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Development of Physical Activity Behaviors Among Children and Adolescents

Harold W. Kohl III, PhD*, and Karen E. Hobbs, MPH‡

ABSTRACT. Physical activity is a key component of energy balance and is promoted in children and adolescents as a lifelong positive health behavior. Understanding the potential behavioral determinants necessitates understanding influences from three fundamental areas: 1) physiologic and developmental factors, 2) environmental factors, and 3) psychological, social, and demographic factors. The literature to date has generally investigated potential predictors of physical activity in children and adolescents in each of these three general areas, although existing data rely largely on cross-sectional studies in which it is difficult to distinguish a determinant from a correlate. In all likelihood, aspects of each of these three areas interact in a multidimensional way to influence physical activity in youth. This article reviews evidence of potential determinants of physical activity in children and adolescents and provides recommendations for future work. *Pediatrics* 1998;101:549-554; youth, exercise, tracking, determinants.

ABBREVIATION. NCYFS, National Children and Youth Fitness Study.

As indicated elsewhere in this article,¹ childhood obesity and overweight is of substantial clinical and public health concern. Physical activity is a key component of the expenditure aspect of energy balance, providing a major outlet for daily caloric usage. Cross-sectional observational and experimental intervention data suggest a significant short-term influence of exercise training on weight loss in children and adolescents,² although prospective observational studies designed to determine the role of physical activity in the prevention of weight gain are lacking. It logically follows that an understanding of the determinants of physical activity behavior in children and adolescents will lead to future opportunities for intervention and prevention of obesity and overweight.

Physical activity is to be encouraged among children and adolescents based largely on the assumption that the behavior will become part of the person's life and carry into adulthood, where it will help lower the risk of several chronic diseases as well as of premature mortality.³ The underlying assumption is that there will be a positive experience in childhood or adolescence and the behavior then will track into adulthood, when it is more likely to provide physiologic benefits. Although several lines of investigation point to evidence of tracking of other cardiovascular disease risk factors, such as serum total cholesterol and systolic blood pressure,⁴ data supporting the tracking of physical activity behaviors into adulthood are scarce. Given current difficulties in accurate assessment of physical activity among children and adolescents,⁵ the lack of evidence for tracking physical activity may be a problem of assessment as much as it is one of tracking. Moreover, physical inactivity may be a better indicator of long-term behavior. Of additional and substantial clinical interest is evidence of a potential covariance (or ctracking) of physical activity with obesity from childhood into adulthood, although such data are similarly lacking.

The terms physical activity and exercise are related but refer to different constructs. For the purposes of this report, we adopt the definitions of physical activity and exercise outlined by Caspersen et al.⁶ Physical activity is any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above the basal level. Exercise refers to a planned, structured, and repetitive bodily movement done specifically to improve or maintain one or more components of physical fitness. Exercise is considered a subset of physical activity.

Should there be short-term health effects of physical activity in children, they most likely would be for an influence on weight loss and control. In adults, regular physical activity is associated with weight loss and maintenance. However, the relationship is more complicated in children and adolescents in that it is difficult to separate training effects (the physiologic effects of increased physical activity) on adi-

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pose tissue from expected changes attributable to growth and maturation, especially in the peripubertal years.⁷ Moreover, data on effects of physical activity on adipose tissue in children and adolescents are lacking.

Although there are no accurate data on temporal trends in physical activity participation, attempts have been made to quantify age-related changes across childhood and into adolescence.⁸ Data from national surveys in the United States and Canada^{9,10} as well as from smaller studies^{8,11} suggest a remarkable downward trend in the prevalence of participation in physical activity with increasingly older children. Sallis⁸ estimated that depending on the type of physical activity assessment methodology used, there could be between 1.8% and 2.7% per year decline in reported physical activity among boys between 10 and 17 years old. Estimated declines for girls were much more severe, ranging from 2.6% to 7.4% per year, depending on the method used to assess activity.

The potential for physical activity behaviors that are learned in childhood to carry through to adulthood and positively affect health, coupled with the age-related declines in physical activity from childhood to adolescence (especially in girls), makes for a critical need for understanding the predictors, antecedents, and determinants of such behaviors. Ideally, given a set of such determinants, a child or group of children could be identified accurately as a candidate or target for intervention. Unfortunately, instead of examining predictors of physical activity behavior, the current literature deals mostly with correlates of behavior. The cross-sectional nature of existing data necessitates that assumptions be made that characteristics occurring with the presence or absence of the behavior are actually predictors and not consequences or results. In addition, as has been addressed elsewhere in more comprehensive reviews,^{12,13} it is likely that physical activity behavior is influenced or caused by a constellation of determinants and their interactions instead of a single factor acting alone.

Potential determinants of physical activity in childhood and adolescence that have been theorized or investigated are listed in the Table. The remainder of this article highlights these areas and summarizes key issues and what is known about each.

REVIEW

Physiologic and Developmental Factors

Much of the literature on the relationship between factors of growth and maturation and physical activity has focused on the role of physical activity in affecting these parameters instead of on the role of these parameters as determinants of activity. Taken as a whole, these studies suggest that physical activity has positive effects on growth and maturation in children.⁷ Higher scores on motor, strength, and cardiovascular fitness tests are generally observed among active children compared with their inactive peers.⁷ Whether these factors are causes or consequences of the increased activity is unclear. It has

TABLE. Potential Determinants of Physical Activity Behaviors Among Children and Adolescents

Physiologic/developmental
Growth and maturation
Physical fitness
Physical limitations
Environmental
Facilities/equipment access
Competing attentions
Seasonality
Safety
Psychological, social, and demographic
Self-efficacy
Knowledge, attitudes
Parental influences
Role modeling
Peer influences
Education/socioeconomic status
Gender
Age

been hypothesized that children are spontaneously active, and it could necessarily follow that activities of more difficulty will be practiced as muscular and skeletal and cognitive function improves to meet the demand.

Perhaps the most evident biological correlate of physical activity behavior is gender. Gender differences in physical activity participation exist, with recent data suggesting that fifth-grade boys are nearly twice as active as girls in moderate-to-vigorous or vigorous physical activities.¹⁴ Possible mechanisms for greater physical activity participation in boys may be related to differential development of motor skills,¹⁵ differences in body composition during growth and maturation,¹⁶ and greater socialization toward sports and physical activity.¹⁷ As with other determinants, the true answer underlying the gender differences in physical activity participation probably lies in an interaction among factors.

Cardiorespiratory fitness (aerobic capacity) may be a potent determinant of physical activity behavior in that participation in physical activity may increase to meet the physical capacity of the child. Cross-sectionally, nationally representative data suggest only low to modest linear associations between various measures of physical activity participation and estimated aerobic capacity.¹⁸ However, exercise training studies suggest that aerobic power responds to increased physical activity, especially during the peripubertal years.⁷ Moreover, aerobic power relative to body mass without training remains stable from ages 6 to 16 for boys, but for girls it declines about 2% per year.⁸ So although it appears reasonable to expect that aerobic capacity could be a determinant, data are lacking and temporality (activity preceding fitness or fitness preceding activity) is a major challenge in this understanding.

Physical health status is likely a powerful determinant of physical activity behavior among children and adolescents. Although disabled youths are less likely to be physically active than their able-bodied peers, there is a variety of physical disabilities (both in type and manifestation) that makes this group a very heterogeneous one.

Although it is important to understand the poten-

tial for physiologic and biological factors as determinants for physical activity behavior in children and adolescents, it is difficult to design intervention programs to alter many of these characteristics. Many such characteristics are nonmodifiable (gender, genetic influences on physiologic characteristics) or are uncontrollable (biological maturation). More data are needed in these areas so that potential at-risk populations and groups can be identified and subsequent intervention designs that are more appropriate for these target populations can be developed and implemented.

Environmental Factors

Nearly all children attend school; therefore, the school can play a significant role in increasing their physical activity levels and habits. According to the National Children and Youth Fitness Study (NCYFS) II,⁹ virtually all first- through fourth-grade children (97%) are enrolled in physical education programs. They take physical education an average of 3.1 times weekly, and 36.4% take classes daily. Data from the NCYFS I¹⁹ indicated the same enrollment for grades 5 and 6 (97%), but rates of enrollment decline with each successive grade. The lowest rates of enrollment are for grades 11 and 12. Girls in grade 12 have the lowest rate overall (48.5%). The biggest drops in enrollment come in grades 8 through 11. Overall only 36% of children/youth participate in physical education class on a daily basis, and <30% of class time is spent in actual physical activity. For first-through fourth-grade children, the frequency with which schools conduct physical education classes is related inversely to the amount of time children are given for recess. This suggests that schools may use recess to substitute for, rather than supplement, physical education. Additionally, 76% of children never see a classroom teacher for physical education, which causes concern that many schools do not make the investment needed to hire certified physical education specialists; increasingly, schools are eliminating physical education programs instead of developing or improving them. Attention to these issues can have a significant effect on children's physical activity levels, as evidenced by results from the Child and Adolescent Trial for Cardiovascular Health. In an experimental program designed to modify and improve existing physical education classes, the Child and Adolescent Trial for Cardiovascular Health increased students' moderate to vigorous physical activity in class from 37.4% at baseline to 51.9%.²⁰ The major intervention components included a modification of existing physical education curricula and materials, teacher training, and on-site consultation to teachers. These results provide evidence that with proper training and support, modification of the school environment can affect the activity levels of children and adolescents substantially. Sports programs also can provide opportunity for physical activity; in fact, most children's physical activity takes place in organized programs outside of school.²¹ Unfortunately, many of these programs are directed toward elite athletes and involve only a minority of the youth population. Improving the school physical

education programs and involving more than elite athletes in sports programs can play a pivotal role in increasing physical activity levels of children and adolescents.

One of the frequently cited determinants of children's physical activity levels, often in the context of social criticism, is the amount of time spent by children watching television and playing video games. Children's hours of television-viewing per week have not been shown specifically to be associated with decreased levels of physical activity,²²⁻²⁵ but viewing hours certainly reduce the opportunity to be active. The amount of television-viewing has been shown to be a strong predictor of obesity in children; in fact, each hourly increment of television-viewing by adolescents has been associated with a 2% increase in the prevalence of obesity.²⁶ Little is known about the way television-viewing affects energy balance. It may be related to increased opportunity for dietary intake, lower metabolic rate, less physical activity, or, most likely, a combination of these factors. Taras et al²² reported that time spent viewing television correlated positively with children's requests for and parents' purchase of foods influenced by television and also positively correlated with children's dietary intake. Klesges et al²⁷ reported that television-viewing decreased resting energy expenditures acutely in both normal-weight and obese children, identifying a metabolic mechanism for the relationship between television-viewing and obesity. Although it has not been shown that decreased physical activity levels are associated with television-viewing, it has been shown that percentage of time spent outdoors is strongly related to physical activity.^{28,29} Because television-viewing reduces the opportunity to be outdoors, it follows that it also reduces the opportunity for physical activity. Recent data have suggested a significant difference between boys and girls in the fifth grade in amount of time spent watching television, indicating a possible focus for intervention efforts.¹⁴

Seasonal and geographic influences likely play a large role in determining physical activity behaviors. According to data from the NCYFS, activity levels are highest in summer, drop in fall, reach the lowest point in winter, and increase again in spring.²¹ Geographic variation in physical activity is not available, but it has been shown that children and adolescents are less active in winter than in other seasons.²¹ It logically follows that children who reside in cities and towns with milder winters can be more active. Data from NCYFS (8- to 9-year-old children) suggest a weak but significant correlation between two health-related fitness measures (aerobic capacity and body fatness) and whether the child resides in a warm climate.¹⁸ Children also are reportedly more active on weekends than during the week.³⁰ Additionally, percentage of time spent outdoors is strongly related to physical activity.^{23,28,29}

Given that time outdoors is strongly related to physical activity, an increasingly important environmental determinant of physical activity is the physical safety of the surroundings and environment. Lack of safety among children and adolescents is an

escalating problem. The Youth Risk Behavior Surveillance System³¹ reports that nationwide, 4.4% of students missed at least 1 day of school during the preceding 30 days because they felt unsafe at school or unsafe traveling to or from school; 41.8% of students nationwide had been in a physical fight within the past 12 months, and 4% had been treated by a nurse or physician for injuries sustained in a physical fight; 32.7% of students had property such as a car, clothing, or books stolen or damaged deliberately. These factors can likely reduce motivation or be actual barriers to physical activity, either by parental decision or control or by the children themselves.

Psychological, Social, and Demographic Factors

Most of the work in attempts to understand determinants of health behaviors in humans, including adults, has necessarily focused on psychological and social factors. Indeed, several key theoretical models have been proposed as ways to understand and explain health behaviors, such as tobacco use, unsafe sexual practices, other risk-taking behaviors, preventive health screening, a heart-healthy diet, and physical activity.^{3,32-35} Each of these theoretical models has sought to explain health behaviors as being a result of the interaction of a constellation of factors. (A complete review of each of these theoretical models of health behavior is beyond the scope of this article.)

Self-efficacy refers to the confidence an individual has to change or maintain a certain action or behavior³⁶ and is the key to several theoretical health-behavior models. Self-efficacy is closely linked to the concept of intentions in helping explain health behaviors in that it is not sufficient for an individual to intend, or want, to become more physically active. That individual must also believe that he or she has the capabilities to do so. Self-efficacy has been shown not only to correlate with physical activity behavior but actually to predict weekly physical activity participation among school-based adolescents 4 months after the baseline measurements.³⁷

Closely linked to self-efficacy of health behavior change are personal beliefs about health behaviors. Health beliefs include perceived benefits and risks to undertaking the behavior as well as perceived barriers that may be impeding the behavior. Perceived barriers such as lack of time, lack of interest or desire, unfavorable weather, or access to equipment and facilities are potential determinants of physical activity behavior in children and adolescents. Moreover, such barriers, if identified as predicting behavior, can provide the basis for tangible and targeted intervention strategies. The few data that do exist on the correlation of perceived barriers with exercise behavior in adolescents do not appear to strongly differentiate between those who are active and those who are inactive,³⁸ although this may be a function of measurement variance.

Attitudes and knowledge are two additional constructs that have been investigated as potential determinants of physical activity. Measurement scales for children's attitudes toward physical activity have been produced.³⁹ It is generally thought that children will participate in physical activities for which they

hold a positive attitude. One study reported substantial and significant correlation between reported attitudes toward physical activity and reports of the behavior,³⁹ although results have been inconsistent.⁴⁰ The role of attitudes in determining physical activity behavior deserves more attention.

Much as with other formative influences on childhood behavior, parents appear to be a strong influence on physical activity behavior. The mechanisms can be either direct (by providing a supportive, nurturing environment), indirect (through modeling), or, more likely, an interaction of the two. Additionally, it has been hypothesized that there could be a significant genetic transmission of factors that predispose the child to increased levels of physical activity.⁴¹ Children whose parents are physically active have been reported to be nearly 6 times as likely to be active than children whose parents are both inactive,⁴² and there appears to be reasonable evidence of a dose-response between number of active parents (0, 1, 2) and activity levels of children.⁴³ Timing of such influences may be a crucial issue in that there could be a stronger association between parental and child behaviors than between parental and adolescent behaviors.⁴⁴ It has also been reported that parental activity may be more highly correlated with frequency of exercise among girls than among boys.⁴⁵

In addition to parental influences, possible other social influences on physical activity behavior among children and adolescents include peer pressure and other role modeling (professional athletes, for example). Peer influences for physical activity behavior among adolescents may actually replace the substantial parental influences observed in younger children. In a study of adolescents, influences of a best friend were more highly associated with physical activity behavior than influences of parents.⁴⁶ Peer influences also appear to be quite important with respect to participation in organized sports,⁴⁷ a large and growing source of physical activity among children and adolescents. Moreover, such peer influences may be more available to boys than to girls, thus pushing boys to be more active than girls. This may help to explain the much more rapid decline in physical activity participation among girls as they move into adolescence.

Educational attainment and socioeconomic status are correlates of physical activity among adults.³ Although educational attainment is somewhat homogeneous in studies of children and adolescents, socioeconomic status may vary substantially. Gottlieb and Chen⁴⁵ reported a direct relationship between father's occupation and physical activity among seventh- and eighth-grade students. Moreover, there appear to be clear ethnic differences in frequencies of reported activities, with Anglo students more likely to report participation in individual (noncompetitive-type) activities than African-American or Mexican-American children. African-American children were more likely to report participation in competitive team sports. More of an understanding of socio-cultural correlates of physical activity among youth is an important goal.

SUMMARY

A variety of factors are potential determinants of physical activity behaviors in children and adolescents. Physiologic, environmental, and psychosocial/sociodemographic factors play a role in influencing physical activity behaviors for children and adolescents. In all likelihood, these factors interact in various forms to potentially "cause" a physical activity behavior in children and adolescents. For the most part, few data are available on such factors as true predictors. Rather, correlates are reported in the literature. We suggest that interventions that target environmental and psychosocial determinants of physical activity behavior may have a greater chance of success than those targeted toward biological and physiologic factors, many of which are unmodifiable. Much more work is necessary to help to establish the temporality of potential determinants as antecedents to development of the behavior.

One likely reason for lack of data and weak associations in physical activity behavior determinants research is the difficulty in accurate assessment of physical activity, especially among children and adolescents. Many methods exist and there is a lack of consistency across methods. Self-report, the most popular format for assessment in large groups of study participants, is extremely difficult with children and adolescents; it is especially not recommended in children younger than 10 years of age. Physical activity assessment methodologies used for children and adolescents and their associated validity and repeatability data have been recently reviewed elsewhere.⁴⁸ In general, most methods used among children and adolescents have a reasonably high repeatability but a low to modest validity. Further progress in understanding determinants of physical activity behavior will occur more rapidly when more accurate and consistent methods of physical activity assessment are used.

Largely because of the inertia of tradition, research investigating determinants of physical activity behavior has occurred largely without a concomitant study of the determinants of dietary intake behaviors and vice versa. If a better understanding of the causes and treatment of childhood and adolescent obesity and overweight is to be achieved, research efforts must focus more on an integrated approach to the study of determinants of energy balance. Such an approach would ideally treat behavioral and developmental influences of both intake and activity behaviors simultaneously instead of separately. More work in this area is urgently needed.

CONCLUSIONS

Three fundamental conclusions and areas for additional research are indicated from this brief review. Information on determinants of physical activity in childhood and adolescence relies largely on data from cross-sectional studies. Although useful, this type of study design does not allow for adequate treatment of temporality between a potential determinant and a desired outcome. For a true assessment of the role of physical activity determinants (predic-

tors), more longitudinal studies must be conducted that evaluate a set of potential determinants as they relate to physical activity at some future point.

Further, studies of determinants have focused largely on univariate relationships between a single determinant and the behavior, whereas determinants of behaviors, including physical activity, are likely complex interrelationships among several factors. New studies, and analyses of existing data sets, should assess not only the relationships between the potential determinants and the behavior but also the relationships among the determinants as well as a multivariable approach to build the most useful prediction models.

Much of our lack understanding of determinants of physical activity in children and adolescents is related to a lack of understanding of accurate ways to measure physical activity. Without an accurate assessment of the outcome of interest, studies of predictors of that outcome are at risk of showing null results, even if a real association exists. More work must be done in development and validation of methods of physical activity assessment for children and adolescents.

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Treatment of Pediatric Obesity

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ABSTRACT. The primary goal of childhood obesity interventions is regulation of body weight and fat with adequate nutrition for growth and development. Ideally, these interventions are associated with positive changes in the physiologic and psychological sequelae of obesity. To contribute to long-term weight maintenance, interventions should modify eating and exercise behaviors such that new, healthier behaviors develop and replace unhealthy behaviors, thereby allowing healthier behaviors to persist throughout development and into adulthood. This overview of pediatric obesity treatment, using predominantly randomized, controlled studies, highlights important contributions and developments in primarily dietary, activity, and behavior change interventions, and identifies characteristics of successful treatment and maintenance interventions. Potential pos-

itive (eg, reduction in blood pressure, serum lipids, and insulin resistance) and negative (eg, development of disordered eating patterns) side effects of treatment also are described. Recommendations for improving implementation of childhood obesity treatments, including application of behavioral choice theory, improving knowledge of response extinction and recovery in regards to behavior relapse, individualization of treatment, and integration of basic science with clinical outcome research, are discussed. *Pediatrics* 1998;101:554-570; *pediatric obesity, treatment, weight maintenance*.

ABBREVIATIONS. BMI, body mass index; PSMF, protein-sparing modified fast; HDL, high-density lipoprotein.

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There has been a lot of interest in developing effective treatments for obesity, with the overwhelming majority of this research focused on treating adults. A salient characteristic of the adult obesity treatment is that although obese adults can

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