Overweight and Obesity in Children:
A Review of the Literature

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Executive Summary

Childhood overweight and obesity are increasingly significant problems, and ones that are likely to endure and to have long term adverse influences on the health of individuals and populations unless action is taken to reverse the trend.

A number of factors have been suggested as contributing to the development of childhood obesity. These include genetic factors, decreasing levels of physical activity, increased time spent in sedentary behaviour and changes in diet. In addition, lifestyle factors, including family influences, changes in society and media advertising, have been associated with the increasing incidence of obesity and overweight in childhood.

To address the problem, health care professionals should incorporate appropriate screening in their child practice. Comprehensive assessment of children who are, or who are at risk of becoming, obese is also necessary.

A range of interventions have been suggested, and although there is no consensus on the best way to prevent and manage childhood obesity, a combination of increasing energy expenditure through exercise, dietary modification, and reduction of sedentary behaviour, appears to be the most effective approach. Breast-feeding is also likely to have a protective influence and should be encouraged. A key element of addressing childhood overweight and obesity is involvement of the whole family and other environments in which children spend significant amounts of time, such as schools and nurseries. The aim of interventions should be to create healthy environments in which a healthy diet and exercise become part of the family's normal daily living.

Given the multifaceted nature of managing overweight and obesity in childhood, health care professionals involved in this area need to be prepared to address potentially difficult issues concerning lifestyle and choices as well as specifics of exercise and nutrition. These are areas in which some health care professionals lack confidence or role clarity. A part of reversing the trends that have led to the international pandemic of childhood obesity will therefore be to support and assist health care professionals in gaining skills and confidence in this area.

Introduction

Kimm (2003) describes childhood obesity as an 'emerging pandemic of the new millennium'. There has been a marked increase in the incidence of obesity in children in the UK over the past 20 years (Wilson 2003, Centre for Reviews and Dissemination 2002) with Caroli and Lagravinese (2002) suggesting that the prevalence of obesity in children and adolescents has doubled and that of overweight children and adolescents has shown an increase of up to 50%. In the USA, obesity is now estimated to affect 20-25% of children and adolescents (Balaban and Silva 2004). It is a worldwide concern (Kaur et al. 2003, Moran and Phillip 2003, Lobstein and Frelut 2003) with the United Kingdom (Wilson 2003), Italy (Gasparrini et al. 2003), New Zealand (Turnbull et al. 2004), South America (Guigliano and Carneiro 2004) Japan (Yoshinaga et al. 2004) and India (Ramachandran et al. 2002) among the countries in which a need for intervention has been identified.

Childhood overweight and obesity are now considered to be major public health problems (Thibault and Rolland-Cachera 2003, Knehans 2002). The increasing prevalence has health consequences likely to adversely affect the lives of a high proportion of the population both in childhood and adulthood. This will represent a significant drain on health care resources if action is not taken to reverse the trend and to assist children and young people who are overweight or obese to improve their health (Ehtisham and Barrett 2004).

This review of the literature identifies the importance of this problem, how it can be identified, the possible causes, interventions and the role of health care professionals.

A search of the available literature on childhood overweight and obesity was performed using:

- Cochrane Library
- Centre for Reviews and Dissemination
- Medline/PubMed
- Ingenta
- OVID

The search terms used were:

- Childhood and obesity
- Childhood and overweight
- Child and obesity
- Child and overweight

- Children and obesity
- Children and overweight

This search yielded over 400 articles, from which those deemed to be most relevant to the prevention and management of childhood overweight and obesity in the United Kingdom were selected.

The criteria for inclusion were that the article should add to the knowledge base that informs the management of childhood obesity or overweight. Articles dealing with obesity in the adult population that inform the debate on obesity in childhood, for example those relating to dietary intake and its effect on body mass, were included. Although articles from outside the developed world were not excluded, as they provide information on the scale of the problem, they were not included in the discussion of interventions or causes because the circumstances and approaches required are significantly different. Articles that were not available in English translation or able to be translated by the team were excluded. The literature included a range of forms of evidence: meta-analyses, single research reports including randomised controlled trails, small non-randomised studies, clinical guidelines, consensus view, expert advice, case studies, demographic information, and physiological principles. This range is necessary to place the problem contextually and to identify the issues involved. It is also appropriate to use these sources as there is a relative paucity of evidence derived from randomised controlled trails with regard to the range of issues covered within this subject area.

The review addresses childhood obesity and overweight only. It does not attempt to discuss the causes of obesity in adulthood, although the effect of childhood obesity in adulthood is alluded to as an important reason for addressing this problem. Unless otherwise stated, the studies used cover the population aged 0 to 18 years.

Definition

If childhood overweight and obesity are to be addressed, they must be defined and diagnostic criteria set to enable health care professionals to identify those who are at risk or affected. Despite the increasing number of children described as overweight or obese, there is a lack of a rigorous scientific definition of these terms and lack of clarity over how they should be assessed (Livieri et al. 2003). However, there are guidelines that can be used to assist health care professionals to determine whether a child is overweight or obese.

Ruxton (2004) and Asayama et al. (2003) define obesity as an excess of body fat, with overweight being seen as a less severe excess of body fat than obesity. Although overweight might logically be thought to refer simply to body weight, weight alone is not considered an accurate measure of whether a problem exists. There are a variety of techniques that can be used to assess the volume of body fat with considerable accuracy. These include underwater weighing (densitometry), multifrequency bioelectrical impedance analysis (BIA) and magnetic resonance imaging (MRI) (Ruxton 2004). Despite their accuracy, such methods are not appropriate or useful in most clinical situations, and would not be considered practical or desirable as screening tools. In day-to-day paediatric surveillance, the important factors in the tools used to assess whether a child is overweight or obese are ease of use, lack of invasiveness and accuracy of measurement. Easy to obtain measures include weight and height (from which the body mass index [BMI] using weight [kg] divided by height [m^2] can be assessed), waist circumference and skinfold thickness (Ruxton 2004). These methods are less exact, but they are practical and generally considered sufficiently reliable (SIGN 2003), particularly when used in conjunction with one another, to enable identification of risk (Ruxton 2004).

In adults, body mass index (BMI) is a common method of assessing whether an individual is considered obese and the definitions of obesity and overweight are agreed. A BMI of greater than 25kg/m^2 is defined as overweight and a BMI of greater than 30kg/m^2 is defined as obese. However, for children and young people (under the age of 18 years), no such absolute consensus exists (Ruxton 2004) and BMI derived from weight and height must be interpreted using percentile measures (Kaur et al. 2003, SIGN 2003). Cole et al. (2000) use the principle of the adult BMI cut-off of 30 to be indicative of obesity and 25 as indicative of overweight, and have calculated percentile figures from these for children to estimate overweight or obesity. Thus, as well as using cut-offs in accordance with a percentile measure, it is consistent with the adult definitions of overweight and obesity. Cole et al.'s (2000) tool is considered to be a reasonably accurate measure of obesity or overweight in children aged from two to six (Livieri et al. 2003, Abrantes et al. 2003, Rolland-Cachera 2004), although Ruxton (2004) suggests four years as the lowest age for diagnosis.

Harrell et al. (2003) define obese children as having a BMI above the 98th age and sex specific percentile. The Scottish Intercollegiate Guideline Network (SIGN) (2003) concur with this measurement, stating that for clinical purposes obese children should be regarded as those with a BMI equal to or greater than the 98th percentile and overweight children as

those with a BMI greater than or equal to the 91st percentile. SIGN (2003) acknowledge that this contrasts with the international consensus used for research purposes, which defines obesity as the 95th percentile or above, and overweight as the 85th percentile or above. They suggest that clinicians should be aware that, although the 98th and 91st percentile for obesity and overweight are the currently used norms in the UK, this is unlikely to be set in stone. The most common internationally accepted definition of childhood overweight and obesity is that described by Cole et al. (2000) (Livieri et al. 2003, Abrantes et al. 2003) (see Figures 1 and 2).

Rolland-Cachera (2004) suggests that in addition to identification of a child's current BMI, the use of a predictive BMI curve to identify the development of obesity even when this is not clinically visible may be helpful to allow early intervention in children who are at risk of becoming obese. Eto et al. (2004) nonetheless suggest that using the BMI as the sole indicator of childhood obesity should be done with caution because it may not accurately identify all obese children. Karasalihoglu et al. (2003) and Livieri et al. (2003) highlight ethnic differences among BMI and suggest that each country should produce its own BMI percentiles to take these into account. This is likely to be more problematic in countries that are multi-ethnic or multi-racial, such as the UK, than in countries where the population is relatively homogenous.

Livieri et al. (2003) state that, because obesity is caused by an excess of body fat, methods used to measure body fat such as subcutaneous skinfold thickness can be used to assess obesity. Triceps skinfold can be used to define obesity in children with triceps higher than the 85th percentile for age and gender, using Tanner's tables. Livieri et al. (2003) suggest that this tool should be used in association with BMI measurement. However, they also identify that, despite its potential usefulness, measuring skinfold thickness requires training and the use of appropriate equations to transform measurements into percentage body fat, making it slightly less easy to use in day-to-day practice and for routine screening than BMI.

Waist circumference has also been suggested as a method for assessing obesity, with McCarthy et al. (2001) providing estimated waist measurement percentiles for boys and girls from 5 to 16.9 years of age. However, these have yet to be validated by further studies, and do not appear as reliable or valid a measure or predictor of obesity as BMI percentiles or subcutaneous skinfold thickness (SIGN 2003).

Although they are not infallible, and do not indicate the cause of overweight or obesity, BMI measures are a useful first point of problem

identification. The percentiles and classifications recommended by Cole et al. (2000) are currently considered the most reliable and valid and should therefore be used at this point in time. They can be incorporated into routine screening and developmental assessments, for example at 18 months, three and a quarter years and four plus years pre-school assessment, or if a child presents for another reason that merits investigation for overweight or obesity.

The Effects of Childhood Overweight and Obesity

Balaban and Silva (2004) and Caballero (2001) identify that childhood obesity increases the risk of poor health in childhood, the development of obesity in adults and subsequent obesity-related health problems in adulthood.

During childhood, Graf et al. (2004) suggest that overweight and obesity are associated with poorer gross motor development and Davidson et al. (2003) identify that children who are obese may be more prone to orthopaedic problems. Type two diabetes, traditionally viewed as a disease of adulthood, is now seen with increasing incidence in the paediatric population and has been linked with childhood obesity (Pinhas-Hamiel and Zeitler 2000, Hotu et al. 2004). Kelley et al. (2004) and Harrell et al. (2003) claim that the changes which result in cardiovascular disease, such as atherosclerotic changes, can begin in early childhood and Al Sendi et al. (2003) identify that adolescent obesity is associated with raised blood pressure. Thus, the physiological changes associated with later cardiovascular disease development seem to be evident in overweight or obese children and adolescents, resulting in the potential for early development of cardiovascular disease. Childhood obesity has also been linked to an increased risk of orthopaedic disorders, respiratory problems and diabetes in adulthood (Balaban and Silva 2004, Caballero 2001).

As well as physiological changes resultant on overweight and obesity, which appear to commence in childhood, obese children are thought to be more prone to psychological distress than non-obese children, and the effect is greater for girls than boys. (Phillips and Hill 1998). Obesity in childhood and adolescence is also associated with poor self esteem, eating disorders and body dissatisfaction (Neumark-Sztainer and Hannan 2000).

As well as such adverse effects, the habits and behaviours established in childhood are hard to change at a later stage (Caroli and Lagravinese 2002). Thus, preventing or reversing habits and lifestyle choices that predispose to poor health in childhood seems preferable and more likely to be successful than attempting to address them in adulthood.

Factors Influencing Overweight and Obesity in Children

The cause of overweight and obesity in children is thought to be a complex dynamic of the balance between energy intake and expenditure in the context of an individual's environment, behaviour and genes (Clement et al. 2002, Kimm 2003, Balaban and Silva 2004). The links between genetics and environmental factors in obesity in children are particularly difficult to disentangle from one another because children often have similar eating habits and approaches to physical activity as their parents (Oliveria et al. 1992, Nguyen et al. 1996).

Genetic factors

Warden and Warden (2001) identified 15 chromosomal loci linked to weight, body fat and other obesity related traits in humans. They state that seven genes have been identified as causing obesity in humans and that, in most cases, obesity results from interactions between multiple genes, not the action of a single gene. In exceptional cases, mutations of the leptin gene and its receptors or mutation of melanocortin receptor 4 have been described. These 'obesity genes' encode proteins that are strongly connected as part of the loop regulating food intake. They all involve the leptin axis and one of its hypothalamic targets, the melanocortin pathway. Thus, successful leptin protein replacement in a leptin deficient child may have potential for reduction of obesity (Clement et al. 2002, Bell Anderson and Bryson 2004).

Breast-feeding

An individual's first nutritional experiences are believed to influence susceptibility to certain chronic diseases, including obesity (Waterland and Garza 1999, Waterland and Garza 2002). Balaban and Silva (2004) suggest that it has long been hypothesised that breast-feeding may help protect against obesity. They suggest that despite the genetic link to obesity there may be a critical period of development which causes mutations in the expression of certain genes. Waterland and Garza (2002) suggest that such early metabolic imprinting may occur by changing the structure of certain organs, for example by altering vascularisation, innervation or the juxtaposition of cell types inside an organ, effecting changes in the number of cells and metabolic differentiation. Thus, changes in expression of certain genes may cause changes in production of, for example, enzymes, hormones and transmembrane transporters, which may result in predisposition to obesity. This theory would mean that nutritional experiences in the prenatal or early neonatal period might affect whether an individual later becomes obese. Breast-feeding is one of the earliest nutritional

experiences and the unique composition of breast milk could be involved in metabolic imprinting (Balaban and Silva 2004).

Alternative biological mechanisms could also account for an increased risk of adiposity in non-breast-fed infants. These include the protein intake in breast-fed infants being significantly lower than in formula fed infants because a high protein intake at ten months of age has been linked with a high BMI later in childhood (Rolland-Cachera et al. 1995). Thus, there is a suggestion that breast-feeding may constitute preventative action for avoiding overweight or obesity in childhood and later life. In addition to the potential physiological effects of breast-feeding on later obesity, the behavioural aspects, such as development of the mother-child relationship, may assist a smoother dietary transit and formation of healthy eating habits (Balaban and Silva 2004).

There is evidence to support the link between breast-feeding and the prevention of childhood obesity. Kramer et al. (1985a, 1985b) found breast-feeding to be protective against obesity at ages 12 and 24 months. Gillman et al. (2001) found that children who had been breast-fed for six months or more were less likely to become obese and von Kries et al. (1999), Liese et al. (2001), and Armstrong et al. (2002) all support the suggestion that there is a lower incidence of obesity in breast-fed infants. Bergmann et al. (2003) showed that early bottle-feeding produces rebound obesity, predictive of obesity in later life. Kramer (1981) and Tulldahl et al. (1999) also found that breast-feeding appeared to have a protective effect against the development of obesity in adolescence. In Kramer's (1981) study, breast-feeding was considered to have ceased if the child was bottle fed more than once a day.

Conversely, Zive et al. (1992), O'Callaghan et al. (1997) and Wadsworth et al. (1999) found no significant differences in adiposity in children who were or were not breast-fed at age four, five and six years respectively. Fomon et al. (1984) also found no difference in adiposity in children aged eight who were breast-fed in comparison with those who were not, although there is some lack of clarity in this study over whether those who were cited as breast-fed were exclusively breast-fed (Balaban and Silva 2004). Li et al. (2003), using data from the offspring of the 1958 British birth cohort, found no support for a protective effect of breast-feeding on obesity. Again in contrast, Agras et al. (1990) suggest that breast-feeding for more than five months is associated with greater adiposity at age six years, although this study had a high loss of follow-up participants.

An editorial by Clifford (2003) points out that randomised controlled trials cannot be conducted in this area and that the largely observational studies that have been reported are subject to large numbers of confounding influences, which may explain the inconsistent results; for example, retrospective reporting of breast-feeding, inadequate sample sizes and ill-defined and disparate end points. Her conclusion is that the possibility of breast-feeding having a protective effect remains and 'that even if [that effect] is small the public health impact can be tremendous' (p879).

Energy balance

Increased energy intake and decreased energy expenditure are often seen as the major causes of obesity. Some authors nonetheless report no difference in energy intake between obese and non-obese individuals (Atkin and Davies 2000, Troiano et al. 2000). However, it is possible that self reports of dietary intake confound such findings (Balaban and Silva 2004) and indeed Strauss (1999) claims that obese adults generally under report the amount they eat. Fox (2004) suggests that self reports are especially unreliable in children, particularly regarding less memorable eating, which may include incidental snacks.

Whether the resting basal metabolic rates of obesity-prone people are lower than those of lean people is a source of debate and important in the prevention and treatment of obesity. This links with the debate on the genetics of obesity, as such traits, if proven, could possibly be genetically modulated. However, Strauss (1999) states that in most obese adults no significant measurable differences in metabolism can be detected and that, contrary to expectations, overweight adults often had higher metabolic rates than lean people. These findings are relevant to childhood overweight or obesity in that they question the assumption that a low basal metabolic rate is a common cause of overweight.

The role of lipids in obesity rather than overall energy intake has also been debated. Chen et al. (2002) found that dietary fat intake is a risk factor in the development of childhood obesity. This reflects the findings of three meta-analyses of randomised clinical trials in adults which identify that reducing the intake of dietary fat causes a significant reduction in body weight (Astrup 2002). However, Willet (2002) identifies that, despite a reduction in fat consumption in the USA (across the population, including adults and children), the incidence of obesity has increased and suggests that other factors, such as diminishing exercise levels, may account for the increased incidence of obesity. However, Aihaud and Guesnet (2004) claim that although the absolute fat content of diets may be unchanged, or may even be reduced, an increase in polyunsaturated fatty acids may account for these apparently

contradictory findings. Polyunsaturated fats are potent in adiposegenesis in vivo during the gestation and lactation periods and thus changes in the fatty acid composition of ingested fats, rather than the total fat content of ingested food, may be important in the development of obesity and overweight across populations, in both adults and children (Aihaud and Guesnet 2004).

Patterns of eating may also contribute to overweight and obesity. It has been suggested that inadequate family meal patterns may contribute to early obesity (Giugliano and Carneiro 2004) and that having the television on during mealtimes is associated with poor quality food intake in children (Coon et al. 2001). Snacking between meals has been debated as a contributory factor to the development of overweight and obesity in childhood. However, Ruxton et al. (1996) report no significant differences between body fat in seven and eight-year-old children between those classified as 'high' and 'low' snackers and Gibson (1996) shows no absolute association between snacking and obesity. Hampl et al. (2003) suggest that the type of food consumed as snacks, rather than snacks per se, should be the focus. Although it appears that childhood overweight and obesity are not solely determined by energy intake and output, St Onge et al. (2003) suggest that, as children's BMI has increased, so has their consumption of fast foods and soft drinks. They report that the proportion of food consumed by children from restaurants and fast food outlets in the USA increased by nearly 300% between 1977-1996. Fox (2004) identifies that children and young people are increasingly exposed to environmental stimuli that promote poor dietary habits and decreased energy expenditure.

Sedentary Behaviour

Inactivity has been associated with obesity but causality has yet to be established (Livingstone et al. 2003). Tremblay and Willms (2003) and Giugliano and Carneiro (2004) suggest a link between physical inactivity and obesity and Vandewater et al. (2004) found that heavier children generally spent more time in sedentary activities. However, levels of physical activity are hard to measure in adults and even more problematic in children due to their more complex and multidimensional activity patterns (Livingstone et al. 2003). Moore et al. (2003) used a device that children wore to record total physical activity levels, and thus, unlike some measures, included organised activity and incidental activity (although the device had to be removed for swimming or bathing) enabling them to more accurately measure children's total activity. They identified that children who have the greatest daily activity from ages four to eleven years have consistently smaller weight gain, BMI, triceps and sum of skinfold throughout childhood. Although there is a problem over what is deemed to constitute an acceptable level of physical activity

(Livingstone et al. 2003), Reilly and McDowell (2003) identify an increasing body of evidence to support the suggestion that tackling physical inactivity is key to managing childhood obesity.

As well as general levels of sedentary activity, television viewing has been specifically linked with obesity (Livingstone et al. 2003, Spagnoli et al. 2003). This is in part due to the reduction in sedentary behaviour that can be achieved by substituting television watching for more active pursuits, but also the reduction in exposure to food-related advertising if television viewing is reduced (Caroli and Lagravinese 2002). It has been estimated that in the USA children and adolescents are likely to watch 22,000 television commercials each year (Caroli and Lagravinese 2002). In Europe, there is scant evidence to support links between television viewing and obesity, but food advertising has been shown to be most frequent during children's peak television viewing hours and, among these, cereal, confectionery and savoury snacks account for 60% of all food advertising (Lewis and Hill 1998). Jeffrey et al. (1982) suggest that exposure to adverts for foods of poor nutritional value increases children's requests for and purchase of them.

Media

Coakley (2003) identifies that, in the eyes of global corporations, children are a huge billion-dollar market, with advertising therefore likely to be targeted at them. Schwartz and Puhl (2003) suggest that powerful environmental inducements are used by marketing experts to encourage children to eat nutritionally poor food. Thus, although a recommendation may be made that children should be encouraged to eat a healthy diet, parents may be torn between attempting to encourage a healthy lifestyle and a battle against media pressure and children's exposure to unhealthy messages.

Family

Although SIGN (2003) identify that there is no recent study in the United Kingdom evaluate the link between parental obesity and the risk of childhood obesity, there is a suggestion that the dietary behaviour and lifestyles of parents have a significant impact on their children. For example, Hodges (2003) suggests that children with active parents are more than six times more likely to be physically active than children whose parents take no exercise. This is not surprising because children are generally provided with or guided in their dietary intake by their parents and siblings, and are influenced in their own food, exercise and leisure time activities by the approaches engaged in by the family as a whole. Thus, all interventions for childhood overweight and obesity should be underpinned by the principle of treating the child as a part of the family.

Family mealtime habits, family dietary patterns and activity levels are thought to influence the development of overweight and obesity in children. However, Bruch (1974) suggests that a severe form of obesity, whose origins are in the first year of life (although this does not necessarily present as obesity at this time) may be due to parents' failure to distinguish their child's physical need of food from other emotional or biological needs. This results in food being used as the only tool to satisfy any of a child's needs. Bruch (1974) suggests that this may result in the child not differentiating needs and emotions and using food as a solution to all their problems. However, emotional eating is also a behaviour seen in non-obese subjects (Bellisle et al. 1990, Caroli et al. 1998) and so cannot be seen as a universal or unequivocal link.

As well as family role modelling, socioeconomic factors are thought to play a part in childhood obesity. Kinra et al. (2000) found a significant relationship between social deprivation and the incidence of childhood obesity and Tomkins (2001) suggest a link between social exclusion, poverty and obesity.

Interventions

Given the increasing incidence of childhood overweight and obesity, careful monitoring of children's growth and development to diagnose obesity and associated disorders is necessary (Ariza et al. 2004). This includes identifying children who are overweight or obese, considering disease or genetic processes that may be at play, investigating dietary input and level of activity, and food-related behaviour, so that assumptions regarding the cause of overweight or obesity are not made.

It is clear that a number of factors affect the development of obesity in childhood. Thus, approaches to prevention and treatment of childhood obesity must encompass the numerous possible causative or predisposing factors. In addition, they must aim to increase the likelihood of compliance with interventions. Reinehr et al. (2003) found that children who were obese and did not receive treatment did not reduce their weight, and that those having single session consultations did not have sustained weight loss. However, weight loss over two years was evident among participants who received long-term specialised treatment. This consisted of physical exercise, nutrition education and behaviour therapy, with regular reviews over the two-year period. Although these findings are from a single study, and not necessarily generalisable, they suggest that sustained intervention and support, which embraces nutrition, exercise, education and food-related behaviour, are necessary to enable children who are overweight to achieve sustained weight loss. They also suggest that ongoing input is necessary.

Despite the undisputed need for interventions to reduce childhood overweight and obesity, Campbell et al. (2001) reviewed literature across eight studies and found limited quality data on the effectiveness of obesity intervention programmes and a lack of generalisable conclusions regarding dietary education and exercise. The Centre for Reviews and Dissemination (2002) identify that there is a lack of good quality evidence on the effectiveness of various strategies related to childhood obesity to inform national strategies or clinical practice. McLennan (2004), Kaur et al. (2003), Suskind et al. (2000), Davidson and Birch (2001) and The Centre for Reviews and Dissemination (2002) nonetheless state that, while there is no absolutely conclusive evidence regarding the best interventions at present, these should include comprehensive management of the issues thought to be involved in the development of obesity, including diet and dietary education, exercise, decreasing sedentary activity, and family-based interventions. Westenhoefer (2002) identifies that, given the problem is one of childhood, education strategies

must be appropriate to the child's stage of cognitive development. This means those providing input being aware of the level of understanding that each child has and being able to communicate with them in appropriate terms.

High compliance is essential to managing childhood obesity (Denzer et al. 2004). Although increased knowledge has been associated with changes in diet and lifestyle in some cases, knowledge without strategies to increase compliance is unlikely to change behaviour in the long term. To be successful, interventions must yield direct, perceivable and immediate benefits (Westenhoefer 2002).

Diet

Various specific dietary approaches have been suggested, but none has unequivocal evidence to support its superiority. Gassparini et al. (2003) studied the long-term effects of different dietary treatments and found that a variety of dietary interventions, including low calorie (1200 or 1400 calories a day) and ketogenic diets were effective in reducing obesity. Bailes et al. (2003) found that a high protein, low carbohydrate unlimited calorie diet was more effective than a restricted calorie protocol for weight loss in obese school-aged children. However, influencing factors for success in any dietary regime also included motivation and previous level of knowledge about obesity (Gassparini et al. 2003). Ruxton (2004) considers that it is inappropriate for all but the most extreme cases of childhood obesity to be treated with a calorie-controlled diet as it could potentially limit the child's intake of vitamins and minerals during critical growth periods. She considers that, in the majority of cases, arresting weight gain over a period of months while the child gains height is a safer option.

Increasing the intake of dietary fibre is often linked with reduction of body weight in adults. However, Edwards and Parrett (2003) suggest that there is a lack of clear and well-founded recommendations for dietary fibre intake in childhood. There is a fear that a high fibre diet in children under the age of five may adversely affect growth and cause mineral imbalance, although these fears are not well supported in the literature, especially for children in the developed world. With the increasing incidence of obesity, increased dietary fibre intake may be useful. However, more research is needed into the effects of increased dietary fibre in children before any recommendations can be made.

Westenhoefer (2002) recommends that children and young people should be educated regarding diet and nutrition, to enable them to gain flexible control of eating to remain within the range of acceptable sizes and weights, rather than focusing on specific 'diets'. They recommend

focusing on a balanced diet, providing of a variety of foods, and including social eating occasions to promote the special meaning and importance of eating, and to enable social learning of food preferences and behaviours. Burniat (2002) and Ruxton (2004) also believe that general guidance on healthy eating with education that enables the child and family to understand the principles of healthy eating rather than specific instructions are the best approaches. The overall message from a dietary perspective seems to be that, in most instances of childhood overweight, what might be broadly considered a 'healthy diet' will be helpful (SIGN 2003, see Figure 3 for details of healthy diet). Ruxton (2004) considers that this will suffice in the majority of cases, and that where children fall into the 'obese' category, they require referral to a paediatric dietician or specialist multidisciplinary team rather than general dietary advice.

Television viewing

Television viewing is a form of sedentary behaviour, and thus decreasing television viewing and supplementing other activities may be helpful. In addition, the reduction of exposure to advertisements for unhealthy foods may be beneficial in dietary terms, as viewing such commercials has been shown to increase the request or consumption of unhealthy foods, even in pre-school age children (Borzeskowski and Robinson 2001). Therefore, a recommendation that families address television viewing and consider how this may be replaced by more active pursuits seems reasonable. SIGN (2003) recommend reducing physical inactivity such as watching television or using computer games to less than two hours a day or equivalent of 14 hours per week.

Given the suggestion that television viewing during mealtimes has been associated with a poorer quality food intake (Coon et al. 2001), having the television off during mealtimes seems an appropriate recommendation.

Physical activity

Reilly et al. (2003) suggest that British children now establish a sedentary lifestyle early on and thus interventions to reverse this trend in early childhood are advisable. Some interventions aimed at increasing activity and encouraging less sedentary behaviour have shown encouraging results (Reilly et al. 2003, Graf et al. 2004, Moore et al. 2003). It seems that encouraging leisure time activities involving physical activity rather than television viewing, should be particularly encouraged because of the double risk of sedentary behaviour and exposure to unhealthy messages associated with television commercials.

Graf et al. (2004) recommend early intervention to support exercise and movement and Moore et al. (2003) suggest that interventions to increase children's activity level begun as early as four years of age may be

helpful in preventing obesity. Mo-Suwan et al. (1998) describe an intervention using a structured aerobic programme where pre-school children participated in a 15 minute walk before nursery school and a 20 minute dance routine after their afternoon sleep, three times a week. This study, involving 300 children, showed a near-significant decrease in triceps skin folds over time in children who had exceeded the 95th percentile. Thus, there is some evidence that organised physical activity, even in children aged four years, can be helpful in preventing or treating obesity. Moreover, relatively simple activities, such as short walks, even in this age group, appear to contribute to a reduction in obesity.

However, exactly what forms of physical activity are the most advantageous is not clear. Fox (2004) identifies that physical activity in children is hard to quantify, and includes the energy expended in travelling to school, informal play before and after school, at breaks and out of school, organised work such as paper delivery rounds, and organised sport. Tremblay and Willms (2003) identify that increased participation in sport is associated with less obesity in childhood in seven to eleven year olds. Conversely, Mallam et al. (2003) found that the amount of the school day sent in sport did not correlate with levels of obesity and that increasing Physical Education lessons does not necessarily address the problem of obesity and overweight. They also suggest that, unless close attention is given to the management of overweight or obese children in Physical Education lessons, these may be counterproductive as overweight and obese children may not enjoy such lessons and be discouraged from participating in sport by them. A range of activities should be available to encourage all children to participate in sport.

Strategies suggested to increase physical activity include encouraging active commuting to school. However, the effectiveness of this is poorly researched and must be considered alongside reasons for parents' transport choices, including perceived safety issues and time factors (Tudor-Locke et al. 2001). Cooper et al. (2003) nonetheless found a positive correlation between walking to school and physical activity in ten-year-olds, with those walking to school more active over the course of the day than those who did not. One approach introduced in some areas is the concept of 'walking buses' whereby children are escorted in walking groups to school. The initial aim of this was primarily to decrease traffic congestion. However, it also has the potential to increase physical activity without placing a burden on parents to walk to school, which may be problematic from a lifestyle perspective and with regard to other child care arrangements. Such schemes are not available in all areas and their effectiveness in relation to childhood health has not been evaluated.

They nonetheless form an option for increasing active commuting to school.

All pursuits involving activity are likely to be beneficial in combating childhood obesity. A part of holistic care of the child and family is identifying the activities most likely to succeed for individuals, for example walking or cycling to school, participating in sports, or engaging in more active breaktime activities at school rather than computer games. Ruxton (2004) suggests encouraging children to participate in active children's clubs, for example Scouts or Guides, or to join other family members in sports such as walking or swimming. Simple activities requiring minimum lifestyle changes should also be encouraged, such as walking up stairs instead of using lifts (SIGN 2003).

Again, family involvement is important, and encouraging whole families to adopt a less sedentary lifestyle seems important in assisting children to achieve this (Hodges 2003). Education of children and their families concerning increasing physical activity is important for them to understand this in relation to body weight. Their involvement is essential to enable them to select lifestyle changes that they will be able to accommodate and sustain.

Behavioural approaches

Behavioural approaches to weight reduction as well as physical interventions have been suggested. Braet and Crombez (2003) suggest that some obese children respond in a specific manner to food words and are hypersensitive to food cues. The suggestion that food may be used by some children to satisfy emotional as well as hunger needs (Bruch 1974) suggests that some obese children may require assistance to identify their needs, to differentiate food needs from other needs, and to develop alternative strategies to cope with emotional needs.

This is not the case for all obese or overweight children, and emphasises the need for comprehensive assessment of the cause of overweight or obesity in individual cases. Behavioural approaches requiring psychologist input aimed at altering responses to food words or cues, or the emotional use of food, may be useful. However, this falls within the remit of specialist staff and is not something recommended for the non-specialist. Non-specialist health care staff should seek to identify children’s eating habits and behaviours, and from this derive information to enable them to see when referral is appropriate.

Family interventions

Pinhas-Hamiel and Zeitler (2000), Zametkin et al. (2004) and Ariza et al. (2004) suggest that the treatment of childhood obesity must involve education and motivation of the whole family. Family involvement may

need to begin with recognition of the problem. Etelson et al. (2003) claim that many parents of overweight children do not perceive their children as overweight. Strategies to reduce obesity or overweight must therefore include helping parents to recognise this and to perceive it as problematic.

It seems unlikely that a child or young person will be able to easily alter their lifestyle and food choices if their family do not act as enabling influences in this. McLennan (2004) suggests that family involvement is especially important in primary school-aged children where the majority of their eating and out of school activities are undertaken with the family. Golan and Weizman (2001) suggest an approach to treating childhood obesity that integrates behaviour related to nutrition and sedentary activity. It emphasises parents acting as a source of authority and as role models, and includes them providing a family environment that fosters healthy mealtime habits and exercise, incorporating healthy activities into the family lifestyle. This encourages participation from the family as whole, rather than personal blame or responsibility being attributed to the child. The intention is for the whole family to create an environment where healthy eating and appropriate activity levels are the norm, not an intervention. Consequently, successful interventions related to childhood obesity appear to require working with families as a whole and considering the knowledge base on which their choices are made. Consideration should also be given to the financial, social and organisational issues involved in changing the family's approaches to activities linked with the development of obesity.

Obesity in adults and children has been linked with poverty. There is a suggestion that less nutritious foods are less expensive, and that families struggling to gain adequate incomes do not have the time or resources to prepare nutritious meals, or to enjoy family mealtimes and healthy leisure time activities. Thus, any discussion of changes in lifestyle must include identification of factors external to diet and activity per se that impinge on these. Resolutions must be devised with these factors in mind so that realistic interventions can be made, which are manageable within the real life of the family.

School-based interventions

As well as the family, school has a significant influence on children, and so school-based strategies to combat childhood overweight and obesity may be useful. Wehling and McCarthy (2002) suggest that school-based education programmes about healthy diet and lifestyles can improve knowledge, and Kaur et al. (2003) consider school-based interventions useful as they have the potential to reach large numbers of children. However, they acknowledge that these are expensive and require follow up to be effective.

School-based interventions, like other interventions, must include factors likely to influence health-related behaviour as well as information giving if they are to succeed. This includes: the structure of the school day, to encourage activity and reduce sedentary behaviour (Fox 2004); provision of a range of activities to suit children who enjoy competitive sports, but also to enable activities such as walking or cycling in those who do not (Fox 2004); food choices at school (St Onge et al. 2003); and pricing of healthy food choices in comparison with unhealthy ones (St Onge et al. 2003). Thus, as well as education, school ethos and policy are important factors in preventing and treating childhood obesity (Carter and Swinburn 2004). Sahota et al. (2001) showed some improvement in BMI in children who engaged in a school-based programme designed to influence physical activity and diet as well as knowledge. This included teacher training, modification of school meals, and implementation of school action plans to promote healthy eating and physical activity. Thus, it appears that strategies embracing every aspect of school life are the most likely to be effective.

The child's well-being

As well as interventions aimed at reducing obesity, the child's overall well-being must be taken into account. Berg et al. (2003) and Golan and Crow (2004) suggest a health-centred rather than weight-centred approach to diet and lifestyle modification as important factors in enabling children and young people to achieve weight loss. They recommend approaches that emphasise living actively, eating in a healthy way, and that focus on the whole child – mentally, physically and socially. Westenhoefer (2002) identifies that education about overweight and obesity should include providing children and young people with reassurance about the range of healthy and acceptable body weights and shapes. Zametkin et al. (2004) also emphasise the need to help obese children build a positive self image and to help them lead full lives regardless of their weight.

Social and political influences

Fox (2004) suggests that children are immersed in lifestyles and cultures that make unhealthy food and drink increasingly available, reduce the opportunity to expend energy and increase the time spent in sedentary pursuits such as television viewing. Such transitions in society's accepted norms of behaviour have coincided with the epidemic of obesity in childhood and adolescence, making the link between the two appear important.

Although involvement of child, family and school seems to be essential in managing childhood obesity, given the influences of society and the media on eating habits, level of activity and other lifestyle issues, it is simplistic to consider that the international epidemic of childhood obesity

can be addressed fully without political and economic involvement (Elrick et al. 2002). Davidson and Birch (2001) also suggest that approaches must include the larger contexts of community and society. This includes, for example, giving consideration to the anxieties parents face when attempting to encourage a less sedentary lifestyle, such as the safety of neighbourhoods and play areas (Fox 2004). Political activity aimed at reducing the unhealthy messages that children, young people and their parents receive via the media, as well as addressing issues of safety, form a part of health care professionals' roles in that they affect the best interests of their clients.

Health Care Professionals

Kaur et al. (2003) and Yoshinaga et al. (2004) suggest that there are three critical periods in the development of obesity: prenatal, early childhood (age four to six years) and adolescence. This influences which health care professionals are likely to be the most crucial in preventing and treating childhood obesity. It therefore seems that midwives (who are in contact with mothers antenatally and postnatally), and health visitors, who provide input for families in infancy and during the early childhood years, are particularly vital in preventing or managing childhood obesity.

The important contribution that breast-feeding makes to the health of mothers and babies is well established (American Academy of Pediatrics 1997) and new evidence continues to emerge (Marild et al. 2004; Martin et al. 2004; Sadauskaite-Kuehne et al. 2004). However, its possible protective effect against obesity may provide one further incentive for midwives to encourage and support mothers to initiate and continue breast-feeding. It may also provide health visitors and paediatric nurses with greater motivation to assist mothers to continue to provide infants with breast milk.

Early childhood is also identified as a key risk time for the development of obesity. Hesketh et al. (2004) therefore suggest that targeting children at this point is necessary. Drohan (2002) suggests that the preschool years are a time when food and activity behaviours interact and thus a critical time for intervention and formation of early eating habits. Health visitors therefore have a key role in the identification of at-risk children. Although the literature suggests these three critical periods, the health visitor is involved in the care of the child and family throughout childhood and is well placed to assist them, not only during the ‘early childhood’ phase, but during infancy. Although a critical period for development of obesity may be between four and six years, habits established before this time are likely to influence behaviour. In addition, education opportunities regarding healthy eating and establishing mealtime behaviours may be especially useful at the time of weaning. Interventions by health visitors throughout infancy may be useful in establishing healthy behaviours and lifestyles to prevent later overweight in children. Given the focus on improving lifestyle, particularly by increasing physical activity, health visitors may need to help parents plan for active travel to preschool and school. They are also likely to be best placed to explore activities and interventions that are practical and manageable in individual family circumstances, as well as assessing risks in a child and their family’s lifestyle and appraising whether or not an obesogenic environment exists.

This should form part of the health promotion role of health visitors. Health visitors or general practitioners generally perform developmental checks, and will therefore be involved in using BMI percentile measures to identify at-risk or overweight infants and children.

The prevention and treatment of childhood obesity as an urgent and commonly encountered issue is a relatively recent addition to the role of health care professionals, and not necessarily one with which they are comfortable. Whitaker et al. (2004) identify that health care professionals need increased training opportunities related to the prevention and treatment of childhood obesity. This not only includes nutritional knowledge, but knowledge of the barriers to implementing alterations in diet and activity levels. Their study indicates that dieticians, who are arguably ideally placed to educate children and their families on obesity related-issues, were less likely to identify barriers to successful interventions (such as lack of parental involvement, lack of motivation, and lack of support services) than paediatricians or paediatric nurse practitioners. Given that knowledge alone is unlikely to result in changes in behaviour, there is clearly a need for educating health care professionals to encompass the many factors associated with addressing childhood obesity.

Health care staff in Whitaker et al.'s (2004) study generally felt least confident in managing behavioural techniques, giving guidance on parenting techniques and addressing family conflict than in other areas of obesity management. Given that the complex interactions of family, school, wider society, food consumption, leisure activities, family interactions, beliefs and values are all interlinked influencing factors in obesity management, the education of health care professionals must include how these elements of care can be addressed. This implies that education for health care professionals must move beyond factual information related to disease processes, genetic predisposition, and nutritional intake and energy output. Given that the evidence related to childhood obesity continues to include some areas of uncertainty, health care professionals must also be able to engage in conversations that include unknown factors. This is problematic in many situations in the broad field of medicine, but is nonetheless a necessary part of current health care practice. Whitaker et al. (2004) suggest facilitated group discussion may be useful in such training situations to enable health care professionals to become more confident in engaging in the potentially difficult and complex discussions that appear to be essential for managing childhood overweight and obesity.

Recommendations

It is clear that childhood overweight and obesity are problems likely to endure and to have long term adverse influences on world health if well planned strategies to reduce them are not devised and implemented. Although there is currently limited high quality data on the effectiveness of obesity prevention and treatment programmes (Summerbell et al. 2004), the themes that consistently emerge are that programmes should include the following:

Assessment

This should include identification of children who are, or who are at risk of becoming, obese. The most useful initial screening tool appears to be Cole et al.'s (2000) BMI percentile measure.

Increasing physical activity

This should aim to improve the child and their family's level of activity, and to enable them to engage in activities they will enjoy and be able to incorporate into their lifestyle. This may include participation in sports, but may also involve less strenuous activities such as visiting parks and playgrounds, and clubs involving active pursuits. A variety of activities should be explored with the child and family, to ascertain what would be most enjoyable and practicable for their lifestyle (and thus most likely to produce compliance). This could include swimming, rollerblading, cycling or team activities. Other options to be encouraged and that could be relatively easily incorporated into daily routines include walking up stairs instead of taking lifts (SIGN 2003).

There is evidence that increasing physical activity such as walking in children as young as four years is effective in treating and preventing overweight or obesity. Active commuting to school is an approach that has seen some success, and health care professionals, schools, local authorities and parents should be enabled to work together to see how this can be achieved. SIGN (2003) recommend that obese children should engage in brisk walking for a minimum of 30 minutes a day, and that healthy children should engage in at least 60 minutes of moderate physical activity per day.

Reduction of sedentary behaviour

Children should be encouraged to participate in active rather than sedentary pursuits, with a particular focus on reduction in television viewing, especially at mealtimes.

Adjustment of dietary intake

The initiation and continuation of breast-feeding should be supported. A healthy diet should be followed by the child and family. Education regarding nutrition and developing healthy eating and lifestyle habits

should be the focus, rather than specific dietary regimes. The healthy approach to eating using the plate model is recommended as being easy to use (SIGN 2003) (see Figure 3) and can be accompanied by additional dietary advice (see Figure 3).

Children should be provided with regular meals and snacks, and 'grazing' all day should be avoided. (SIGN 2003). In addition, eating should be separated from other activities such as television viewing (SIGN 2003).

Rewards should not always be food-based, and comfort should include attention, listening and hugs, not food (SIGN 2003). Furthermore, children should be encouraged to listen to internal hunger cues and to eat to appetite (SIGN 2003).

When to refer a child

This guidance is recommended in most cases for the prevention and management of childhood overweight and obesity. However, in some cases, urgent referral to specialists is appropriate before initiating treatment. SIGN (2003) suggest that referral to community or paediatric consultants is appropriate before treatment is initiated where:

- Children have serious obesity-related morbidity that requires weight loss (e.g. benign intracranial hypertension, sleep apnoea, obesity hypoventilation);
- Children are suspected of having an underlying medical condition causing obesity;
- Children are above or equal to the 99.6th percentile BMI.

Where additional behavioural interventions are required, specialist referral (for example to a psychologist) is appropriate and such specialist interventions should not be initiated by staff who do not have appropriate experience in these fields. Consideration of psychological and behavioural factors affecting nutrition are important but, generally, non-specialist health care staff should assess whether such referral is merited rather than attempting such therapy themselves.

Family focused care

Involvement of the whole family is a key issue in the prevention and treatment of childhood overweight and obesity. Parents should be encouraged to role model healthy behaviour and to display consistent behaviours in relation to food (SIGN 2003). Thus, health care professionals must be able to work with whole families, and to address the complex issues of family dynamics, beliefs and values, and how healthy lifestyles can be developed by individuals. This is likely to require additional education and training to build confidence in this key aspect of care.

Ongoing intervention and support to embrace family involvement, dietary modification and exercise has been shown to be the most effective approach for assisting children to achieve sustained weight loss, with one-off consultations being regarded as relatively ineffective. Therefore, health care staff should design and facilitate ongoing intervention, support and monitoring for children and families who require treatment for overweight or obesity.

Creating healthy schools

As well as active commuting to school, a healthy ethos in schools should be created to enable children to choose food and activities that promote health. This includes pricing and availability of snacks and meals, and encouraging active rather than sedentary pursuits in break times.

Wider social issues

Political and economic action to reduce a culture that promotes sedentary behaviour and poor eating habits should be addressed. This includes issues of safety, so as to enable outdoors activities, and social expectations that may create problems for parents engaging with their children in active pursuits.

Health care professionals

Suskind et al. (2000) recommend that multidisciplinary programmes are the most effective for treating children and adolescents to ensure that maximum knowledge and skills are accessed. Specific staff groups are most likely to require refined skills and knowledge in this area. These are midwives, health visitors, school nurses, general practitioners, community paediatricians and paediatric dieticians.

Screening for overweight or obesity should be incorporated in developmental checks performed by general practitioners and health visitors.

Investigation into health care workers' knowledge, confidence and perceptions of their role in this area are merited, so that appropriate support and education can be designed and facilitated to enable them to provide the best possible input for children and their families.

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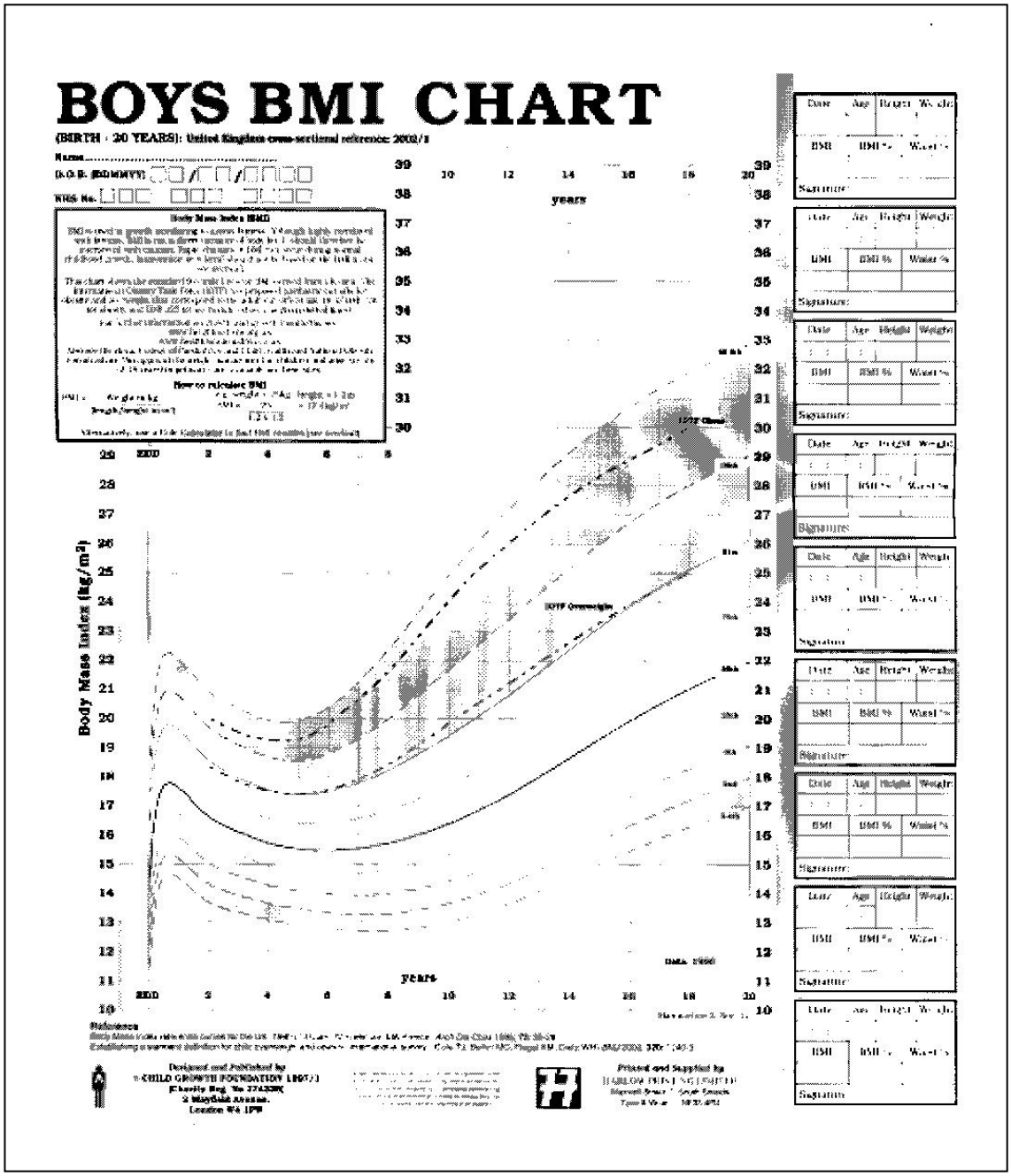
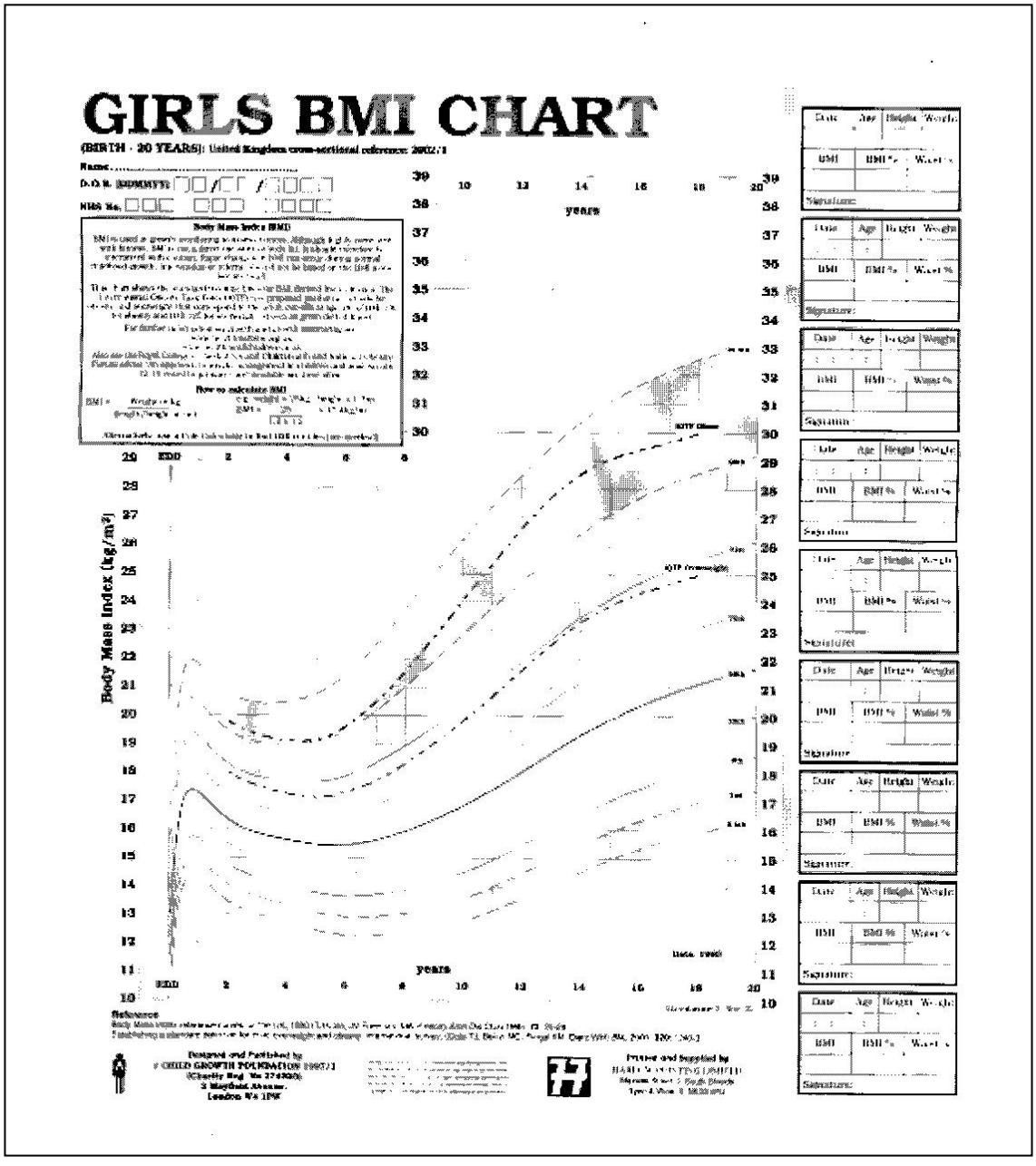
Appendix 1

Boy's BMI Chart



Appendix 2

Girl's BMI Chart



Appendix 3

Healthy Eating Guidance (SIGN 2003)

Birth to five years

Breast milk is the food of choice for infants. Introduction of solid foods should be delayed until between four and six months of age. Weaning is best done gradually with small amounts of pureed fruit or vegetables, or rice or other gluten-free cereal.

From six months, the range of foods introduced should be gradually increased. Full fat versions of dairy products should be used. Starchy food and very high fibre foods should be avoided.

From age two, gradual introduction of low fat dairy products can be considered for children who are growing well and eating a varied diet.

Children from approximately one year should eat three meals a day and two between-meal snacks. Foods high in fat and sugar are not needed.

Children over five years

Approximately one third of the child's intake should be composed of carbohydrates, one third fruit and vegetables, and smaller amounts from meat, fish and low-fat dairy products. Although not necessary for good health, fatty, sugary foods in small amounts can be part of a normal healthy diet.

Fluid intake should be adequate and suitable drinks are water, low fat milk, very well diluted low calorie diluting juices and diluted fruit juice.

The diagram of 'The Eating for Health Plate' can be helpful to assist children and their families to plan their eating.

In addition, children should:

- Eat regularly;
- Include bread, pasta, cereals, rice or potatoes at every meal;
- Eat some form of fruit or vegetables at every meal;
- Limit foods that are high in sugar, such as sweets or chocolate;
- Limit foods that are high in fat such as crisps, chips and pastries;
- Limit fried foods;
- Meals and snacks should be provided at regular times. Avoid 'grazing' all day.

Healthy Eating Plate Model

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