Opportunities and Challenges in the Prevention and Control of Cancer and Other Chronic Diseases: Children's Diet and Nutrition and Weight and Physical Activity

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Objective The purpose of this article is to review the role of behavioral research in disease prevention and control, with a particular emphasis on lifestyle- and behavior-related cancer and chronic disease risk factors—specifically, relationships among diet and nutrition and weight and physical activity with adult cancer, and tracking developmental origins of these health-promoting and health-compromising behaviors from childhood into adulthood. **Method** After reviewing the background of the field of cancer prevention and control and establishing plausibility for the role of child health behavior in adult cancer risk, studies selected from the pediatric published literature are reviewed. Articles were retrieved, selected, and summarized to illustrate that results from separate but related fields of study are combinable to yield insights into the prevention and control of cancer and other chronic diseases in adulthood through the conduct of nonintervention and intervention research with children in clinical, public health, and other contexts. **Results** As illustrated by the evidence presented in this review, there are numerous reasons (biological, psychological, and social), opportunities (school and community, health care, and family settings), and approaches (nonintervention and intervention) to understand and impact behavior change in children's diet and nutrition and weight and physical activity. **Conclusions** Further development and evaluation of behavioral science intervention protocols conducted with children are necessary to understand the efficacy of these approaches and their public health impact on proximal and distal cancer, cancer-related, and chronic disease outcomes before diffusion. It is clear that more attention should be paid to early life and early developmental phases in cancer prevention.

Key words behavior; cancer; children; chronic disease; disease prevention; health promotion; lifestyle.

Behavioral science is one of the five core disciplines of public health. Along with biostatistics, epidemiology, environmental health sciences, and health services administration, behavioral science has the potential to assist in the prevention, reduction, and elimination of chronic disease (Schneiderman & Speers, 2001). With respect to cancer, behavioral science plays a rather key role (Hiatt & Rimer, 1999; Lerman, Rimer, & Glynn, 1997). That is because a majority of cancer deaths in adulthood are attributable to lifestyle and behavioral factors, such as consuming a high-fat/low-fiber diet, uncontrolled weight gain, physical inactivity, tobacco use and alcohol consumption, and excessive sun exposure. It is estimated that as much as 50% or more of cancer in

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adulthood can be prevented through smoking cessation and improved diet alone, with additional benefits likely to be seen from promoting weight control and physical activity [U.S. Department of Health and Human Services (USDHHS), 2000]. Although many childhood cancers are caused by known hereditary syndromes (Stiller, 2004), it is clear that some cancer morbidity and mortality in adulthood are avoidable (USDHHS, 2000).

There is an increasing convergence from epidemiologic and biologic sources that both environmental and genetic factors are responsible for the onset of cancer in adulthood (Perera, 2000). Examples of environmental factors include exposure to tobacco smoke, certain diets, and pollutants. Genetic factors take account of carcinogen-induced DNA damage and polymorphisms in enzyme-related genes. Prenatal exposure and exposure early in life to organochlorine pesticides, polycyclic aromatic hydrocarbons, and polybiphenols can significantly increase the risk of some cancers in adulthood (Perera, 2000). Other sensitive stages of development include adolescence and young adulthood. Beginning smoking, for example, at an early age (<16 years) increases one's risk of lung and other types of cancer, possibly through greater DNA damage and adduct formation (Perera, 2000). Diet and nutrition have been extensively studied in relation to cancers of the colon and breast (see Kritchevsky, 2003 for review). This work has led to an increased focus on the role of fiber and antioxidants in adenoma formation and raises questions as to when in the life cycle, dietary change can and should occur to reduce cancer risk. So too in the case of skin cancer, where it has been hypothesized that ultraviolet radiation exposure early in life increases one's risk of malignant melanoma later on (see Mancini, 2004 for review). Thus, there is plausibility from a number of perspectives that exposure early in life affects later cancer risk and cancer morbidity in adulthood.

As Wurtele (1995) has noted, childhood is an optimal time in development in which to promote healthy behaviors because children are still in the process of adopting stable lifestyles. Further, "parents, teachers, pediatricians, and pediatric psychologists, among others, can be especially influential in this process" writes Wurtele (1995, p. 200). Thus, childhood offers an unprecedented window of opportunity in which to support health-promoting/cancer risk-reducing behaviors and to deter health-compromising/cancer risk-enhancing behaviors, with possible greater success than would be achieved during adulthood when lifestyles are more firmly established.

Consistent with a cancer prevention and chronic disease prevention focus early in the lifespan, *Healthy People 2010*—a comprehensive nationwide health promotion and disease prevention agenda—has established behavioral objectives that are relevant to the health of children that can also shape the health of the nation (USDHHS, 2000). The Division of Adolescent and School Health at the Centers for Disease Control and Prevention (CDC), the Maternal and Child Health Bureau at the Health Resources and Services Administration, and key partners have formed the *National Initiative to Improve Adolescent Health by the Year 2010*. The purpose of this initiative is to heighten national awareness of *Healthy People 2010* and the health and well-being of children. It also seeks to promote the accomplishment of 21 critical health objectives in youth by focusing attention on children's lifestyle and behavioral factors that contribute to cancer and other chronic diseases (e.g., cardiovascular disease and diabetes), such as diet and nutrition, weight, physical activity, tobacco use, and alcohol consumption (CDC, 2005). Thus, increased attention is being paid to the role that childhood plays in adult cancer and chronic disease prevention.

With respect to cancer, Baranowski et al. (1997, (1999) effectively echoed many of Wurtele's (1995) sentiments, adding that primary prevention of cancer during childhood might be feasible given that carcinogenic processes often begin early in life and that some of these processes are controlled and/or strongly affected by behaviors learned in childhood. Some children's adult cancer risk behaviors are believed to "track" (i.e., are consistent) over time, making it important to understand the factors that may contribute to their initiation and maintenance, so that they can be prevented, delayed, or offset. Performing longitudinal studies of such processes are complicated, as any observed consistencies may be behaviorally or physiologically specific and vary in degree. For example, physical activity levels may decline as children mature (USDHHS, 1996), but their strength and flexibility may track. Pate, Baranowski, Dowda, and Trost (1996) have observed that physical activity levels track in very young children. Alfano, Klesges, Murray, Beech, and McClanahan (2002) have observed that physical activity levels in youth are a strong marker of adult health behaviors, including adult physical activity levels. This is but one example of the way in which a behavior during childhood (physical activity) must be studied over time and in its full complexity to develop a more complete understanding of its ultimate impact on adult cancer risk. With respect to diet and nutrition, Resnicow et al. (1998) reported fair to moderate tracking of fruit and vegetable intake over 2 years among elementary school-aged children

(r = .40–.48). In a review article concerning transitions out of high school as a time of increased cancer risk, it was concluded that diet and nutrition were specifically affected during the teenage to young adult years: consumption of high-fat foods increased, daily fruit intake for males decreased, and dietary calcium decreased (Baranowski et al., 1997). With respect to tracking, these authors also noted that healthy eating among preadolescents was likely to continue into adolescence (as evidenced by healthier food choices). Evidence suggests that both gender (Cullen et al., 1999) and ethnicity (Baranowski et al., 1999) may moderate these and other cancer risk behaviors, as Hispanic males and African Americans may be more likely to use tobacco over time. As the goal of cancer prevention and control is the prevention and control of cancer (Lerman et al., 1997), adopting a developmental, life span perspective would likely serve the field, and the nation's public health agenda, rather well (see Colditz & Frazier, 1995 for review).

In this article, we describe the rationale for, and the application of, behavioral science research to the prevention and control of adult cancer with an emphasis on research performed with children. This includes research organized around three child health behavioral factors that have long been suspect for their impact upon adult cancer and chronic disease risk: (a) diet and nutrition, (b) weight, and (c) physical activity. Other work has addressed three child health behavioral factors that have long been known to impact adult cancer and chronic disease risk: (a) tobacco use, (b) alcohol consumption, and (c) sun exposure (see Chassin, Presson, & Sherman, 2005, Heffernan & O'Sullivan, 1998, and Loveland-Cherry, 2000, for reviews). For each factor, we review the prevalence and burden of its related cancers, the factor's prevalence, key component behaviors and social and psychological correlates, and examples of interventions that have been conducted in different settings to date to effect change. Limitations and recommendations are acknowledged for each factor as well.

Cancer Prevention and Control

According to the National Cancer Institute (NCI) at the National Institutes of Health (NIH), cancer control research is defined as: "the conduct of basic and applied research in the behavioral, social, and population sciences to create or enhance interventions that, independently or in combination with biomedical approaches, reduce cancer risk, incidence, morbidity, and mortality (Cancer Control Review Group, 1997)." Similarly, NCI notes that cancer prevention research is directed at healthy populations, including those at high risk and/or those with detectable precancerous lesions, and cancer survivors (Cancer Control Review Group, 1997).

As applied to children, the definition of cancer prevention and control takes on new significance. Borrowing from the NCI definition above, we consider pediatric cancer prevention and control research to be the conduct of basic and applied biobehavioral research with children that reduces cancer risk, incidence, morbidity, and mortality across the life span. This work is highly necessary, is qualitatively different from research in adults, and represents an emerging focus within cancer prevention and control. Data suggesting that a majority of school age children are poorly informed about cancer and other chronic diseases, about ways to help prevent these conditions, and how to stay fit and healthy and maintain an active lifestyle (McGregor, Murphy, & Reeve, 1992) underscore this need.

In the sections that follow, we focus on key child health behavioral factors that have the potential to impact upon cancer risk later in life. Studies were largely selected from the pediatric published literature from the past 10 years, including behavioral nutrition, exercise and sports science, psychology and behavioral medicine, and health education and promotion. Importantly, studies were selected based upon their potential relevance and impact on cancer prevention and control objectives, as well as some chronic disease prevention and control objectives that overlap with cancer. Cited studies are intended to serve as examples of research in their respective areas, and citations are by no means exhaustive. All studies are illustrative and are intended to highlight potential future directions.

The process of synthesizing the research results was not performed using statistical methods (i.e., meta-analysis). Rather, articles were retrieved, selected, and summarized to illustrate that results from separate, but related fields of study are combinable to yield insights into the prevention and control of cancer and other chronic diseases in adulthood through the conduct of nonintervention and intervention research with children in clinical, public health, and other contexts.

Diet and Nutrition

Prevalence and Burden

Approximately 79% of high school students do not consume the recommended five or more servings per day of fruits and vegetables, and females and white students are among the least likely to consume these foods at this

level (CDC, 2002). With respect to fat, saturated fat, and cholesterol, children older than 2 years are to consume no more than 30% of calories from total fat, less than 10% of calories from saturated fat, and no more than 300 mg per day of cholesterol (USDA & USDHHS, 1995). The recent U.S. Department of Agriculture's Supplemental Children's Survey to the Continuing Survey of Food Intakes by Individuals (USDA, 2000) reveals 68, 75, and 22% of children above these recommended levels, respectively. In light of the fact that persons whose diets are rich in fruits and vegetables have a lower risk of developing a number of cancers, including cancers of the aerodigestive tract, breast, and pancreas (NCI, 2004; Riboli & Norat, 2003), these data underscore the importance of more thoroughly examining behavioral aspects of children's diet and nutrition.

Mechanisms of action explaining why fruit and vegetable consumption is related to decreased cancer risk are the subject of intense scrutiny and debate. One hypothesis is that bioactive plant chemicals such as phenolics and carotenoids that are found in fruits and vegetables act as antioxidants. When consumed in sufficient quantities and combinations, these phytochemicals prevent or slow oxidative stress-inducing and cancer-causing damage to lipids, proteins, and DNA (Liu, 2004). Other epidemiological and meta-analytic research has linked diets high in certain types of fat, particularly saturated fatty acids, to several types of cancer, including colon, prostate, lung, and endometrial cancer (NCI, 2004; Riboli & Norat, 2003), making diet and nutrition top priorities in cancer and chronic disease research. This is reflected in *Healthy People 2010* objectives pertaining to nutritional health in children by targeting fat intake and consumption of fruits, vegetables, and grains (USDHHS, 2000).

Behavioral Risk Factors, Social and Psychological Correlates

Social and psychological factors have been examined in relation to both healthy and unhealthy diet, nutrition, and eating patterns in children (Edmundson et al., 1996). Resnicow et al. (1997) reported on the relationship of self-efficacy, outcome expectations, and skills with fruit and vegetable intake in a sample of over 1,000 third graders; modest correlations among these social cognitive variables and nutrition were observed. Other research has identified that low family connectedness, weight dissatisfaction, and substance abuse are correlates of inadequate fruit and vegetable intake among children (Neumark-Sztainer, Story, Resnik, & Blum, 1996). The researchers speculated that families who are less connected eat fewer meals together, which could contribute to poorer nutrition in children. Additionally, dieting may also result in less healthy food consumption as can health-compromising behaviors such as substance use that might co-occur in youth. Yet another study of social and psychological correlates of fruit and vegetable intake in girls found that preferences, self-efficacy, subjective norms, and skills were significantly associated with intake, suggesting the importance of social and psychological factors as possible determinants of healthy eating behavior.

Interventions

School

The majority of interventions designed to change the dietary habits of normal, healthy children have been school-based, are typically initiated in elementary school and focus on modifying the composition of school lunches or the actual eating patterns of the child. For example, Simons-Morton, Parcel, Baranowski, Forthofer, and O'Hara (1991) set out to promote healthy diet and randomly assigned two elementary schools in Texas to an intervention condition and two schools to a control condition. The intervention consisted of a behaviorally based classroom health education curriculum to enhance children's knowledge and skills and modified the school lunch program. An outcome analysis of the school lunch programs in the intervention conditions revealed that they were significantly lower in fat and sodium relative to baseline and relative to schools in the control condition. Children's individual diets were also affected; those in the intervention condition consumed fewer calories, fat, and sodium than children in the control condition.

In another study, the 5-a-Day Power Plus program was designed to increase fruit and vegetable consumption among elementary school children (Perry et al., 1998). The program was implemented in a racially diverse Minnesota school district (n = 1,600; 48% white). Twenty schools were randomized to either an immediate or a delayed intervention condition. The program consisted of a skill-building and problem-solving behavioral curriculum that included snack preparation and taste testing, parent involvement and education, school food service changes, and industry support. The program was successful at increasing children's consumption of fruit and vegetable servings per 1,000 kilocalories, predominantly at lunchtime. A process evaluation of the program revealed that all of the intervention components were implemented as intended, except for parental involvement (Story et al., 2000).

Another school-based intervention to promote fruit and vegetable consumption in elementary school children was the Gimme 5 program (Baranowski et al., 2000). Gimme 5 was implemented in 16 intervention schools in the southeast; 16 matched schools served as controls. The program consisted of a number of components, including an educational curriculum, skill building, and taste testing. The results indicate that Gimme 5 was successful at increasing children's overall fruit, juice, and vegetable intake by 0.2 servings. The overall magnitude of change was modest, which may have been because of the level of program implementation in the classroom and at home (Davis et al., 2000). A third elementary school program was the High 5 Project, designed to increase fruit and vegetable consumption in fourth and fifth graders (n = 1,600; 83% white) (Reynolds et al., 2000). Relative to children in the control condition, those in the intervention condition consumed more fruits, vegetables, and fruits and vegetables combined for up to 2 years later. Specifically, a greater proportion of children in the intervention condition were consistently more likely to be consuming quantities of fruits and vegetables in line with 5-a-Day guidelines than were children in the control condition. A significant intervention effect was also observed among these children's parents up to 1 year later, such that parents of children in the intervention condition consumed more servings of fruits and fruits and vegetables combined than parents of children in the control condition.

Another strategy that has been proposed in school-based interventions is to train peer educators to deliver nutrition information to their classmates (Story, Lytle, Birnbaum, & Perry, 2002). Birnbaum, Lytle, Story, Perry, and Murray (2002) reported on the results of one study program—the Teens Eating for Energy and Nutrition at School (TEENS). TEENS was designed as a school-based trial to evaluate school, classroom, and family interventions to promote fruit and vegetable consumption and to decrease fat intake among low-income children enrolled in district middle schools in Minnesota (n = 3,500; 69% white). The intervention program consisted of four incremental exposure conditions: control, environment only, environment and curriculum only, and environment, curriculum, and peer education. The results suggested a dose–response relationship, as the condition that included peer education demonstrated the largest treatment effect—on the order of a one full-serving increase in fruit and vegetable consumption.

Perhaps the most recognizable school-based dietary intervention program is the National Heart, Lung, and Blood Institute's Child and Adolescent Trial for Cardiovascular Health (CATCH) (Luepker et al., 1996). Implemented in four sites throughout the United States, CATCH was performed with over 5,000 children. CATCH was successful at modifying the fat content of school lunches and in reducing children's fat intake. Sustained intervention effects have been observed up to 3 years later as evidence by the 31.6% daily energy intake from fat among children in the control condition and the 30.6% daily energy intake from fat among children in the intervention condition (Nader et al., 1999). These and other observed differences in diet are clinically significant as they reflect a reduction in fat at the individual level. CATCH also included physiological study outcomes in the form of blood pressure, cholesterol, and anthropometric measurements, although these outcomes were largely unaffected.

Recognizing that psychological and behavioral factors are important in changing food intake patterns, a number of school-based programs have attempted to better understand and change these factors as well. For example, the CATCH program improved knowledge, dietary intentions, and perceived social support for healthy food choices up to 3 years later (Edmundson et al., 1996). Small-to-moderate effect sizes for knowledge, self-efficacy, and social support were observed at 0.41, 0.27, and 0.45, respectively. Equally impressive results were observed for the High 5 Project, particularly in the areas of children outcome expectancies and knowledge of the Food Guide Pyramid and 5-a-Day servings (Reynolds et al., 2000). A study by Wilson et al. (2002) reported that dietary self-concept and dietary self-efficacy were significantly correlated with fruit and vegetable intake indices among African-American children enrolled in a motivational intervention designed to improve these outcomes; self-concept evidenced a large correlation with fruit and vegetable consumption change scores (r = .67), as did self-efficacy (r = .67–.85).

Health Care

Clinic-based studies have also attempted to effect dietary change among children. The largest and the most well-designed example is the Dietary Intervention Study in Children (DISC) (DISC Collaborative Group, 1995). The DISC was designed to lower dietary intake of fat and cholesterol. Over 600 high-risk children (i.e., those with elevated low-density lipoprotein cholesterol levels) were randomized to either an intervention or a control condition. Children in the intervention condition and their family members met individually and in groups with nutrition, behavior change, and health education

professionals approximately 20 times throughout the first year and several more times afterwards; children in the control condition received usual care (i.e., parents were informed of their children's high-risk status). Compared with children in the control condition, children in the DISC intervention condition had modest but statistically significant decreases in their total and saturated fat and cholesterol levels. For example, levels of low-density lipoprotein cholesterol ("bad" cholesterol) decreased by 15.4 mg/dl in the intervention condition and by 11.9 mg/dl in the control condition. Berg-Smith et al. (1999) subsequently tested and reported on the effect of a brief motivational intervention to maintain these effects on a nonrandomized, uncontrolled subset of DISC intervention children as they transitioned into adolescence. The results suggest that this behavioral technique was acceptable to participants and interventionists and that it holds promise to maintain treatment gains.

Recently, the use of technology has become more widely recognized as a likely aid to dietary behavior change, especially in the health care setting. For example, the Patient-centered Assessment and Counseling for Exercise plus Nutrition (PACE+) program relies upon interactive health communication technology used in the primary health care setting with children (Prochaska, Zabinski, Calfas, Sallis, & Patrick, 2000). The program uses computer software to assess patients' self-reported dietary behaviors, score their responses compared with established guidelines, generate individual profiles, create action/relapse prevention plans, and summarize this information for health care providers. Providers then use this information to make behavioral contracts with their patients. Patrick et al. (2001) reported on using PACE+ technology in a primary care setting and by randomizing children to receive either PACE+ alone or PACE+ and one of three incremental exposure conditions (mail only, mail and infrequent telephone, or mail and frequent telephone). Unlike the TEENS program which also utilized an incremental exposure approach, no dose–response relationship was observed: without extended intervention, the PACE+ program resulted in a 12% reduction in fat consumption and an 18% increase in fruit and vegetable consumption over baseline levels. A more recent analysis of PACE+ data suggests that total energy consumption differed by body mass index, with overweight and at risk of overweight children consuming fewer total calories and grams of fiber per day than normal weight children (Patrick, Norman, et al., 2004). This unexpected finding could be because of underreporting of food intake among heavier children. On balance, these preliminary data are encouraging, but more controlled research is warranted.

Limitations and Recommendations

Promoting adequate fruit and vegetable intake, and reducing fat intake, among children is challenging, and the study of this topic can be limited by a number of factors. First, the reliability and validity of nutrition data can be poor, especially if it is ascertained via food frequency questionnaires. Although clinical assessments, such as 24-hr recall interviews, address this limitation, they may not be useful in school- and community-based studies. Second, children do not consume all of their meals at school, so changing school lunch menus may not translate to other changes in other environments. Third, parents and family members are important determinants in children's eating habits, but school-based programs (which dominate this literature) have not sufficiently incorporated the family environment. Fourth, children are bombarded by advertising and other commercial media that market fast, high-fat foods with low nutritional value. Thus, any intervention that seeks to counteract this influence must be potent at the individual level, but individual interventions may not be feasible in most public health settings.

Despite these limitations, focus groups with children suggest that barriers to better nutrition include perceived lack of availability of fruits and vegetables, lack of variety, and inconsistency in their taste, but attitudes and awareness toward improving diet and parental involvement are favorable/high (Nicklas et al., 1997). Hoelscher, Evans, Parcel, and Kelder (2002) have offered many suggestions for designing effective nutrition interventions for children. Their summary of the literature suggests that programs include a behavioral focus, elements of Social Cognitive Theory, attend to changes in the physical and social environment (i.e., educate parents and family members), provide more hours of education, and use strategies that are appropriately tailored to the developmental capacities of children and relevant to the demographic characteristics of the population under study.

Weight and Physical Activity

Prevalence and Burden

According to the CDC 2001 Youth Risk Behavior Surveillance System, 13.6% of high school students are at risk for becoming overweight based on their body mass index and 10.5% are overweight. With respect to physical

activity, nearly one-third of high school students do not participate in a sufficient amount of vigorous activity regularly (defined as exercising/participating in physical activities for ≥20 min that made them sweat and breathe hard on ≥3 of the past 7 days) or moderate physical activity regularly (defined as participating in physical activities that did not make them sweat or breathe hard for ≥30 min on ≥5 of the past 7 days) to derive health benefit. Not surprisingly, these and other statistics confirm a growing trend in the United States for more children to be at risk for obesity than ever before and for these children to lead more sedentary lifestyles (USDHHS, 1996). In a cohort study of several hundred school-aged children, it was observed that both body mass index and waist circumference increased substantially over time (Rudolf et al., 2004). A recent report by Ogden, Flegal, Carroll, and Johnson (2002) found that from 1988–1994 to 1999–2000, the prevalence of overweight among U.S. children increased significantly—from 11.5 to 15.5% among preadolescents and from 10.5 to 15.5% among adolescents. Consequently, objectives for targeting high levels of obesity and low levels of physical activity are addressed by the *Healthy People 2010* agenda (USDHHS, 2000).

The health consequences of being overweight are significant. Specific to cancer, being overweight among females substantially raises the risk of endometrial cancer and doubles the likelihood of developing breast cancer after menopause (Calle & Thun, 2004; NCI, 2004). Colditz and Frazier (1995) have argued that physical activity promotion among young girls could be an effective breast cancer prevention strategy, as it is hypothesized to delay menarche and reduce the future risk of breast cancer (Apter, 1996). For females living in high-risk families, such as those with known mutations in *BRCA1* and *BRCA2* breast cancer susceptibility genes, these issues take on even greater significance (King, Marks, & Mandell, 2003). In both men and women, having increased body fat, being overweight, and obesity are associated with the risks of developing colorectal cancer and some forms of esophageal and kidney cancers (NCI, 2004). By contrast, participating in physical activity produces many cardiovascular health benefits and is currently being studied regarding its impact on lowering the risk of developing cancers of the colon, the breast, and the prostate (NCI, 2004). Together with diet and nutrition, body weight and physical activity constitute one's "energy balance." Low body weight and high physical activity have been associated with lower cancer rates (Michels, 2005). As overweight and obesity track over time, and participation in physical activity tends to decrease as children get older, childhood remains a critical window for this aspect of cancer and chronic disease prevention and control.

There are several possible biological mechanisms of action that may contribute to the obesity–cancer risk relationship in adulthood. One focus is on obesity's relationship to levels of certain circulating hormones, including insulin, insulin-like growth factors, their binding proteins, and role in cancer expression. These may affect the development and progression of certain cancer types largely through their impact upon sex steroids (Calle & Thun, 2004). Reducing one's caloric intake decreases harmful tumor properties, possibly through changed metabolism and DNA damage and repair (Calle & Thun, 2004).

Behavioral Risk Factors, Social and Psychological Correlates

A comprehensive review by Sallis, Prochaska, and Taylor (2000) suggested that a consistent set of demographic, social, and behavioral variables are positively related to increased physical activity. Although these sets differ for preadolescents (≤12 years of age) and adolescents (≥13 years of age), some consistencies emerged. For example, boys are consistently more active than girls, children with higher intentions to be physically active are more active than those with lower intentions, and previous physical activity level is steadily related to current activity. Saunders et al. (1997) examined the relationship between social influences (e.g., family member or friend co-participating in physical activity and seeking support for physical activity, overcoming barriers to physical activity, creating ways to incorporate physical activity in the face of challenges with intention to engage in physical activity) and actual physical activity levels in a sample of over 400 fifth graders. The data suggest that social influences were positively associated with intention and actual engagement with physical activity, whereas support, barriers, and challenges more consistently associated with intention than actual physical activity levels. Other work suggests that children who use their time in the afternoon for physical activity (vs. watching television and other sedentary pursuits), those who enjoy physical education, and those who receive support from their family members for physical activity (e.g., verbal encouragement, providing transportation) are more active (Sallis, Prochaska, Taylor, Hill, & Geraci, 1999). In another study, Strauss,Rodzilsky, Burack, and Colin (2001) showed that there is a decline in children's physical activity levels between ages 10 and 16 years, and that this decline is rather well pronounced in girls.

Furthermore, higher self-efficacy and greater support and encouragement from family members and friends were positively associated with physical activity.

Interventions

In 2002, Campbell, Waters, O'Meara, Kelly, and Summerbell performed a comprehensive review of obesity prevention programs for children. In the review, they concluded that very limited data exist from high caliber studies on the most effective ways to prevent obesity. Encouraging a reduction in sedentary behaviors and increasing physical activity were singled out as likely avenues of exploration that could result in favorable outcomes. Jago and Baranowski (2004) also performed a review on ways to promote physical activity in children that do not rely upon school physical education. Those authors concluded that school vacations are optimal times to promote children's physical activity levels, especially through existing youth- and community-based organizations and day camps. Thus, the following studies are reviewed with these comments and suggestions in mind.

School and Community

The CDC, National Center for Chronic Disease Prevention and Health Promotion (1997) have offered 10 key recommendations to encourage physical activity and reduce overweight in children. Among the recommendations made are that schools and communities establish policies that promote enjoyable physical activity, implement physical education curricula, sponsor extracurricular physical activity programs, and provide community sports and recreation programs that are attractive to children.

In keeping with these recommendations, the CDC have developed the VERB campaign. VERB is a national, multicultural social marketing media campaign designed to promote healthier lifestyles and encourage physical activity among 9- to 13-year olds with the support of parents, other adults, and community efforts (CDC, 2002). VERB portrays physical activity as desirable, fun, and socially appealing to children; advertisements are aimed at parents as well. Although outcome data on the success of the VERB campaign have not yet been released, baseline data suggest that there is much room for improvement in children's levels of participation in organized sports and other physical activities (CDC, 2002).

Perhaps one of the largest school-based trials of physical activity promotion among healthy children is CATCH (described above; Luepker et al., 1996). CATCH demonstrated that the intervention was successful at increasing the intensity of physical activity during physical education classes and that students in the intervention condition reported engaging in approximately 12 more minutes of vigorous physical activity daily than students in the control condition. This trend was also maintained across time (Nader et al., 1999). In the study by Simons-Morton et al. (1991) described above, the Go For Health program specifically targeted improvements in vigorous physical education among elementary school children. That study showed a significant increase in the percent of time children engaged in moderate-to-vigorous physical activity during physical education classes in intervention schools.

Resnicow and Robinson (1997) performed a comprehensive review of the literature on 16 school-based cardiovascular disease prevention program outcomes for children, including the outcome of physical activity. Their study results suggest that the magnitude of intervention effect for physical activity was relatively lower when compared with other outcomes such as smoking, cognitions, fitness, diet, and lipids. Gortmaker, Peterson, et al. (1999) reported on the impact of their Planet Health intervention for youth. In that study, 10 Massachusetts public schools serving children in grades 6–7 were randomized to either an intervention or a control condition. The intervention condition included in-service teacher workshops, classroom lesson plans (i.e., teacher resources, student behavioral and learning objectives, classroom and homework activities, and handouts), physical education materials, and funds for wellness and fitness. Although Planet Health was found to be effective in reducing the prevalence of obesity in girls, it was not effective for either boys or girls in changing their physical activity levels. Television watching (an index of sedentary behavior) was also reduced. In another study, Gortmaker, Cheung, et al. (1999) reported on the impact of their Eat Well and Keep Moving intervention for youth which also failed to demonstrate a significant impact on schoolchildren's physical activity levels. And finally, a recent report on a school-based intervention to reduce body fat and other outcomes in children found little impact on weight (McMurray et al., 2002). Although many limitations may have contributed to these studies' overall lack of finding, they nevertheless underscore the point of Resnicow and Robinson (1997) regarding the challenges posed by school and community approaches to effect change in physical activity and weight. One exception is a recent study by McKenzie et al. (2004), which sought to increase physical activity among middle schoolers (n = 25,000; 55% white) during

their physical education classes. The intervention resulted in significant improvements in students' physical activity levels during class (approximately 3 min per lesson); larger effects were observed for boys than for girls. Over time, such changes in physical activity levels may positively impact weight, cancer and obesity risks, and overall health and wellbeing.

Health Care

Health care has been another popular source of physical activity and weight intervention programs for children, although much of this research is still at an early stage. Evidence is emerging to suggest that brief patient education and counseling by a health care provider can produce beneficial short-term effects on patient physical activity levels (Ockene, McBride, Sallis, Bonollo, & Ockene, 1997; Sallis et al. 2000). For example, the PACE+ program (described previously; Patrick et al., 2001) was designed with promoting physical activity change for children seen in the primary care setting; both moderate and vigorous physical activity were targeted. PACE+ was shown effective for moderate (which increased by 17% over baseline) but not vigorous physical activity (which increased 10% over baseline) which failed to reach statistical significance. However, the preliminary data are encouraging.

Family

There has been a lack of family-based weight maintenance and physical activity promotion interventions for healthy children. Many interventions are for families of those who are overweight or obese rather than those who are normal weight but may be at risk of overweight. As such, their applicability to healthy children is limited. Nevertheless, those interventions provide promising and insightful data into the important role that family integration plays in addressing children's weight and physical activity. One such program incorporates a range of behavior change strategies, including self-monitoring, social reinforcement, stimulus control, and modeling and social skills strategies, along with health education. The program's goal is to affect the family environment, parenting styles, and other contributory factors to eating and physical activity in obese children (Epstein, 1996). A series of well-controlled studies suggest that the involvement of a parent is central to this type of program's success and that increasing physical activity is key to weight maintenance over time. In a recent review, Wing (2003) concluded that family-based programs to treat overweight in childhood are among the most effective approaches to preventing overweight in adulthood.

Limitations and Recommendations

It is clear that despite our high level of knowledge about the prevalence of overweight and physical inactivity in American children, these facts have yet to fully compel the public healthy community to develop and evaluate comprehensive prevention and intervention programs. Large-scale efforts such as the CDC's VERB campaign are impressive, given their far and wide reach; yet, the evaluation components of school and community interventions are complex. Oftentimes, such efforts require school- and community-based assessment and outcomes, rather than relying on individual reporting and behavior change. Truly comprehensive programs will embrace both approaches and seek to integrate other aspects of children's lives such as health care and the family. Each of these areas shows promise in their potential to effect behavior change, which ultimately should impact on the nation's cancer and chronic disease prevalence.

With respect to improving the treatment of overweight children, Epstein, Myers, Raynor, and Saelens (1998) suggested many areas of focus for future research, including the need for a deeper understanding of behavioral principles, understanding how and why some children choose to be active or sedentary, individualizing treatments, and addressing comorbidity (e.g., hypertension and insulin resistance). Recent reviews by Campbell et al. (2002) and by Jago and Baranowski (2004) are also reminders of the importance of performing randomized controlled trials to investigate weight and physical activity outcomes in children, and the benefits of linking children with existing community-based resources to increase children's physical activity levels. Promising new data that are still coming to light on the role of genes and other biological factors in maintaining one's energy balance could prove essential and lead to breakthroughs in this area. However, distinctions must be drawn with respect to interventions conducted with overweight and obese children (clinical populations) and those who are normal weight (nonclinical populations). While one may guide and inform the development of the other, it is not to say that these approaches are interchangeable or universally applicable. Rather, developing a better understanding of the behavioral epidemiology of correlates of weight and physical activity within specific populations of interest and then applying those findings to intervention studies performed with those populations would likely be more effective. Open questions exist, for example, whether the incorporation of family-based weight maintenance and physical activity promotion interventions designed for nonclinical

populations might be as effective as they appear to be in clinical populations.

Conclusion

As supported by this review, there are numerous reasons, opportunities, and approaches to impact behavior change in children's diet and nutrition and weight and physical activity. While several of these approaches may be successful in the short-term, more work must be carried out to determine their effect over time. Among the most pressing, yet unanswered, questions relate to tracking of children's cancer risk behaviors into adulthood and how changes in behavior early in life impact change on biological markers of cancer risk. These, in turn, should be related to distal cancer risks and the development of cancer itself.

Just as cancer is determined by multiple influences, so too are the behaviors that underlie risk. The nonintervention studies and interventions examined herein speak to this fact by suggesting that change must occur at multiple levels of influence. Comprehensive cancer and chronic disease prevention and control efforts should reach out to children at home, at school, in their communities, and within the health care and other systems with which they interact. They must be developmentally appropriate and reach a wide audience. To the extent that these efforts are guided and informed by behavioral research with and for children, we may sooner realize our public health goals of eradicating cancer and preventing and controlling chronic disease.

For the field of child health psychology, these findings underscore both a mandate and an opportunity to meet that mandate through behavioral research. Doing so requires greater recognition of our potential contributions to public health through cancer and chronic disease prevention and control research (Fuemmeler, 2004). Although the fields of behavioral medicine and health psychology are dominated by nonintervention studies, those studies are informative as they provide insights into social and behavioral factors that promote the maintenance of healthy and unhealthy behaviors (Sallis, Owen, & Fotheringham, 2000; Tercyak et al., in press). Furthermore, heath promotion initiatives ultimately rely upon behavior change at the individual level for population impact and depend on biobehavioral research findings at all phases of maturity. Our focus on children makes a unique and important contribution to understanding how and why behaviors originate, are maintained, and change over time—into adolescence, young adulthood, and beyond—and how they impact health. Many of the health behavior and health education theories that guide public health research are not readily translatable to children. Developmental adaptations of concepts and models are necessary to better effect change across multiple levels of influence (i.e., school and community, health care, and family) (Black, 2002). In a similar fashion, it is becoming increasingly recognized that behaviors impacting on health do not occur in isolation and that changing more than one behavior at a time may be necessary to adequately impact cancer, obesity, and other chronic diseases (Orleans, Gruman, Ulmer, Emont, & Hollendonner, 1999). With its longstanding interest in children's physical and behavioral functioning, health promotion, and chronic diseases, an increased focus on prevention in child health psychology research and practice is warranted.

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