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The Juvenile Obesity Epidemic: Strike Back with Physical Activity

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KEY POINTS

- The prevalence of juvenile obesity is on the rise in many developed and undeveloped countries. It has reached epidemic proportions.
- A reduction in physical activity, mostly due to increased "screen time" (TV, Internet, computer games, video), is an important likely cause of this epidemic.
- Enhanced physical activity induces several beneficial effects on the health and well-being of obese children and adolescents. Less information is available regarding its effectiveness in the prevention of juvenile obesity.
- Several published sets of guidelines are available regarding the amount, frequency, intensity and nature of activities suitable for the general population of children and youth. However, the validation of these guidelines requires further research.

INTRODUCTION

Determining who is overweight and who is obese

The terms "overweight" and "obesity" are often used as if they are synonymous, but they are not. Both denote excessive body weight, but obesity is a more advanced state than is overweight. The definitions and criteria of obesity depend to a great extent on the method used to determine it. Ideally, one should measure or assess percent body fat by determining skinfold thickness or underwater weight or by using techniques of dual energy X-ray absorptiometry (DEXA). Body fat in excess of 30% is often used as a criterion for obesity.

In the absence of tools to estimate percent body fat, one must resort to the simpler measurements of body weight and height. The most commonly used index of overweight and obesity, based on weight and height, is the Body Mass Index [BMI = weight (kg) divided by height squared (m^2). For adults, a BMI of 25-29 kg/m^2 denotes overweight, and a BMI of 30 kg/m^2 or more denotes obesity. These cutoff points, however, are not valid for children and adolescents. Based on data of more than 97,000 subjects from various countries, the cutoff levels for adolescents are lower than for adults, and they are even lower in children (Cole et al., 2000). For example, the obesity cutoff level for a 15-year-old boy is 28 kg/m^2, and for an 8-year-old boy it is 23 kg/m^2. The corresponding cutoff points for overweight are 23 and 18 kg/m^2 respectively.

In spite of the popularity of BMI, one must realize that it does not differentiate between a person whose excessive body weight is due to high body fat content and one whose excess bodyweight is attributed to a large fat-free mass. This drawback is particularly relevant for athletes, who may vary markedly in their muscle bulk and fat-free mass. For such people, one should attempt a measurement of percent body fat.

The purpose of this article is to concisely describe the recent rapid increase in obesity among children and adolescents, to summarize the results of investigations that have studied the potential causes of the epidemic in juvenile obesity, and to briefly discuss approaches to the prevention and treatment of this disease. Most of the studies that report an increase in the prevalence of obesity used BMI data to assess obesity.

RESEARCH REVIEW

The juvenile obesity epidemic

The last three decades have seen a dramatic surge in the prevalence of juvenile obesity. (In this article "juvenile" is used collectively for children and adolescents.) For example, as seen in Table 1, the prevalence of juvenile obesity and overweight in the US increased dramatically from 1965 to 1995. The increase was faster in boys than in girls.

TABLE 1. Increase over 30 years in the prevalence of juvenile obesity, comparing data from the 1965 NHANES I and 1995 NHANES III national surveys in the US. Data from Troiano et al. (1995). Obesity was assessed according to BMI perecentiles.

Gender	Age Group (years)	% Increase in Prevalence
Girls	6-11	106
Girls	12-17	69
Boys	6-11	108
Boys	12-17	146

A nationwide Canadian study showed a major increase in the prevalence of juvenile overweight and obesity between 1981 and 1996 (Tremblay & Willms, 2000). The increase appeared particularly dramatic in the younger age groups. For example, among 7-year-old boys there was a startling six-fold increase in obesity and a three-fold increase in overweight. The rate of increase in juvenile obesity is considerably greater than in Canadian adults (Tremblay et al., 2002). This fast surge of juvenile obesity occurs not only in technologically developed countries (Livingstone, 2001), but also in less developed societies in which *undernutrition* had previously been prevalent (Seidell, 1999). The World Health Organization has termed this phenomenon a Global Epidemic (World Health Organization, 1997).

Possible Causes for the Obesity Epidemic

The causes of the current juvenile obesity epidemic are not clear (Bar-Or et al., 1998; Jebb & Moore, 1999; Livingstone, 2000). Conceptually, there are three possible causes: genetic mutations, increased energy intake, and decreased energy expenditure. A genetic hypothesis can be rejected because it is unlikely that mutations can be expressed in such a short time-span. One cannot exclude, however, the possibility of a gene-environment interaction in which changes in activity or food consumption are affected by a person's genetic disposition (Clément & Ferré, 2003).

In the US, increased energy intake seems unlikely as a general cause of obesity because data from the 1970s to the 1990s do not confirm an increase in total energy consumption of most 2- to 19-year-old people (Troiano et al., 2000). The only exceptions were adolescent girls, whose intakes did increase. The same survey showed a decline in the percentage of fat consumption in the diets of both genders. In contrast to the US, the emergence of juvenile obesity in less developed countries seems to accompany an increase in food consumption.

If, indeed, energy and fat intake have not increased over the recent decades, a most probable cause for the current obesity epidemic in North America is a decline in energy expenditure due to a reduction in habitual physical activity (Bar-Or et al., 1998; Troiano et al., 2000). While this hypothesis is plausible, there are insufficient data to confirm it (Jebb & Moore, 1999).

Are obese children and youth insufficiently active?

Several cross-sectional studies were conducted over the years in an attempt to document the activity behavior of obese young people compared with their non-obese peers (Bar-Or & Baranowski, 1994; Bar-Or et al., 1998). Most (Bruch, 1940; Bullen et al., 1964; Dionne et al., 2000; Pate & Ross, 1987; Waxman & Stunkard, 1980), but not all (Klesges et al., 1990; Stunkard & Pestka, 1962; Wilkinson et al., 1977) of these reports suggest that obesity coincides with a relatively sedentary lifestyle.

The possible relationship between juvenile obesity and the amount of time spent watching TV has attracted special attention. Several studies (Andersen et al., 1998; Crespo et al., 2001; Dietz & Gortmaker, 1985; Gortmaker et al., 1996), but not all (Robinson et al., 1993; Wolf et al., 1993), have shown that the risk for being obese is strongly related to TV viewing. For example, Crespo et al. (2001) analyzed data from more than 4000 children and youth, ages 8-16 years, who took part in a 1988-1994 national US survey (NHANES III). They found that the prevalence of obesity was highest among those watching TV four or more hours daily and lowest among those watching one hour or less per day. Television viewing was positively associated with obesity among girls, even after controlling for age, race/ethnicity, family income, weekly physical activity, and energy intake (Crespo et al., 2001). Another study has shown that the likelihood of being obese is three-fold greater in adolescents who watch TV more than 5 hours/day, compared with those who watch 0-2 hours/day (Gortmaker et al., 1996) (Figure 1). The same study demonstrated that the likelihood of remission of obesity over a four-year period is considerably greater among adolescents who watch TV less than one hour/day compared with those watching 5.5 hours or more each day. The authors concluded that (even though most studies of this problem are cross-sectional, not experimental) there is a cause-and-effect relationship between the extent of television viewing and juvenile obesity.

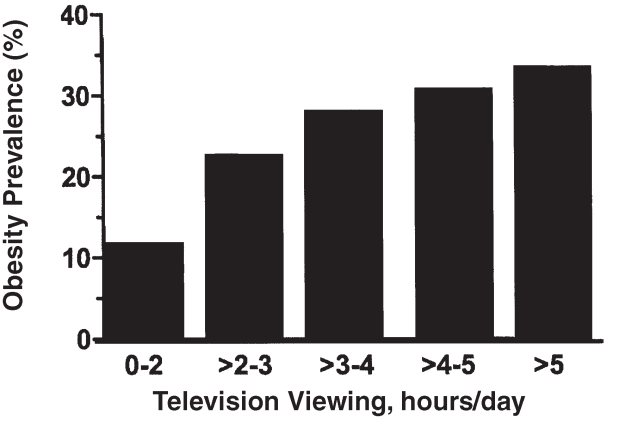

FIGURE 1. Television viewing and the likelihood of being obese. Based on a national representative sample of 746 girls and boys aged 10-15 years. Modified from Gortmaker et al. (1996).

In spite of the apparently strong relationship between television watching and juvenile obesity, there is little or no relationship between the amount of time of television viewing and the overall daily energy expenditure (Robinson et al., 1993; Taraset al., 1989). However, although data from the general population indicate no recent increase in energy consumption, it is possible that one of the effects of excessive TV viewing is over-consumption of fast-foods and other high-energy products in this population of television watchers, perhaps because of the large number of food-related commercials in prime-time programs (Story & Faulkner, 1990).

Even though there is ample evidence for low habitual activity in obese children and youth, there is a more complex relationship between obesity and total energy expenditure, which includes resting energy expenditure in addition to energy expended during physical activity

(Ekelund et al., 2002). Some studies show that total daily energy expenditure (MJ/24 h) is similar in obese and non-obese subjects, or even greater among the obese (Bandini et al., 1990; Goran, 1997; Treuth et al., 1998). Nor are there differences in total daily energy expenditure between children who are disposed to future obesity and those who are not (Treuth et al., 2000).

On the assumption that a high energy expenditure in the obese is a function of their larger body mass (Maffeis et al., 1993; Volpe-Ayub & Bar-Or, 2003), some authors expressed energy expenditure per unit of body mass, as the difference between total energy expenditure and resting energy expenditure, or as the ratio between total daily energy expenditure and resting energy expenditure (Physical Activity Level = PAL). Even with these corrections, the outcomes were equivocal, ranging from an inverse relationship (Bandini et al., 1990; Davies et al., 1995) to no relationship (Bandini et al., 1990; Ekelund et al., 2002; Goran et al., 1997) between adiposity and energy expenditure.

It is not easy to reconcile the lack of relationship between obesity and total daily energy expenditure. One possible explanation is that subjects in most of these studies were already obese when the observations were made. It is possible that, had they been tested during the transition period from non-obesity to obesity (i.e., when their energy balance was excessively positive), the energy expenditure of those who later became obese would have been lower.

The beneficial effects of enhanced physical activity

Although this review focuses on the effects of enhanced physical activity, one must realize that a proper management of juvenile obesity should also include nutritional changes and behavior modification (of the child and the parents) (Bar-Or et al., 1998; Epstein et al., 1996; Sothern et al., 2000). There are many documented benefits of enhanced physical activity in juvenile obesity (Epstein & Goldfield, 1999; Gutin & Humphries, 1998)). Tables 2 and 3 summarize the overall results from the literature on the effects of enhanced physical activity on body composition and on variables other than body composition, respectively. The scope of this review does not allow a comprehensive discussion of all these effects. For more details, see recent reviews (Bar-Or et al., 1998; Epstein & Goldfield, 1999; Gutin & Humphries, 1998; Sothern, 2001).

TABLE 2. Summary of literature reports on effects of enhanced physical activity on body composition.

Variable	Increase	Decrease	No Change
Body Mass		X	X
Fat-Free Mass	X		X
% Body Fat		X	X
Visceral Fat		X	
Body Height			X

TABLE 3. Summary of literature reports on effects of enhanced physical activity on variables other than body composition.

Variable	Increase	Decrease	No Change
Arterial Blood Pressure		X	
Insulin Sensitivity	X		
Plasma Triglycerides		X	X
HDL Cholesterol	X		X
LDL Cholesterol		X	X
Total Cholesterol		X	X
Physical Fitness	X		
Self Esteem	X		

Body fat and body mass. The specific changes that accompany greater physical activity depend on the nature of the activity as well as any dietary changes. For example, to expend reasonable amounts of metabolic energy, a child must engage in aerobic-type activities such as team games (e.g., basketball, soccer), brisk walking, skating, or swimming. An activity lasting 45-60 min can then yield an energy expenditure of some 200-250 kcal (Blaak et al., 1992; Gutin et al., 2002). An aerobic program may help the obese child lose body fat and total body mass (or slow down the growth-related increase in body mass). It is also likely to induce an increase in aerobic fitness. In contrast, a program that includes resistance training may not yield a reduction in body mass, but it may help preserve, or even increase, fat-free mass (Pikosky et al., 2002; Sothern et al., 2000; Treuth et al., 1998). Without concomitant dietary changes, meaningful fat reduction may not occur (Epstein et al., 1996).

Visceral fat. In studies with adults, excessive intra-abdominal or visceral fat has been linked to coronary risk and is part of the "metabolic syndrome." There is now evidence in juveniles that enhanced physical activity of an aerobic nature is accompanied by a reduction (or slowing down of an increase) in visceral fat (Gutin et al., 2002; Owens et al., 1999). Lack of increase in intra-abdominal fat has also accompanied resistance training (Treuth et al., 1998).

Insulin resistance. The current juvenile obesity epidemic has been accompanied by a rapid increase in the incidence and prevalence of type 2 ("adult type") diabetes mellitus (Berenson et al., 1995; Pinhas-Hamiel et al., 1996). Growing numbers of obese children have high fasting insulin levels and abnormal glucose tolerance tests, suggesting high insulin resistance. The strong association between type 2 diabetes and juvenile obesity is another reason why clinicians should attempt to prevent and treat obesity in children and youths. It is now clear that programs of increased physical activity can decrease insulin resistance. However, these changes and other beneficial effects disappear once the intervention program is concluded (Ferguson et al., 1999).

Spontaneous physical activity. An important issue that has been given little attention is whether and to what extent prescribed physical activity programs may affect the

spontaneous activity of the obese child, that is, the non-prescribed activity engaged in by the child. Using the doubly-labeled water technique (the "gold standard" for measurement of total energy expenditure), it has been shown that the increment in total energy expenditure during a four-week aerobic program was twice that expected from the structured cycling sessions in which the subjects participated (Blaak et al., 1992). Another study, using accelerometry, heart rate monitoring, and an interview, reported that spontaneous physical activity and energy expenditure increase on the day after a structured exercise task in the laboratory (Kriemler et al., 1999). It thus seems that obese children may be "energized" by an enhanced physical activity program and assume a more active lifestyle. This issue needs further research.

The elements of an activity program

It is commonly assumed that for enhanced physical activities to be effective in controlling weight and adiposity, they should include a component that induces an appreciable increase in energy expenditure (Bar-Or & Baranowski, 1994; Epstein et al., 1996; Gutin et al., 2002; Sothern, 2001). The intensity of such activities is not important if the treatment focuses on changes in body composition such as a reduction in total body fat and visceral fat. However, to induce an increase in aerobic fitness, the activities should include a high-intensity element (Gutin et al., 2002).

Unlike adults, children seldom exert themselves purely for the health benefits of exercise. They need immediate gratification from the activity, which, therefore, must have enjoyable elements. This aspect cannot be overemphasized. Furthermore, long-term maintenance of a program's benefits is more likely to occur if the activities are of a "lifestyle" nature rather than a regimented aerobics or calisthenics intervention (Epstein et al., 1994). Another important element is the reduction of time spent on sedentary pursuits, such as television viewing (Faith et al., 2001). A reduction in television time may also be efficacious in the *prevention* of obesity among school children (Robinson, 1999). Finally, in constructing a program one must focus on increasing the child's motivation to become and stay active. Parents, for example, can reinforce a child's enhanced activity by token awards. In our outpatient clinic, we periodically launch motivational projects such as the Frequent Exerciser Program (in analogy to the airlines' "frequent flyer" programs), which are appreciated by young patients of all ages. In one such project, for example, patients were encouraged to accumulate "stairs" at the CN Tower (a Toronto landmark). Each 15-minute block of activities was converted into a certain amount of stairs and recorded by the child on a special form. Once the child accumulated enough stairs to "reach the top of the tower" an award was given.

Ideally, enhanced activity should become a family project, particularly for children in the first decade of life. Some practical information on how parents can become involved in enhanced physical activity of their child can is available at www.paguide.com. This website accompanies the 2002 *Canada's Physical Activity Guide for Children and Youth*. A special section in the site provides "Tools for Parents."

SUMMARY

Recent decades have seen a dramatic worldwide surge in the prevalence of juvenile obesity. While the causes of this epidemic are not clear, a reduction in the time spent on physical activities and the increase in sedentary pursuits such as TV watching or computer games are likely important factors. Enhanced physical activity is an important component of any program that focuses on weight control. Such a program should include elements that induce appreciable energy expenditure. However, the inclusion of resistance training is efficacious in the enhancement of fat-free mass. Children will not increase their activity "because it is healthy." They must see immediate gratification in becoming more active. This can be achieved by engaging the child in enjoyable activities.

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