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Symposium on 'Growing up with good nutrition: a focus on the first two decades'

Charting the physical activity patterns of contemporary children and adolescents†

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The impact of physical inactivity on health is well accepted throughout the medical and health service community. However, the case has largely been established through epidemiological studies with adults. Substantial attention has been paid to the activity levels of children and adolescents, largely because of changing lifestyles that have threatened the opportunity to be active and also introduced attractive sedentary alternatives such as playing computer games. The research evidence that children have become less active to the point where it is seriously damaging their current and future health has been difficult to establish. This situation is due to difficulties in establishing sensitive health risk markers, and also with the assessment of the different elements of physical activity which in children and adolescents is a complex profile of social behaviours. Self report of activity is unreliable with young children, and objective measures are required that are cheap and effective with large samples and that are capable of measuring levels, volume and patterns of physical activity. Accelerometry in combination with diaries offers the best current solution for most activity–health relationships, and for informing intervention need and design.

Physical activity: Exercise: Energy expenditure: Body fat: Children

The case for physical activity and health is now widely accepted worldwide among health and medical authorities (Killoran *et al*. 1994; World Health Organization, 1995; Department of Health and Human Services, 1998). Reviews of the effect of exercise on cardiovascular disease mortality and morbidity (Powell *et al*. 1987; Berlin & Colditz, 1990) reveal that sedentary living doubles the risk of dying from cardiovascular disease. This is a level of risk similar to that of hypertension, dyslipidaemia and smoking cigarettes. Rightfully, lack of physical activity is now considered to be the fourth primary risk factor for CHD and stroke. Physical inactivity is also related to increased risk of diabetes, osteoporosis and some cancers. In addition, secular downward trends in levels of activity are widely regarded as a major contributor to the burgeoning incidence of obesity (Prentice & Jebb, 1996; British Nutrition Foundation Task Force, 1999) which has now reached 17 % in men and 20 % in women in England (Department of Health, 1998). There has also been a growth in interest in the contribution of physical activity to mental well-being, with recent national consensus conferences being held in the UK and guidelines produced for health services commissioners (Grant, 2000). Accumulating evidence shows that exercise can be successful in the treatment of depression and anxiety, and can enhance the mental well-being of otherwise healthy populations, including children (Biddle *et al*. 2000). Added to the substantial burden of suffering caused by inactivity is the widespread and increasing prevalence of inactivity as a risk factor. It has been estimated that about 40 % of the middle-aged and elderly UK population take part in infrequent, or no, moderate to vigorous physical activity (Health Education Authority and Sports Council, 1992). The strength of this evidence has led to the development of public health policy to promote physical activity. Campaigns for increased physical activity, such as the Health Education Authority's (1996) 'Active for Life' campaign, have been launched throughout the UK. Furthermore, grass-roots initiatives to promote adult activity

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through primary care and leisure centre schemes throughout Britain continue to grow (Fox *et al*. 1997; Riddoch *et al*. 1998).

Although the case for exercise has largely been constructed around epidemiological and experimental data with adults, concerns that have in part been fired by the media have increasingly been expressed regarding the levels and patterns of activity of children and adolescents, and their potential impact on both present and future health. Reviews of the evidence have been published (Sallis & Patrick, 1994; Biddle *et al*. 1998; Riddoch & Boreham, 2000), and there is a greater understanding of this area of investigation than ever before. We have known for some time that children's freedom for activity has been endangered. Hillman (1993) indicated that between 1971 and 1990 there had been reductions in walking to school, low levels of cycling to school, and generally less licence offered to children by their parents to play out of the home on their own and be independent. Recent surveys (British Heart Foundation, 2000; Gregory & Lowe, 2000) have confirmed these trends and the general view that many children are insufficiently active for optimal health benefit. The National Diet and Nutrition Survey of over 2000 children and adolescents between the ages of 4 and 18 years (Gregory & Lowe, 2000) indicated that 30 % of boys aged 7–10 years and 56 % of boys aged 15–18 years did not achieve 1 h of moderate physical activity daily. The corresponding levels for girls were 51 % and 69 %. At all ages, but particularly from early adolescence, girls are much less active than boys, and for both girls and boys activity decreases as they get older. The British Heart Foundation (2000) survey *Couch Kids – The Growing Epidemic* also revealed that more than 25 % of 11–16 year-olds watch more than 4 h television pe rd and that physical education in primary schools has more than halved in the past 5 years.

Children's physical activity, as with their food intake and eating behaviours, has provided serious measurement challenges for researchers, with the result that there are limitations to the existing data. Much of the data provides little more than a gross estimate that is based on some form of children's self report. If researchers are to fully establish the effects of children's activity levels and patterns on their health, and if public health policy is to be adequately informed about the problem of inactivity in children, then many questions remain unanswered. Further progress in the way children's activity is conceptualized and assessed is required.

The present paper, therefore, presents an overview of key issues concerning the conceptualization and measurement of children's levels and patterns of activity. Its thesis is presented in the social context of the lives of children and adolescents that appear to be increasingly different from those of their parents, and certainly their grandparents, at the same age. These changes have resulted from technical developments which have produced cheaper labour-saving products and attractive home entertainment, and greater reliance on the car for transport, as well as the breakdown of the traditional nuclear family unit, changing work practices that often involve both parents, and public policies such as greater choice of schooling. These changes suggest a greater diversity in the lifestyles that are adopted by our children, and a subsequent increase in the complexity in the ways these lifestyles might influence their health. This complexity needs to be accommodated in our measurement perspectives and techniques.

Characterizing children's physical activity patterns

Physical activity in itself provides a serious definitional challenge. Fortunately, some degree of consensus has been reached regarding definitions of different elements of energy expenditure (Casperson *et al*. 1985; Biddle *et al*. 1998).

(1) Physical activity is an umbrella term describing any bodily movement produced by the skeletal muscles that results in energy expenditure.

(2) Exercise is a subset of physical activity which is volitional, planned, structured, repetitive and aimed at improvement or maintenance of an aspect of fitness or health.

(3) Sport is a subset of physical activity which involves structured competitive situations governed by rules. In Europe, sport is often used in the wider context to include all exercise and leisure-time physical activity.

(4) Physical fitness is a set of attributes rather than a behaviour. It is a multidimensional indicator of several functional capacities such as cardiovascular endurance, muscular strength or mobility, which in varying degrees are a result of genetics and stage in the lifespan, as well as physical activity levels.

As defined here, physical activity includes all gross and minor body movement, including fidgeting and postural adjustment. However, for the remainder of the present paper, comment will be confined to locomotor physical activity, or that involving the larger muscle groups to move the body around or to apply force to objects. How often and how much children move is an important aspect of health-related behaviour, and one which is likely to be susceptible to the effects of the technological and social changes that have taken place in the last two decades.

Knowing the context in which children move is important for health promotion policy making. Young children spend almost all their time either at home or at school. The part-time work practices and social lives of adolescents increasingly diversifies their behaviour patterns. However, for all children and adolescents activity is mainly incurred through:

(a) transport, as in cycling or walking to school or shops;

(b) informal play, such as playground, street or park games during free time;

(c) formal play, as in physical education classes, organized sport or exercise sessions at school or elsewhere;

(d) work, such as in delivery rounds, jobs in sales or shelf stacking, or household tasks.

In addition, there has been increasing interest in the quantification of elements of inactive behaviour (DuRant *et al*. 1994). Time spent watching TV and videos or playing computer games has been of interest, because many children are in front of a screen for more than 4 h/d. This factor ensures a sustained period of low energy expenditure, it has the potential to reduce opportunity for active leisure pursuits, and it is associated with the consumption of energy-dense snacks.

Clearly, children's activity is best described as a profile rather than a single entity. Such profiles are essentially characterized as a complex matrix of behaviours that take place in a range of social contexts, each with its own set of physiological, psychological and sociological determinants and outcomes. For example, the amount of walking to school undertaken by a primary-school child might be determined by distance from school, parental attitudes and work circumstances, and habits of other children in the neighbourhood. The long-term benefits might be as diverse as impact on energy balance, muscular and skeletal development, or mental and social well-being, and there may be negative consequences such as exposure to pollution and increased risk of traffic accidents. Participation in vigorous team sports in secondary-school children, on the other hand, will be determined by a different equation and produce a different menu of consequences.

Patterns and profiles of children's activity differ by demographic characteristics such as age, gender, social group and living environment. These differences have been made clear in the recent National Diet and Nutrition Survey (Gregory & Lowe, 2000), which indicated that young children's activity is dominated by chasing games that are intermittent in nature, that adolescent boys are more likely to walk and play sport such as football, and that adolescent girls do little more than walk for transport and household chores, while many adolescents frequently attend discos. Adolescents are more likely to be physically active if they have a circle of friends who are active. Similarly, it might be expected that children who live on traffic-calmed housing estates are likely to play out of the home more than those living in built-up areas, and children will be more active in the warmer and sunnier summer months.

Against this taxonomy of physical activity contexts can be superimposed the various dimensions of physical activity, including (a) the type of participation such as running, walking, cycling or swimming, (b) the intensity at which the activity is undertaken, usually categorized as light, moderate or vigorous, (c) the frequency of participation, (d) the duration of each session and/or the duration for which a particular exercise intensity is maintained. Often these types of activities are combined into some form of total index of activity. Researchers interested in establishing relationships with health outcomes are likely to be interested in the quantification of activity such as total energy expenditure at a particular intensity. Public health policy makers and health promoters, on the other hand, may seek information on activity patterns and their demographic and environmental determinants.

It can be seen, therefore, that treating children's physical activity as an isolated unidimensional variable can lead to over-simplified and inaccurate descriptions that reveal little information about group or individual variations. This factor has made it difficult to assess the true relationship between elements of activity and health, and has done little to inform health promotion policy.

Establishing physical activity and health relationships in children and adolescents

Health is in itself multidimensional, and we may be interested in elements as diverse as children's cardiovascular health, lipid profile, haemodynamics, bone mass, body fat levels, muscular development or aspects of psychological well-being. Activity–health relationships, therefore, form two matrices with different aspects of activity relating to specific packages of health variables. In adults the accumulated energy expenditure at moderate intensity and above appears to be the critical dimension of physical activity that is most closely related to many aspects of health, particularly cardiovascular disease (Paffenbarger *et al.* 1986). It seems that moderate-intensity activity may be sufficient to stimulate the haemostatic, haemodynamic and biochemical changes necessary for coronary health. This finding is in contrast to earlier thinking that emphasized vigorous training-type activity for sustained periods of 20–30 min. A similar line has been adopted for children and adolescents by the Health Education Authority (Biddle *et al.* 1998) and in the US by the Department of Health and Human Services (1996), so that 1 h activity of moderate intensity daily is the primary recommendation. However, when we consider the escalating problem of obesity in children in both the USA (Troiano *et al.* 1996) and the UK (Hughes *et al.* 1997; Gregory & Lowe, 2000), then all movement, but particularly weight-bearing activity, regardless of intensity at which it is performed, becomes important. Similarly, in consideration of achieving a high peak bone mass and the prospect of avoiding future problems such as osteoporosis in children, then amount of load-bearing activity may become the critical variable.

The relationship between activity and health in children offers further challenges:

(1) epidemiologists are starved of their usual key end points. The major morbidities of childhood, at least in the USA, are unwanted pregnancy, substance abuse, physical and sexual abuse, and anxiety disorders, and the primary cause of death is violence (accidents, homicides, suicides; Blum, 1987). Disease and mortality as a result of lifestyle factors such as inactivity or poor eating patterns are rare in children, with the result that it is difficult to show any deleterious effects;

(2) difficulties of research with children include ethical clearance, availability of funding, attrition and confounding factors such as stage of sexual maturation;

(3) for the majority of children it is likely that physical inactivity has not had sufficient time to have had a serious negative influence on traditional risk indicators;

(4) insufficient numbers of children may be inactive for the effects to become evident in small sample comparisons;

(5) there may be a lack of variability in the health outcomes assessed. Where groups are homogeneous, statistically significant associations are difficult to identify. In other words, you can't make a healthy child healthier.

Indeed, the literature has been reviewed extensively on two occasions in the past decade for the San Diego Censensus Conference on Adolescent Physical Activity

(Sallis & Patrick, 1994), and the Health Education Authority Young and Active Conference (Health Education Authority, 1997). Weak relationships at best were found between risk markers (such as blood lipids, blood pressure, bone mineral density and body fatness) and physical activity. The strongest relationships were found between body fatness and mental well-being and physical activity. Reasons given for the weak evidence included the scarcity of well-designed studies and measurement difficulties with children.

Significant associations can be identified in some epidemiological studies that have high statistical power. We can accept that such studies are valid and important in demonstrating that physical activity levels are related to health outcomes. However, in order to translate such findings into health policy, a higher order level of data is required. Wareham & Rennie (1998) have suggested that we need to (a) clearly identify the dimension of physical activity exhibiting the relationship with a particular health outcome and (b) estimate more accurately the effect size. In short, we need to know what type of physical activity will have what level of effect for each of the key health outcomes. This information cannot be achieved through gross estimates of activity. For children who have reached a diseased state, such as obese children, many of whom exhibit signs of adult-onset or type II diabetes, then relationships with activity tend to be stronger and interventions more likely to be effective.

Although the relationships are often weak and the effects of increased activity disappointing in children, we are not only concerned about the potential impact of physical activity levels on current health, but also future health. While children are relatively free of disease and have extremely low mortality rates, it is possible, if not likely, that degenerative biological processes are initiated during infancy and childhood which will manifest themselves as chronic disease in later life. Current activity patterns might predict future health consequences, such as the early onset of CHD, osteoporosis or adult obesity. Similarly, some elements of physical activity habits track into adulthood to produce healthier adults (Malina, 1996; Riddoch, 1998). This relationship means that activity measures need to be accurate and sensitive to change over several time points through longitudinal studies.

Given these difficulties, it is not surprising that researchers and public health policy makers have struggled to produce definitive activity recommendations for children. The recommendations of the Health Education Authority (1997) and the San Diego conference (Sallis & Patrick, 1994), which were established on existing evidence and expert opinion, are featured in Table 1.

Table 1. Activity recommendations for adolescents (from the International Consensus Conference on Physical Activity Guidelines for Adolescents; Sallis & Patrick, 1994) and children and adolescents (from the Young and Active Policy Framework; Health Education Authority, 1997)

Adolescents (11–21 years)
1. All adolescents should be physically active daily, or nearly every day, as part of play, games, sports, work, transportation, recreation, physical education, or planned exercise, in the context of family, school, community activities
2. Adolescents should engage weekly in three or more sessions of activities that last 20 min or more at a time and that require moderate to vigorous levels of exertion
Children and adolescents (5–18 years)
1. All children and adolescents should participate in physical activity of at least moderate intensity for 1 h daily
2. Children and adolescents who currently do little activity should participate in physical activity of at least moderate intensity for at least 0·5 h daily
3. At least twice weekly some of these activities should help to enhance and maintain muscular strength and flexibility and bone health

Measurement of physical activity

It is against this complex social, psychological, physiological and temporal backdrop, that available measures of physical activity need to be appraised. It soon becomes clear that the challenges encountered in the assessment of food and energy intake in children in free-living conditions (Livingstone & Robson, 2000) are closely paralleled in the measurement of physical activity.

There are at least five dimensions of activity that might interest the researcher in establishing the effect of children's activity on health. These five categories are (a) energy expenditure for energy balance and fat regulation, (b) moderate to vigorous aerobic activity for heart health, (c) weight-bearing activity for skeletal health, (d) resistance and endurance activity for muscular strength and (e) high-range movement for flexibility. The vast majority of studies have used estimates of either category (a) or category (b). In addition, the time of day, setting and type of activity may be important aspects of measurement. No existing single method of activity measurement can accurately encapsulate all these dimensions, modes and contexts.

Self-report estimates

Both large- and small-scale studies have relied heavily on self-reported activity through questionnaires, check lists, diaries or interviews. These self reports have ranged from quite simple lists of key activities to detailed diaries requiring recall that are completed several times throughout the day. Most frequently, the data are quantified by assigning kilojoules or multiples of estimated resting metabolic rate values to duration and frequency of different categories or modes of activity. These values are presented either as composite indices, estimates of total energy expenditure, or time spent in various intensities of activity. Unfortunately, self-reported activity is not recommended for children under the age of 10 years (Sallis & Owen, 1999). As with eating inventories, reliability remains low due to recall difficulties, and validity is threatened by socially-desirable responding, and difficulties that young children have in separating the fantasied or intended self from the actual self (Harter, 1988). These problems persist at a less severe level through into early adolescence. Furthermore, the activity of young children is often characterized by frequent short bursts of energy (average 6 s) which are very difficult to remember and record. This unreliability makes the valid documentation of activity through self report in young children impossible at anything more than the extremely simplistic level.

Even with older children and adolescents, only the formal, discrete or routine units of activity such as sport, exercise or walking to school are likely to be assessed through self report with any degree of reliability. Incidental activity such as playing out of the home is difficult to define in questionnaires, and even more difficult to recall. However, despite the limited validity and reliability of self-report measures, particularly for the quantification of activity, they are useful for assessing patterns, frequencies and type of activity, and recording the context in which activity takes place. Diaries framed in time slots around the routine of the day appear most useful, although this approach is easier on school days that are more highly structured than weekends or holidays. Self reports of activity remain the primary method of assessment due to their convenience and cost, particularly with large samples.

Doubly-labelled-water method

To counteract these weaknesses, attempts have been made to develop more objective methods. The doubly-labelled-water method is now recognized as the reference method or 'gold standard' for the assessment of activity energy expenditure in free-living subjects (Stager *et al*. 1995). A quantity of water with a known concentration of stable non-radioactive naturally-occurring isotopes of H (^{2}H) and O (^{18}O) is ingested and allowed to equilibrate with the total body water. The principle of the method is to measure the difference in the rate of loss between ^{2}H (lost in the form of $^2H_20$) and ^{18}O (lost as $H_2{}^{18}0$ and $C^{18}O_2$) in urine or saliva. From the difference in elimination rates of the two isotopes the production of CO_2 can be calculated, and through estimation or measurement of the RER, along with the CO_2 production rate, O_2 uptake and energy expenditure can be calculated. The amount of energy expenditure due to physical activity is found by subtracting that due to resting metabolic rate.

The doubly-labelled-water method provides a well-respected measure of total energy expenditure, and is particularly helpful in establishing rates of metabolic turnover. However, this method has limited value in tackling many of the issues concerning children's physical activity. It does not allow energy expended from frequent minor movement such as postural adjustment or fidgeting to be separated from locomotor-induced energy expenditure. Also, this method does not give any indication as to how, when and where energy expenditure took place, and so is not informative for characterizing children's patterns of activity. Furthermore, the method is expensive, and as such is largely reserved as a gold standard against which to assess the validity of other measures of physical activity.

Heart-rate telemetry

After self report, heart-rate telemetry has been used most frequently in the assessment of children's physical activity. Monitors similar to wristwatches record data transmitted from sensors strapped to the chest, that are later downloaded to a computer. Ideally, heart rate should be calibrated against O_2 uptake and CO_2 production in each individual to allow heart rate to be used as a measure of energy expenditure. In the main, the use of heart-rate monitoring has been driven by an interest in the degree to which children are exposed to exercise dosage of sufficient intensity to promote their cardiovascular fitness and health. Heart-rate monitoring is capable of producing minute-by-minute read-outs over periods of several days, and has largely been used to detect the frequency of sustained periods of activity at either moderate or vigorous intensity (Armstrong *et al*. 1990; Riddoch *et al*. 1991). This focus on sustained bouts of activity (mirroring adult exercise prescription) has been criticised conceptually as an inappropriate model for characterizing the activity of children and young adolescents (Corbin *et al*. 1994). The activity of youngsters involves intermittent and spontaneous play rather than sustained bouts of exercise, and so energy expenditure would be underestimated.

The assumption underpinning heart-rate monitoring as an indicator of energy expended through physical activity is that a linear relationship exists between heart rate and O_2 uptake. However, this relationship only holds true for medium to high heart-rate registers. Heart rate is affected by emotional factors at lower ranges, and there are several other confounders including fatigue, state of hydration, food intake, ambient temperature and humidity, body position, posture, active muscle group, type of muscle contraction and type of exercise (Riddoch *et al*. 1991; Livingstone, 1997). These factors have led some researchers to question the validity of heart-rate monitoring at anything other than vigorous activity levels (Rowland, 1996).

For many health-related research questions it may be more appropriate to convert heart-rate data into energy expended at a level of moderate intensity or above. Saris (1986) suggested the use of heart rates corresponding to each individual's heart rate equivalent to 50 % of their maximum O_2 uptake, a level that many individuals equate with 'brisk walking' or slow jogging. However, this approach requires individualized O_2 consumption data from a laboratory test, and often arbitrary heart-rate cut-off points are used such as 140 beats/min, which is believed to correspond to a 'healthy' threshold. Despite its limitations, heart-rate monitoring is still the method of choice for objectively establishing moderate to vigorous activity levels.

Motion sensors

More recently, the use of motion counters and sensors have come into favour. These monitors include pedometers that allow the estimation of numbers of steps taken through displacement of a mechanical device, and also accelerometers that record movement through piezo-electric elements that convert displacement into an electric signal. Monitors are usually worn firmly attached to a belt at the hip. Data are collected over a user-defined sampling period (epoch) at the end of which it is stored in the memory for subsequent retrieval through a computer interface. The movement counts can be collected for 2 or 3 weeks, dependent on the sample frame.

Caltrac accelerometers (Hemokinetics, Madison, WI, USA) were the first of the recent generation to quantify movement, but provide only a total single count as an immediate read-out on the instrument. This type of monitor is not capable of minute-by-minute data output and does not interface with a computer, but it does provide an overall estimate of energy expenditure (in kcal), based on regression equations developed by the manufacturer. In the last 5 years, the Actigraph™, or CSA as it is more frequently known (Computer Science and Applications, Shalomar, FL, USA), which is a unidimensional accelerometer, and the Tritrac™ three-dimensional accelerometer (Hemokinetics) have been developed to allow the minute-by-minute recording of movement, similar to heart-rate monitors. Also, similar to heart-rate monitoring, this type of motion sensor has provided a rich data source of patterns of movement throughout the day. The CSA is about the size of a matchbox, but only measures movement in the vertical plane. The Tritrac provides an assessment of movement in all three planes and calculates a total movement or vector score, but is about the size of a pack of cards, which makes it cumbersome, particularly for smaller children.

Although promising, accelerometers are relatively new, and there remain only a handful of validation studies. Using the CSA a correlation of 0·61 between movement counts and physical activity level (assessed by the doubly-labelled-water technique) has been reported recently (Nilsson *et al.* 1999). In particular, valid translation of movement counts into energy expenditure has not yet been fully achieved for children. Research through laboratory-based and field studies is in the early stages of establishing this conversion and also establishing movement count equivalents for low-, moderate- and high-intensity activity (Trost, 1998; Almeida *et al.* 2000).

As yet, accelerometers are not usable in water and appear insensitive to expenditure changes due to inclines. Also, their validity for assessment of resistance exercise and cycling is questionable. However, accelerometers do appear valuable in the assessment of activity of an incidental nature, particularly in the lower to moderate intensity ranges. This category of activity, which occurs at high frequency, has to date been the most difficult aspect to assess through self report or heart-rate monitoring, and may be the most critical to overall energy expenditure. At a recent consensus conference on obesity and physical activity (Bouchard & Blair, 1999) accelerometry was seen to be the most promising future type of measure for addressing research questions concerning energy balance, body fatness and obesity development (Westerterp, 1999).

Accelerometers remain expensive at several hundred pounds each. However, with the increasing importance of physical activity on the health agenda, and the previously-articulated arguments in favour of accurate assessment, their use will undoubtedly be seen in larger studies. The European Youth Heart Study (Riddoch *et al.* 2000) is a large multi-national study that now has CSA physical activity measurements on over 4000 children. As instruments become smaller and cheaper they are likely to offer the first objective type of measure to become feasible in epidemiological studies. Furthermore, the notion of combining heart-rate telemetry with accelerometry has been considered for some time (Haskell *et al.* 1993), and newer more-refined instruments are now in development. Should these instruments reach commercial feasibility for the fitness and health market, then prices will reduce dramatically. There will be a need for systematic development of regression equations for specific populations, such as children and adolescents, that allow translation into energy expenditure, and this process may take some years. However, these instruments could provide valid objective assessment of physical activity on a minute-by-minute basis (average of sampling every 5 s) throughout the range of intensity for weeks at a time. A range of outcome indices could be used, including total energy expended through physical activity, at particular exercise intensities. In combination with diaries they would provide a comprehensive picture of when, where and how physical activity is taking place for each youngster. If this is the case, there appear to be good prospects ahead for the future of physical activity measurement.

Concluding comments

It is against this background of conceptual complexities and measurement difficulties that research concerning the activity levels and patterns of the contemporary child and adolescent has to be judged. Indirect indicators suggest that children's activity patterns are under threat. They are becoming increasingly restricted by parental fears of traffic and child abduction, there is increasing reliance by families on the car for transport, there is a reduction in curriculum time for physical education in schools, and there is the increasing attractiveness and availability of wall-to-wall screen entertainment in the home that takes away time for physical pursuits. However, we still do not have definitive data that provide us with accurate assessments of how active our children are. Much of the literature is based on surveys that rely on children's self report and that focus largely on leisure and sports activities only. Often different criteria for categorization into active *v.* inactive groups are used, because there has been no certain level defined at which children can be deemed sufficiently active for health. There have been no nationally-representative samples studied longitudinally.

Perhaps the important questions have still to be seriously addressed. If health is the key consideration, then it is important to discover which children are dangerously inactive, how they become so inactive and what can be done to make them more active. This population will best reveal the real effects of inactivity on health, and is in most need of carefully-designed campaigns and interventions. At the moment, a combination of measurement methods that includes minute-by-minute accelerometry and diaries appears to offer the most promise for charting their activity levels and patterns.

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