1.0 Introduction

Obesity has become a leading cause of preventable morbidity and mortality worldwide and is now one of the most visible global health problems. Described by the World Health Organisation (WHO) as a ‘global pandemic’, its prevalence is rising dramatically in both industrialised and developing countries. Overweight and obesity are now replacing the more traditional public health concerns such as under-nutrition and infectious diseases as some of the most significant contributors to ill health (WHO, 2002). The problem has also extended into the paediatric population; childhood overweight and obesity have escalated globally to epidemic proportions in recent years (James, 2004) and obesity is now the most common disease of childhood and adolescence (Reilly, 2006).

1.1 The scale of the problem

The 2004 International Obesity Taskforce (IOTF) report on worldwide prevalence rates identified that at least 10% of school-age children (5-17 years) worldwide are overweight or obese, using IOTF standard definitions of paediatric overweight and obesity (Cole, Bellizzi, Flegal & Dietz, 2000). Obesity rates in children and young people vary between different countries and regions, led by the USA at 32% and followed by Europe at 20% (Lobstein, Baur & Uauy, 2004). Lobstein, James and Cole (2003) describe how the prevalence of obesity in children and adolescents in England has almost tripled in the past 20 years, and the most recent figures published from the 2006 Health Survey for England (DH, 2008), presented in figure 1, demonstrate the significant increase seen in childhood overweight and obesity since 1995.
An evaluation to review the effectiveness of an established residential weight management intervention on short term health outcomes in overweight and obese children and adolescents.

Figure 1: Prevalence of (a) obesity and (b) overweight including obesity among boys and girls aged 2-15 years in England in 1995 and 2006

16% of children aged 2-15 years were classed as obese in 2006 (17% boys, 15% girls), relating to an overall increase in obesity prevalence among boys and girls of 6% and 3%, respectively, since 1995. If the figures for overweight are also included, around three in ten children were classed as either overweight or obese (31% boys and 29% girls) and a similar overall increase was observed for overweight including obesity prevalence since 1995; 7% in boys, 4% in girls. It has been estimated that these figures relate to approximately 4.5 million children who are overweight or obese in the UK currently and these numbers are on the increase.
1.2 Defining overweight and obesity

The WHO Consultation on Obesity (1997) provided a simple definition of obesity as “a condition of abnormal or excessive fat accumulation in adipose tissue to the extent that health may be impaired” (WHO, 1997).

Classifying levels of overweight and obesity in adults is relatively straightforward. An international classification system has been produced based on body mass index (BMI) – calculated as weight in kilograms divided by the square of height in metres, (kgm\(^{-2}\)) – to allow identification of individuals at risk and prioritisation of treatments for individuals and groups, in addition to enabling meaningful comparisons of populations (Table 1).

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI(kg/m(^{-2}))</th>
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<tbody>
<tr>
<td></td>
<td>Principal cut-off points</td>
</tr>
<tr>
<td>Underweight</td>
<td>&lt;18.50</td>
</tr>
<tr>
<td>Normal range</td>
<td>18.50 - 24.99</td>
</tr>
<tr>
<td>Overweight</td>
<td>≥25.00</td>
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<tr>
<td>Pre-obese</td>
<td>25.00 - 29.99</td>
</tr>
<tr>
<td>Obese</td>
<td>≥30.00</td>
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<tr>
<td>Obese class I</td>
<td>30.00 - 34.99</td>
</tr>
<tr>
<td>Obese class II</td>
<td>35.00 - 39.99</td>
</tr>
<tr>
<td>Obese class III</td>
<td>≥40.00</td>
</tr>
</tbody>
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Table 1: Classification of overweight and obesity in adults (Adapted from WHO, 1997)

Defining overweight and obesity in the paediatric population however is more challenging due to the influence of growth; fat-free mass, fat and height are changing, and at different rates, especially around the onset of puberty. New WHO Child Growth Standards, launched in April 2006, include BMI charts for infants and young children up to age 5, but
there is no universally accepted definition or classification system for children aged over 5 years.

The WHO is currently developing an international growth reference framework for school-age children and adolescents but at the present time BMI is widely considered to be the best objective approach available to assess obesity in childhood (Cole et al., 2000; Power, Lake & Cole, 1997; Reilly, Wilson, Summerbell & Wilson, 2002; SIGN, 2003). BMI is a clinically meaningful measure, identifying children and adolescents at high risk of the co-morbidities of obesity (Janssen et al., 2005).

BMI is not a static measurement; it differs between the sexes and changes with age, and therefore its interpretation requires comparison with population reference data. In the UK age and gender specific BMI reference charts based on population reference data from 1990 are used for assessment and monitoring of individual children (Cole, Freeman & Preece, 1995). These charts utilise the 91st and 98th percentile cut-off points in BMI distribution to define overweight and obesity respectively. However, globally there is a lack of consistency both in terms of applicable reference populations and the selection of appropriate cut-off points; the majority of published epidemiological studies have used 85th and 95th percentile cut-offs to define overweight and obesity, respectively, and the IOTF have developed an international age and gender specific classification system that corresponds to BMI of 25 and 30 (kgm⁻²) at age 18 years (Cole et al., 2000). The National Institute for Clinical Excellence (NICE) considers there to be a lack of evidence to support specific cut-offs in children, and concerns have been raised over the sample population size and sensitivity of the IOTF’s international classification system. However, for diagnostic purposes in clinical practice, NICE, in agreement with the Department of Health
(DH) and the Scottish Intercollegiate Guideline Network (SIGN), recommend that pragmatic indicators for action should be the 91st and 98th percentiles on the 1990 BMI charts, as they provide high diagnostic specificity (low false positive rate i.e. very few lean children are diagnosed as overweight or obese) and moderate sensitivity (modest false negative rate i.e. few overweight/obese children are diagnosed as lean) (NICE, 2006; Reilly, 2006; SIGN, 2003).

Whilst BMI is used to define and classify levels of excess weight it is does not provide any indication of the distribution of adiposity. Data from the Bogalusa Heart Study (Freedman, Serdula, Srinivasan & Berenson, 1999) showed that central adiposity, indicated by waist circumference, in children aged 5-17 years was associated with adverse concentrations of triglycerides and low- and high-density lipoprotein cholesterol and insulin, and a study by Higgins, Gower, Hunter and Goran (2001) also demonstrated a strong relationship between waist circumference, percentage body fat and cardiovascular disease (CVD) risk factors in pre-pubertal children. UK national data has shown a dramatic increase in adolescents’ waist circumferences since 1990; a rise that is even more pronounced than the increase in BMI (McCarthy, Ellis & Cole, 2003). However, although the evidence base is growing regarding the importance of waist circumference as a measurement of adiposity and a possible indicator of CVD risk, at the present time it is not recommended for routine use in the assessment of overweight, but NICE do suggest that waist circumference measurements may be used to give additional information as appropriate (NICE, 2006).
1.3 Aetiology

Energy balance is central to obesity aetiology; the fundamental principle of energy balance is:

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\text{Change in energy stores} = \text{energy intake} - \text{energy expenditure}
\]

Energy intake is defined as “the amount of energy consumed as food and drink that can be metabolized inside the body” (WHO, 1997).

Energy expenditure comprises three main components:

1. **Basal Metabolic Rate (BMR)** - the minimal rate of energy consumption necessary to support all cellular functions, accounts for 50-70% total energy expenditure in humans.

2. **Physical activity** – the only modifiable component of energy expenditure; energy expended depends on the type and the length of duration of activity. There is a wide variation in the energy cost of any activity both within and between individuals due to differences in body size and the speed and dexterity with which an activity is performed (Garrow, James & Ralph, 2000).

3. **Thermic Effect of Food (TEF)** - food ingestion causes an increase in energy expenditure over several hours; TEF represents the energy used for digestion, absorption and storage of ingested nutrients.

Figure 2 illustrates the influences on energy balance and weight regulation. Positive energy balance occurs when energy intake exceeds energy expenditure; energy stores increase leading to weight gain. Negative energy balance occurs when energy intake is less than energy expenditure; energy stores decrease leading to weight loss. Weight maintenance occurs when energy intake equals expenditure.
Obesity can only occur when energy intake remains higher than energy expenditure for an extended period of time, i.e. a state of long term positive energy balance (WHO, 1997).

Despite the seeming simplicity of energy balance, obesity is a highly complex syndrome and the exact mechanisms of its development are still incompletely understood. Although genetic predisposition can be a contributing factor, it is now known that energy intake and expenditure are influenced by a wide range of environmental and societal factors and these are playing pivotal roles in the rising prevalence of obesity worldwide; the National
Diet and Nutrition Survey (Gregory et al., 2000) has identified trends towards reduced physical activity and energy expenditure, as well as a change in eating behaviours towards a high consumption of energy dense foods and beverages, across the UK population.

Food commercialism has led to huge change in the composition of foodstuffs and the way in which food is obtained; energy dense convenience meals, fast food and high calorie snack items and beverages are now widely available and are very popular with children and young people. The impact of these changes to food supply, variety, price and availability on eating practices has been significant and it has been reported that “the consolidation of many food-related industries into a handful of food giants has influenced nutrition patterns globally” (Maziek, Ward & Stockton, 2007). Technological advances have made large-scale advertising and marketing campaigns of the food industry possible, which until recently often targeted children directly via ‘child-orientated’ media and themes. Activity patterns of children and adults have also changed across the world; technological developments in electronic equipment such as computers, game consoles, mobile phones and the advances of the world wide web have seen huge increases in sedentary ‘screen time’. Changes in community structure, neighbourhood safety, parental perceptions and time constraints, school curricula and the availability of suitable recreation areas for children have all been cited as contributors to the reduced energy expenditure trends seen. These factors amongst others are contributing to the creation of ‘obesogenic environments’ which are nurturing over-eating and inactive lifestyles (Maziak et al., 2007).

In 2005 Government asked Foresight - the UK Government’s science-based futures think tank - to carry out a review of obesity. The aim of this review, “Foresight Tackling Obesities; Future choices”, (Butland et al., 2007) was to build on the scientific evidence
An evaluation to review the effectiveness of an established residential weight management intervention on short term health outcomes in overweight and obese children and adolescents.

base and to inform government strategies, policies and priorities. As part of this review Foresight identified all the factors that can contribute to obesity aetiology and developed a ‘system map’ to illustrate the interplay between these influences (figure 3). At the centre of the systems map is the ‘core engine’ of energy balance. The complex web of external and internal influences that stems from the core engine can be divided into seven overarching categories (figure 4) but it should be recognised that there is some overlap between these categories and that considerable variation in terms of specific influencing factors occurs between individuals.
An evaluation to review the effectiveness of an established residential weight management programme on short term health outcomes for overweight and obese children and adolescents.

Figure 3: Foresight Obesity System Map
An evaluation to review the effectiveness of an established residential weight management programme on short term health outcomes for overweight and obese children and adolescents.

Figure 4: Foresight Obesity System Map - overarching influencing factors of obesity aetiology
1.4 The consequences

Childhood obesity is not a cosmetic issue; it is a serious public health problem that has profound health and social consequences in both the short and long-term. In children and adolescents excess weight is associated with a wide range of medical complications which include CVD risk factors such as elevated blood lipid levels and increased blood pressure, impaired glucose tolerance and insulin resistance, orthopaedic complications and poor immune function (Must & Strauss, 1999; Wabitsch, 2000). Although many of these complications are not seen clinically until adulthood there is now an increasing incidence of ‘adult’ morbidities such as non-insulin dependent diabetes mellitus (NIDDM) being seen in overweight children and adolescents (Rosenbloom, Joe, Young & Winter, 1999; Sinha et al., 2002) and adults who were obese children have an increased risk of morbidity and mortality independent of their adult weight (Must & Strauss, 1999).

In addition to the physical health complications of childhood obesity there are also significant psychological implications that need to be considered; obesity has an immediate impact on a child’s physical appearance and this can lead to social alienation, decreased self-esteem and decreased quality of life (Dietz, 1998; Strauss 2000; Strauss & Pollack, 2003). The extent of the psychological impact should not be underestimated; a study by Schwimmer, Burwinkle and Varni (2003) reported that the obese child has a fivefold increased risk for low health-related quality of life, which is a similar risk to that seen in children affected by cancer.

A recent systematic review of current literature revealed an increased risk of overweight and obese youth becoming overweight adults, indicating that childhood obesity tends to persist into adulthood (Singh, Mulder, Twisk, van Mechelen & Chinapaw, 2008). This
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review highlights the importance of preventing and treating obesity in children and adolescents as part of a comprehensive approach to tackling the global obesity epidemic.

1.5 The Financial Burden of Obesity

Analysis by Foresight has estimated the current cost of obesity to be in the order of £10 billion per year, and projects that nearly 60% of the UK population could be obese by 2050. A study by Daviglus et al. (2004) outlines the adverse long-term consequences on health care costs in older age caused by overweight and obesity in young adulthood and middle age, and if levels of overweight and obesity continue to increase in line with Foresight projections the overall cost per annum could rise to as much as £45.5 billion (Butland et al., 2007).

1.6 Current Initiatives

The growing financial burden of obesity coupled with the associated adverse health implications means that developing effective strategies for the prevention and treatment of childhood obesity has been highlighted as a Government-wide public health priority by DH. Reducing obesity is one of the six overarching priorities in the Governments public health white paper ‘Choosing Health’, and a Government Obesity Public Service Agreement (PSA) has been outlined to ‘reduce the proportion of overweight and obese children to 2000 levels by 2020, in the context of tackling obesity across the population’ as part of the ‘Healthy Weight, Healthy Lives’ cross-Government strategy for England (DH, 2008). However, developing effective prevention and treatment strategies is extremely challenging due to the diversity of the influencing factors involved in obesity aetiology.
1.7 Prevention

A range of on-going preventative initiatives are currently in place, set up by DH and aimed at all children, and include the Healthy Start scheme, the Healthy Schools Programme, the Physical Education, School Sport and Club Links strategy, the National Child Measurement Programme and most recently the ‘Change 4 Life’ initiative (DH, 2009). However, whilst it is recognised that preventing overweight and obesity in the first place is an important course of action, prevention is not the main focus of this study and a detailed dissemination of prevention strategy is beyond the scope of this report.

1.8 Treatment

Expert guidance and frameworks that outline best practice treatment options are now available and include the Obesity Care Pathway and the Obesity Toolkit (DH, 2006). Co-ordinated, multi-sectorial partnerships, local commissioning of dedicated weight management services and specialised training and resources for health care workers and delivery staff involved in weight management are all efforts being made to enhance obesity treatment options.

Obesity is a multi-faceted disorder and the influences involved in its aetiology can vary considerably between individuals. It therefore makes sense that a variety of treatment options are required as one size will not fit all; a wide range of therapies are available including diet, exercise, behaviour modification, pharmacological and surgical intervention. The effectiveness of an intervention may vary depending on the age, sex, physical maturation, psycho-social development, nutritional needs and metabolic differences of the individuals taking part (Oude Luttikhuis et al., 2009).
Reilly (2006) specified the aims and objectives of obesity treatment interventions for the paediatric population:

The principal aim of treatment for most individuals should be maintenance as opposed to loss of body weight as children and adolescents are still growing. Maintenance of body weight with continued linear growth will mean they will ‘grow into’ their weight to a certain extent. For more severely obese patients and patients where co-morbidities may be improved by weight loss (e.g. sleep apnoea, NIDDM) the aim should be modest weight loss (approx 0.5kg/month) and a more intensive approach to treatment would be justified.

(Reilly, 2006, p.435)

Another important consideration in relation to treatment interventions is highlighted by the report of the British Nutrition Foundation Task Force (BNF, 1999): “a successful programme should also lead to improvements in quality of life, self-esteem, social functioning, anxiety and depression.” The sensitivity and psycho-social issues around overweight and obesity are complicating factors for treatment and sufficient attention needs to be directed towards addressing these issues within treatment interventions.