intake* (+.72 servings/day*), vitamin C intake, and fiber consumption among intervention schools.* Reduction in television viewing (-.55 hours/day) was marginally significant (p=.06). Other significant changes included a reduction in percent energy from fat and saturated fat, and increases in knowledge concerning healthy diet and activity choices. Long-term effects of the program were not assessed.

Gimme 5 Fruits, Juice, and Vegetables for Fun and Health was a multi-component intervention designed to impact 4th and 5th grade children's fruit, juice, and vegetable (FJV) consumption and related psychosocial variables (Baranowski, 2000). Sixteen elementary schools were randomly selected and assigned to control and intervention groups. The intervention was developed using social cognitive theory and social marketing techniques including formative research to identify and address barriers to increasing consumption of FJV at school and home. The intervention included a curriculum (12 sessions over 6 weeks each year), newsletters, videotapes and point-of-purchase parent education. Evaluations were done using 7-day food records and psychosocial measures from the students, telephone interviews with the parents, and observational assessments. *Small but significant differences were seen in fruit and juice consumption, FJV consumption during weekday lunch, FJV self-efficacy measures, and knowledge.* Changes were small and persistence of changes was not measured. Through observations, the authors found that only 22% of activities identified as crucial to achieving behavior change were performed during teacher implementation of the curriculum. Only 65% of parents reported watching the program videos, and the number of attendees at the point-of-purchase education sessions was relatively low.

In a randomized experimental design, the *Alabama High 5 program* tested longer-term effects of a school-based intervention to increase fruit and vegetable consumption among elementary school students and examined the effects of the intervention on parents' consumption. (Reynolds, 2000). The intervention was designed around health education theory and social marketing techniques were used. There were three program components: classroom curriculum delivered by trained instructors, parent education and activities, and food service training and activities to improve availability of appealing fruits and vegetables. The program was delivered during the 4th grade, with three short booster sessions in the 5th grade. Measures were taken three times (at the end of the 3rd, 4th and 5th grades) using 24-hour recall interviews, cafeteria observation, student psychosocial questionnaires, and parent questionnaires. *The intervention produced increased fruit and vegetable intake* (combined and separately) among students, and increased vegetable and combined fruit and vegetable intake among parents (only after the first year and with Caucasian, married, parents of boys). The effects in children were similar across most sub-samples of sex, race and socioeconomic classes, including African-American and low-income samples. The authors note that the program may have been enhanced by the use of outside teachers trained for the program.

The 1% Milk Campaign demonstrated the effects of a social marketing and theory-based intervention focused on a single behavior (Weschler, 1998). The intervention was intended to affect lunchtime milk selection (whole versus low-fat milk) and consumption in public elementary schools in a low-income, inner-city, largely Latino community. The program was designed using the PRECEDE framework of behavior change. Social marketing techniques included product positioning, celebrity endorsements, facilitation of product trials, point-of-purchase and teaser advertising, sales promotion incentives and products, a slogan, and persuasion through entertainment. Among 6,902 children in six randomly selected schools (three intervention, three control), the proportion of discarded low-fat milk

cartons increased from 25% to 57% in the intervention schools, and remained constant at 28% in the control schools. The differences between the schools remained significant at 3 to 4 months follow-up. No decrease in overall milk consumption was seen. As in other studies, the desired change in the children's behavior occurred during the school day when the children had choice of selection.

New Orleans' Gimme 5: A Fresh Nutrition Concept for Students was a three-year intervention trial designed to impact knowledge, attitudes and practices related to consumption of fruits and vegetables among high school students (Nicklas, 1998). Twelve schools were randomized to control or intervention conditions and 2,213 students were followed from 9th to 12th grade. This intervention was also based on the PRECEDE model and used focus groups to identify barriers to fruit and vegetable consumption. The program was composed of an extensive school-wide media-marketing campaign tailored to teens, classroom workshops, school meal modification to increase appealing fruits and vegetables options, and parental support. Program effects were measured using questionnaires during Spring of each year. Over the first 2 years, *usual daily intake of fruit/vegetables increased significantly* by 14% in the intervention group, with no change in the control group. At the final follow-up, consumption within the control group also increased, resulting in no significant difference between groups, a result attributed to the changes in all school food services that occurred following the school district's commitment to a public 5-a-day program and federally-mandated changes to school meals. Knowledge scores of the intervention group were significantly higher than those of the control group. The students in this trial were largely upper-to-middle socioeconomic status Caucasians, limiting generalization of these results to other populations.

The *Minnesota Heart Health Youth Program* evaluated the effects of a school-based program embedded in a community campaign, designed to prevent cardiovascular disease risk behaviors (smoking, dietary habits, and physical activity) targeting students from 6th to 12th grade (Kelder, 1993). The programs were based on a social learning model and specially designed for each year from age 11 to 16. Programs involved lessons, activities, trained peer leaders as role models for healthy behavior, and behavioral health-enhancing concepts. Also included were mass media and education campaigns complementary to school-based efforts. Evaluation was done using seven annual surveys to collect self-reports of food knowledge and preferences, exercise patterns, and smoking behaviors. Both males and females in the intervention community reported *significantly healthier food choices at all but the 11th* (males) *and 12th grade* (males and females) time points. Students in the intervention community gained significantly more knowledge than students in the reference community. However, only a weak relationship was found between healthy eating knowledge and behavior (Kelder, 1995). Females in the intervention community reported significantly greater hours of exercise per week in all but the 11th grade time point. Males in the intervention community reported exercising more frequently, but differences were found to be significant only in the 7th and 11th grades.

The *Child and Adolescent Trial for Cardiovascular Health (CATCH),* a randomized, controlled field trial was designed to test the effectiveness of a school-based program to reduce cardiovascular risk factors (dietary, physical activity, smoking) in school-aged children (Edmundson, 1996). More than 6,000 student in 4 states participated in the intervention from the 3rd to 5th grades. The program design was based on Social Cognitive Theory and employed environmental changes, classroom nutrition education, and interactive family homework assignments. Psychosocial factors influencing the children's behavior were assessed prior to this trial and guided the intervention. Health behavior questionnaires were administered at the beginning and end of the 3rd grade and in the Spring of the 4th and 5th grades. *Intervention schools reduced dietary fat over control schools, but not sodium intake. The intervention affected positive changes in dietary intention and knowledge, social reinforcement for healthy food choices, and dietary self-efficacy.* Despite these positive outcomes, there were no differences in physiological changes (BMI, blood pressure, serum lipid/cholesterol levels) between groups (Lytle, 1998). Without further intervention after grade 5, a three-year follow-up assessment during the 8th grade showed maintenance of significant differences in reported daily energy intake from fat, daily vigorous activity, and dietary knowledge and intentions (Nader, 1999). Again, no significant differences in physiological indicators were found.

Project LEAN (Low-Fat Eating for America Now) is an on-going national social marketing campaign that was initiated in 1987. The campaign aims to reduce risk for heart disease and cancer by increasing availability and accessibility of low-fat foods and promoting collaboration around low-fat food messages and program strategies (Samuels, 1993). Formative research with consumers was used to develop the campaign messages and strategies (Samuels, 1990). These strategies included: media techniques to increase public awareness; chefs and food journalists to demonstrate how to influence behaviors and popular tastes; collaborations with agencies, organizations

and industry to reinforce messages; and community programs to create and institutionalize change in the marketplace (Samuels, 1993). The public service advertising reached 50% of the television viewing audience and the print publicity reached more than 35 million readers. The toll-free hotline received more than 300,000 calls in one year. Thirty-four organizations joined into partnerships and raised $350,000 over three years for collaborative activities. Thirteen states implemented local campaigns.

California Project LEAN (Leaders Encouraging Activity and Nutrition), a campaign of the California Department of Health Services and the Public Health Institute, is designed to increase physical activity and healthy eating among teens. Food on the Run, organized by California Project LEAN, was a pilot project conducted during the 1994-95 school year at inner-city Hoover High School in San Diego. The project utilized a social marketing approach that included formative research, trained peer educators/advocates, a media campaign, taste tests, coupons, and hip-hop dance classes. By the end of the school year the *campaign prompted two major policy and environmental changes*: the establishment of a 2,800 square foot fitness center open to students, staff and community members six days a week before and after school; and the addition of a weekly low-fat combo meal at high school cafeterias throughout the school district. Pre- and post-campaign surveys indicated an increase in the number of students throughout the general student population who were able to correctly identify ways to cut down on fat in fast foods (California Project LEAN, 2001c).

Since the 1994-95 pilot, *Food on the Run* has expanded to 30 low-income high schools. In 1998-99, an outcome evaluation was conducted to assess cognitive and behavioral changes among the student advocates (CPL, 2001a). After receiving training in nutrition and physical activity concepts and environmental/policy changes methods and participating in five or more school-based advocacy activities, standardized pre- and post-surveys were administered to 220 student advocates from 20 high schools. There were *significant positive changes in physical activity and nutrition knowledge, attitudes, and nutrition behaviors*; there was no significant change in physical activity behaviors. The evaluation study authors note a correlation between the nutrition and physical behavior scores and environmental and policy changes (based on unpublished evaluation). During the year studied, there was significant improvement in healthy food options offered at the schools, but no improvement in physical activity options offered during or after school hours.

To expand the piloted social marketing program, Project LEAN designed the *Simple Solution campaign* using extensive formative research with students from the targeted high schools (CPL, 2001b). The campaign, implemented in the 1999-2000 school year, was designed to motivate students to eat healthier and engage in more physical activity using a social marketing approach. Strategies included TV and radio PSAs, school public address system announcements, and posters and countertop displays throughout the schools. Pre- and post-surveys of students (n=66) from participating schools reflected 10-18% positive change in intent to eat healthier snacks, eat more low fat foods, eat more fruits and vegetables, move their bodies at least 30 minutes per day, and be more active. Actual behavior change outcomes of this intervention are currently being evaluated separately.

3. SUMMARY

Table 1 contains summary information for the published evaluations of the campaigns described above. Many of these *interventions produced significant cognitive and behavioral changes among targeted children, but often these changes were small and in most cases the behavior changes appear to be limited to the school environment* (Carroll, 2000). The interventions reviewed here were designed to measure changes in behaviors related to weight and health status (i.e dietary and physical activity patterns), and have generally not been evaluated for their impact on weight and health status itself. Of the thirteen studies reviewed here, one tracked anthropometric and physiologic changes, and none measured changes in physical fitness. Therefore, it is difficult to determine the role that social marketing interventions like these can play in impacting obesity outcomes.

Based on this review, *social marketing techniques appear to have been most effective in achieving cognitive and behavioral changes, especially when:*

- *Multiple communication and delivery channels are used*
- *A strong family component is included to facilitate changes outside the school environment*
- *Changes in the social structure, environment, and/or system are included to facilitate the promoted behavioral changes*

Further recommendations for promoting nutrition and physical activity through social marketing are summarized in the Alcalay and Bell report (2000). For reference the executive summary from the Alcalay and Bell report is included herein (see Appendix 2).

Table 1. Published evaluations of school-based social marketing diet and physical activity interventions. (Adapted from Carroll, 2000)

Publication	Intervention	Change Theory	Evaluation Question	Eval Design	Evaluation Measures & Methods	Evaluation Findings
Minnesota Heart Health Program and Class of 1989 Study (Kelder, 1993)	School-based health promotion program, embedded in a community campaign, to improve dietary & physical activity habits, and reduce smoking.	Social Learning Theory & Problem Behavior Theory	How does a combined school- and community-based CVD intervention affect physical activity outcomes among school-age children?	Quasi-experimental	Hours of exercise, & activity scores (reported frequency and intensity) measured using annual student surveys	Intervention community females reported significantly more hours of exercise/week for all but the 11th grade follow-up. Intervention community males reported exercising more frequently, but with significance only found in 7th and 11th grades.
Minnesota Heart Health Program. (Kelder, 1995)	School-based health promotion program, embedded in a community campaign, to improve dietary & physical activity habits, and reduce smoking.	Social Learning Theory & Problem Behavior Theory	How does a social learning model of community & school intervention affect knowledge of and choices for healthy foods?	Quasi-experimental	Student knowledge, dietary habits measured using annual student surveys	Males and females in the intervention community reported significantly healthier food choices at all but the 11th & 12th grade (males) and 12th grade (females) follow-ups. Intervention community students gained significantly more knowledge than control community students.
The California Children's 5 a Day-Power Play! Campaign (Foerster, 1998)	Nutrition education and mass media campaign. Intervention groups were school-only and school-and-community.	Resiliency Theory, Social Learning Theory, and Reciprocal Determinism.	Are there significant differences in changes in fruit and vegetable consumption between intervention groups?	Experimental	Daily consumption of fruits & vegetables measured using pre/post-intervention 24-hour dietary diaries	Daily fruit and vegetable consumption increased by 7% in the school-only group, by 14% in the school-and-community group, and decreased by 12% in the control group.
CATCH (Lytle, 1998)	School-based health promotion field trial in 96 schools to reduce cardiovascular risk factors in children with	Social Cognitive Theory	How did the intervention affect school environmental changes, student-	Quasi-experimental design comparing intervention	Dietary psychosocial factors, intake of dietary fat & sodium, physical	There were no differences in physiological changes between groups. Intervention schools reduced dietary fat over control

Publication	Intervention	Change Theory	Evaluation Question	Eval Design	Evaluation Measures & Methods	Evaluation Findings
	environmental changes, classroom nutrition education, and interactive homework assignments completed with families.		level physiological changes, dietary intake changes, and dietary psychosocial changes?	and control schools with baselines and follow-up	activity levels, smoking, anthropometric measures, serum cholesterol measured using health screenings & questionnaires	schools, but not sodium intake. The intervention affected positive changes in dietary intention and knowledge, social reinforcement for healthy food choices, and dietary self-efficacy.
The 5-a-Day Power Plus Program (Perry, 1998)	National school-based nutrition program which consisted of nutrition education, parental involvement, food service changes, and industry involvement & support.	Social Learning Theory	What effect did the intervention have on students' observed and self-reported daily intake of fruits and vegetables?	Experimental	Food consumption measured using lunchroom observations & 24 hour food recalls with students, & parent telephone survey	The intervention increased, among girls, lunchtime fruit, vegetable and combined consumption. Overall daily fruit & vegetable consumption, and proportion of daily calories attributable to fruits & vegetables.
Promoting the selection of **low-fat milk** in elementary school cafeterias (Wechsler, 1998)	Multi-component school-based campaign to promote consumption of low-fat white milk at lunchtime via multiple social marketing techniques	PRECEDE framework	What effect did the intervention have on elementary students lunchtime choice of low-fat or whole milk?	Experimental design, 3 control and 3 intervention schools	Discarded lowfat and whole milk cartons measured by sampled milk cartons and/or tallying disappearance of cartons.	Discarded low-fat milk cartons increased in the intervention schools from 25% to 57%, but remained constant at 28% in the control schools. Differences were still significant at 3-4 month follow-up.
Eat Well and Keep Moving (Gortmaker, 1999)	Interdisciplinary health education campaign targeting 4th & 5th grade children in the classroom.	Social Cognitive Theory	How did intervention affect dietary intake and activity levels of target population?	Quasi-experimental field trial	Dietary intake and activity levels measured using longitudinal and cross-sectional survey data	Intervention schools improved significantly more than control schools in % of fat, vegetables, vitamin C

Publication	Intervention	Change Theory	Evaluation Question	Eval Design	Evaluation Measures & Methods	Evaluation Findings
High 5 Project (Reynolds, 2000)	School-based dietary intervention to increase fruit/vegetable intake among 4th graders, using classroom curriculum, parent home activities, and food service training.	Social Cognitive Theory (reciprocal determinism)	What effect did the intervention have on children's and parents' consumption of fruits/vegetables and psychosocial variables related to consumption, and on children's percent calories from fat?	Experimental design, 28 paired elementary schools	Daily intake of fruits/vegetables for parents & students, measured using 24-hour recall interviews, cafeteria observations, student psychosocial questionnaires, & parent questionnaires.	Intervention students reported increased fruit & vegetable intake (combined & separately) among students, and increased vegetable & combined fruit & vegetable intake among parents (only after the first year and only with Caucasian, married, parents of boys).
California Project LEAN's Food on the Run Program (CPL, 2001a)	Multi-component school-based intervention to promote healthy eating and physical activity among adolescents, using trained student advocates and student-led advocacy activities.	Not identified	What effect does the intervention have on student advocates' knowledge, attitudes & behaviors related to nutrition & physical activity?	Quasi-experimental	Changes in knowledge, attitudes & behaviors measured by self-reports using pre- and post-surveys.	Significant positive changes in physical activity and nutrition knowledge, attitudes, and nutrition behaviors were reported; there was no significant change in physical activity behaviors reported.
California Project LEAN's Simple Solution to the Energy Problem campaign (CPL, 2001b)	School-based social marketing campaign to motivate students to eat healthier and engage in more physical activity	Diffusion of Innovations	What effect does the intervention have on exposed students' intentions to make positive changes in nutrition and physical activity behaviors?	Quasi-experimental	Changes in students knowledge and intentions measured by self-reports using pre-and post surveys	There was a 10-18% positive change in reported intent to eat healthier snacks, eat more low fat foods, eat more fruits and vegetables, move their bodies at least 30 minutes per day, and be more active.

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H. POLICY AND LEGISLATIVE APPROACHES TO BEHAVIOR CHANGE

1. INTRODUCTION

Policy approaches to addressing obesity have often been designed to reduce or eliminate individual and/or environmental barriers to healthy food choices and active lifestyles (Nestle, 2000). Because policy interventions often lack a systematic framework for implementation and evaluation, it may be difficult to identify and measure their effects. The following is a review of research evaluations focused on some of the policy approaches affecting nutrition and physical activity.

2. NUTRITION

2.1 School Meals:

Recommendations made by federal and state governments may have little discernable effect if they simply advise and do not require or enable changes (Nestle, 2000). An example of such recommendations are the Dietary Guidelines for Americans, the federal government's official policy statement on diet and disease prevention. Until 1994, meals served through the National School Lunch and Breakfast Programs (NSLP and NSBP, respectively) were not required to comply with these guidelines. Correspondingly, national studies consistently indicated that school meals did not conform to the Dietary Guidelines, particularly for fat intake (Story, 1996). However, in 1994, legislation was passed requiring that NSLP and NSBP meals conform to the Dietary Guidelines. In 1995, USDA also instituted the School Meals Initiative for Healthy Children (SMI). SMI was designed to address the nutritional quality of school meals by providing the educational and technical resources to school food service systems needed to prepare meals that are more nutritious as well as appealing to children.

The USDA recently released findings from two studies reflecting adoption of these standards by more schools and improvements in school meals subsequent to the School Meal Initiative for Healthy Children (USDA, 2001a,b). The USDA report of the findings of the second School Nutrition Dietary Assessment Study based on data collected in school year 1998-99 indicated that schools have made substantial improvements in the nutritional quality of lunches. The proportion of schools offering lunches that met nutrition guidelines for total fat increased from 34% to 82% among elementary schools, and from 71% to 91% among secondary schools. Fat levels as a percent of total calories were reduced from 31% to 26% in school breakfasts and from 38% to 34% in school lunches. About two-thirds of all school lunch menus offered more than two fruit and vegetable choices, while more than one-quarter included five or more choices (USDA, 2001a). Students who participated in the NSLP consumed significantly less added sugars, but higher amounts of total fat over 24 hours, in comparison to non-participants (USDA, 2001b). While additional changes may be desirable, these improvements to date reflect the ability of federal policy to positively impact the composition of the food made available to children through school meal programs when policy is combined with educational and technical assistance.

2.2 Access to Snack Foods in Schools:

NSLP participation rates and type of food consumption may be impacted by the availability of other sources of food on school campuses. In a survey of 24 public middle schools from nine school districts in San Diego County, California, 100% of schools had a school cafeteria and a majority (96%) served a la carte items. However, a substantial number of schools also had a student store (58%) and vending machines (29%). In student stores, 88.5% of inventory items were found to be high in fat (>5g) and/or sugar (>20g). Half of the student stores were open during lunchtime, allowing direct competition with the cafeteria**.** Fruit and vegetables were not sold at any store. Forty percent of beverages sold were soft drinks (Wildey, 2000). Similarly, a 1996 study of 55 high schools in Minnesota found that 31% of schools operated student stores, 47% of which were open during lunch, and 47% of which were located in or near the cafeteria (Story, 1996). In addition 87% of schools had vending machines, 25% of which were open all day and 81% of which were located in or near the cafeteria. Also 11% of schools offered soft drinks in vending machines during school hours.

In a study of 4th and 5th grade students, Cullen et al. (2000) found that *fruit, vegetable, and juice (FVJ) consumption was significantly lower* (0.6 servings) *in 5th grade students* (middle school) *with access to a snack bar than that of 4th grade students* (0.8 servings) *with access to the NSLP only*. In addition, 5th grade students who chose only snack bar meals reported significantly lower consumption (0.40 servings) of FJV than those who consumed only the NSLP meal (0.82). Both the 4th and 5th grade students had access to the NSLP meals, which offered a mean of 2.5 servings of FJV per day. The middle school snack bar offered french fries and pickles, as well as other snacks and high-fat and high-sugar dessert foods. Preference did not account for the differences in FJV consumption between the NSLP and snack bar meals, suggesting that availability may be responsible for the different consumption rates.

Federal law allows the sale of most foods that compete with the NSLP in food service areas during meal periods as long as the proceeds go to the school or an approved student organization (USDA, 1986). Prohibited are Food of Minimum Nutritional Value, defined as those foods that provide less than 5% per serving of the US Recommended Daily Allowances for eight specified nutrients (i.e., carbonated beverages, water ices, chewing gum, and most hard candies). These regulations do not apply, however, to sale of these food items outside the food service area at any time during the school day. Further, *federal regulations do not prohibit the sale of other foods (e.g., beverages, snacks or other a la carte items from vending machines, student stores, or snack bars) offered for individual sale at any time during the school day anywhere on the school campus.* Schools may also allow students access to off-campus food sources during the lunch period. States and local authorities may impose additional restrictions.

2.3 Pricing Strategies to Alter Food Choice:

In a national sample of 2,967 adults, *respondents most frequently reported that taste is the most important influence on their food choices, followed by cost* (Glanz, 1998). Nutritional concerns were found to be less relevant. Similarly, in a study of cognitive influences on vending snack choices among 419 adolescents and 226 adults, snack taste was the most important factor. However, snack price was ranked as very important (French, 1999).

Relatively little research has been done with environmental strategies designed to influence food choice through mechanisms of cost rather than nutrition education. The role of price on the purchase of low-fat foods from vending machines was studied in a university setting (French, 1997a). Sales of low-fat and regular snacks were monitored in nine vending machines during three time periods (4-week baseline, 3-week intervention, and 3-week post-intervention). Low-fat items were clearly marked, and reduced by half in price during the intervention period. The proportion of low-fat snacks purchased was 25.7%, 45.8% and 22.8% during the three periods, respectively. Reducing the price of low-fat products effectively doubled their sale, with no change in total snack purchases from these machines.

Using a similar study design, pricing effects on fruit, carrot and salad purchases were monitored in two high schools with different types of student populations (French, 1997b). Sales were tracked weekly during baseline, intervention, and post-intervention periods. The price of the observed items was reduced by 50% during the intervention period. *During the low-price period, fruit sales increased by about fourfold, carrot sales increased by about twofold, and no significant effect was seen on sales of salads, overall sales revenue, or number of customers.* The magnitude of the intervention effect for fruit was larger in the urban (socioeconomically and ethnically diverse) school, and larger for carrots in the suburban (middle-income and primarily White) school. While reducing the price of "healthier" snacks by half may not be economically feasible for vendors, smaller reductions in price accompanied by price increases in products with higher fat and sugar content may result in acceptable net profits. This approach might be attained through price supports and subsidies for "healthy" foods and taxation on "unhealthy" foods, initiated at either the state or federal level (French, 1997a).

3. PHYSICAL ACTIVITY

Many recommendations have been made regarding approaches to changing environments to encourage physical activity among children (Brownson, 2000; Sallis, 1998; Stone, 1998). *Suggested approaches include school policies and environments that promote physical activity during and after school hours, community parks and play areas, liability legislation allowing children to use school grounds during non-school hours, zoning and land use, and building construction that encourages physical activity.* However, data on the uses and effects of these approaches, particularly among children, are limited.

3.1 School and community youth interventions:

A review of studies of physical activity in school and community settings among school-aged children assessed the characteristics and effects of various multi-component interventions (Stone, 1998). Eight of 22 school-based studies and one of seven community-based studies reviewed included policy change as a small part of the intervention. At the time of the Stone review, five of these studies had published results, with only two finding significant increases in physical activity and/or fitness. In a 12-year follow-up of participants in one of these interventions, the Oslo Youth Study, early physical activity levels were predictive of physical activity levels in adulthood. Because these interventions involved significant components in addition to policy changes, the individual effects of policies are unknown.

3.2 Safe Environment:

Data from the 1996 Behavioral Risk Factor Surveillance System in four states were used to characterize the relationship between perceived physical inactivity and neighborhood safety (MMWR, 1999). *A higher level of perceived neighborhood safety was associated with a higher level of physical activity*, with the greatest differences reported among older adults and racial/ethnic minorities. Parents have also expressed concerns about the safety of their children's play areas. Interviews of 300 Mexican-American and White parents identified the safety of parks as the most important factor in deciding whether to use them, as well as lights, toilets, and drinking water (Sallis, 1997a). These are all areas for potential policy intervention.

3.3 Access issues:

To determine the extent of walking trail use and possible effects on rates of physical activity, Brownson et al. (2000) conducted a study of walking-related behaviors and activities. A survey of walking behaviors, knowledge, and attitudes was administered to 1269 adults in 12 rural counties. Among those with access to trails, 38.8% reported having used the trails and 55.2% of these reported having increased their amount of physical activity since they began using the trail. Women and lower socioeconomic groups were more likely to report an increase in walking since using the walking trails. This study did not assess use of trails by children.

The influence of proximity to exercise facilities on activity levels was assessed in a survey of 2,053 adults (Sallis, 1997b). Those who reported engaging in three or more exercise sessions per week reported a statistically greater density of pay facilities near their homes than did those who reported no exercise sessions. Similarly, observational studies of preschool children have shown that *activity levels are associated with the number of play spaces near their homes and the amount of time children use those play spaces* (Sallis, 1998). Children were also more active when playing outdoors (Baranowski, 1993). These data suggest the need for access to safe community play spaces and exercise facilities.

4. PUBLIC SUPPORT FOR POLICY INITIATIVES

In order for policy level interventions to succeed, they must have substantial public support. As part of the Minnesota Heart Health Program, support for policies designed to regulate the sale and consumption of high-fat food was evaluated in a survey of 821 adults in Minnesota (Schmid, 1989). Three communities receiving the multi-component education and mass media intervention and four comparison communities were surveyed. The strongest support was expressed for policies controlling the condition of sale and information about high-fat foods. These policies included a requirement for school cafeterias to offer low-fat food items, elimination of high-fat snack foods from school vending machines and concession stands, limiting the amount of advertising of high-fat foods on children's television, and requiring labels on high-fat foods that warn about possible health effects of eating a high-fat diet. Moderate support was shown for taxation as an incentive to food producers to provide alternatives to high-fat food. Adding taxes to high-fat foods as disincentive to consumers to purchase these foods and limiting sales of high fat foods to minors were opposed. Compared to control communities, the intervention communities were significantly more supportive of two of the policies: providing tax breaks for low-fat menu items and adding a tax to high-fat foods. While the effect of the intervention on the views of the community were not significant for all proposed policies, the effects of a public health or other type of campaign on community support of policies is important to consider (Schmid, 1989).

There has been at least one survey assessing public support for policies to increase physical activity. In a survey of 3,024 adults, the majority supported zoning regulations to promote exercise (85%), use of local funds for exercise facilities (77%), and mandatory physical education (95%) (Brownson, 1999).

Resistance to obesity prevention through restrictive policy measures may be strong if all members of the community are subjected to such restrictions as a result of a problem that affects only a proportion of the community (Schmitz, 2000). Resistance is also likely to come from industry groups who have vested financial interests in continuing to sell their products to children and adults, whether or not they are likely to be contributing to poor health. Since 1980, food industry representatives have been involved in the development and review of federal recommendations to reduce dietary risk factors for chronic disease (Nestle, 1993), and are unlikely to passively allow enactment of legislation that restricts or limits the sale of popular food products in specific settings.

5. CURRENT LEGISLATIVE ACTIVITY IN CALIFORNIA

Numerous bills with nutrition and physical activity policy implications are currently under consideration in California (Table 1). The extent to which these bills become law and effect outcomes remains to be determined. Additional studies are needed to evaluate policy needs, acceptance, and health measures among children.

Table 1. Legislation currently being considered in California that contain items related to nutrition and/or physical activity.
(Source: Developed by the California Children's Coalition for Activity and Nutrition (CCCAN) policy task force members, 2001.)

Author(s)	Bill #	Summary	Vote Required for passage	Appro-priations	Fiscal Com-mittee	State mandate local program	Hearing Information
Escutia, Alpert, Kuehl, Ortiz	SB 19	This bill establishes nutritional requirements for foods sold at elementary and secondary schools, increases the state reimbursement for school lunch program meals, creates incentive grants for school districts to develop and adopt policies on child nutrition and physical activity, requires the Superintendent of Public Instruction to enforce the provisions of the bill, and imposes other nutrition-related requirements on schools.	majority	yes	yes	yes	Last history action 6/14/2001. Read third time. PASSED. 6/14/2001 To Assembly Committees on Health and Education.
Escutia	SB 59	Healthy Families Program demonstration projects: Authorize grants to health care providers and community based clinics to organize networks to serve migrant populations.	majority	no	yes	no	Last history action 5/31/2001. Set. First hearing. Held in committee and under submission.
Ortiz	SB 292	This bill would require the State DHS to expand the activities provided under the Physical Activity and Health Initiative (PAHI) in the Epidemiology and Health Promotion Section of the departments CDControl Branch and would require the PAHI to work in conjunction with the California Project LEAN leaders to promote health education, health activities, and health awareness to the public regarding the need to increase physical activity to prevent major chronic disease, to the extent that necessary funding in included therefore in the annual Budget Act or other statute.	majority	no	yes	no	Last history action 5/31/2001. Set, first hearing. Held in committee and under submission.
Perata	SB 310	This bill requires every school site to allow for outdoor use during the school day, articles of sun-protective clothing, including, but not limited to, hats.	majority	no	yes	yes	6/07/2001: From committee with author's amendments. Read second time. Amended. Re-referred to committee on Education. Set for hearing 6/20/2001.

Author(s)	Bill #	Summary	Vote Required for passage	Appro-priations	Fiscal Com-mittee	State mandate local program	Hearing Information
Escutia	SB 354	Extend the California Interscholastic Federation from 1-1-02 until 1-1-07. (CIF is a voluntary organization consisting of school and school-related personnel with responsibility for administering interscholastic athletic activities in secondary schools.)	majority	no	yes	no	6/11/2001 to Committee on Education. Set for hearing 6/20/2001.
Murray	SB 359	Create Pocket Parks fund to provide grants to develop parks in urban areas of less than 3 acres in size.	majority	no	yes	no	Last amended 6/4/2001. Last history action 6/14/2001. Sent to Committee on Water, Parks & Wildlife. 31 days in print: suspended.
McPherson	SB 391	Make a legislative finding and declaration that school districts, especially low-performing ones, employ a full time nurse consultant in each county office of education.	majority	no	no	no	Mar. 12 to Committee on Rules. Last amended 5/23/2001. Last history action 6/14/2001. To Committee on Education.
Vasconcellos	SB 417	DHS must establish an alternative treatment cancer research project ($3,000,000) (involves research on the effect of behavioral changes on the reduction and reversal of illness and disease).	two-thirds	yes	yes	no	Set for hearing April 4. Last amended 4/17/2001. Last history action 5/31/2001. Set, first hearing. Held in committee and under submission.
Machado	SB 450	Establish the School Food Service Staff Development and Safe Food Handling Program ($2,120,000).	two-thirds	yes	yes	no	Last amended in Senate 5/1/2001. Last history action 5/31/2001. Set, first hearing. Held in committee and under submission.
Costa	SB 477	Expand SNO-PARK program to facilitate access to recreational areas.	majority	no	yes	no	Mar. 19 passed as amended, and re-referred to the Committee on Appropriations. Last amended 4/2/2001. Last history action 5/24/2001. To Committee on Water, Parks & Wildlife. 31 days in print: suspended.
Sher	SB 493	This bill would require DHS to implement the WIC Express Lane Program the primary purpose of which would be to implement enhanced health care enrollment assistance targeted at individuals.	majority	no	yes	no	Last amended 6/4/2001. Last history action 6/14/2001. To Committee on Health and Human Services.

Author(s)	Bill #	Summary	Vote Required for passage	Appro-priations	Fiscal Com-mittee	State mandate local program	Hearing Information
		participating in the WIC program who are eligible, but not enrolled in the Medi-Cal program or Healthy Families Program.					
Murray	SB 586	Establish the California Youth Soccer and Recreation Development Program and Fund. 5-year grants to local agency and community based organizations.	majority	no	yes	no	Last history action 6/14/2001. To Committee on Water, Parks & Wildlife. Suspended.
Peace	SB 665	No junk food sales at schools. All milk in schools must be skim, 1% or non-fat.	majority	no	no	no	Last history action 04/19/2001. Set first hearing. Hearing canceled at the request of author.
Alcaron	SB 788	Grants to develop urban river park projects.	majority	yes	yes	no	Last history action date 6/5/2001. In Assembly. Read first time. Held at Desk. 31 days in print: suspended.
Battin	SB 1077	Allows school-wide parent teacher organizations to fund raise using on-campus food sales not more than 2 days per month under existing regulations that 50% of food must be of a certain type. **This is an increase above current number of allowable sales.**	majority	no	no	no	Last history action 4/24/2001. Set, first hearing. Hearing cancelled at request of author.
Torlakson	SCR 5	Concurrent Resolution- March is California Fitness Month.					Last amended on 3/8/2001. Last history action 3/27/2001. Chaptered by Secretary of State.

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APPENDIX 1. Guidelines for the prevention and treatment of childhood overweight issued by national groups and organizations.

Who	When to treat	Goal of treatment	Behavioral	Activity	Diet	Other
Department of Health and Human Services Expert Committee Recommendations, Barlow and Deitz, 1998 [3]	Children with BMI of ≥95% should undergo an in-depth medical evaluation. Refer to pediatric treatment centers when children present with complications needing rapid weight loss.	Strong emphasis on family-based behavioral goals—awareness of and identification of problem behaviors; modification of behaviors; small, permanent changes. The primary goal of a program to manage uncomplicated obesity is healthy eating and activity, not achievement of ideal body weight. For children with secondary complications of obesity, improvement or resolution of the complication is an important medical goal.	Improve parenting skills focused on eating and activity behaviors. Nine specific skills are indicated: Find ways to praise the child's behavior: never use food as a reward; parents can ask for "rewards" for children in exchange for the changes in their own behavior; establish daily meal and snack times; parents or caregivers should determine what food is offered and when, and the child should decide whether to eat; offer only healthy options; remove temptations; be a role model; be consistent	Increase activity as part of daily living, as opposed to periods of defined exercise. The best way to increase activity may be to decrease inactivity--follow AAP recommendation to limit television viewing to 1 to 2 hours per day.[5] Incorporate activity into daily routine—walk to school, play with a friend. Seek team sports whose coaches emphasize participation over winning. Recognize deterrents to activity, including unsafe neighborhoods and lack of adult supervision after school; help parents address these concerns. Advocate for quality school-based activity programs.	Well-balanced, healthy meals and a healthy approach to eating. Consider changes as permanent rather than as a temporary eating plan for rapid weight loss. Use the Food Guide Pyramid as a guide.[20] Reduce or eliminate specific foods; use "stoplight diet".[12]	Clinicians who care for families of overweight children must treat them with sensitivity, compassion and a conviction that obesity is an important, chronic medical problem that can be treated. It is important to assess readiness for change because a weight-management program for a parent or adolescent who is not ready for change may be not only futile but also harmful. An unsuccessful program may diminish the child's self-esteem and impair future efforts to improve weight. Regular contact of parents and child with clinician is essential to review and reinforce goals. Support of other health professionals can augment this.
American Academy of Pediatrics, Pediatric Nutrition Handbook, 1998 [6]	Children with strong family histories of morbidities exacerbated by obesity should be firmly and repeatedly counseled about good dietary (reduced fat) and exercise habits. This may reduce cardiovascular morbidity even if body weight is not significantly altered. If adiposity related morbidity is present, therapeutic weight reduction may be warranted. No evidence supports the role of radical surgery or pharmacological therapies, except in extremely obese children in whom all other interventions have failed. Reduction in weight (as opposed to reduction in rate of weight gain) should not be attempted in obese infants. Older children without evidence of adiposity related morbidities should decrease or eliminate weight gain, allowing height to catch up with weight.	The major goal of obesity therapy should be to decrease the morbidity and risk of morbidity rather than to achieve a cosmetically endorsed body habitus. The initial therapeutic approach should combine exercise and a closely supervised dietary plan. Decrease or eliminate weight gain, allowing height growth to continue so height eventually becomes appropriate for weight.	Family-oriented approach is important. If possible, entire family should adhere to a similar diet. If patient with adiposity related morbidities is unable to lose weight or morbidity persists, placement in a weight reduction summer camp should be considered; follow up is essential.	Regular exercise allows the child to ingest more calories and, hopefully, encourages long-term continuation of exercise. Exercise should not be viewed as "license to eat." Treats such as ice cream or chips should not be used as incentives to exercise.	All diets should be nutritionally balanced and designed to meet growth requirements. Periodic adjustment of calories is necessary. Diets consisting of drastically altered portions of various nutrients may be dangerous. Dietary restrictions should not be presented in a punitive manner.	As many as 80% of kids with unsupervised diets from popular magazines have medical problems resulting from the diets. Closely monitor children on diets for medical and psychological morbidities. Don't assume that every obese child is strongly motivated to lose weight. Consider the possibility that the risks and difficulties of weight reduction may exceed the benefits in the older and otherwise healthy overweight child without a family history of adiposity-related morbidities. Set reasonable, modest and attainable goals for changes in diet and activity level. Realize certain individuals may be medically healthy at higher functional body fatness than is held to be ideal by current cosmetic norms of Western society

Who	When to treat	Goal of treatment	Behavioral	Activity	Diet	Other
American Dietetic Association Pediatric Manual of Clinical Dietetics, 1998 [7]	Nutrition intervention is initiated after nutrition screening and identification of the overweight or obese child or adolescent. Nutrition intervention is indicated for overweight or obese pediatric patients with endocrine, orthopedic or pulmonary conditions; genetic syndromes, and weight gain secondary to medical/pharmacological therapies. For obese and overweight children and adolescents who have not experienced their growth spurt, intervention should focus on cessation of weight gain rather than weight loss to allow for growth to an appropriate weight for height. Adolescents who have completed their growth spurt need to be more aggressive in nutrition and exercise programs	Promotion of healthy lifestyle behaviors, which will help the child achieve and maintain a desirable body weight. A well-balanced diet, regular aerobic exercise, and cognitive self-management are essential components of an intervention program that includes frequent long-term monitoring by the registered dietitian and the pediatrician. Weight normalization in children is designed to produce slow weight loss and/or weight maintenance while providing the nutrients necessary to promote growth and development. Weight normalization is not as important as weight maintenance. For kids who could benefit from weight loss, up to 2 pounds a month is safe	A family approach in which parents learn to support the child or adolescent is an essential component of successful weight management. Key components include nutrition education on lifestyle behaviors, modification of the home/school environment to enable the child to make wise choices, and motivation to change by modeling behaviors or contracting. Encouraging the whole family to participate in physical activity and supporting the child in his or her program enhance participation in "lifetime activities". Setting time limits for television watching or computer use aids in scheduling aerobic activities	Developing a physical activity program is an essential component of the weight management program. Active pursuits can replace hours of television, video games and computer use. Implementation of a physical activity program that is both vigorous and frequent has to overcome personal, familial and societal barriers. Physical activity goals should include aerobic activity lasting 30 minutes, with additional time for warm-up and cool-down periods, at least four times a week.	Nutrition care plan should include goal setting with the patient and family to identify specific nutrition-related problem areas and ways to approach these problem areas. Base diet on the Dietary Guidelines for Americans;[8] include sufficient energy to support growth. Limit empty calorie foods like beverages, fat-free baked goods and candies; increase whole grains and fresh fruits and vegetables. Nutrition education including meal planning, dining out, eating with peers, food labels and grocery shopping will promote discussion and problem solving	The degree of energy and nutrient modification, exercise frequency and intensity, parental involvement, and cognitive behavioral therapy is dependent on medical condition, age, degree of overweight/obesity, and psychosocial factors. It is important to understand the child's and the family's perceptions of obesity and whether the overweight is chronic, or is the result of a crisis or dynamics of family life-style. Pediatric patients with superobesity (>140% of mean body weight for height) may benefit from a short-term, medically supervised protein-sparing modified fast.
American Heart Association, Understanding Obesity in Youth, 1996 [17]	Values >75th percentile for skinfold and weight for height measures should be considered at risk, especially when there is a family history of risk factors. More aggressive medical intervention and treatment are warranted in the significantly obese child. Pharmacological or surgical therapy is indicated only with life-threatening complications of obesity and after conventional therapy has failed.	Prevention of weight gain above that appropriate for expected increases in height. For many children, this may mean limited or no weight gain while linear growth proceeds normally. Achieving ideal weight for height should be considered an unrealistic goal.	Factors predicting success are frequent intervention visits, inclusion of parents in the dietary treatment program, strong social support for the dietary intervention from others involved in food preparation, and a regular exercise prescription. The importance of continuing lifestyle modifications well past the initial intervention period should be emphasized for the entire family. The entire family should be targeted in the recommendations to improve family health and avoid stigmatization of the overweight child.	Public health recommendations for primary prevention: accumulation of at least 30 minutes of endurance-type physical activity of at least moderate intensity on most—preferably all—days of the week	Calorie intake should not be restricted in infants; rather, prevention of overfeeding should be emphasized. Public health recommendations for primary prevention: Consumption of the prudent diet recommended by the American Academy of Pediatrics and the American Heart Association. [15]	Because long-term studies of weight reduction in children have shown that 80-90% return to their original weight percentile, efforts at primary prevention should be made. Interventions that have been most successful in preventing long-term weight maintenance have been implemented in children between the ages of 6-12 years old. The risks and difficulties of weight reduction may exceed the benefits in an older and otherwise healthy child without a family history of adiposity-related morbidities. Physician monitoring of weight reduction in children is essential because calorie restriction in children has been associated with many problems.

(Reproduced from: Ikeda JP, Mitchell RA. Dietary approaches to the treatment of the overweight pediatric patient. Ped Clin N Am 2001;48:955-68)

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APPENDIX 2

Executive Summary

[Reproduced from: Alcalay, R and Bell, RA. Promoting Nutrition and Physical Activity through Social Marketing: Current Practices and Recommendations. Center for Advanced Studies in Nutrition and Social Marketing, University of California, Davis, CA, 2000]

Objectives
This report describes the essential features of the social marketing perspectives, as well as the primary social-behavioral theories used by social marketers; reviews social marketing campaigns intended to promote better nutritional practices and increased physical activity; and offers recommendations for improving future health promotion efforts in this area.

Research Questions and Review Methodology
Thirty-three questions were posed and organized around a four-phase model of social marketing campaigns (research/planning, strategy design, implementation, and evaluation). To be considered a social marketing intervention, minimum criteria were established that a campaign had to satisfy to be included in this review. Fifty campaigns satisfied these criteria. Published reports for each intervention were collected, grouped, and then treated as the unit of analysis in out review. Each intervention was coded on the variables identified in the research questions. Data analyses were based on descriptive statistics, as the assumptions required for inferential tests were not met by these data.

Key Findings
Research and Planning
The most common goal targeted in these fifty interventions was he prevention of cardiovascular disease, followed by prevention of obesity, high cholesterol, cancer, hypertension, diabetes, and osteoporosis. The specific objectives most frequently pursued were reductions in dietary fat intake, increases in physical activity, and the promotion of fruit and vegetable consumption. A majority of campaigns promoted both improved nutrition and regular physical activity. Campaign goals were given in measurable terms in fewer than one-third of campaigns and were rarely formulated on the basis of data descriptive of target audiences. The social-behavioral theories most often referenced in these campaigns were Social Learning Theory, the Community Organization Model, and the Social-Ecological Model; many campaigns did not mention any theory whatsoever. Audience segmentation strategies were primarily based on demographics (usually age) and only occasionally made use of psychological and lifestyle principles. Adults were more likely to be targeted than children and adolescents. Consumer research about target audiences was obtained in a minority of campaigns and the nature of these research activities was often not described. Individual behaviors were more likely to be the focus of change efforts than family practices and/or community norms/activities. Changes in policy were attempted in only a few cases and media advocacy techniques were infrequently employed. Most interventions had community involvement in the planning/research activities of the campaign.

Strategy Design
Pretesting of key concepts and messages was reported in only two-fifths of campaigns, with focus groups being the most common method utilized. Pretesting of the entire campaign was reported in less than one-fourth of campaigns. With regard to the social marketing product, nine-tenths reported creating material products such as manuals, recipe books, and brochures, for distribution. Nearly three-fifths offered one or more health-related services (e.g. free health screenings) to target audiences. The incentives and appeals used in these products could not be discerned from the information provided in campaign planners' reports of their activities. Most campaigns made use of broadcast, print, and interpersonal channels for product dissemination.

Implementation
Community members were enlisted as collaborators in more than four-fifths of the campaigns. Local organizations and groups, employers, health care providers, and school personnel from the community were used in roughly the same proportion of campaigns as mechanisms of community involvement. More than one-half of campaigns explicitly identified intervention maintenance as a long-term goal.

Evaluation
Nearly nine-tenths of campaigns made an effort to evaluate outcomes, but the summative research reported was often modest in scope. The most common evaluation strategy used was a quasi-experimental design. Knowledge gain was the most common cognitive/affective outcome measure reported, self-reported behavior change was the most frequently used behavioral outcome, and measured clinical changes (e.g. cholesterol levels) was the most frequently mentioned health outcome measure. Attempts to measure changes in morbidity and mortality were reported in less than one-tenth of campaigns. Cost-effectiveness evaluations were also uncommon.

Recommendations
The success of intervention has been limited, particularly in earlier social marketing campaigns. We offer a number of recommendations in order to improve future results. More attention should be paid to setting realistic, specific, and measurable objectives. Subsequent campaign activities should be consistent with these goals and objectives, as well as with desired outcomes. Social marketing concepts should become more central to campaigns, which often mention this framework but do not integrate it throughout the campaign. Behavioral theories should also more actively applied to the design of campaigns. Audience segmentation and research should be more central to the planning of campaigns. Better definitions of audiences' psychographics and ethnicity should be present. Communication strategies should be formulated based on better information about target audiences' communication patterns. Better understanding of message design decisions and appropriateness should be included. Constructive models of public-private collaboration used in some of these interventions should be widely disseminated. More importantly, a major thrust of social-marketing/media advocacy campaigns should be altering the environment and modifying environmental policies.

APPENDIX 3

Books On Marketing To Various Audience Segments

The Kids Market, Myths and Realities
By James McNeal
Comprehensively discusses the process by which kids become consumers (starting at age 2 months) and how to effectively market to them.

The Great Tween Buying Machine, Marketing to Today's Teens
By Dave Siegel, Tim Coffey & Greg Livingston
"Tweens (ages 10-11) don't fit easily into any category, but they have the power to create a $100-million brand….Discover how to market to tweens…"

What Kids Buy and Why, The Psychology of Marketing to Kids
By Dan S. Acuff
Provides provocative information about the cognitive, emotional and social needs of children from birth through late teen years.

Wise Up to Teens, Insights into Marketing and Advertising to Teenagers
By Peter Zollo
Guide to teen market and media.

Creating Ever-Cool, A Marketer's Guide to a Kid's Heart
By Gene Del Vecchio
Provides a framework for developing a stronghold in the exploding kid's market.

Marketing to American Latinos, A Guide to the In-culture Approach
By M. Isabel Valdes
Gives facts and figures needed to understand the size and power of the rapidly growing US Hispanic market, and explains how to market to them.