Obesity in children—the importance of physical activity

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Abstract The focus of this paper is the role of energy output, i.e. physical activity, in the prevention and management of childhood obesity. However, this does not mean that the other side of the energy balance equation, food intake, is not important. An excess fat gain is the result of an imbalance between energy intake (food) and energy output (physical activity). There is evidence that physical activity is declining for the whole population, including children, and that this decline is a major factor in the increasing prevalence of obesity. Many childhood leisure activities, including viewing television, increase sedentaryness. Active time may be limited by safety concerns, lack of suitable environments and lack of family time. There is little scientific evidence on the role of increasing physical activity in the management of childhood obesity. The intuitive and practical advantages of increasing physical activity are a counterbalance to food-related issues. Healthy eating (as outlined in the national dietary guidelines) remains important but does not become the only focus for family change. Additionally, increasing physical activity allows children to grow into their weight and an improvement in the metabolic (lipid, insulin) status of obese children. Physical activity in children has genetic, environmental and behavioural components. Genes influence spontaneous physical activity and also muscle fibre type and nutrient partitioning (how the body selects which fuel to burn—fat or carbohydrate). Space, access and appropriate types of play are vital. Children model behaviours on parental behaviours and the family activity philosophy is an important one, just as are the family’s food beliefs and eating. Thus any proposed change in physical activity must take these three components into account. Maintaining a healthy level of physical activity in childhood has a number of potential advantages, including the initiation of a lifelong habit and improvement in physical skills and achievement, which in turn support the activity habit. Evidence for a decline in physical activity in populations, in an environment that is becoming more and more supportive of inactivity, is presented. This inactivity increases the risk of obesity. Lifestyle activity or the activity of day-to-day living is very important for overall energy expenditure in children. Families influence childhood physical activity patterns in a number of interconnecting ways. (Aust J Nutr Diet 2001;58 Suppl 1:S28–S32)

Introduction

The importance of physical activity may refer to the management of childhood obesity and/or the prevention of obesity. The two are not exclusive concepts and both are addressed in the following discussion.

The definition of obesity and overweight in children

The definitions of overweight and obesity are not simple in children for two reasons—children change height, weight and body composition with physical growth and development, and the comorbidities (complications of obesity) on which the definitions of adult obesity are based, do not appear consistently in childhood. In practical terms this means that the actual body mass index (BMI) in childhood is lower than in adults and that each BMI must be interpreted in light of the age and gender of the child. For this reason BMI values are often quoted as a percentile (1) or as a standard deviation score. The latter numerically states how far from zero (50th percentile) is the child’s BMI. Recently published is a large international data set of BMI cutpoints for children and adolescents from two to 18 years which pass through BMI of 18.5, 25 and 30 for adults—relating childhood obesity to adult obesity in a clinically useful manner (2).

Unfortunately, there is no repetitive Australian sampling of heights and weights for children and adolescents. On available and recent data (including the ‘Health of young Victorians’ survey) (3), 25 to 30% of Australian primary school children and adolescents are overweight. This paper generally refers to primary school-aged children, but also to adolescents where relevant and when data are available. There is evidence that falling levels of physical activity in the adult population contribute significantly to the increase in prevalence of obesity, and it is not unreasonable to infer a similar happening in children.

Energy expenditure in childhood

The major component of energy expenditure is the resting metabolic rate (RMR). There is a contribution from the thermic effect of food, and in children 1 to 2% of daily energy expenditure is accounted for by growth (3–4% in adolescents). Physical activity is the one component of energy expenditure which is variable and discretionary. The doubly-labelled water (DLW) technique, a safe but expensive way to measure total (daily) energy expenditure, has considerably increased our knowledge of energy expenditure in children. Our group has shown in 6– to 8-year-olds that current dietary recommendations overestimate total (daily) energy expenditure by approximately 11% (4). This figure has been found to be even higher in younger children (5). The DLW technique, combined with a measure of RMR can be used to calculate the physical activity component of energy expenditure.

What is meant by physical activity?

Physical activity encompasses many concepts but is basically the state of not being sedentary or asleap. Physical activity can be the activity of day-to-day living (incidental or lifestyle) or planned, which includes more formal sporting activities. It can be of aerobic or resistance type and will vary in duration and intensity. A child’s develop-
mental stage governs physical activity type, as will the presence of physical limitation, family beliefs and the surrounding environment. The concept of sedentary behaviour is important as will be seen later when therapeutic approaches are discussed. Wriggling or spontaneous physical activity, a physical activity in children discouraged by adults, may need to be revisited and perhaps even encouraged (6).

The measurement of physical activity presents difficulties and many modalities have been used, ranging from self (parental) report, direct observation, heart rate and motion monitors (accelerometers) to the DLW/RMR technique, and also encompassing even less direct measures such as fitness, skills, flexibility and power testing.

Generally speaking, any physical movement will expend energy; most physical movement can be modified so that more is expended; and ceasing being sedentary implies physical activity. Children are not adults either physiologically or behaviourally, and hence extrapolation from adult recommendations for and prescriptions of physical activity is to be considered with caution.

What is known about physical activity in childhood?

Observational studies of small children support the concept of stop-start activity, with up to half the time being spent in sedentary activity and 10% of time in vigorous play. The opportunity for more vigorous play and greater endurance changes play with increasing age. Our group has looked at physical activity in six- to eight-year-olds (a sub-group of the DLW study which was described previously) where physical activity was recorded by diary and by tri-directional accelerometer (motion monitor) (7). The importance of the use of discretionary activity time is highlighted. There are also concerning physical activity trends in adolescents (8). In the NSW schools study there was a loss of aerobic capacity in both sexes over time with one-third of both males and females displaying low aerobic capacity by Year 10 (9) (see Figure 1). While children are fatter than they were 20 years ago, there is perhaps less consensus as to whether they are fitter. The 1985 Australian Council for Health, Physical Education and Recreation cohort, if re-identified and recruited for follow-up study, would provide valuable data on the effect of fitness in childhood on adult activity, as well as comparisons with the NSW schools study.

Physical activity has been shown to positively affect cardiovascular risk factors in adults. In the Young Finns Study (10) high levels of physical activity appeared especially beneficial for males. In younger children the effects of physical activity on the cardiovascular risk profile are less clear, and overall the results are not strong, with cross-sectional data reporting both some effect and no effect of childhood activity on cardiovascular risk factors. It has been suggested that the intensity of physical activity may be important, even in the pre-pubertal age group. The Bogalusa group has data on Heart Smart program participants which looked at aerobic fitness using a one-mile run or walk time. Lipids and blood pressure were correlated only modestly with run time but there was a stronger correlation with fatness (11).

Generally the correlation with physical activity and body fatness (12) has been stronger in children than physical activity effects on cardiovascular risk factors. Recently our group has described a gender difference in the relationship between physical activity and percentage of body fat (4) (see Figure 2). Physical activity level is significantly related to percentage of body fat for boys, but not for girls. Unfortunately our study did not allow us to provide an explanation of this. It is hypothesised that in pre-pubertal boys, body fatness is influenced significantly by physical activity, but that there are significant additional factors that play a role in girls. Dietary fat may have a more significant effect in girls or there may be differences in nutrient partitioning, and these in turn may be intrinsic or related to the pre-pubertal hormonal milieu.

There are also family effects on physical activity. Children have higher activity levels than their parents (13). Children of active mothers are twice as likely to be active as children of inactive mothers, and children of active fathers are three-and-a-half times as likely to be active as children of inactive fathers. If both parents are active children are six times as likely to be active (14). This observation is likely due to learned behaviour (parental modelling), shared environment, support for activity and to genetic effects. Genetic influences on physical activity, particularly spontaneous movement, have been well docu-

![Figure 1](image1.png)

**Figure 1.** The percentage of NSW school students in Years 6, 8 and 10 who fall below the criterion referenced standards of adequate aerobic capacity. From the NSW Schools and Physical Activity Survey (9)

![Figure 2](image2.png)

**Figure 2.** Physical activity level correlates with body fatness in boys but not in girls. From Baur et al (4)(a)

(a) TEE, total energy expenditure; REE, resting energy expenditure.
mented. Recent work from Fogelholm et al. has suggested that the parent child relationship was actually stronger for inactivity than for activity (15).

Other predictors of physical activity are less clear. From the third US National Health and Nutrition Examination Survey data there was no relationship observed between daily television viewing hours and bouts of vigorous activity (16). The previously reported observation that hours spent viewing television were related to BMI and fat skinfolds still held true, and indeed more strongly why television viewing was related to BMI and skinfold thickness (17).

There are of course potential effects of physical activity in childhood and adolescence on adult health outcomes. Physical activity in adolescence is inversely related to body fatness in young adulthood in a six-year follow-up in the Young Finns study (18). A similar result came from the Amsterdam Growth and Health Study (19) where the less active children had higher fat skinfold thickness in adulthood. A follow-up of the youth fitness test developed in the USA in the sixties demonstrated that those children and adolescents who scored in the lowest quintile of aerobic activity were much more likely to be inactive adults. Low scores on other activity tests also predicted adult inactivity.

What do we know about activity in children who are overweight?

There is general agreement in the literature that children with established obesity have a number of characteristics around physical activity. They are less likely to participate in vigorous or moderate exercise. On both field and laboratory tests of aerobic fitness they are less fit than their leaner peers or siblings. They have increased upper body power and static strength as a result of their increased lean body mass (which is required for their greater fat mass). Their greatest difficulties are experienced in walking, running and flexibility. Having described these apparently negative changes it does not necessarily follow that these are causal. Rather the inactivity could also be a result of high body weight. The energy cost of walking or running is in fact greater than their lean peers as a raw score (see Figure 3), but normalises when adjusted for their greater lean body mass (20). While adiposity itself is likely to be the greatest influence, mechanical factors may also be important in the differences described in obese children. The forward lean of the body needed to maintain balance at higher walking speeds, and repeatedly having to readjust their centre of gravity are likely influences. Physical fitness will also influence the energy costs of activity. It has been shown repeatedly, at least in the short term, that weight reduction and an activity program improves physical capabilities in obese children.

What is known about physical activity in the individual management of overweight children?

The simple answer is not very much at all. Over the last thirty years of literature in childhood weight management there has never been an attempt to separate out the effects of dietary counselling and physical activity on childhood weight management. Most methodologies are very impre-

cise when it comes to the actual exercise prescription. Few studies make an attempt to evaluate change in behaviours as the prime outcome indicator is always weight change. There are two groups of researchers worth mentioning in this respect. The first is Golan et al. who have reported extensively on the parents as the sole agent of change in childhood weight management (21,22). Their approach is based on weight management involving environmental manipulation, which is a parental responsibility. By supporting parental leadership skills the child’s resistance to change should be reduced. Additionally, the stigma of the child being ‘the obese patient’ is reduced. Children in the ‘parent group’ lost more weight than those treated by a conventional approach, and showed more improvement in eating styles. There was no change in either group in physical activity. Mean maternal activity increased but paternal activity did not (staying at one hour per week) and possibly supporting the previous observations on parental influence on activity. The second group is that of Epstein et al. who are the only group to provide 10-year follow-up data showing that children are more effective in the long term than their parents in maintaining weight loss (23). Physical activity was always a part of their program, including regular gym-based activity at the clinic.

More recently Epstein reported on a weight management program targeted at reducing physical inactivity (24). Nutritional advice and cognitive behaviour therapy were included for the four groups studied: increased activity—high and low dose; and decreased sedentary—high and low dose. All groups did equally well in weight loss and this is a promising line of management, but as there was no diet-only control group, interpretation must be guarded.

Figure 3. Treadmill energy expenditure in children [obese (ob), control (cont), P < 0.01]. The energy cost of walking or running is greater for obese children than their lean peers as a raw score, but normalises when adjusted for their greater lean body mass. Adapted from Maffeis et al. (20)

![Energy expenditure vs Speed](chart.png)
What is known about physical activity in the prevention or prediction of obesity?

To date the evidence that comes from epidemiological studies can be summarised generally as the influence of childhood activity, either on later childhood or early adulthood obesity, is inconsistent, with studies divided between no effect or a protective effect, with some bias towards the latter. Television viewing hours come into these studies as a paradigm of inactivity—a potentially flawed paradigm, as the effects of television on energy expenditure and intake are complex. In the children’s Framingham study with its prospective data collection and using bidirectional accelerometers the 3- to 5-year-olds who had activity counts greater than the median had a lower increase in triceps fat skinfold thickness over one year (25). There is no evidence of what type of activity is preferable in the prevention of excess weight gain in childhood.

What is known about broad-based non-targeted community interventions into childhood obesity that involve physical activity?

A few studies are considered to highlight the difficulties of non-targeted intervention. How the study is approached (methodology) and outcomes are highly variable and it is thus difficult to compare studies. The Western Australian schools physical activity and nutrition intervention (26) in 10- to 12-year-olds was primarily a cardiovascular risk intervention, and was not targeted at obesity. When analysed for a high risk subgroup, fatness was significantly less at 12 months in programs involving a school fitness and home nutrition program. Additionally, any program with fitness had a better effect on lipids and blood pressure

A recent American study (27) targeted at obesity and directed at reducing television viewing to less than two hours per day, increasing moderate and vigorous physical activity, decreasing intake of high fat foods and increasing fruit and vegetable consumption to five serves per day, demonstrated a significant reduction in obesity prevalence in girls, but not boys. The only behavioural change that predicted response was television viewing.

More specifically to our age group of interest was a school-based randomised controlled trial (28) over 12 months of 200 8- to 9-year-olds, with an intervention directed at reducing television viewing, and with parental involvement. Body mass index, hours of viewing television and playing video games (not videotapes) and meals eaten in front of television were less in the intervention group, but no difference in snacking, reported physical activity or other sedentary behaviours was observed.

How can physical activity be linked with healthy eating in childhood obesity in a meaningful way?

It is obvious that nutrient intake and physical activity are two important aspects of the energy balance equation. In the current environment, nutrient intake above actual requirement and low levels of physical activity are likely possibilities, and these possibilities clearly begin in child-

References


