Tackling childhood obesity within schools: A review of interventions

Research report

Janet Wordley and Professor Rachael Dixey

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Tackling childhood obesity within schools: A review of interventions.

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The aim of this review is to address two questions to enable the UAE education sector and policy makers to think about how they could incorporate schools-based interventions into the wider strategy to tackle childhood obesity. The questions are:

1. What is the context of childhood obesity internationally?
2. What is it feasible for schools to achieve in managing the issue of childhood obesity?

Introduction:

Involving schools in tackling obesity would seem a logical and useful way forward. However, school-based work can be seen against a backdrop where:

"Hundreds of interventions to the combat obesity epidemic are currently being introduced worldwide, but there are significant gaps in the evidence base for such interventions and few have been evaluated in a way that enables any definitive conclusion to be drawn about their effectiveness." (Thirlaway and Upton 2009 p82)

There are no simple ways forward, and there is no consensus among the public health community about the best ways to tackle the obesity epidemic. This review will introduce promising interventions, and also try to make sense of some of the issues in evaluating interventions to tackle obesity within schools. The lessons for the UAE are not spelt out, as this will be left to educationalists and policy makers within country.

RQ1 Provide an outline of the context of childhood obesity internationally

1. Introduction: Obesity – the 'global epidemic'

The increase in the prevalence of obesity during the last two or three decades has arisen so rapidly that the World Health Organisation (WHO) has described it as a 'global epidemic' (WHO, 1997). There has been a major shift from it primarily being a public health concern of the most affluent societies to now being seen in less industrialised countries and in particular, those undergoing economic transition, such as the Gulf states (Seidell, 2000; Prentice, 2006; Candib, 2007). Current figures suggest that 250 million people worldwide are obese and by 2025 this is estimated to rise to 300 million (WHO, 1997).

The rapid global increase in obesity of recent years includes children of all ages (Gortmaker et al, 1987; Troiano et al, 1995).

Figure 1: Increasing overweight in children around the world (Foresight, 2007, p25)

Lobstein et al (2004) estimate that worldwide there were 155 million overweight school children with a further 30-45 million that were obese.

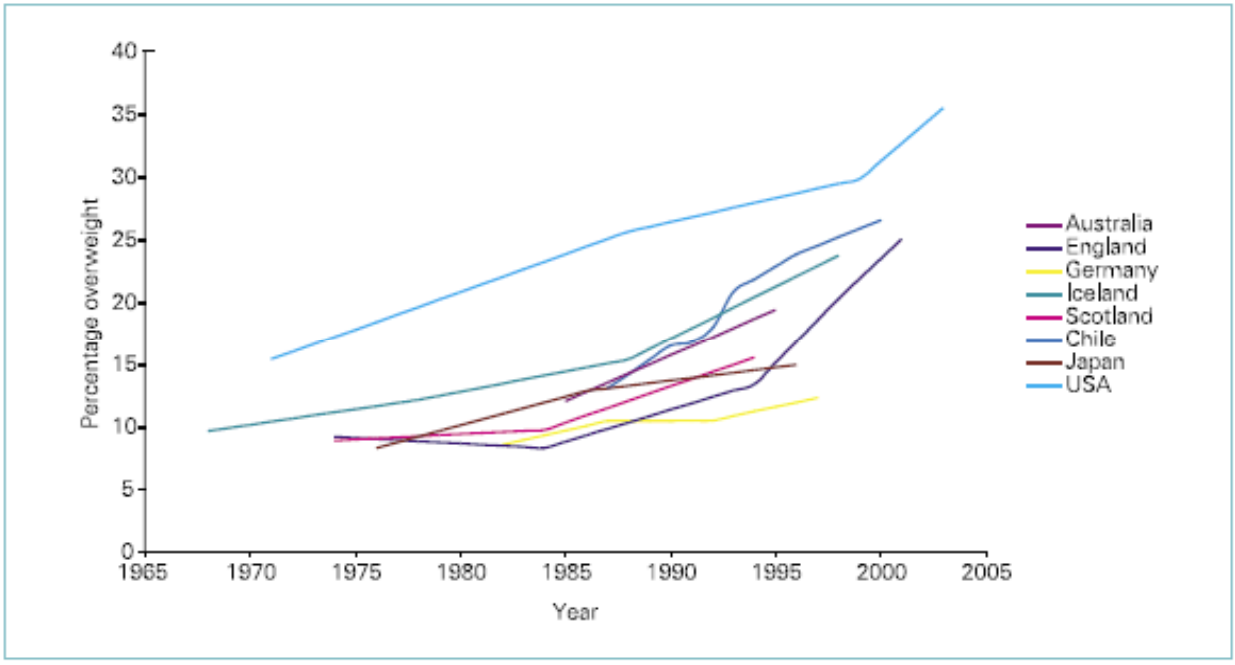
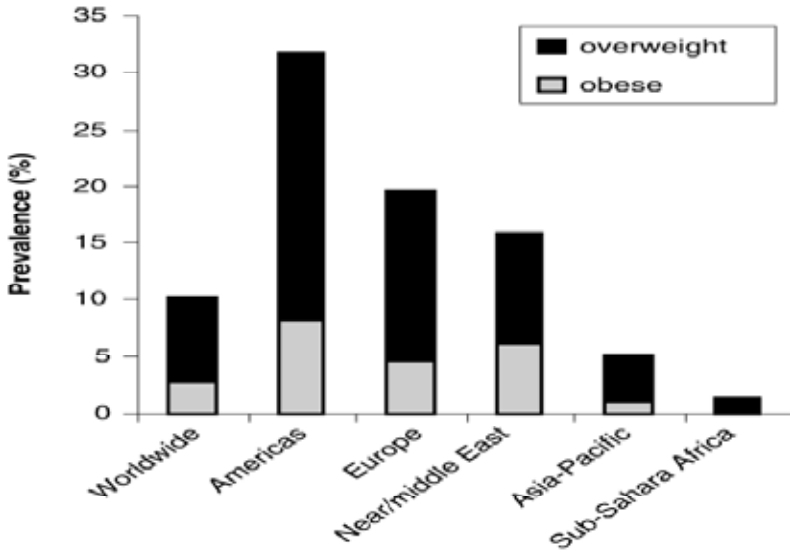
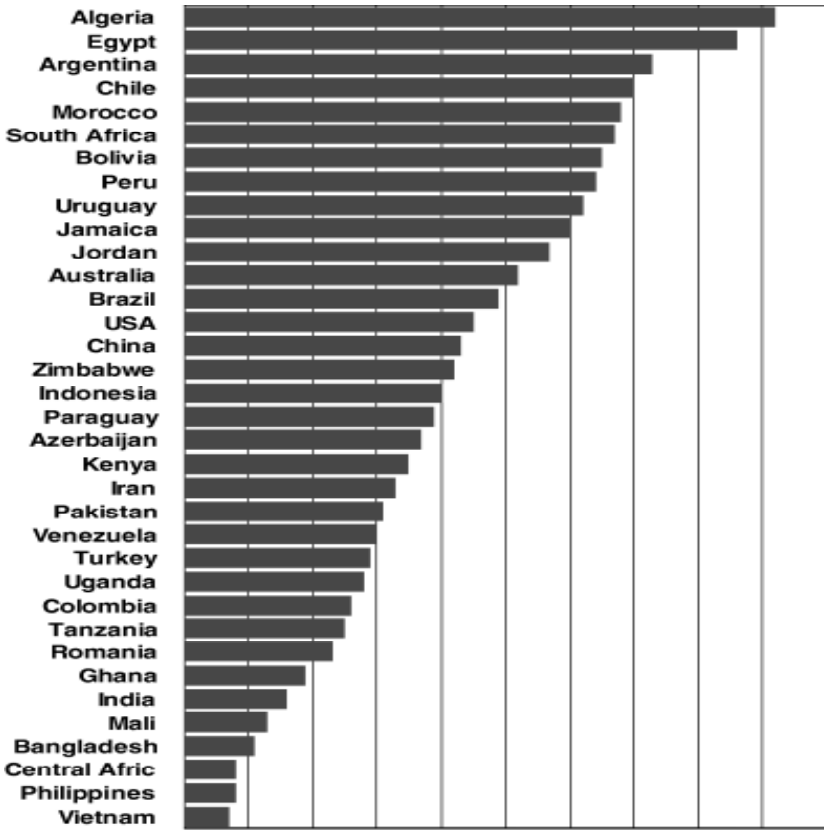


Figure 2: Prevalence of overweight and obesity among school-age children in global regions. Overweight and obesity defined by IOTF criteria. Children aged 5–17 years. Based on surveys in different years after 1990. Source: IOTF



Additional data highlights increasing prevalence of obesity in preschool children (under 5's).

Figure 3: Prevalence of obesity among children aged under 5 years. Obesity in under fives according to WHO standardized cut-offs (Z > 2.0). Based on surveys in different years. Source: de Onis & Blossner, (2000)



The Gulf States have not escaped the trends of rising obesity. Bagchi (2008) concludes for the EMRO region of the WHO that overweight and obesity are increasing dramatically, with particularly high rates in UAE, Kuwait, Egypt, Saudi Arabia, Jordan and Bahrain. In the UAE, Al-Haddad et al (2000), in a study carried out in Ras Al-Khaimah, found 9.3% of girls and 8.5% of boys aged 6-16 were overweight and 7.9% of both sexes were obese. Their earlier study carried out in 1998-99 (Al-Haddad et al 2005) showed that in 6-7 year olds, 18.9% of girls and 10.8% of boys were overweight, and 7.8% of girls and 5.6% of boys were obese. Similar prevalence rates can be seen in other Gulf states, with slightly higher rates in Qatar (Qotba and Al-Isa 2002, Bener (2004), Kuwait (Sorkou et al 2003, Al-Isa and Moussa 2000) and Saudi Arabia (Al-Nuaimi et al 1996, El-Hazmi and Warsy 2002, Abalkhail et al 2002). These studies show a higher rate amongst girls, and among older children.

2. Health consequences of obesity

The public health concern about these high prevalence figures across all age-groups relate largely to the health impacts of obesity. Evidence shows that obesity is associated with a wide range of health problems such as diabetes, certain cancers, hypertension and cardiovascular problems (WHO 2000; 2003; Visccher & Seidell, 2001).

The increasing prevalence in children raises concern about the creation of a growing health and economic burden for the next generation particularly as there is evidence that obesity in childhood persists into adulthood (Serdula et al, 1993; Freedman et al, 2001, Guo et al, 1994, Parsons et al, 1999). Research into cardiovascular risk factors has predicted increased adult cardiovascular morbidity and mortality due to childhood obesity (Reilly et al, 2003; Singh et al, 2008). Evidence links childhood obesity with increase risk for metabolic syndrome in adulthood (Vanhala et al, 1998).

However, there is need for prevention, as obese children already suffer. The most common consequences of obesity in childhood are psychosocial (Dietz, 1998; Strauss, 2000; Reilly et al, 2003) with obese children being stigmatised (Latner & Stunkard, 2003; Cramer & Steinwert, 1998). Cardiovascular risk factors are seen frequently in obese children (WHO, 19981; Freedman et al, 1999; Reilly et al, 2003; Berenson et al, 1992). Other consequences of childhood obesity are earlier onset of puberty (Lee et al, 2007), childhood asthma (Reilly et al, 2003), gastro-oesophageal reflux; sleep apnoea and orthopaedic conditions (WHO, 19981; Sokol, 2000). Time off school directly or indirectly due to a child's obesity could negatively impact on their educational attainment, affecting job choice and consequently income (Morris, 2006; Erikkson et al, 2003).

In addition to the health consequences, disease-treatment as a consequence of obesity is expensive and the direct and indirect economic costs to countries as obesity prevalence rises will continue to increase (WHO, 2000, Mazzocchi et al, 2009). Developing countries with fewer health resources will find these costs particularly difficult to meet.

3. Factors affecting and influencing childhood obesity prevalence

Any attempt to prevent obesity requires an understanding of its causes. An incontestable fact is that obesity occurs due to an excess of energy intake over expenditure over a prolonged period of time. Genetics can also greatly affect predisposition to obesity. Twin, sibling and family studies show that individuals with a family history of obesity are more likely to become obese themselves (Allison et al, 1999; Whitaker et al, 1997; Lake et al, 1997; Stunkard et al, 1986; Bouchard & Tremblay, 1997; Perusse et al, 1999). Genetic disorders such as Prader-Willi, Bardet-Biedl, Cohen and Alstrom syndromes (Holm et al, 1993; Katsanis et al, 2001; Farooqui & O'Rahilly, 2000) account for a small fraction of obesity cases.

However, the rapidity of the world-wide increase in obesity, together with the lack of uniformity in its prevalence, both at a country level and with-in population sub-groups, has highlighted that socio-environmental factors are the key cause of the current obesity epidemic causing 'obesogenic' (i.e. obesity promoting) environments (Swinburn et al, 1999). An environment's 'obesogenicity' has been defined as 'the sum of influences that the surroundings, opportunities or conditions of life have on promoting obesity in individuals or populations (Swinburn & Egger, 2002, p 292). Factors that contribute to the development of such obesogenic environments will therefore be discussed in detail.

3.1. Environmental risk factors associated with childhood obesity

a. Dietary factors

As dietary factors relate to the 'energy-in' side of the energy balance equation, they are essential potential childhood obesity risk factors.

i. Maternal weight status and dietary intake through pregnancy

Understanding childhood obesity starts while the child is still in the womb. Studies have shown a direct relationship between maternal obesity, increased infant birth weight and later obesity in the child (Whitaker & Dietz, 1999).

In increasingly obesogenic environments, maternal over-nutrition and resulting insulin resistance is becoming more commonplace and has resulted in heavier babies (Nanan, 2002; Dyck et al, 2001; Dabelea et al, 2000; Silverman et al, 1998; Srinivasan et al, 2003). Furthermore a positive relationship has also been reported between insulin content of the amniotic fluid and the child's BMI in adolescence (Silverman et al, 1998; Srinivasan et al, 2003).

Conversely however, other studies (Whitaker & Dietz, 1998; Strauss, 1997; Ozanne et al, 2004; Vajnik, 2004) have reported the relationship between poor intrauterine growth and later obesity in childhood. Mothers enduring the Dutch famine showed that maternal under-nutrition results in permanent physiological changes in their infants which predisposed them to obesity (Ravelli et al, 1976). Infants born with low birth weights and who then become obese in later childhood have been found to be more susceptible to coronary heart disease and type 2 diabetes than other obese people (Barker et al, 2002).

Smoking during pregnancy is associated with low birth weight and there is a reported link between maternal smoking and subsequent adiposity in their children (Power & Jeffries, 2002; Toschke et al, 2002). In a study by von Kries et al (1999) the relationship between mothers' smoking levels during pregnancy and prevalence of overweight and obesity in their children at 5-7 years was independent of mothers' social class, mothers' weight or birth weight of their child. Additionally their findings suggested that there was no influence on child adiposity from mothers continuing to smoke after birth, suggesting that it was the intrauterine environment created that influenced later obesity. Similar findings were reported by Al Mamun et al (2006) who found adolescents of mothers who smoked during pregnancy were more likely to be overweight and obese than those whose mothers had stopped or never smoked.

Low birth weight has also been linked to the development of stunting in early childhood (short height for age) and abdominal obesity later in life. Globally, one third of children under 5 (270 million) in developing and transitional countries are affected by stunting (UNICEF, 2001). Some studies show a relationship between stunting early in childhood and overweight in later childhood (Sawaya et al, 1995; Steyn et al, 1998). Longitudinal studies have reported children with severe stunting in early childhood have increased risk of developing abdominal obesity in later childhood and adulthood but are not considered obese by Western standards (Walker et al, 2002; Schroeder et al, 1999). However studies report that due to this predisposition to central obesity, these children have increased risk of insulin resistance (Boule et al, 2003).

It therefore appears that what happens in the mother's womb has major consequences on the child's subsequent weight. Both heavier and lighter infants are more at risk of later obesity than are infants born at normal weight. In an increasing obesogenic environment, physiological changes triggered by the intrauterine environment could further increase the risk of obesity. For example, de Graft & Aikens (2005) suggest that the increasing prevalence of glucose intolerance, diabetes and hypertension in Cambodia is directly due to deprivation suffered there due to civil conflict.

Where there is high prevalence of low birth weight, public health supplementary feeding programmes are common, but evidence suggests that these could encourage rapid weight gain in early infancy. Studies have shown however, that no improvement in length for age status in stunted children will occur if nutritional improvement comes after the child is 24-36 months (Uauy & Kain, 2002). Consequently supplementary feeding could induce development of obesity in both the low birth weight infant and the stunted infant, particularly as most PEM prevention programmes provide energy and protein but are often deficient in micronutrients which would support linear growth (Uauy et al, 2001).

ii. Infant feeding: breast v bottle

Numerous studies have reported that breast fed infants are less likely to develop childhood obesity compared to bottle-fed (von Kries et al, 1999; Gillman et al, 2001; Armstrong & Reilly, 2002) and can protect children at risk of type 2 diabetes from developing it during adolescence (Young et al, 2002). Bergmann et al (2003) in a longitudinal study found bottle-fed babies had increased risk of being obese at 2 years, and this relationship persisted even when controlling for SES and mothers' BMI and smoking behaviour.

Breast-feeding duration is also important. Baker et al (2004) reported that weaning before 16 weeks significantly increased weight gain in the first year. Sloan et al (2007) found that Infants weaned earlier than 4 months were heavier at 7 and 14 months, and gained more weight between 8 weeks and 14 months, even after breastfeeding was controlled for.

Ong et al (2006) showed that bottle-feeding and early weaning had a potential synergistic negative effect, reporting that formula-fed infants weaned before 4 months had higher energy consumptions and this determined their weight gain.

iii. Soft drinks and snack foods

Studies have shown that globally, soft drinks are a major contributor of calories in the diets of children of all ages (Popkin & Nielsen, 2003). Whilst quantity consumed appears to increase with age, findings from more industrialised countries show they are fast becoming the largest single source of non-milk extrinsic sugar within even very young children's diets (Gregory et al, 2000; Webb et al, 2006; Fox et al, 2006).

A recent systematic review, (Brown et al, 2007) found strong evidence that increased consumption of sugary drinks increases the risk of overweight and obesity. Similarly Bray et al (2004) found a link between obesity and intake of the high-fructose corn syrup, the caloric sweetener used in soft drinks. It has been hypothesised that high intake of sugar sweetened drinks promotes weight gain due to their high glycaemic index or because regulations of calories after ingestion of a liquid is less complete than after a solid (Ludwig et al, 2001). Hawkes' review (2005) shows how the leading soft drink and fast food companies are targeting rapidly developing economies, and especially children and young people. Soft drink consumption in less developed countries is outpacing that of countries such as the USA (Gelhar and Regmi 2005).

Globally, 'fast foods' are becoming universal. These foods can be described as 'energy-dense', giving a measure of how much energy the food contains per unit weight of food. Higher fat foods will have the highest energy density but lower nutrient density. Energy-dense, nutrient-poor foods tend to be high in fat and refined sugar and low in vitamins and minerals. A study conducted in the UK, (Prentice & Jebb, 2003) analysed a variety of fast foods and reported that their energy density (by weight) was greater than other foods in a typical Briton's diet and their energy-density was over twice that of foods recommended for a healthy diet. Bowman et al (2004) reported that children's diets were less healthy on the days when they ate fast foods. Levels of fat and energy density were higher and fruit and vegetable intakes were lower.

Energy-dense foods tend not to be entirely satisfying and are often eaten as a regular addition to the diet rather than an occasional treat (Astrup, 1996). Whilst direct evidence is lacking that increased consumption of fast foods leads to overweight and obesity, evidence from epidemiological studies has shown that even if the total energy intake is similar or even reduced, weight gain is associated with a higher proportion of fat (Hill & Prentice, 1995; Canoy & Buchan, 2007). This evidence together with evidence from higher-income countries showing that children's intake of fast food has increased by 300% over 2 decades (St-Onge et al, 2003) highlights increased consumption of fast foods as a childhood obesity risk factor.

iii. Eating patterns

Eating patterns in higher-income countries have shifted from the traditional three meals a day culture to more frequent, less well-defined 'grazing' (Nicklas et al, 2001), with an increase in the number and variety of readily available inexpensive highly palatable foods, resulting in more frequent opportunities for consuming large quantities of food (Hill & Peters, 1998). Snacking behaviours have particularly increased in adolescents and young adults (Jahns et al, 2001; Zizza et al, 2001). In the US the average snack size consumed by young adults has increased significantly and compared to eating occasions classified as 'non-snacks', the nutrient contribution of snacks had increased in energy density and proportion of energy from fat (Popkin, 2005).

There is some evidence that skipping breakfast can increase a child's risk of developing obesity (Wolfe et al, 1994; Siega-Riz et al, 1998). However due to the cross-sectional nature of these studies it is unclear whether skipping breakfast resulted in obesity or whether those children who were obese skipped breakfast as a weight-loss method. Two prospective studies report that children and adolescents who skipped breakfast had larger increases in weight gain and were significantly more likely to become overweight (Berkey et al, 2004; Barton et al, 2005). This relationship seems to be dependent on ethnic group: in a prospective cohort study investigating dietary intake of African American and white young adults, Lewis et al (1997) showed that white adults who skipped breakfast were more likely to become overweight than those who did not, even after adjustment for baseline BMI. The relationship was not significant for African-Americans, suggesting that skipping breakfast may be an obesity risk factor only for some sub-groups.

iv. Increased portion sizes

Increases to the standard portions of various foods have occurred in most higher-income countries (Young & Nestle, 2002; Ello-Martin et al, 2005). Although younger children have the innate ability to rely on their internal cues to regulate food intake (Rolls et al, 2000), it appears that this mechanism can be overridden by environmental and social factors. Indeed, studies with children aged 4 and over have found that they tended to eat more even when not hungry (Rolls et al, 2000; Fisher et al, 2003). Within the current obesogenic environment, it is becoming more likely that children will consume more calories than they require. For instance, a meal of a double cheeseburger, fries, soft drink and dessert could provide 2200kcal (Ebbling et al, 2001).

b. Physical activity related risk factors

Weight gain is a result of an energy imbalance between energy out and energy in, and as physical activity levels relate to an individual's energy output, they are an obesity risk factor. However, it has proved difficult to demonstrate this association in order to provide guidance for obesity prevention:

i. Activity levels

Some cross-sectional studies from higher-income countries have suggested that children who are obese spend less time doing moderate and vigorous physical activity than do non-obese children (Trost et al, 2001; Anderson et al, 1998; Kimm et al, 2005). However, others have found no relationship (Nader et al, 1999; Story et al, 2003). Some studies report gender differences: Berkey et al (2000) reported physical activity was protective of further weight gain in females but Gordon-Larsen et al (2002) found this protective effect was only present for males. A systematic review exploring the relationship of physical activity on subsequent fatness in childhood found evidence roughly divided into having a protective effect or having no effect (Parsons et al, 1999).

Data from the UK and US exploring physical activity levels in the 1980s and 1990s suggested a decrease in walking and cycling and increased use of the car as the transport method of choice to get to school (DiGuiseppi et al, 1997; US Department of Transportation, 1997). Cross sectional studies from the UK (Armstrong et al, 1990; Riddoch et al, 1991) and a longitudinal one from the Netherlands (Kemper et al, 1999) both reported that physical activity during adolescence decreases considerably. As some studies have given evidence that physical activity behaviours track into adulthood (Raitakari et al, 1994), declining activity levels in adolescence could have negative implications for physical activity in later life. Bleich et al, (2008) in a major study of the role of energy-out/energy-in conclude that although rates of physical activity have declined, the magnitude of the obesity epidemic is best explained by increased calorie intake. This issue remains controversial.

ii. Sedentary behaviours

Being sedentary encompasses a range of activities (e.g. reading, listening to music, doing homework), but most studies exploring its effect have looked at the relationship between TV viewing and increased risk of obesity.

A popular theory is that TV viewing displaces physical activity and therefore contributes to the prevalence of obesity (Dietz & Gortmaker, 1985). A UK study (Robinson, 1999) reported that over one year, adiposity had increased in children continuing to watch television at their normal levels, compared to those who had decreased their viewing by 40%. Cross-sectional and prospective studies conducted in a variety of countries have found a close relationship between amount of television watched and obesity prevalence (Dietz & Gortmaker, 1985; Wake et al, 2003; Hernandez et al, 1999; Ruangdaraganon et al, 2002; Krassas et al, 2001; Hanley et al, 2000). Gortmaker et al (1996) found children watching more than 5 hours a day were 5 times more likely to be overweight than those watching less than 2 hours daily; at the end of the 4 year study period this relationship was still there even when key variables were controlled for.

Wiecha et al (2001) reported that televisions in bedrooms increased a child's viewing time by an average of 38 minutes a day; additional sets within the household increased viewing by 7 minutes each and children in families where family dinners were rare had increased viewing times of 33 minutes. In families where parents did not limit or control a child's viewing, television viewing times were increased by 29 minutes.

Another hypothesis is that TV viewing provides an environment for frequent snacking, pre-prepared meals as well as increased exposure to adverts for high fat, salt and sugar (HFSS) foods (Dietz & Gortmaker, 1985). Borzekowski & Robinson (2001) showed that exposure to a 30 second commercial increased the likelihood that 3-5 year olds would later select an advertised food when presented with options. While this research shows that adverts have an effect on children's preferences, it only becomes a potential obesity risk factor when it affects their dietary intakes. A study in Australia (Wake et al, 2003) showed that children's television viewing ceased to have an effect on their BMI after adjusting for food intake and general activity level therefore suggesting that television viewing as an obesity risk factor is mediated through both hypotheses suggested above.

3.2. Changing societal structures in transition countries

The studies discussed above explored environmental risk factors in Western countries. There has been a marked shift in dietary patterns and related disease patterns in less industrialised countries over recent years (Kim et al, 2000; Monteiro et al, 1995; Popkin, 1994; 1998; World Cancer Research Fund, 1997). These changes have included an increase in fat and non-milk extrinsic sugars and a decrease in cereals.

The emerging food system in these countries is based on an industrialised approach to agriculture, providing food regardless of season and supplying highly processed outputs. The consequences have been variable. Whilst food availability may have improved, under-nutrition in the poorer sub-groups of the population has not been solved and the quality of the diet in the affluent groups has decreased (Tansey & Worsley, 1995). There is also increasing evidence that these dietary shifts to a more 'Westernised' diet are accelerating such that health-related diseases associated with an energy-dense diet (and indeed low levels of physical activity) are increasingly seen amongst the poorest groups (Popkin, 2001; Monteiro et al, 2000).

The nutritional transition and its accompanying restructuring of economies has resulted in shifts within the labour force to occupations requiring increasingly more sedentary work (Popkin, 2001), alongside fewer opportunities outside the work-place for leisure activities and sport. There has also been a marked increase in the number of households owning a television or computer.

The shift in the labour force has been accompanied by increased urbanisation: globally, the numbers of people living in urban dwellings has increased from 16.7% in 1950 to 37% in 1994 with predictions of a rise to 57% by 2025 (UN, 1995). In light of evidence of an association between urban residence and obesity (Monteiro et al, 1995), this is a concern.

Longitudinal studies in these countries have given evidence that this societal shift has caused dietary and physical activity shifts and consequently has impacted on BMI which have progressively increased (Bray & Popkin, 1998; Paeratakul et al, 1998).

3.3. Socio-cultural risk factors associated with obesity

Understanding why people adopt the dietary and physical activity behaviours they do requires an understanding of social relationships and culture (Lake & Townshend, 2006).

a. Ethnicity and culture

Much of the data exploring the influence of cultural factors on body weight has been conducted in the USA. Prevalence data indicates higher rates of overweight and obesity amongst African-Americans than Causasians or Hispanics and lower rates in the Asian population (Matthews et al, 2001; Gordon-Larsen et al, 2002; Ogden et al, 2002). It is unclear from the prevalence data whether differences in obesity between different ethnic groups are primarily due to ethnicity or biological factors. A UK study reported South-East Asian children had higher insulin levels than Caucasian ones and they also showed a stronger relationship between raised insulin concentration and adiposity (Whincup et al, 2002). Other studies have found that certain ethnic populations have predispositions to visceral fat deposition, which is directly related to insulin resistance and development of diabetes (Yajnik, 2004). For instance, Native Americans and Canadians, Maori, Asian Pacific Islanders and other ethnic groups have higher prevalence of insulin resistance and are more likely to develop diabetes than White Caucasian populations (Genties et al, 2007; Riddell et al, 2007; Zimmet et al, 1997).

However, it is unclear just how important biological factors are in contributing to ethnic group differences. Results from 'acculturation' studies which investigate the changing weight status of immigrant groups, suggest that environmental as well as culturally determined social norms and behaviours play a role in obesity predisposition. For instance, Brussaard et al (2001) found children of Turkish and Moroccan immigrants in Holland more at risk of overweight than Dutch children. Lauderdale & Rathouz (2000) found a positive relationship between risk of overweight and length of duration in the US for Asian immigrants. Ball & Kenardy (2002) reported similar findings for female immigrants to Australia. Evidence also suggests that the second generation within immigrant families may fair much worse and be at higher risk of obesity and related disorders than their parents, as a result of adopting the dietary behaviours of the country rather than eating their traditional diet which historically may have contained more nutrients and less energy (Landman et al, 2001; Popkin, 1998).

b. Socio-economic status

Socio-economic status (SES) includes a range of indicators such as income, parental education and occupation. Evidence suggests that adults and children from low socioeconomic backgrounds in Western societies have increased risk of developing obesity than those with higher SES. This trend is repeated in middle-income countries such as Thailand and Tunisia (Popkin and Ng 2006). Additionally, an inverse

relationship has been reported between childhood SES and obesity later in adult life (Ball & Crawford, 2005; Parsons et al, 1999). These results suggest that adult obesity does not lead to low SES but rather low SES early in a child's life contributes to their later obesity. Similar conclusions were drawn by Hardy et al (2000), exploring whether an individual's SES was mediated through their level of education. However both factors were independently associated with adult BMI again suggesting that it is factors within the physical and social environment resulting in low SES early in a child's life that have a more important effect on their subsequent weight status.

Data from transition countries indicate that the association between a child's SES and the patterns of obesity are more complex. In China, Wang et al (2000) reported that children from urbanised, affluent families had higher prevalence of obesity than those from more disadvantaged backgrounds. Whereas in Brazil, women in the lowest socio-economic group show the highest prevalence of both obesity and underweight (Caballero, 2005). Other countries are showing similar patterns. For instance in Madagascar, childhood obesity has risen from 1.6% in 1992 to 6.2% in 2004 yet there are still around 36% underweight and roughly half were stunted (IRINnews, 2009). Underweight is a feature of Gulf States, with high rates in Qatar foe example (Qotba and Al-Isa 2002).

In some developing and transition countries it is common to find cases of under and over-nutrition within the same household (Benjelloun, 2002). In Asia, this coexistence is estimated at 15% of households (Popkin et al, 2001). More recent research quoted by Popkin (2001) found 44%, 23% and 57% of households in Brazil, China and Russia respectively had an underweight and an overweight member. One explanation could be that whilst cheap, energy dense and nutrient poor food has adverse effects on the growth of the child, it causes weight increase in the adult (Caballero, 2005).

It is clear from the studies discussed that in both industrialised and transition countries socio-economic status is an important risk factor in development of obesity.

c. Social and cultural norms and behaviours

Different socio-cultural groups have different patterns of diet and physical activity. In Western countries those from low SES reportedly have high fat diets, eat fast food more frequently and consume fruit and vegetables less frequently than those from higher SES (Giskes et al, 2002; Mishra et al, 2002; French et al, 2001). They are less likely to participate in sport and physical activity (Britton et al, 2000; Crespo et al, 1999).

Adults living with a partner have higher fruit and vegetable consumption than single, divorced or widowed adults (Billson et al, 1999; Shahar et al, 2001). Dietary guidelines are more closely adhered to in women with children, but (Roos et al, 1998) motherhood is linked with lower physical activity (Sallis & Owen, 1999; Trost et al, 2002). In terms of ethnicity, evidence suggests that groups other than white Caucasians adhere less closely to dietary guidelines (Patterson et al, 1995). These groups have also been reported as being less physically active (Trost et al, 2002; Crespo et al, 2000).

Better nutritional knowledge is related to better diet (Wardle et al, 2000) and studies have shown an association between higher SES and better nutritional knowledge (Parmenter et al, 2000; Buttriss, 1997; Crawford & Baghurst, 1990). However, nutritional knowledge per se does not necessarily translate into more healthful behaviours. For instance, in a study of European 14,331 adults, almost 80% reported difficulty trying to eat a healthier diet despite understanding key messages (Kearney & McElhone, 1999). The main barriers were time (e.g. irregular working hours and busy lifestyles) and taste (giving up liked foods). Other barriers included willpower, price, preferences of others and not wanting to change.

It is essential to recognise that food and its meaning are culturally derived. Evidence of obesity prevalence differences between sub-groups within affluent populations implicates cultural behaviours and traditions as mediators of the effects of the obesogenic environment on obesity (WHO, 2000). For example, cultural differences exist in how an obese body shape is perceived. In societies where famine and deprivation have been common, positive connotations may be connected to obese individuals (Sobal & Stunkard, 1989; Gremillion, 2005). Obesity is related to power, wealth and status, - a fat baby is a healthy one and losing weight is contrary to the social construction of health and what is considered attractive (Gremillion, 2005). In the US African Americans and to a lesser extent Hispanic populations consider an obese body-shape to be acceptable (Lynch et al, 2007; Bennett & Wollin, 2006; Davidson & Knafl, 2006; Becker et al, 1999).

Additionally, cultural differences exist in the values and beliefs people hold about diet and healthy lifestyle. The same populations revering an obese body shape also do not understand the idea of engaging in physical activity as a leisure time pursuit. In contrast, Nordic populations are positive towards fitness and spend considerable amounts of their leisure time in vigorous activities (WHO, 2000).

d. Family lifestyle

Whilst parental obesity may convey some degree of genetic predisposition to the development of obesity in the child, the impact of the home environment and parental influence on their child's diet should not be overlooked as a potential risk factor in the development of obesity (Wardle, 2007). Evidence shows that early exposure to an obesity-promoting family environment (i.e. low activity and poor dietary patterns) has negative effects on a child's subsequent BMI trajectory (Davison & Birch, 2002; Davison et al, 2005) and more child resistance to healthy eating (Hughes et al, 2005).

A Danish study gave evidence that the quality of the home environment in terms of levels of parental support and parental neglect was an important risk factor in childhood obesity (Lissau & Sorensen, 1994). Other studies have shown similar results (Klesges et al, 1992; French et al, 1996; Johnson et al, 2002).

Parents have the opportunity to be good role models of healthy eating behaviours and the power of social learning and role modelling should not be underestimated. Harper and Sanders (1975) found mothers' eating had a particularly powerful influence in shaping young children's (1-4 year olds) food preferences: children were more likely to imitate them and put food in their mouths than with other carers. In terms of obesity development, studies have shown that parents providing energy-dense foods to their child and additionally modelling the eating of such foods in front of their child enhance their child's innate preferences for such foods (Jansen & Tenney, 2001; Cutting et al, 1999; Lee et al, 2001).

Parents' role modelling also influences their child's physical activity behaviours. A systematic review (van Sluijs et al, 2007) found strong evidence that including parents in physical activity interventions targeting adolescents increased their physical activity. Due to a lack of rigorous studies there was less conclusive evidence that this was the case for younger children. Kohl & Hobbs (1998) suggest that parents have a key role for encouraging physical activity either directly by providing a supportive environment encouraging exercise or indirectly, through modelling a physically active lifestyle, or a combination of the two. Moore et al (1991) and Trost et al (2003) found that active parents tend to have active children.

4. Summary

Given the increasing evidence for the impact of environmental factors on the development of obesity, it is clear that focusing solely on the individual at risk of obesity, without consideration for their environment,

both physical and socio-cultural, is unlikely to be successful. Furthermore it could be considered unethical to subject people and especially children to obesity 'treatments' rather than tackling the environmental causes. Genetic studies have shown that within the current obesogenic environment, the majority of children are at risk of excessive weight gain (Allison et al, 1999; McDermott et al, 1998; Popkin & Udry, 1998). Targeting those individuals most at risk might ensure investment of limited resources into the most appropriate service but it would also greatly contribute to the stigma which has been shown to exist in regard to how overweight and obese people are viewed (Latner & Stunkard, 2003; Cramer & Steinwert, 1998). It is therefore more realistic to suggest a focus on prevention of obesity for the whole population.

Furthermore, prevention requires an holistic approach, at a variety of levels, including local and individual, national and international, requiring integrated working between a range of sectors including government (local and national), education, social and welfare services, environment and planning, transport, food production and media.

RQ2 what is it feasible for schools to achieve in managing the issue of childhood obesity?

There has been increased recognition for evidence-based school-based obesity prevention, as reflected in the numerous school-based programmes developed over recent years (e.g. Warren et al, 2003; Sahota et al, 2001). However, these programmes have differed greatly in terms of design, duration, focus and results gained. How programme effectiveness has been defined has also differed greatly between studies, with some interventions targeting reduction in BMI and others focusing on increasing knowledge and awareness. Still others have concentrated on establishing behaviour change. These differences make comparison difficult and the numerous reviews that have been conducted to establish evidence-based approaches for obesity prevention (for instance, Doak et all, 2006; Summerbell et al, 2005; Sharma et al, 2006; Campbell et al, 2002; Brown & Summerbell, 2008; Flynn et al, 2006; NICE, 2006; Kahn et al, 2002; Budd & Volpe, 2006) have utilised such different parameters to define success that the health practitioner is presented with a range of differing recommendations for future programmes. Indeed, there appears to be no consensus from reviews as to what components future interventions should include to be effective. Additionally these previous reviews often set strict parameters for the inclusion of studies (e.g. RCT design and anthropometric outcome measures) which has resulted in a dearth of evidence from which to draw. Indeed as Summerbell et al (2005) stated 'at a time in which we see obesity prevention nominated as a public health priority, we have only a limited number of studies from which to examine findings' (Summerbell et al, 2005, p 18).

Paradoxically, when there is a need for evidence-based recommendations and guidance to inform policy and future initiatives, very little is known about what components of interventions are effective. Whilst there is recognition of the important role schools can play in obesity prevention work and there have been many school-based initiatives developed, the lack of definitive evidence makes recommendations difficult. This makes writing this literature review difficult. Whilst the majority of studies reviewed are based in the US and other industrialised countries (see Doak et all, 2006; Summerbell et al, 2005; Sharma et al, 2006; Campbell et al, 2002; Brown & Summerbell, 2008; Flynn et al, 2006), the lack of consensus for defining effectiveness makes it difficult to make recommendations to other countries such as the UAE. It is therefore proposed that examples of what has been conducted in schools will be outlined and described.

This review is in three sections. Section one will outline nutrition-focused programmes and initiatives, section two will concentrate on those initiatives and strategies aimed at increasing children's physical activity and section three will describe those programmes that have taken a multi-component approach,

targeting both nutrition and physical activity within the school environment. Discussion will focus on who the audience was, channels used to reach the target population, outcome measures utilised and how effectiveness was measured. As far as is possible, this review will conclude with recommendations for future work, drawing on those made by the various reviewers in the literature. Discussion here will focus on specific barriers found to effective implementation and in supporting long term behaviour change.

Section One: Nutrition based programmes and initiatives

Schools provide a valuable opportunity to influence children's dietary habits. The taught curriculum offers a means of embedding nutritional education and with the majority of children and staff eating at least one meal within the setting of the school, gives an ideal opportunity to make the food environment healthier.

Examples will be given of nutrition-focused interventions targeting different aspects of the school environment. Successful components and recommendations from the various reviews and study authors themselves will be integrated.

1.1. Classroom based – education only

Schools have the potential to reach large numbers of children for education about healthy diet. Studies have shown that modern play-based methods can be utilised effectively to convey nutrition education and facilitate learning, giving a fun alternative to simply giving children advice or prohibitions about what they shouldn't eat (Bartfay & Bartfay, 1994; Corbett & Lee, 1992; Amaro et al, 2006; Baranowski et al, 2003). For instance, Amaro et al (2006) devised 'Kaledo', a board game aimed at 11-14 year olds in schools in Naples, Italy. Players had to match differences between total energy intake (with nutrition cards) and total energy output (with activity cards). At the end of their 24 week study Amaro et al (2006) reported that intervention children showed a significant increase in their nutritional knowledge ($p<0.05$) compared to control children. No significant differences were seen in BMI in either the control or intervention groups and no difference was reported between the groups. The authors did report a significant increase in vegetable intake in the intervention children but limitations with the methods used and randomisation procedure within the study cast doubt on these findings. However, another study evaluating the effectiveness of a 10 session multi-media game 'Squire's Quest' aimed at 9-10 year olds and which incorporated behaviour change techniques as well as nutritional knowledge, (Baranowski et al, 2003; Cullen et al, 2005) reported dietary behaviour changes in intervention children at lunch times and snack times when in school such as increased fruit and vegetable consumption. Therefore it would appear that dietary changes occurred in eating occasions over which the children had more control.

In summary, whilst educational games can be effective in promoting increases in nutritional knowledge, it is less clear whether they are effective at promoting dietary behaviour change. Games incorporating behaviour change techniques have shown that dietary behaviour changes can occur whilst eating at school. It is less clear whether they have impact on dietary behaviour at home.

Other classroom-based nutrition education interventions focused on the reduction of carbonated drink consumption. James et al (2004; 2007) reported on an English longitudinal study for 7-10 year old children. One hour education sessions each term encouraged children not to drink carbonated drinks and to switch to water and diluted fruit juice. They reported that 12 months after the intervention had finished the percentage of overweight and obese children in the control group had increased by 7.5% compared to intervention children where a decrease of 0.2% was reported. However, this difference did not remain after an additional 2 years follow-up indicating that the intervention had no longer-term effects and suggesting

that such interventions need to be maintained for long periods. Whilst there is evidence in the literature of the association between carbonated drinks and obesity (Ebbling et al, 2006; Tam et al, 2006; Smith West et al, 2006; Rush et al, 2006; Mrdjenovic & Levitsky, 2003; Vartanian et al, 2007), no measures of children's intake of carbonated drinks were reported in the study, therefore it is unclear whether the intervention was effective in its aim of decreasing consumption of carbonated drinks. Additionally, no measures were made of children's dietary intake or physical activity levels, so simply concluding weight changes is problematic.

In their review of nutrition education interventions, Thirlaway & Upton (2009) concluded that "despite considerable efforts over a number of years, there is limited evidence to suggest that educational approaches to dietary change (that is providing basic information about what constitutes a 'healthy' diet) alter children's eating habits." (Thirlaway and Upton, 2009, p79). Two points can be made here; Firstly, because there is limited evidence of effectiveness may not necessarily mean that interventions are not effective (but rather that effective ways of evaluating have not been found). Secondly, that whilst there are some promising nutrition education interventions within schools, these need to be underpinned with relevant theory such as Social Cognitive Theory (Bandura, 1986; SCT) if behaviour change is to occur (Lytle & Achtenberg, 1995).

1.2. Nutritional education and dietary behaviour change

interventions incorporating educational components with active learning techniques and practical strategies underpinned by appropriate behaviour change theories will be discussed below:

In a pilot study in Michigan, US, Fahlman et al (2008), evaluated the impact of a nutrition education curriculum based on SCT on 11-14 year old children's nutritional knowledge, efficacy expectations and eating behaviours. Lessons included giving knowledge of the 5 food groups, balanced eating based on these groups, reading food labels, surviving fast food restaurants and school cafeterias as well as teaching skills such as dietary self-evaluation, peer role-modelling, interpretation skills, and goal setting. Lessons were one hour long, taught by classroom teachers who had received 8 hours of in-service training. Despite being a short-term study (10 weeks) results indicated that by post-programme intervention children had not only increased their nutritional knowledge but had also improved their eating behaviours and increased in their efficacy expectations. They were significantly more likely to eat fruit and vegetables and less likely to eat junk food compared to the control group.

In another study aimed at 7-9 year olds, Raby Powers et al (2005) reported significant improvements in intervention children's dietary behaviours ($p < 0.001$) and nutritional knowledge ($p < 0.001$) than in control children by post programme. The 6 week nutrition-focussed intervention was based on SCT and taught skills to select healthy foods at home and school, provided hands-on learning opportunities, provided role models as well as nutritional education on concepts like the 5 food groups and balanced eating.

Whilst both these studies utilised self-report measures and thus caution should be taken when assessing results, of note was that improvements seen in intervention children's dietary behaviours (namely increases in dairy foods and fruit and vegetable), occurred during lunchtime. No school food modification occurred and both control and intervention children attended the same schools. Therefore such a nutrition education curriculum positively affected intervention children's dietary behaviours when presented with a choice. In addition both programmes reported children had changed their dietary behaviours at home as a result of the intervention. Both therefore gave evidence that primary school children's dietary habits can be positively influenced by such nutrition-focused curricula that incorporate behaviour change techniques, and such programmes could be successfully incorporated into wider school multi-component interventions.

An innovative approach to supporting children's dietary behaviour change was the development of an interactive multimedia CD ROM, designed to promote nutrition education in 12 year old secondary school children in the UK (Livingstone et al, 2002). The 'Dish it Up!' tool was based on SCT and promoted autonomy and self-esteem related to healthy eating as well as teaching decision-making skills. The programme guided pupils through a virtual school day and covered a range of issues relating to balanced diet. A key component was self-evaluation and monitoring of set goals. Intervention pupils showed statistically significant improvements in their nutritional knowledge by post-programme compared to controls ($p<0.0005$) and they also reported significant increases in frequency of consumption of fruit, pasta, yogurt, breakfast cereals (more than normal) and sweets (less than normal). However, findings were limited by the non-validated tools used to evaluate the intervention and no differences in nutritional attitudes were reported.

All nutrition-focused interventions discussed so far have been implemented by classroom teachers. The Food Dude Programme from the UK, designed for 4-11 year olds took a different approach using peer educators to encourage children to eat more fruit and vegetables. It is a good example of the incorporation of SCT theory into such interventions, as it built in peer modelling and rewards. 'Food Dudes' are role models who gain superpowers when they eat fruit and vegetables. Children are encouraged to try fruit and vegetables repeatedly and the idea is that they come to see themselves as fruit and vegetable eaters within a strongly supportive school ethos. Initial evaluation showed that fruit and vegetable eating increased to a statistically significant extent (Lowe et al 2001, 2002) and Lowe et al (2007) show that not only have the effects persisted 15 months after the programme ended, but also that fruit and vegetable consumption went up at home, and children were also eating a wider range than just that given on the programme.

Whilst nutrition-focused studies incorporating behaviour change techniques have shown positive effects on children's nutritional knowledge and eating behaviours, it is possible that the effects would be more potent if implemented in tandem with interventions targeting the wider school food environment. Indeed, it has increasingly been recognised that the wider school food environment will have an influence, either positive or negative on a child's dietary habits and behaviours (USDA, 1999).

1.3. The school food environment.

There have been several studies solely targeting the 'school food environment'. Examples that will be given include: breakfast clubs, strategies that increase availability or promotion of healthier options at lunchtime and snack time, free fruit schemes, school meal standards. These studies have not included a classroom based education or behaviour change component.

a. Breakfast clubs

These consist of before-school provision of breakfast to children arriving early to school. They originated in the US in 1966 when federal funding was given to schools to ensure they provided breakfast to low income children (US Department of Agriculture, 1999). Other countries such as Australia (Shaw, 1998) and the UK (Smith & Barker, 1997) have since taken them up.

It has been suggested that breakfast clubs can improve children's nutrition (Hanes et al, 1984; Nicklas et al, 1993) as well as their educational attainment and psychosocial functioning (Murphy et al, 1998; Pollitt & Matthews, 1998). Additional evidence has suggested that providing breakfast also improves children's school attendance and punctuality (Simpson, 2001; Harrop & Palmer, 2002). Studies exploring these issues have found conflicting results:

In a pilot study lasting 4 months in Norway, Ask et al (2006) reported on the impact of a healthy breakfast on the school performance of 15-16 year olds. Breakfast was served when the adolescents arrived at school but they could decide whether they had it. The authors reported that at 4 months students' BMI in the control group had increased significantly but not in the intervention group. However, whilst the healthy eating index (gained from a food frequency questionnaire) of intervention children had increased by 4 months, this was only significant for boys ($p<0.01$).

The study has several limitations, such as being of short duration with a small sample size and not taking an objective measure of students' behaviour and performance. Instead the measure used was based on the students' self assessment of their own behaviour. There was also a lack of teacher input into the evaluation to give a more balanced view regarding behaviour and performance. Additionally, the school chosen had a history of anti-social behaviour potentially biasing results. No evaluation was made of students' opinions about the breakfast and teachers did not attend the breakfast, giving very little support to the project.

In another study, Shemilt et al (2004) evaluated the impact of breakfast provision on children's health, educational and social behaviours. The study was conducted in 30 primary and secondary schools in the UK with a total sample size of 6076 (200 from each school). Results at 3 months indicated that those children eating breakfast showed improved concentration and fewer reported skipping classes within the last month. Results at 1 year showed whilst a higher proportion of primary aged children attending breakfast clubs reported eating fruit for their breakfast, there were also a higher proportion of primary aged children attending breakfast clubs having borderline or abnormal conduct and total difficulties scores. In the secondary school children at 1 year, a higher proportion of breakfast club attenders had higher prosocial scores than non-attenders. Across the entire sample, fewer breakfast attenders reported skipping 1 or more days of school within the last month than did control children. Yet again however, the study showed methodological limitations, but the results indicated that breakfast club provision had both positive and negative impacts on children's nutritional, educational and psychosocial behaviours.

Thus there is inconclusive evidence that breakfast clubs have an impact on students' school attendance, performance, eating behaviours or BMI. However, evidence from studies conducted in the 80's and 90's in the US indicated that breakfast clubs had the potential to improve children's dietary intakes (Hanes et al, 1984; Nicklas et al, 1993). Whilst more robust studies are required to evaluate their effectiveness, breakfast clubs may provide a means of positively influencing children's diet within the school environment.

b. Food availability and food promotion

Mazzocchi et al (2009, p145) state that, 'there is limited information' about the role of consumption of foods in school (both vended and provided) on obesity rates.

Evidence from a cross-sectional study investigating the relationship between school lunches and vending machine options and adolescents' dietary intakes (Kubik et al, 2003) indicated that when students are provided with a greater availability of higher fat foods, their intakes of more healthful foods was lower. Thus the study demonstrated that the food choices available within the school have significant effects on students' dietary intakes. Restricting vending machines has a significant effect on consumption and obesity; Anderson & Butcher et al (2004) demonstrated that a 10% increase in the proportion of schools making 'junk' food available translated into a 1% increase in students' BMI, and where the child had an obese parent, this increased to 2%.

In recognition of the contribution of school meals on children's diets, many countries across the world have developed school meal guidelines. Japan, which has enforced standards for school meals since 1954, and an emphasis on traditional foods within schools, has one of the lowest rates of obesity in the world (Dalmeny et al, 2004). Current school food standards in the UK are considered some of the most detailed in the developed world (Harper & Wells, 2007). By September 2008 primary schools had to meet the standards and secondary schools, special schools and pupil referral units had to meet nutrient-based standards by September 2009. In each school the board of governors is legally responsible for ensuring food and nutrient-based standards are met and schools must present evidence during Ofsted inspections that they are meeting the standards. Additionally, take up figures for school lunches are included in set of National Indicators used to report on performance (Communities and Local Government, 2007). No impact measures have yet been used as it is early in the implementation of the standards. However, longitudinal studies have demonstrated that food environment modification can improve children's dietary intakes by supporting them to make healthier food choices:

For instance, a 2 year study conducted in the US (French et al, 2004) investigated the impact on adolescents' dietary intakes of an environmental intervention to increase sale of lower-fat foods (5g or less per serving) at lunchtime in secondary schools. Schools involved in the project set themselves goals to increase their availability of lower-fat foods by 30% with the ultimate goal being to increase availability by 50%, using peer promotion of lower-fat foods. Promotional activities run by students included taste tests, food choice self-assessments and media campaigns. After one year sales of lower fat foods had significantly increased by 10% in intervention schools but had decreased by 2.8% in controls. By the end of the intervention, intervention schools reported sales increased by 51% but the decrease in sales seen in control schools continued, dropping to 5%. In terms of peer promotions, 49 occurred in year one and 127 in year 2. Students in intervention schools reported being significantly more likely to see media promotions than students in control schools.

Perry et al (2004) conducted a similar study aimed at 7-9 year olds in elementary schools in the US to achieve increased fruit and vegetable consumption of children in intervention schools after 2 years by modifying the school lunch menus. School catering staff received 1 day of training and twice yearly meetings were conducted with food service managers. Intervention schools set themselves goals to offer at least one more serving of fruit or vegetable a day. Staff were encouraged to make fruit and vegetable options more attractive and to encourage children. Lunchtime observations showed significantly higher intakes of fruit by children in intervention schools with the magnitude of the difference being 0.14 to 0.17 servings. No significant increases were seen for vegetable or fruit juice intakes.

Therefore findings discussed above suggest that modifying the lunchtime choices available to children can improve their dietary intakes even without curriculum modification. It has been argued in the US that providing school lunches contributes to obesity, as children who consume the provided lunch take in 40-120 more calories per day at lunch compared with those who take a packed lunch from home (Whitmore Schanzenbach, 2005, cited in Mazzocchi et al 2009). However, the school lunch is an important part of the diet especially for lower income families, and if healthy lunches were provided, could greatly improve overall diet.

c. Fruit tuck shops

A study in the UK (Moore, 2001) evaluated the effect of fruit tuck shops on 9-11 year old children's fruit consumption. The study ran over one academic year and fruit sales increased over the autumn and spring terms but declined during the summer term; intake in intervention schools only equated to 0.06 fruits

per pupil per day. However, statistically significant increases were reported in the proportion of children reporting that they used the tuck shops (p= 0.002) and that they ate fruit at school (p = 0.005). Whilst fruit consumption increased in intervention schools, the increase was not consistent across the school year, perhaps indicating the novelty value of the tuck shops declined. Additional promotional activities are required in parallel with such interventions. Another school-based programme evaluating the effectiveness of healthier food kiosks (Kain et al, 2004) reported they were not effective due to lack of regulation and lack of revenue available to schools to support them.

d. Free fruit in schools

In the UK the 'National Fruit Scheme' was implemented between 2000 and 2002 with the aim that by 2004, every primary school child in the UK would receive a piece of free fruit daily whilst at school (Wells & Nelson, 2005). Findings showed significant differences between fruit consumption in intervention children (117g per day) and control children (67 g per day) ($p<0.0001$).

In another study evaluating the effect of free fruit on 11-12 year old children's fruit consumption in Norway, Bere et al (2001) reported significant improvements in fruit consumption ($p<0.001$) in intervention schools compared to controls after a year.

Thus it appears that providing free fruit at school could improve children's fruit consumption at school. However, additional work is required to understand whether eating fruit in school caused children to compensate by not eating as much fruit at home. This lack of information should not discourage schools from adopting such a scheme; the evaluation from the 'National Fruit Scheme' highlighted other benefits such as it providing a social time and a time for learning, giving support to teaching and learning about healthy eating.

e. A whole school approach to healthier diet

Studies have demonstrated that implementing environmental changes within a wider school and family-based nutrition-focused programme, (Perry et al, 1998) can increase the strength of interventions (for example, Perry et al, 1998; Birnbaum et al, 2002). Examples are given below:

The GIMME 5 project (O'Neil et al, 2002; Baranowski et al, 2000), a 4 year dietary intervention for 14-15 year olds in schools in New Orleans, USA, aimed to increase students' fruit and vegetable intakes to 5 or more a day. It consisted of a school media-marketing campaign to promote positive attitudes towards fruit and vegetable consumption; a series of workshops incorporating a range of learning strategies based on the Stages of Change model; an environmental intervention targeting school meals and a parental component including brochures, newsletters and homework assignments for the parent and child to complete together, all designed to support parents in healthy eating at home. In addition parents received 'point of purchase' education which was conducted at grocery stores most frequented by parents. Parents were provided with suggestions for selecting, storing and preparing inexpensive fruit and vegetables. They were also given videos to watch at home containing information supporting the GIMME 5 curriculum. Lessons were delivered by a trained class teacher. Results showed that intervention students' knowledge increased significantly from baseline ($p<0.0001$) and when compared to control students' ($p<0.05$). Intervention students' daily intakes of fruit and vegetables had significantly increased by 14% between baseline and post-programme compared to the control ($p<0.001$). However no statistically significant differences were reported in students' psychosocial variables and no differences were reported between intervention and control schools in terms of the number of servings of fruit and vegetables in the school lunch.

This study included a process evaluation and findings indicated why results were not more promising. For instance, only 47% of curriculum activities were implemented and out of approximately 120 participating students per school the mean attendance at 'point of purchase' events was reported at 13.9 (sd = 9.4; range 1-30) and mean number of adults was 7.9 (sd = 4.9, range 1 to 18). Only 65% of parents receiving a video said they had watched it. It is unclear whether behaviour change would have been more pronounced had implementation been conducted more rigorously and both students and parents received a more intensive intervention.

The 5-a-day Power Plus Program (Perry et al, 1998) was conducted in elementary schools in Minnesota. It aimed to increase fruit and vegetable consumption of 9-10 year olds. The intervention consisted of 4 components: a) a curriculum underpinned by SCT b) parental involvement and education c) food service modification and d) involvement from industry. The curriculum was taught by classroom teachers who had attended a one day training. Two classroom curricula were developed, aimed at fourth and fifth grade students. Lessons were 40 to 45 minutes long, implemented twice a week and incorporated learning activities such as skill building and problem solving, snack preparation, taste testing and stories. Teams were devised and competitions were organized for eating fruit and vegetables during lunchtime. Students achieving the goal of eating two or more servings of fruit and vegetables daily at lunchtime were awarded incentives. Fourth grade children's parents received five home packs over the course of the programme with activities to do with their child, information about the curriculum content, tips for encouraging their child to eat fruit and vegetable at home and a snack recipe. Fifth grade parents received four snack packs which involved children and parents making a snack at home together. Catering staff were encouraged to promote fruit and vegetable at point of purchase, enhance the attractiveness of how fruit and vegetable were served to children, increase the variety served and provide additional fruit when baked desserts were offered. Local industries provided fruit and vegetables. Results showed significantly increased lunchtime fruit consumption and combined fruit and vegetable consumption in intervention children, lunchtime vegetable consumption in girls and daily fruit consumption as well as proportion of total daily calories from fruit and vegetables. Results varied by ethnicity with trends being more favourable in Asians and African-Americans than in Hispanics and no changes were reported in white children.

Process results reported that teacher training was attended by 100% of teachers and 78%-85% of curriculum activities were implemented by teachers in lessons. However, 68% of parents participated in at least one home activity each year and a high adherence was reported for the school lunch component.

This study showed that such a programme was feasible to run in US urban public schools with a multi-ethnic populations and a key strength of the study was its process evaluation finding. The programme was implemented to a high degree in intervention schools and the authors consider their success was due to the strong teacher training component and the frequent communication between the intervention staff and the school throughout the programme. However, results indicated that whilst the programme was effective in increasing children's fruit and vegetable intakes at lunchtimes, it was not effective in achieving increases in their consumption across the whole day. The disappointing family participation could explain this lack of influence. Only 50% of families returned cards from completed homework assignments. Clearly more work is needed to involve families and thus positively influence the home.

1.4. Summary of nutrition-focused initiatives

It is difficult to draw conclusions from the array of school-based nutrition focused interventions conducted globally, as they vary in size, duration, focus of main outcomes, age group and ethnic grouping. Whilst some contain an education component only, others have targeted food in schools and still others have

integrated a whole school approach. A large number have targeted changes in food choice and dietary behaviour as the main outcome measure. Several have included a measure of body fatness and others have concentrated on changes within the food environment itself. Whilst the results show positive changes occurring in children's food choices and dietary behaviours, the extent of success on body fatness is less clear (Resnicow & Robinson, 1997).

Section Two: Physical activity interventions

Physical Education classes are often an integral part of the school curriculum, and school playgrounds, playing fields, gym and sports equipment feature in most schools. The school day is organised around breaks and lunch times, providing ideal opportunities to promote physical activity. It is not surprising that they are a common focus for interventions aimed at children (Cale & Harris, 2005).

The following section will give examples of interventions focusing on reducing sedentary behaviours, multi-component interventions combining an active PE component with an education component and multi-component interventions combing PE with a classroom-based curriculum of behaviour modification.

2.1. Classroom based

In a small-scale study in California, Robinson (1999) evaluated the impact of a classroom-based intervention on primary school-aged children's media use (TV, videotape and video game use). Lessons were 30-50 minutes long and taught by the regular classroom teacher. The 18 lessons were based on SCT and encouraged children to self-monitor and self-report their TV viewing with the aim of motivating them to want to reduce viewing time. Further lessons challenged children to have a TV and video game-free 10 day period. After this children set themselves goals to achieve a 7 hour a week budget, and lesson content encouraged them to become 'intelligent viewers', by being more selective in what they watched and how they used their time. At the end of the 18 weeks statistically significant decreases were reported in intervention children's measures of body fatness (including BMI, triceps skinfold thickness, waist circumference and waist-to-hip ratio). Additionally intervention children reported statistically significant decreases in TV viewing compared to controls ($p<0.001$) as well as in number of meals eaten in front of the TV ($p<0.02$).

In contrast, results from a similar intervention incorporating similar components and also based on SCT, 'Switch Off-Get Active', (Harrison et al, 2006) reported no statistically significant changes between intervention and control groups for BMI. However, significant differences were reported in physical activity between intervention and control groups with intervention children showing greater activity ($p<0.05$) and self-efficacy for physical activity ($p<0.05$) than controls which was not seen in Robinson's (1999) study. However, results relied on self-report and thus caution is needed in concluding that there is a simple relationship between increased physical activity and decreased screen time. Additionally, whilst the study indicated a co-existence of lower MVPA, aerobic fitness and self efficacy in being able to do physical activity in those children reporting high screen times, it would be too simplistic to suggest high screen times displace physical activity: it could be that they serve as a marker of children with low self-efficacy for physical activity and thus predict their lower physical activity levels.

These studies show that classroom based studies aimed at decreasing TV viewing have mixed effects on children's weight status and such short-term studies make it unlikely that behaviour-change is maintained

in the longer-term. Additionally, Harrison et al (2006) concluded that behaviour-change techniques taught within the classroom may not be sufficient on their own to have major impact on children's screen times. Furthermore, whilst such interventions have shown promise in affecting children's TV viewing behaviours, it should be remembered that TV viewing is not the only sedentary behaviour that children do (e.g. reading, painting, doing homework) and sedentary delivery of such health-related concepts can have little impact on children's physical activity levels, particularly in the longer-term.

Simon et al (2006) conducted a classroom-based study for 11-12 year olds in schools in France, aimed to change children's attitudes towards physical activity, through an educational intervention, giving knowledge about physical activity. In addition children were given increased access to activities and more opportunities to partake in physical activity at breaks, lunchtimes and after school. Thus whilst classroom-based, the programme sought to make the school environment more supportive. Results at 6 months showed those children in intervention schools not partaking in physical activity at school had reduced significantly ($p<0.0004$) compared to controls and the proportion spending more than 3 hours in sedentary activity had also significantly decreased compared to controls ($p<0.0004$).

Such a programme could be useful in schools without regularly scheduled PE classes as it provides children with daily opportunities to be active in a non-competitive, non-structured way whilst also providing an educational component through the curriculum to motivate children to be more active.

2.2. Multi-component- classroom based and PE

Some interventions have included PE sessions (either

adding a new curriculum into existing PE classes or adding new PE classes into the existing curriculum) as well as a classroom-based component.

In some, the classroom-based component was education focussed, giving children information about the benefits of increasing their physical activity.

For instance, Flores (1995) reported on 'Dance for Health', an aerobic dance programme aimed at 10-13 year old African American and Hispanic children in Palo Alta, USA. The 12 week programme included twice weekly dance focused PE sessions and a supporting health education component of 25 lessons covering nutrition, exercise, obesity, smoking prevention, substance abuse, stress management and peer pressure. Significant reductions in BMI were reported between intervention and control girls, but there were no significant reductions for boys. Intervention girls' fitness increased significantly whilst intervention boys' fitness increased but not significantly. By choosing dance, the intervention ensured all students, whatever size and shape or of whatever skill could participate in non-competitive physical activity. Schools did not require specialist equipment and the choice of popular music ensured its appeal. However, its effectiveness with girls and not boys indicates the need to explore more thoroughly how to tailor interventions to be gender-sensitive.

In another study, Pangrazi et al (2003) devised an intervention (PLAY) aimed at 9-10 year olds in Arizona, USA with the focus of promoting 30-60 minutes of moderate to vigorous physical activity daily. The intervention comprised a PE component, integration of 15 minute activity breaks into lessons and a classroom-based curriculum promoting the importance of physical activity and encouraging children to set goals to increase their physical activity. The first week included promotion of play behaviour followed by 3 weeks of teacher-led activities highlighting games suitable for outside school. The last remaining

8 weeks of the programme encouraged children to engage in self-directed activity and goal setting to achieve 30 minutes of activity a day. Whilst no statistically significant differences in BMI were reported between intervention and control groups, girls were significantly more active when the PLAY (classroom-based component) was delivered with PE. Boys showed no statistically significant differences between intervention and control. This study again highlights the need for gender to be taken into account.

There are examples of programmes that have been specifically developed to target girls or boys. These have focused more on behaviour change techniques and promotion of self-efficacy and self-esteem related to physical activity.

For instance, the 'New Moves' study (Neumark-Sztainer et al, 2003) targeted 14-16 year old girls who were either overweight or at risk of becoming so, in secondary schools in Minnesota, USA and was underpinned by SCT and Stages of Change. The focus was on promoting life-long physical activity within a supportive, non-competitive environment, suitable for girls with a variety of shapes, sizes and skill level. The main component was a physical activity programme offered 4 times a week. The support curriculum offered on alternate weeks focused on behavioural techniques such as skill building and increasing self-efficacy related to diet and exercise. It gave nutritional guidance, emphasising balanced eating, and encouraging girls to avoid dieting. A key component was the link with the community with one of the four PE sessions each week being run by a guest instructor, aiming to give the girls a range of role models as well as alert them to the possibilities for physical activity in the community. The intervention included a parental component aimed at increasing parental support for their child, including postcards sent home related to physical activity, nutrition and social support. Results indicated that support from parents, peers and teachers was positively associated with increased physical activity. Additional findings indicated that girls watching more TV had higher BMI's and time constraints were inversely associated with physical activity. Results showed no statistically significant differences between intervention and control schools for girls' dietary and physical activity behaviours, psychosocial variables (e.g. self efficacy, self-worth, self-acceptance), or BMI. This lack of significant findings indicates the need for a more intensive and longer intervention. However, the rigorous process evaluation gave evidence that such a programme was feasible and effective in engaging adolescent girls with low levels of physical activity. High program satisfaction was reported from participants, parents and staff. By incorporating the programme into the existing school day, girls who would perhaps not seek other means of being active after school were given the opportunity to be active and to actually enjoy the experience. The program was sustained by all intervention schools after the study was completed and links with the community were continued.

Another intervention aimed at girls was LEAP (Dishman et al, 2004), targeting 12-14 year old girls with the aim of enhancing their self-efficacy and behavioural skills related to physical activity, and underpinned by SCT. A series of classroom-based sessions were delivered within the normal curriculum and integrated into health education, biology and family and consumer science classes. These classes aimed to support girls in practicing self regulatory behaviours such as goal setting, time management, identifying and overcoming barriers and self-reinforcement. In addition the intervention integrated a physical activity component into normal PE classes. These classes aimed to enhance girls' physical activity levels by giving them positive experiences of physical activity and give opportunities to develop skills to adopt a physically active lifestyle outside school. The intervention was run by specialists, possibly limiting its sustainability. However, its strength was that teachers in intervention schools were involved in the development of the subsequent intervention and their views were sought about what was feasible. By reporting the fidelity of each school's implementation of the programme, results showed that some schools implemented the programme better than others. This highlights which schools need additional support to implement programmes more effectively in future. Like the New Moves study, this study also had direct effects on

girls' self-efficacy, goal setting and physical activity suggesting that self-efficacy and satisfaction had a synchronous relationship with physical activity. These studies (New Moves and LEAP) therefore show promise in being able to reach adolescent girls with low physical activity levels. Mixed PE classes (boys and girls together) present girls with a myriad of concerns and single sex lessons are better for girls. (Taylor et al, 1999).

Other multi-component physical activity focused programmes targeting both boys and girls have also incorporated behaviour change techniques. For instance, SPARK targeted 9-10 year old girls and boys in 6 schools in California (Sallis et al, 1997). The intervention comprised a PE programme and classroom-based self-management component. PE classes were scheduled 3 times a week for 30 minutes in two parts: health-fitness activities (such as aerobic dance, skipping, jogging) and skill-fitness activities (including basketball and football). The self-management component taught children behaviour change techniques such as self-management, goal setting and problem solving. The aim was to help children transfer skills learnt in school to physical activity outside school. Monthly homework assignments were devised to include parents although these were not evaluated. In addition, the study compared the effect of the intervention being teacher-led to being specialist-led. At 2 years, results showed that children in specialist and teacher-led classes spent more time per week being active compared to control ($p<0.001$). Teacher-led classes had comparable effects to specialist-led classes and thus were sustainable. Results also showed that the programme increased intervention children's physical activity levels whilst in school but had no effect on their out of school levels. Whilst studies (both nutrition focused and physical activity focused) have highlighted that teaching children behaviour change techniques can help them improve their health behaviours whilst at school, it is less clear whether these skills can be implemented effectively at home. In addition, there were gender differences reported in this study. Ironically, it was girls again that showed greater improvements in abdominal strength and endurance ($p<0.001$) and cardio-respiratory endurance ($p<0.001$) than controls. Thus whilst the programme was aimed at both boys and girls, taking these findings together with the previously discussed studies suggests that gender differences are a key consideration when designing physical activity components for future interventions.

2.3. Interventions to increase physical activity focusing on environmental changes

The majority of interventions targeting physical activity have been integrated into PE lessons. Very few have considered the aspects of the school environment (Weschler et al, 2000).

a. Playground markings

In a small-scale study in the UK, Stratton (2000) explored the effect of changing playground markings on activity levels of 5-7 year olds during break times. Children in the intervention school designed a series of markings which were then painted onto the playground. Results showed the marking significantly improved activity levels in intervention children compared to controls. Additionally, increasing the availability of balls, skipping ropes etc. and increasing length of break-times influenced children's activity behaviours. However, the short duration of the study (20 days) limits the impact of the findings. Additionally, the results are a combination of increasing the length of playtime, incorporating playground marking and making play equipment more available therefore it is unclear which factor had the most effect. However, the study does show that in schools where physical activity is low, adding such components to playtime can positively influence children's activity levels and such measures are affordable and easy to implement in most schools.

b. Walking buses

Walking school buses are groups of children that walk to and from school chaperoned by responsible adults, usually a group of parents. Children can join the route at various points and those living off the route can be brought by parents to join the 'bus' as it passes. They originated in Australia as a practical solution to traffic congestion, physical activity promotion, levels of pollution and reliance on cars (Engwicht, 1993). They are included here within a discussion of physical activity interventions because their primary goal is to allow children actively and safely to commute to school.

Whilst walking buses have been set up in a number of countries, studies evaluating their effectiveness are limited and have shown varying results (Jago & Baranowski, 2004; Davison et al, 2008; Lee et al, 2008). In a UK study, Rowland et al (2003) reported no change in the method of transport to and from schools between intervention and control schools. However, the input of the school travel coordinator assisting the schools in implementing the scheme was limited (16 hours over the school year). In contrast other studies reported significant effects. For instance, McKee et al (2007) reported significant increases in the mean distances walked by intervention children compared to control children in their Scottish study and Mendoza et al (2009) reported significant increases after one year in the number of intervention children who walked to school compared to controls. Mendoza et al (2009) reported that the school travel coordinator spent 10-15 hours per week throughout the entire evaluation in intervention schools ensuring systematic implementation and maintenance of the scheme.

It appears that walking buses may improve the numbers of children walking to school, thus increasing the amount of physical activity achieved in a day. Sufficient input is required from a coordinator in order to ensure proper implementation and maintenance of sustainable and effective schemes.

c. Community partnerships

The ICAPS study (Simon et al, 2006) is a multi-level program run in schools aimed at improving adolescents' physical activity. As well as an educational component run in schools to increase adolescents' knowledge and skills about physical activity, the intervention promotes new physical activity opportunities in lunch and break times and after school. The entire focus is to develop lifelong active behaviours. The educational component explores physical activity opportunities in everyday life and promotes such things as active commuting and taking the stairs. Physical activity is also encouraged in each class (active breaks). The new opportunities presented by the programme aim to overcome such obstacles as poor accessibility to facilities, unsafe areas, inappropriate opening times, lack of transport and facilities being too expensive. Guest instructors provide adolescents with opportunities within school to participate in informal games or aerobics and dance and the emphasis is on being non-competitive and open to all. Sporting events and bicycle and on-foot school transfers are also organised. Community representatives met to change the local environment to make it more supportive. Initiatives have included low cost or free entry to swimming pools and sports clubs and free transportation. Planning for cycle lanes has also been initiated. The local media were approached to emphasise the community involvement and promote the initiatives.

Results after the first 6 months of the project showed that adolescents in the intervention schools had increased their physical activity. The proportion not performing in supervised physical activity at school reduced significantly ($p<0.0004$) as did the proportion of those spending more than 3 hours a day in sedentary activity ($p<0.0004$). Again gender effects were reported with more girls participating than boys ($p<0.05$). However, parental participation was low, particularly in low socioeconomic groups (25% to 40%)

despite parents stating their interest in the project. The study shows that school-based PE programmes have the potential to form community links in order to influence positively the wider environment in terms of physical activity opportunities for adolescents. Such a programme may be less effective with younger children who have less autonomy when out of school.

2.4. Summary of physical activity focused school-based programmes

Whilst the studies discussed above show promise in supporting children in increasing their physical activity, the fact that some added additional sessions on top of the children's normal PE classes (e.g. Flores et al, 1995; Neumark-Sztainer et al, 2003; Sallis et al, 1997) raises questions about whether they are practical to implement and consequently whether they are sustainable. Findings have also highlighted that there are gender differences in how physical activity is perceived and what activities are appealing.

Section Three: Multi-component interventions

There has been a wide range of multi-component interventions developed for schools focusing on nutrition and physical activity. Some simply focus on educational and informational approaches whilst others incorporate behaviour change techniques. Still others intervene in the school environment such as providing healthier school meals or increasing opportunities to be more physically active. The wide range prevents accurate comparison. This section will simply show-case particular approaches and programmes.

3.1. Nutrition education and physical activity

a. In school

A multi-component intervention aimed at 5-7 year olds was conducted in Germany by Muller et al (2001). The intervention aimed to develop knowledge, self-monitoring, increase children's elf-esteem and build autonomy. It focused on increasing children's fruit and vegetable consumption, reducing their fat consumption and increasing their physical activity to at least 1 hour a day and decreasing their TV viewing to less than 1 hour. Intervention schools received 8 hours of nutrition education including 'active breaks'. A novel component was the home-based element which included 3 to 5 hours of home visits for obese children and/or those with obese parents. Family counselling encouraged families to assess personal preferences of family members and considered family structure, organisation and lifestyle (diet and activity) of family members. A 6 month structured sports programme was also offered to overweight children. Short-term effects at 3 months indicated increased nutritional knowledge, increases in physical activity daily and decrease in TV viewing ($p<0.05$) in intervention schools. At 1 year, triceps skinfold thickness increased significantly less than in control children ($p<0.01$) and % fat mass also increased significantly less ($p<0.05$). Whilst the programme showed effectiveness in the short-term it was unclear how sustainable the intervention would be. Teachers were trained by specialists and co-ran the nutrition classes but no details of how frequently this training was or how teachers were assessed was given. Additionally, it is unclear what effect the specialist programmes had on the obese children's self-esteem or perception of social inclusion.

Another programme for which this concern could be raised is a primary school based intervention developed in Beijing (Jiang et al, 2006). The intervention included nutritional lectures to parents and gave families educational materials for use at home. Classroom lessons were given to children with additional lessons for those who were overweight and obese. Parents of overweight and obese children attended

extra meetings once a semester. Whilst Jiang et al (2006) reported the prevalence of overweight and obesity reduced significantly in intervention children (p,0.01) as well as significant differences in BMI between intervention and control schools, no evaluation was made of outcomes such as child self-esteem or self efficacy or the extent to which obese children felt socially excluded. Indeed, a systematic review of school-based interventions in China, (Li et al, 2008) highlighted that discrimination of overweight and obese children was a major factor in all Chinese school-based studies included in the review. In order to explore such issues, one multi-component intervention targeting 7-11 year olds in the UK, aimed at improving diet and physical activity behaviours (Sahota et al, 2001) incorporated outcome measures such as global self-worth, dietary restraint, body shape preference and self-perception as well as the more common measures of dietary intake and physical activity behaviours. Results showed that global self-worth scores were higher in the obese children in the intervention group compared to obese controls. Thus the programme was successful at changing children's attitudes and did not do harm. It would be sensible for future programmes to incorporate such measures to explore whether some children are negatively affected.

A US intervention aimed at 9-11 year olds incorporated a wellness and PE intervention into various classes including wellness, nutrition, language, art, maths and PE (Spiegel & Foulk, 2006). The curriculum was implemented through the school year, taking into account individual schools' schedules. It was underpinned by the Theory of Reasoned Action and aimed to build students' academic skills whilst also developing their health attitudes and behavioural intent, with the longer term aim of affecting their behaviour. Activities involved students exploring their own attitudes and intentions, collecting, reporting and analysing information about their own health such as measuring their own height and weight using tape measures and scales. Physical activity modules encouraged students to devise ways of incorporating physical activity into their daily lives and the nutrition module focused on learning about balanced eating and then comparing their beliefs with their own food intakes. The curriculum also included practicing how students could take home information and skills, to become health advocates in their families. The curriculum activities included reading, writing and reflection skills as well as being a health promotion intervention. Classes finished with 10 minutes of aerobics each day. At 6 months significant decreases in development of overweight were reported in intervention children and a 2% reduction in numbers of intervention children being overweight was seen. Increases in fruit and vegetable consumption were reported in both groups but were noticeably higher in the intervention group. Children in the intervention group reported increases in their physical activity levels at home and at school. However no objective measures of physical activity were taken and similar multi-component interventions with such measures have reported no significant increases in physical activity levels (e,g, Gortmaker et al, 1999; Manios et al, 1998; 1999; 2002; Kafatos et al, 2007). It has been suggested that the effectiveness of the physical activity component of such interventions is hindered by the minimal PE classes and limited after-school provision. However, the fact that the programme was designed to be incorporated into the existing curriculum in a range of subjects and promoted academic skills may make it more appealing for schools to adopt, rather than them perceiving it as an additional programme to somehow be slotted into the academic curriculum.

Spiegel & Foulk's (2006) programme was of short duration and whilst classroom teachers delivered the programme, no assessment of teacher training or teacher effectiveness was conducted or indeed whether teachers implemented all components of the programme. This was the case in similar multi-component interventions implemented by classroom teachers (e.g. Gortmaker et al, 1999; Manios et al, 1998; 1999; 2002; Kafatos et al, 2007). In addition, in order to be effective at improving children's health behaviours, programme effectiveness is not just dependent on intensity but also on teachers' ability and enthusiasm for the programme (Bush et al, 1989; Resnicow et al, 1992). Other evidence indicates that in terms of encouraging adolescents to increase their physical activity levels, unsupportive teachers are a key barrier

(Mason, 1994; Mulvihill et al, 2000; Orme, 1991; Sports Council for Wales, 1994). Thus future programmes would benefit from integrating teacher evaluation into their studies not only to assess their level of expertise but also their views and attitudes.

Other multi-component school-based interventions have included additional components within the wider school environment than just nutrition and physical activity class-room based curricula.

For instance, the CATCH (Luepker et al, 1996) intervention including nutrition curriculum, enhanced physical education and school-food modification plus family education, aimed primarily at prevention of cardiovascular disease, was one of the first and largest multi-component school-based programmes developed. Like other multi-component interventions the classroom programme was implemented by teachers and involved skills development related to eating habits and physical activity. Additionally, the PE component sought to increase the amount of moderate and vigorous physical activity (MVPA) during PE. Other components included a family-based intervention and food modification. At the end of 3 years the physical activity intensity of PE classes in intervention schools had increased significantly compared to control ($p<0.02$) and significantly more daily vigorous activity was reported by intervention than controls (58.6 mins vs 46.5 mins, $p<0.003$). Intervention children's self reported energy intake from fat in intervention children significantly reduced (32.7% to 30.3%) compared to control children (32.6% to 32.2%) ($p<0.001$) and dietary knowledge, dietary intentions and self-reported food choice changes were significantly greater for intervention children than controls. Thus the program was effective but as found in other interventions, whilst a high degree of compliance was reported by PE and classroom teachers implementing the programme, showing that it was compatible to needs and structure of schools, implementation was limited by costs, staff time and competing classroom instructional requirements. In addition staff training time was limited, compromising effectiveness and intensity. The family-based component comprised 19 activity packs sent home over the 3 years, with the child to be completed with the parent. These complemented the curriculum content, with rewards given to children who completed them. In addition family fun nights were run consisting of dance performed by the children for their parents, distribution of recipes and games and food booths giving away healthy snacks. Family fun nights had more than 70% parental attendance; however a comparison between schools receiving the curriculum and those receiving it plus the family component found little benefit was gained by adding the family component. These findings suggest that the family component of such programmes need to be more intensive and extensive.

The food modification component aimed to reduce total fat of school meals to 30% total energy, saturated fat to 10% total energy, and sodium to 600-1000mg per serving whilst maintaining nutrient content and child participation. Caterers received a training day at the beginning of each school year and monthly follow-up visits from intervention staff as well as booster sessions provided them with additional information, added motivation and support for planning menus. Schools were also given a wide variety of promotional materials to help them encourage students to eat the modified menus. Results showed a significantly greater mean reduction in % calories from total fat ($p<0.001$), and saturated fat ($p<0.003$) in the intervention schools compared to controls. In addition whilst the sodium content increased in both intervention and controls, the increase was significantly lower in intervention schools ($p = 0.034$). No significant changes were reported for carbohydrate, protein, fibre, calcium, iron, vitamin A and C and the mean total calories (683kcal) in intervention schools remained above one-third of the RDA's for the age group. Thus the food modification component was successful in meeting its goals and this was achieved in a wide variety of schools representing a range of food services and diverse student populations. Whilst there was a high degree of compliance in implementation of CATCH by food service staff, the ability

of schools to reach intervention objectives varied. The degree of implementation of the food service component was determined by differences in food service operations, food purchasing and associated barriers. For instance, schools in Texas all had on-site food preparation and came from a single school-district. This facilitated support given by policy makers to modify food purchasing, and on-site facilities meant a greater number of goals could be achieved. In contrast schools in California had meals provided from a central kitchen and this precluded implementation of any of the intervention goals.

The availability of CATCH curriculum materials has resulted in its wide dissemination and use in other elementary schools across several states in the US and tailoring of the programme to other target populations and school systems. For instance, Coleman et al (2005) reported on the adaptation of CATCH for low income schools with Hispanic children. Results indicated that whilst the proportion of overweight girls in both control and intervention schools increased, the increase in intervention schools was significantly lower.

Whilst many school-based programmes cite using SCT as the theoretical framework and tend to target children's self efficacy, outcome expectancies and behavioural capability of knowledge and skills, Sallis et al (2003) took a novel approach and devised a multi-component intervention based on social marketing. The aim was to increase children's total energy expenditure from physical activity and decrease the number of grams of saturated fat purchased. The intervention targeted 10-14 year olds in San Diego. Physical activity was increased by changing lesson structure, incorporating activity into classes and improving teachers' instructional skills as well as increasing the availability of equipment during breaks and lunchtimes and provision of organised activities. The nutritional component included changes in school food provision (lunches and vending machines). Catering staff received 11 hours of training and action plans were devised to reduce fat content of foods and increase numbers of lower fat options. Students were set goals to bring more lower-fat alternatives into school in their packed lunches. An additional novel aim was to create a supporting policy change within the school. Student health committees were set up and parental education was delivered through existing communication channels such as newsletters, and PTA meetings. At the end of the 2 year intervention, intervention boys' BMI had significantly decreased ($p=0.044$) but no change was seen in girls. Boys' MVPA increase significantly ($p=0.001$) but again no effect was seen in girls. Findings also indicated similar barriers cited in previous studies; that is that some schools found it difficult to increase the availability of physical education throughout the school day due to lack of volunteers to run sessions and there were substantial financial barriers to schools increasing the amount of lower-fat options on their menus. Some districts also were provided with meals from a central food system which eliminated the amount of control over food preparation and choice that schools had. In addition there was a requirement for food services to be self-supporting and therefore schools were reluctant to serve new menus with lower fat and perishable items such as fruit and vegetables when there had been no demand for such items and no time in which to promote and encourage them. Also there was often no appropriate place for promotional materials to be displayed. The study shows that whilst targeting the school environment appears feasible and to some extent achievable, considerable barriers exist. More understanding of school systems and structures and policies underpinning these is required. Yet again, gender differences appeared, highlighting the need for more exploration about what girls and boys benefit from and what appeals to them.

b. Outside lesson times

Whilst schools have been used as a setting for nutrition and physical activity interventions, with increasing focus on meeting educational and academic standards, there is not always sufficient time to incorporate health promotion efforts. There is a need to be innovative and utilise non-curriculum time such as

lunchtimes, break times and after school. Teachers are under considerable pressure to deliver the standard curriculum and presenting them with an additional programme to implement may not be feasible or practical.

A study that sought to reduce teachers' work-load was 'Be Smart' (Warren et al, 2003), a UK based multi-component programme for 5-7 year olds. The intervention was delivered in lunch-time clubs and aimed to increase children's outcome expectancies and expectations of physical activity and nutrition behaviours. Additionally it provided opportunities for children to taste healthy foods, develop practical skills in order to build their self-efficacy. Furthermore there was a parental component although details were poor and authors reported difficulty in engaging them. Significant improvements after 20 weeks were seen in nutritional knowledge ($p<0.01$) in all children but particularly in those getting both nutrition and physical activity components ($p<0.0001$). Significant improvements in fruit consumption ($p<0.01$) and vegetable intake ($p<0.05$) were seen in all children but changes in fruit intake were particularly significant in those children getting just the nutrition component ($p<0.05$) and the control ($p<0.05$). No significant differences in BMI were reported. Whilst the intervention was a pilot and depended on specialists to deliver it, teachers expressed interest in incorporating the intervention into the curriculum. Thus the programme showed promise for the future. However, if schools wanted to keep such a programme integrated into lunchtimes, a more sustainable means of delivering it needs to be found as reliance on specialists may not be practical in the longer term.

A novel way of not directly increasing teachers' workload yet delivering a multi-component intervention aimed at improving healthy eating and physical activity in 5-12 year olds was devised by Taylor et al (2007) in New Zealand. The intervention was delivered by appointed community activity coordinators whose role was to increase the variety and opportunities for physical activity beyond normal provision within school hours. This included increasing non-curricular activities at breaks, lunchtimes and after-school, as well as weekends focusing more on lifestyle-based activities rather than organised sports. Additionally, schools were given money to purchase sports equipment although no details were reported on how schools spent this money. Nutrition-based components focused on reducing sugary drink intake and increasing fruit and vegetables. This component did incorporate a curriculum into existing science-lessons although it was unclear who delivered these and how these were incorporated. Additionally an interactive card game was developed which involved children completing specific nutrition or physical activity –related tasks with friends and family. Results at the end of 2 years showed significantly lower BMI z-scores and waist circumference for intervention children. Intervention children consumed fewer carbonated drinks than controls and ate more fruit ($p<0.01$). Physical activity was significantly higher in intervention children at 1 year although no effects were reported for reductions in TV viewing times. A lack of process evaluation meant that it was unclear how the intervention was perceived by schools and how the community activity coordinators were assessed.

Schools must also be culturally inclusive and therefore there is less opportunity to tailor interventions to specific ethnic groups. The GEMS intervention which targeted African American girls specifically, (Story et al, 2003) was implemented after-school and aimed to increase 8-10 year old girls' physical activity and improve their eating. The 12 week intervention took the format of 'club meetings' held twice a week. Intervention content was based on SCT and focused on behaviour change, incorporating physical activity and nutrition components. Goals were to increase girls' participation in PE, decrease their time watching TV, decrease consumption of high fat foods and sweetened beverages, adopt healthy eating practices such as portion size awareness and increase their consumption of fruit and vegetables. The family component was designed to reinforce these messages and provide a supportive environment at home. It consisted of weekly family take-home packets, family events and phone calls home by GEMS

staff to encourage parents and check progress. The intervention was culturally appropriate and aimed at low-income African-Americans. Results at 12 weeks showed BMI did not differ between groups but were in the hypothesised direction. Intervention girls had significantly higher scores on the healthy choice behavioural intentions (p= 0.001), dietary knowledge (p = 0.001) and preference for physical activity (p = 0.04) compared to control girls. Parents of intervention girls reported significantly less availability of high fat foods (p=0.001) and lower energy intake from fat in their own diets (p = 0.03) compared to control parents. A key strength was the process evaluation which demonstrated the programme was well-attended and well-received by girls and parents. Parental participation was high because the girls were excited about the events and wanted their parents to attend. All parents said they would recommend it to other parents and the majority of parents wished the programme had been longer. Other studies have explored the feasibility of implementing nutrition and/or physical activity programmes in channels such as Girl and Boy Scouts. The rationale behind this is that such an international movement reaches large numbers of boys and girls and earning of badges provides a useful mechanism through which to promote learning and behaviour change. Examples of such programmes include the development of the 5 a Day Badge for Girl (Cullen et al, 1998) and Boy Scouts (Baranowski et al's, 2002). The programme was underpinned by SCT and aimed to increase children's consumption of fruit and vegetables. The programme included self-monitoring, goal setting, problem solving and reward activities and aimed to increase children's skills at asking for fruit and vegetables at home and being able to prepare simple snacks and meals incorporating fruit and vegetables. In their study of African-American Boy Scouts, Baranowski et al (2002) reported that the intervention resulted in a difference of 0.8 daily servings of fruit and vegetables between control and intervention boys after only 8 weekly troop meetings. However, yet again authors highlighted difficulties in engaging with parents reporting poor attendance at parents' meetings. They also reported that leaders at all levels of the Scouting movement stated their difficulty in engaging with parents, suggesting that parental involvement is not just a problem for school-based programmes.

3.2. Summary of multi-component interventions

Programmes targeting nutrition and physical activity have also included food service modification, forging of community links and a family-based component. Whilst positive results have been reported as a result of food modification programmes, there is less evidence that such schemes influence children's dietary behaviours at home. Additionally, whilst targeting the home environment is recognised as important, there appears to be no difference in effectiveness between those programmes that have included a family-based component and those that have not (Kropski et al, 2008). Indeed many studies reported their difficulty in engaging with families.

Section Four: Lessons learnt from school-based interventions (nutrition, physical activity and multi-component programmes)

This review began by outlining the paradoxical situation that exists in terms of obesity prevention research in the school setting. Whilst there is clearly a need for obesity prevention to stem the tide of increasing childhood obesity prevalence, the range of school-based programmes and initiatives that exist currently makes recommendations difficult. An additional difficulty encountered whilst conducting this literature review was the dearth of information given by authors about their intervention components and their content, and the lack of process evaluation meant it was unclear how the programme had been implemented or received by teachers, children and parents. Indeed, whilst it is important that programmes implemented are effective in terms of targeting obesity risk factors and changing behaviours, it is also imperative that they are easily integrated into existing school systems, that they are cost effective and sustainable. With these considerations in mind, the following section will outline issues that future initiatives need to address.

4.1. Programme type

A range of programmes has been outlined in this review. The most common physical activity focused programmes and those that have been most effective have involved lengthening the existing time of PE lessons or adding new lessons (Cale & Harris, 2006). However, schools are faced with the difficulty of implementing these programmes due to the pressures of utilising curriculum time for core subjects rather than PE (Kahn et al, 2002). Another concern is that a PE lesson will comprise of other non-active elements such as changing. Indeed Fox et al (2004) describe a study of a 40 minute PE lesson where on average only 8 minutes were taken up with moderate or vigorous physical activity. In addition, Biddle et al (2004) question the wisdom of developing structured activity programmes. They argue that whilst the aim of such interventions is often cited as teaching children about integrating physical activity as a normal part of their lives, adult physical activity is often more unstructured. Sallis et al (1992) hold a similar view stating that programmes encouraging activity across the lifespan should focus on skills development 'that promote generalisation and maintenance of physical activity during youth and adolescence and enhance the probability of carryover to adulthood' (Sallis et al, 1992, pS255). Despite these recommendations there have been very few physical activity interventions targeting schools or indeed, taken a non-competitive approach. Interventions that stand out include Pangrazi et al (2003) where 15 min activity breaks encouraged children in movement of any sort rather than specific or high intensity and New Moves (Neumark-Sztainer et al, 2003) deliberately emphasised exercise for all shapes, sizes and skills levels. Davison (2005) urges researchers to develop the concept of the 'active classroom' where physical activity can be incorporated into lessons.

In terms of nutrition-focused initiatives, Contento (1995) highlighted that integration of nutritional education into the curriculum was a key to success, and other authors came to the same conclusion. For instance, whilst effort has been spent in devising interactive and fun teaching materials and tools, often involving multi-media and CD ROMS and incorporating behaviour change techniques,(Amaro et al, 2006; Baranowski et al, 2003), Livingstone et al (2002) found that to have longer-term use the place of such tools within the existing curriculum needed identifying. Increasing fruit and vegetable intake and decreasing sweetened beverages appear to be the most commonly promoted messages by interventions (e.g. Reynolds et al, 2000; Baranowski et al, 2000; Perry et al, 1998; James et al, 2004; 2007) and reviewers have urged researchers to promote these in future despite limited understanding of how much change in these variables needs to occur to result in significant weight loss (Baraonowski et al, 2002; Sharma, 2006). However, schools have an obligation not just to promote simplistic nutritional messages. Clearly nutrition education should not just provide information but needs to provide opportunities to develop skills and behaviours related to areas such as food selection, storage, and preparation as well as consider the social and cultural aspects of food (Dixey et al, 1999). Several programmes have incorporated nutritional elements into lessons other than those immediately thought of. For instance Perez-Rodrigo et al (1997) integrated their curriculum into maths and language lessons and components of the 'Eat Well Keep Moving' programme (Gortmaker et al, 1999) were integrated into maths, science, language, arts and social studies.

Whilst some interventions targeted only one dimension such as reducing carbonated drinks (James et al, 2004; 2007) or reducing TV viewing (Robinson, 1999), others were multi-faceted, aimed at both nutrition and physical activity behaviours (Manios et al, 1998; 1999; Gortmaker et al, 1999; Muller et al, 2001). Still others targeted specific components of the environment such as school meals (French et al, 2004; Perry et al, 2004) or playground markings (Stratton, 2000). However, it cannot be concluded whether single-component programmes are more effective than multi-component ones. From an entirely pragmatic point of view it seems sensible to consider future interventions which incorporate all the issues discussed above and take a 'whole-school' approach to obesity prevention.

Additionally, whilst multi-component interventions have been developed, their focus is still largely on targeting individual behaviour change and if the environment has been targeted it is from the perspective of supporting this behaviour change, rather than considering for the longer-term how whole school policies or the school environment can be changed to promote a healthy school setting. Whilst environmental strategies have been explored, looking at school meal and snack provision, the environment in terms of physical activity at school has rarely been explored. As Cale & Harris (2006) state 'it is logical to assume that interventions are likely to be most successful if they target the same behaviour across a number of levels' (Cale & Harris, 2006, p 329). This concept is emphasised in the Health Promoting School philosophy (WHO Euro-EC-CE, 1993) where equal importance given to the taught curriculum, the whole school ethos and the family and community with the aim of coordinating messages that the children receive.

4.2. Information provision v behavioural approach

The number of studies combining information-giving approaches with behaviour-change techniques is increasing. Indeed, in their review of interventions aimed at increasing physical activity, Kahn et al (2002) identified 13 studies that evaluated the effectiveness of classroom-based health education focusing on information provision and 9 of these were implemented before 1990. Instead, more recent studies have comprehended that increased knowledge does not necessarily translate into behaviour change and have targeted behaviour change through the curriculum (for example Warren et al, (2003) focused on increasing children's outcome expectancies and expectations related to nutrition and physical activity behaviours; Muller et al, (2001) incorporated self monitoring components and sought to increase children's self esteem and autonomy at making healthier choices related to nutrition and physical activity; Neumark Sztainer et al, (2003) focused on skill building and increasing self efficacy).

4.3. Target group

There have been more programmes targeting the primary-school age group to date than those targeting older children (Sharma, 2006; Cale & Harris, 2006). As it is at this age that dietary and physical activity behaviours are formed, Sharma (2006) considers it entirely appropriate that interventions target primary school in order to support children in forming lasting healthy behaviours. One element identified by Lytle & Achterberg (1995) for successful nutrition-focused school-based interventions were primary school interventions with a family component. However, Baranowski et al (2002) consider the most effective interventions in terms of reduction seen in BMI have been in older children, and they suggest that this could be due to the target population being more mature and/or having more control over their own dietary and physical activity behaviours and choices. Other researchers have reached this conclusion (Kropski et al, 2008; Budd & Volpe, 2006). However, recommendations such as this are based on limited evidence and whilst there is recognition that interventions must be age-appropriate (Lytle & Achterberg, 1995) no research has outlined how developmental differences can be tailored for, and what approaches might be more suited to different ages and stages of development. Additionally, Cale & Harris (2006) hypothesise that the large number of primary-school based programmes may reflect the greater degree of flexibility within the primary-school curriculum and the more holistic approach to health education. There is clearly a need to work with school principals and staff when considering the feasibility of integrating such programmes into the existing school curriculum.

4.4. Targeting parents

Whilst school-based programmes have often been successful in improving children's dietary and physical activity behaviours whilst in school, there is less evidence to show that it improves these behaviours outside school (Stone et al, 1998; Lytle et al, 2002; Lytle & Achterberg, 1995). Indeed, Wechsler et al (2000) consider it unrealistic to expect schools to facilitate changes in children's behaviours without the support from families. However, whilst several interventions have tried to incorporate a family component, few have shown added effectiveness from doing so (Baranowski et al, 1997). For instance whilst Hopper et al (1992) reported that a school-based nutrition-focused intervention significantly increased at-home dietary and nutritional knowledge, no correlation could be demonstrated between this increased knowledge and more positive domestic dietary habits and behaviours. Often authors stated that it was not practical to run an entire parental intervention in parallel (Perry et al, 1998) and therefore take-home packs were usually utilised (Perry et al, 1998; Reynolds et al, 2000; O'Neil et al, 2002; Baranowski et al, 2000; Sallis et al, 1997). Several programmes reported their difficulty in engaging with parents, reporting poor attendance at parents' meetings (O'Neil et al, 2002; Baranowski et al, 2000; Warren et al, 2003) or return of homework assignments (Reynolds et al, 2000). Salmon et al (2005) reported that the majority of parents were unaware of intervention aims and the majority of children lacked support in their behaviour-change attempts at home. Others have reported good attendance for those families who participated, yet these families represented only a small percentage of the families who could potentially have got involved (Nader et al, 1992). It seems ironic that whilst young people associate home with healthy foods and family members are often used as sources of nutritional information (Ross, 1995; Watt & Sheiham, 1996; Watt & Sheiham, 1997), it continues to be a problem for interventions in how to engage with families effectively.

However, very few explored parents' perceptions of the programme and how useful they found the take-home packs. Indeed, Baranowski et al (1998) stated that GIMME 5 would have worked better if it had been explored how families could be better supported and engaged with, and if factors affecting food choice had been integrated into programme activities.

4.5. Community involvement

Very few interventions have included community involvement and it is unclear whether incorporating these components increased intervention effectiveness. However, as schools only have limited time within a school day and stretched resources to tackle obesity prevention, it seems prudent to work with representatives from industry and the wider community to tackle the issue. For example in the 5 a day Power Plus programme (Perry et al, 1998; Story et al, 2000), local fruit and vegetable producers provided produce for classroom taste testing as well as snack packs that children took home and were able to contribute to expanding the food choices given at lunchtimes. In addition they did a 30 minute presentation to intervention children on fruit and vegetables.

Despite evidence in the literature that a key barrier to young people choosing healthier foods is their perceived lack of convenience and poor food labelling (Shepherd et al, 2006) very few school-based interventions have incorporated such wider aspects of eating behaviour into their programmes. One such initiative (the Minnesota Heart Health Program, (Kelder et al, 1995) integrated a school-based behavioural education programme alongside community-wide health promotion strategies. The community component included nutritional labelling in local restaurants and supermarkets, and mass media education via local television, radio and newspapers. Such an approach resulted in modest but lasting improvements in adolescents' knowledge and choices. In terms of encouraging physical activity outside of school, only one study was found (Simon et al, 2006) that aimed to address children's barriers such as lack of money, lack of transport and lack of provision of acceptable activities (Rees et al, 2006).

Future interventions would benefit from forging more community links to encourage increased physical activity and improved dietary habits out of school (Lytle et al, 2002).

4.6. Engaging with schools

Whilst school-based interventions have varied considerably it is also clear that schools and education systems differ greatly between and within countries. However, for any initiative to be implemented effectively, the school culture needs to be targeted for change including all stakeholders - students, families, staff, administrators, principals as well as the location and surrounding area and any external political influences. Before a programme can be implemented it is important to have full understanding of how these stakeholders are involved, their interrelated roles and how these can be influenced. In other words, school-based initiatives need basing on a thorough needs assessment of the current situation (Ford et al, 2007; Summerbell et al, 2005; Parcel et al, 2003; Lytle et al, 2002; Sharma, 2006) and building relationships with and involving key stakeholders is a key step in the process (Summerbell et al, 2005). Several factors need consideration:

a. School structure and organisation

Before intervening in the school environment it is important that a full understanding is gained of the barriers and challenges facing schools in terms of implementing sustainable programmes targeting healthy eating and exercise behaviours.

Ford et al (2007) describe schools as 'political, complex, interactive, evolving environments' (Ford et al, 2007, p359).

In terms of physical activity programmes, financial constraints and budget cuts have been correlated with reduction in the availability of extra-curricular sports programs and a lack of facilities (Shaya et al, 2008). In reviewing the effectiveness of PE intervention incorporated into the normal PE curriculum, Almond & Harris (1998) concluded that those showing positive effects involved programmes including additional PE time, but they questioned the sustainability of such programmes in light of school structures and timetables. For dietary focused programmes, challenges include school meal provision. In countries with an absence of healthy meal guidelines, it is often the case that schools on limited budgets will opt for 'fast-food' cafeteria-style menus. In an intervention evaluating the effectiveness of fruit tuck shops, Moore (2001) reported that schools funded these themselves and whilst the initiative was received positively by the schools involved, the study has importance in highlighting that for schools with limited budgets, such schemes may be the first to suffer.

Additionally, whilst the opportunity presented by schools for obesity prevention work has been widely recognized, it is clear that such schemes present a considerable burden to school administrators in terms of planning and budgeting. Indeed, in their evaluation of a programme to increase students' fruit and vegetable consumption, Anderson et al (2000) reported that schools found enlisting the help and support of the school administrators invaluable for the smooth running of the programme.

A key to successful implementation is the support of the school principal. In a study of school principals, Price et al (1987) reported that they were unsupportive of obesity prevention work. It is logical to predict that a lack of support from such a key figure will prevent effective implementation of any programme. Indeed, in their 'New Moves' intervention, Neumark-Sztainer et al (2003) consider a strength of their programme was the strong support generated from PE teachers and principals in the participating schools, including their decision to apply for funds to continue the intervention after the study was completed.

There is also a burden to teachers in terms of training to deliver the programme and then in implementing the programme. A range of ways of decreasing teacher burden have been explored including utilizing the lunchtime (Warren et al, 2003) or after-school (Story et al, 2003) slot in which to implement programmes. Another novel way of decreasing teacher workload was the use of community representatives to come into school and plan initiatives at lunchtimes and break times (Taylor et al, 2007).

Whilst school based interventions have targeted students' dietary and physical activity behaviours in numerous ways as outlined above, the majority did not make use of the school nurse. Indeed, the role of the school nurse in obesity prevention still remains relatively undefined: Survey data from the US on their School Health Policies and Programs Study (SHPPS), highlighted that whilst health services within school were delivered by the nurses, relatively few of these services were aimed at obesity prevention (Brener et al, 2001). A review of progress of the SHPPS in 2007 still found this to be the case (Brener et al, 2007). In there review, Bindler & Bruya (2007) found a dearth of evidence of school based health programmes run by school nurses in the US and UK. Indeed, the current role of the school nurse in the US and UK appears limited to school-based height and weight screening which is reported to parents (ION, 2004; NCMP, 2005).

However, studies exploring nurses' perceptions have reported that the majority support the use of school health services to provide obesity prevention services (Price et al, 1987; Stang et al, 1997; Moyers et al, 2005; Kubik et al, 2007). A study in the US (Moyers et al, 2005) explored the perceptions of school nurses with regard to obesity in school children. Their results showed that whilst nurses supported the use of school health services for obesity prevention work, they found counselling for obesity difficult, particularly when parental support was lacking. They also stated they felt unconfident in their counselling skills and only provided counselling and referral to obese children when parents had asked for help. A later study also showed that school nurses in the US were supportive of obesity prevention services however, this support increased as nurses' perceived support from school staff and other health care providers increased. These studies also bring to light the fact that in the current obesity crisis, the expertise of school nurses is not being fully utilised.

b. Teacher training

In terms of curriculum-based programmes, several programmes to date have utilised the existing classroom teacher to deliver the intervention (Sahota et al, 2001; Manios et al, 1998; 1999; 2002; Muller et al, 2001; Gortmaker et al, 1999; Sharma, 2006) whereas others used specialist staff (Salmon et al, 2005; Dishman et al, 2004; Lazaar et al, 2007).Sharma (2006) considers having a multi-disciplinary team of health professionals supporting such health promotion initiatives is advantageous. However this approach may not be feasible, practical or sustainable. Indeed reviewers have recommended addressing sustainability by incorporating staff training whilst also targeting behaviour change (Sharma, 2006; Summerbell et al, 2005; Brown & Summerbell, 2008).

Studies incorporating teacher training tended to report giving one day of training to staff (e.g. O'Neil et al, 2002; Baranowski et al, 2000), Perez-Rodrigo, Fahlman et al (2008), yet no assessment of whether this was adequate was conducted and no measure was incorporated into such interventions to measure teachers' capability. Indeed, research suggests teachers often complain about lack of information, training or materials they are given for such programmes (Dixey et al, 1999). For instance, Price et al (1990) reported that primary school teachers did not feel capable or competent enough to deliver physical activity programmes aimed to reduce obesity. They went further to state that they felt under-trained to help prevent obesity. This need from teachers was also highlighted in recent joint report on a consultation

with teachers from The Audit Commission, The Healthcare Commision and The National Audit Office in the UK (2006). Teachers asked for more support and guidance about advising children who were obese or at risk of becoming so and wanted more support on what advice to give to parents. Therefore future programmes would benefit from more intensive teacher training.

However, implementation of curricula depends on factors other than the degree of teacher training. For instance, characteristics of the teacher, the materials, degree of support provided by specialists all influence the degree of implementation of a programme or curriculum (Tones et al, 1997). Kealey et al (2000) suggest that teacher training itself should be considered as a behaviour change process, incorporating motivational components which could help support the teacher to consider how they implement such a curriculum into their existing classes. Other issues regarding programme implementation are influenced by wider factors within the school environment and will be considered in the next section.

c. Attitudes, behaviours, norms and knowledge of staff

There has been concern expressed that promoting obesity prevention work in schools could have potentially detrimental effects (Garner, 1985). For instance there is potential for such programmes to stigmatise overweight children and introduce children to the concerns of weight control, fear of food, negative body image and labelling. Yager & O'Dea (2005) highlight the considerable potential that teachers' attitudes towards obesity may be transferred through modelling to the children they teach. Evidence suggests that prejudiced viewpoints about obese children exist amongst teachers (Neumark-Sztainer et al, 1999; Schwartz & Brownell, 2004; Puhl & Brownell, 2001) but to what extent is unknown. However, as Davidson (2005) advises 'before we can begin to reduce the negative stereotyping of obese children there may be a need to help teachers face their own bias' (Davidson, 2005, p 387).

d. A Child-centred approach – attitudes, norms, knowledge of children

Only a few school-based studies were based on an initial pilot study or needs assessment to ensure the subsequent intervention was tailored to the child population it was aimed at or that the intervention components were relevant and of interest to children. Studies have found that children were more positive when their views were sought (Woolfe & Stockley, 2005) and children more engaged with the programme were more likely to get their parents involved (Neumark-Sztainer et al, 2003). However, in general basing the study on a needs assessment was rarely done. In a systematic review of physical activity interventions outside school, Brunton et al (2005) reported that whilst children and parents had clear views about factors that helped or hindered children's physical activity levels, these views had rarely been sought and nor did they inform the development of physical activity interventions.

Additionally, several studies have found favourable outcomes for either girls or boys but not both (e.g. effect for girls: Perry et al, 1998; Flores, 1995 – Dance for Health; Gortmaker et al, 1999 – Planet Health; effective for boys: Sallis et al, 2003), suggesting that messages were more accessible or appealing to specific genders. However, no details of children's needs or perceptions, makes it difficult to understand why such differences in outcomes arose. Reviewers suggest that programmes should be focused on specific target groups so that programme design and content can be ensured to address their specific needs (e.g. Cale & Harris, 2008; Doak et al, 2006; Kropski et al, 2008; Brown & Summerbell, 2008). It is clear that girls' and boys' perceptions and needs differ. One example of tailoring specifically to girls

is the GEMS after-school programme designed in a 'club format' for overweight African-American girls. Whilst no significant differences were reported in BMI at 12 weeks, other outcome measures showed favourably in intervention girls and parents were complementary of the programme and would promote it to others. Whilst no firm conclusions can be made about how girls and boys' dietary behaviours can be more effectively and differentially targeted, reviewers have concluded that in terms of physical activity programmes, girls may respond better to classroom instruction based on social learning whilst boys may be more influenced by structural and environmental changes that encourage increased physical activity (Kropski et al, 2008; Budd & Volpe, 2006;

In the UK, key motivators for healthy eating for children and adolescent boys were sports, being strong and achieving better performance, whereas for girls the emphasis was personal appearance. Food choice factors included taste, availability of ready to eat food, appealing packaging and perceived filling quality (Urbick et al, 1999). Studies have also shown that barriers to children taking part in physical activity include cost, distance and availability (Mulvihill, 2000) for structured activities and threat of crime and intimidation from older children as well as perceived lack of safety of the play areas available (Davis & Jones, 1996).

Other studies have specifically targeted population sub-groups and have tailored components accordingly. For instance, Perez-Rodrigo & Aranceta (1997) developed a nutrition education programme for schools in a deprived area of Bilbao, Spain which had a high proportion of Gypsy children. Educational methods were culturally appropriate as the community participated in designing them, and included drawing, craft work and puppet shows. However, no study has assessed weight reduction or behaviour change in relation to ethnicity or socio-economic status (Brown & Summerbell, 2008).

An additional concern is how obesity prevention is perceived by those already obese or overweight. For instance, Curtis (2008) reported on results from a qualitative study with young people. It highlighted that issues targeted by the National Healthy School Programme (HSP) in the UK such as physical activity and healthy eating, implemented as part of a wider aim to promote social inclusion, actually reinforced obese and overweight children's feelings of vulnerability to bullying and contributed to their social exclusion. She highlights that future health initiatives within schools should be sensitive to, and tailor programmes for, vulnerable groups of children such as the obese and overweight. Haines et al (2007) go further and suggest that such programmes should incorporate strategies that improve children's body image. Although some programmes reviewed appear successful at reducing prevalence of overweight and report significant reductions in BMI, it is unclear whether the overweight and obese children involved felt marginalised and vulnerable (see Jiang et al, 2007).

4.6. Research concerns – implementing and evaluating interventions

a. Experimental design

The majority of school-based studies used random assignment experimental designs (Dishman et al, 2004; Salmon et al, 2005; Robinson, 1999; Jiang et al, 2007; Caballero et al, 2003; Luepker et al, 1996; Manios et al, 1998; 1999; 2002) though some were quasi-experimental (SPARK; Sallis et al, .Kain et al, 2004; Gortmaker et al, 1998; Donnelly, 1996). The process of stratification and randomisation also varied widely between interventions and there were often methodological limitations. For instance, whilst most studies using such designs tended to randomise schools, some studies randomised by class (e.g. Flores (1995); James et al (2004;2007); Ask et al, 2006; Amaro et al, 2006) thus risking contamination between intervention and control groups. Woolfe & Stockley (2005) in their review of 5 school-based nutrition-focused interventions give some recommendations for such studies. They suggest that the curriculum

or programme that the control group are getting should be considered and indeed reported and that by using different geographical locations for intervention and control schools, contamination could be avoided.

b. Duration

School-based studies have varied in their length with the majority being implemented across one academic school year, but no pattern has been determined between length of programme and its success (Sharma, 2006). Thus there have been several short-term studies lasting less than 6 months that have shown statistically significant reductions in diastolic blood pressure, increasing physical activity and reducing tricep skinfolds of intervention participants (Wilson et al, 2005; Harrell et al, 1996; Rodgers et al, 2001; Robinson, 1999) whilst others of longer duration have shown no such positive effects (James et al, 2004; 2007; Simon et al, 2006; Caballero et al, 2003). Additionally, some studies have highlighted positive changes in children's food choices, dietary and physical activity behaviours, yet this has not translated into improvement in anthropometric measurements (Resnicow & Robinson, 1997; Kropski et al, 2008) due to the short duration of the study. Whilst it is logical to assume that studies must be of long enough duration to enable an impact to be seen, very little can be concluded as to the optimal length of such initiatives. Indeed current recommendations that currently are related to the practicalities of the length of programmes. For instance, Wolfe & Stockley (2005) suggest that duration of the study is important to consider for interventions into the food environment, as food availability changes across the year, as do eating patterns. They therefore suggest that baseline and follow-up measures for nutrition-focused interventions should be done at similar times of the year.

c. Intensity

Programmes vary considerably in terms of their intensity. Manios et al's (1999) programme exceeded the 40 to 50 hours of annual instruction recommended by Contento et al (1992) and stated the intensity of their programme as a key factor to its effectiveness. However, Baranowski et al (2002) reporting on their 5 a Day Boy Scout badge reported significant results after only 8 weeks of input. It is unclear what the optimum intensity of such programmes should be and it is obvious that there are many other factors that impact on programme effectiveness other than intensity. To be implemented effectively, intensity of such programmes needs to be considered in the context of the school structure and timetable.

d. Long-term follow-up

Follow-up has only been carried out in a number of studies and longer-term effects of such programmes have rarely been conducted. One study that had a 3 year follow-up was the CATCH intervention which showed that children's dietary and physical activity related behavioural changes that occurred during primary school had persisted into early adolescence; however no significant changes were seen in physiological outcomes such as serum cholesterol (Resnicow et al, 1998; Nader et al, 1999). Other studies with longer-term follow up include Nicklas et al's (1998) which reported a 14% increase in daily fruit and vegetables in high school children but found that this effect had disappeared at 3 years follow-up. James et al (2004; 2007) reported the significant differences seen at 12 months between groups for % overweight and obese were no longer evident at 3 years. Whilst these short-term impacts of the programme on behaviour change are encouraging, it is not surprising given the short-term nature of many of the programmes reviewed that no significant changes have been reported in some studies for outcomes such as BMI (Kropski et al, 2008) or that there is no evidence of maintenance of behaviour change in the longer-term. Perez-Rodrigo & Aranceta (2001) recommend that more long-term studies

need conducting to assess which behaviour changes are enduring and which are more transitory. Other reviewers recommend future programmes should have long term follow-up (Flodmark et al, 2006; Kropski et al, 2008). The lack of longer-term behaviour change shown in current studies does not mean that school-based programmes are ineffective or should not be commissioned. It simply gives more evidence that interventions are required at all ecological levels both inside school and in the wider environment if positive health behaviours are to become enduring and maintained into adulthood.

e. Outcome measures

The diversity in assessment approaches seen in the studies reviewed makes comparison across studies problematic, resulting in recommendations being difficult. Quantitative measures such as BMI's and other anthropometric measures are still considered by reviewers to be the most desirable measures of intervention effectiveness on reducing childhood obesity (Shaya et al, 2008; Sharma, 2006).

In terms of outcome measures for physical activity interventions, Stone et al (1998) found that most school-based physical activity interventions measured knowledge, attitudes, physical activity behaviours and most identified increasing physical fitness as the primary outcome of the study. However, the use of such outcome measures has raised controversy particularly in regard to whether they cause embarrassment for the less fit or active children (Rowland, 1995; Corbin et al, 1995; Docherty & Bell, 1990). Cale & Harris (2006) therefore recommend that physical activity interventions should be inclusive and reflect the target populations' activity needs, interests and preferences. Their focus should be on a range of non-competitive and unstructured lifestyle activities and thus outcome measures should be tailored accordingly. They suggest including behavioural, affective and cognitive outcomes.

A range of methods has been utilised to measure children's dietary habits but often these have included food frequency questionnaires, food records or repeated 24 hour dietary recalls (Perez-Rodrigo & Aranceta, 2001). Researchers have been plagued for years on how to measure accurately an individuals' food intake (Bingham, 1991; Nelson, 2003; Thompson & Subar, 2001; McPherson et al, 2000). These arguments will not be elaborated on here; it is sufficient to state that in general there is always the potential for participants to over-report what they perceive as 'healthy' foods and under report less healthy ones (Wrieden et al, 2003) as people want to be seen eating a healthier diet than they actually are. When reporting for others such as parents reporting their child's diet, over-reporting is still present (Reilly et al, 2001). However Woolfe & Stockley (2005) suggest the following: if the study is a single-blind one (where participants don't know that the researchers are evaluating dietary behaviour), giving them some tool to measure food intake will invalidate this. If the aim is to focus on specific foods such as fruit and vegetables, it might be possible. However, they advise researchers to consider any changes in single food items in the context of the wider diet. Indeed, most dietary-focused interventions targeted specific messages such as increasing fruit and vegetables without considering whether children were compensating for this increase in school by decreasing their intake when at home. Indeed, whilst Baranowski et al (2002) recommend researchers to promote increasing fruit and vegetables they suggest further work is required to assess whether such messages are having a detrimental effect on other areas of the diet such as decreasing milk intake by increasing water.

Other outcome measures included in studies have been psychosocial such as self efficacy (Neumark-Sztainer et al, 2003; Salmon et al, 2005; Simon et al, 2006), body image (Neumark-Sztainer et al, 2003; Sahota et al, 2001) social support (Salmon et al, 2005; Simon et al, 2006) and global self worth (Sahota et al, 2001).

When choosing appropriate outcome measures it is important to consider both qualitative and quantitative dimensions of evaluation, particularly in complex multi-component initiatives. Such programmes have incorporated a range of methods. For instance, studies utilising lunchtime observations reported significant increases in fruit and vegetable consumption (Kelder et al, 1995, Minnesota Heart Health; Luepker et al, 1996; Nader et al, 1999, CATCH; Perry et al, 1998, 5 a day Power Plus; Gortmaker et al, 1999, Eat Well and keep Moving) and observations during PE have reported significant increases in children's physical activity (Gortmaker et al, 1999, Planet Health; Gortmaker et al, 1999, Eat Well and Keep Moving; Manios et al, 1999). As qualitative and quantitative results are treated differently, juxtaposing the two methods generates insights so creating a bigger picture. The result is 'investigative strategies that offer evidence to inform judgements, not techniques that provide guaranteed truth or completeness' (Hammersley, 2005, p 12). This is similar to Tones' (1997) term 'judicial review' which he compares to the situation of a jury making a decision despite there not being 100% proof available.

In addition it is important to consider a combination of self reported and objective measures. Whilst self-report is really the only feasible way of assessing participants' and stakeholders' views, attitudes, beliefs and knowledge, the way they are implemented can subject the results to bias. For instance, people may answer questions in a way perceived to be socially acceptable. In order to reduce such bias Baranowski et al (1999) suggested collecting data on different days, separated by enough time that single personal events which might affect a participant's answers, have passed with them being unlikely to remember their responses from the first data collection. They also suggested that assessment should be made of which variables are more likely to be enduring and slow to change and which variables might show quicker changes. Data collection could be organised around this. Diaries kept by participants to record feelings or beliefs could be converted into variables and data collection could be done outside the group setting of the programme, perhaps reducing the social approval bias when in the group setting. Individuals could be interviewed separately to understand more fully how their beliefs and behaviours changed throughout the intervention. Alternatively, both objective and subjective measures could be utilised. For instance, Salmon et al (2005) utilised accelerometers and fitness tests such as 20 m shuttle runs as well as self-reported questionnaires to assess the degree of participants' physical activity in their 'Switch Play' intervention.

f. Process evaluation

A growing number of studies are utilising process evaluation as part of their evaluation measures and reviewers have been urging researchers for years to incorporate such measures. In the GIMME 5 project (Davis et al, 2000) the process evaluation included: extent of implementation, fidelity to programme, reach, use of materials, mediators such as teacher training, curriculum delivery, parental involvement, participation in family activities, attendance at evening activities, availability and accessibility of healthy foods at home. Another example was the '5 a day power plus' programme (Perry et al, 1998) where process evaluation of the changes implemented to the school meals included exploration of service changes, staff views, industry support and identification of any external factors that had affected implementation. Process evaluations can also help to clarify which are weaker components or why performance varies by demographics or declines over time. For instance, in the High 5 programme, Reynolds et al (2000) used focus groups, classroom observations and checklists to explore factors affecting attendance and obstacles to dietary change.

Whilst studies begin to incorporate such evaluation, process measures continue to be missing or incomplete in most school-based studies. Indeed, Baranowski et al (2002) comment that the lack of process evaluation within studies is what makes comparison difficult because researchers cannot assess which components were effective or not. With such limited details about intervention protocols and

course components, replicability is difficult and without such information as could be provided by process evaluation, previous studies provide little guidance for researchers contemplating future initiatives.

g. Fidelity

It has already been discussed previously that to implement a programme effectively better teacher training is needed. This is particularly important from a research point of view when exploring which components of a programme are the most effective. No accurate measure of this can be made unless all components are implemented in the intended manner and fidelity is checked. Indeed Baranowski et al (2002) recommend future research considers better methods for training teachers in implementing the experimental curriculum. In the studies explored and reviews consulted, variable implementation was often reported (For example Reynolds et al, 2000 – 'High five')

h. Theoretical framework

There is increasing recognition that behaviour-change interventions need to be underpinned with appropriate psychological theories of behaviour change (Campbell et al, 2000; Michie & Abraham, 2004; Michie et al, 2008; 2009; Baranowski, 2006). Although rigorous evaluation of processes, impacts and outcomes is important, if no attempt is made to uncover why behaviour change occurred or did not occur, full understanding of the process cannot be elicited. Yet the number of studies underpinned with appropriate behaviour-change theory are limited. The majority choosing a theory chose SCT (e.g. Warren et al, 2003; Manios et al, Robinson et al, 1999, Caballero et al, 2003; Dishman et al, 2004; Harrison et al, 2006; Gortmaker et al, 1999). Key theoretical constructs used included social learning, skills building, role modelling, goal setting and self-evaluation and self-monitoring. However, as Baranowski et al (2002) state, nothing is known about how children usually utilise these skills and that procedures integrated into interventions is rather ad hoc. Whilst theory may have been chosen, it was often used to chose the strategies used rather than understand the behaviour change going on. Indeed, in his review of international school-based studies targeting obesity prevention, Sharma (2006) stated that the apparent advantage of having a behavioural theory underpinning an intervention was not evident, making it clear that the use of theory in interventions is not being properly applied. Underpinning interventions with appropriate theory is widely recommended from reviews of school-based studies (Lytle et al, 2002; Lytle & Achterberg, 1995; Brown & Summerbell, 2008; Summerbell et al, 2005).

4.7. Summary

This review began by advocating a public health approach to childhood obesity prevention. This approach recognises that preventive strategies need to include universal, strategic and targeted initiatives and that programmes need to exist at all socio-ecological levels. For children, school is just one environment in which they can be reached and influenced.

The review of effective interventions found a variety of programme and initiatives with a range of effectiveness. Of particular note was that school-based programmes have the potential to influence children's health behaviours whilst in school but are less effective in influencing these behaviours once at home. No intervention to date has found an effective means of engaging with families. Additionally, whilst some interventions targeting single factors such as TV viewing or nutrition education have proved effective in the short term, there are now more and more multi-component interventions emerging which

target a range of influences within the school environment such as nutrition education, behaviour change techniques, food service provision and PE classes both within the curriculum and after school. Such a whole school approach subscribes to the settings approach which has become popular within health promotion and which recognises that valuable opportunities exist in such settings to influence health issues such as obesity through policy measures and education. Some school-based initiatives discussed have been due to Government policy. For instance, in the UK the National School Meals Programme gives dietary guidelines for school lunches provided in UK schools.

One issue highlighted clearly in reviews of school-based interventions and reflected in the studies discussed in this review is the large number of initiatives being developed in the US, UK and other Westernised countries. Whilst programmes exist that have targeted specific sub-groups within the population (e.g. African Americans – e.g. Story et al, 2003; American Indians – e.g. Caballero et al, 2003) and whilst programmes are emerging from countries that have undergone rapid economic transition in recent years, these tend to be small-scale pilot projects (Doak, 2002) or are plagued by a range of methodological limitations (Li et al, 2008). However, a large number of these countries undergoing rapid economic transition have focused on their school lunch provision. For instance, in South Korea the Korean Food and Drug Administration (KFDA) recently developed a national strategy aimed at improving the food safety and nutrition, focusing particularly on children (Park, 2008). One of their aims by 2010 is to designate Green Food Zones around schools where junk food cannot be sold and ensure the quality of food provided by the school lunch program. In Brazil, the Government recently included in their National School Meals programme, the requirement that 70% of foods used were minimally processed ones and in Chile the requirement that more fruit and vegetables are included in school meals has been set (Doak, 2002).

Several of these countries have adopted the 'Healthy Schools' initiative which is underpinned by the Health Promoting Schools philosophy. For instance, as part of the national health promotion campaign, 'Vida Chile', Chile has started up a 'healthy schools' programme in more than 1000 schools which includes a nutritional curriculum, increases the number of hours devoted to physical activity and a community component devised to include participation from parents and teachers (Doak, 2002; Muzzo et al, 2004). In South Africa too, the 'healthy schools' initiative has included a focus on obesity and nutrition-related chronic disease prevention (Doak, 2002).

Other 'economic transition' countries have recognised the need for obesity prevention initiatives in the school environment and are in the process of ensuring that policies related to school initiatives and programmes are being delivered effectively. For instance, in Mexico whilst the Ministry of Education implemented a nationwide primary school-based programme which included 2 30-50 minute sessions of PE a week and a nutrition education programme promoting healthy diet, evaluative research showed that the programme was not being delivered as designed in many schools (Joint U.S.-Mexico Workshop on Preventing Obesity in Children and Youth of Mexican Origin, 2007; Doak, 2002). It is hoped that the results of the evaluation will facilitate identification of the elements in the school environment that provide opportunities for success. Thailand is exploring the effectiveness of school-based strategies, and evaluative research has been done in regional primary and secondary schools where programmes targeting physical activity and healthy diet have been developed (Banchonhattakit et al, 2009).

Overall Conclusions

There is no evidence to indicate that the UAE has a worse obesity epidemic than comparable countries. However, most countries in the same position are taking steps to consider how to tackle this epidemic, and to involve schools in those attempts. We remind the reader of the point made above - there appears to be no consensus from reviews as to what components future interventions should include to be effective. This rather pessimistic view suggests that caution is required, rather than that no action should be taken at all! The message is that there are some effective school-based ways to address those factors known to be implicated in the development of obesity, viz. healthy eating and exercise promotion. These interventions must go beyond merely telling children about eating and exercise, and need to be based on social cognitive theories and developmental principles; they must also alter the broader school environment such as the catering arrangements or playground facilities, and must also extend beyond the school walls into the communities and homes where children live.

Schools alone will not solve the problem of obesity, and interventions within the education sector must be complemented by broader governmental actions to institute some of the other interventions known to help, such as promotion of breastfeeding, reform of welfare schemes such that poorer families have adequate diets, regulation of the food and drinks industries and the advertising associated with them, encouragement of active lifestyles, and so on. There is a need for schemes which help those already overweight and obese, including children, whilst promoting approaches which do not stigmatise these groups. It is also necessary to be mindful that whole-population approaches might not be suitable in a situation where some children are underweight and/or stunted and where some children are not at risk at becoming overweight.

References:

Abalkhail, B.A. and Shawky, S. (2002) Validity of self reported weight and height among Saudi school children and adolescents, *Saudi Medical Journal,* **23**, 3, 831-7.

Al-Haddad, F. Al-Nuaimi, Y., Lille, B., Thabit, M. (2000) Prevalence of obesity among school children in the United Arab Emirates, *American Journal of Human Biology*, **12**, (4), 498-502.

Al-Haddad, F.H. Little, B., Ghafoor, A.G. (2005) Childhood obesity in United Arab Emirates schoolchildren: A National study. *Annals of Human Biology*, **32**, 1, 72-9.

Al-Isa, A.N., and Mousa, M.A. (2000) Nutritional status of Kuwaiti elementary school children aged 6-10 years: Comparison with NCHS/CDC reference population, *Int. J. Food Sci Nutr* **51**, (4) 221-8.

Al-Nuaim, A.R., Bamgboye, E.A. and Al-Herbish, A., (1996) The pattern of growth and obesity in Saudi Arabia school children, *Int. J Relat Metab Disorder* **20**, (11) 1000-5.

Allison, D.B., Matz, P.E., Pietrobelli, A., Zannolli, R., Faith, M.S., Bendich, A. & Deckelbaum, R.J. (eds) (1999). *Primary and Secondary Preventive Nutrition.* Humana Press: Totowa, New Jersey, pp 147–164.

Allison, D.B., Matz, P.E., Pietrobelli, A., Zannolli, R. & Faith, M.S. (1999) Genetic and environmental influences on obesity. In: Bendich, A., Deckelbaum, R.J. (eds). *Primary and secondary Prevention Nutrition.* Humana Press: Totowa, New Jersey, 1999, p147-164.

Al Mamun, A., Lawlor, D.A., Alati, R., O'Callaghan, M.J., Williams, G.M. & Najman, J.M. (2006) Does maternal smoking during pregnancy have a direct effect on future offspring obesity? Evidence from a prospective birth cohort study. *American Journal of Epidemiology*, ***164***, (4), 317-325.

Amaro, S., Viggiano, A., Di Costanzo, A., Madeo, I., Viggiano, A., Baccari, M.E., Marchitelli, E., Raia, M., Viggiano, E., Deepak, S., Monda, M. & De Luca, B. (2006) Kaledo, a new educational board-game, gives nutritional rudiments and encourages healthy eating in children: a pilot cluster randomised trial. *European Journal of Pediatrics,* **165**, 630-635.

Anderson, P.M. and Butcher, K.F. (2004) *Reading, Writing and Raisinets: Are School Finances contributing to Children's Obesity?* Federal reserve Bank of Chicago Working Paper, 2004-16.

Ask, A.S., Hernes, S., Aarek, I., Johannessen, G. & Haugen, M. (2006) Changes in dietary pattern in 15 year old adolescents following a 4 month dietary intervention with school breakfast – a pilot study. *Nutrition Journal*, **5**, 33. doi; 10.1186/1475-2891-5-33.

Almond, L. & Harris, J. (1998) Interventions to promote health-related physical education. In: S. Biddle, J.Sallis & N.Cavill. (eds) *Young and Active? Young People and Health-enhancing Physical Activity-Evidence and Implications* London, Health Education Authority. (p133-149).

Anderson, A.S., Cox, D.N., McKellar, S., Reynolds, J., Lean, M.E. & Mela, D.J. (1998) Take Five, a nutrition education intervention to increase fruit and vegetable intakes: impact on attitudes towards dietary change. *British Journal of Nutrition*, **80**, 133-40.

Anderson, A., Hetherington, M., Adamson, A., Porteous, L.E.G., Higgins, C. & Foster, E. (2000) *The Development and Evaluation of a Novel School based Intervention to Increase Fruit and Vegetable Intake in Children.* London, Food Standards Agency.

Armstrong, N., Balding, J., Gentle, P. & Kirby, B. (1990) Patterns of physical activity among 11 to 16 year old British children. *British Medical Journal*, **301**, 203-205.

Armstrong, J. & Reilly, J.J. (2002) Child Health Information Team. Breastfeeding and lowering the risk of childhood obesity. *Lancet*, **359**: 2003–2004.

Astrup, A. (1996) *Food and eating habits.* Background paper prepared by Food and Eating Habits subgroup of the International Obesity Task Force.

Bagchi, K. (2008) Nutrition in the Eastern Mediterranean Region of the World Health Organisation, *Eastern Mediterranean Health Journal,* **14**, S107-114.

Baker, J. L., Michaelsen, K. F., Rasmussen, K. M. & Sorensen, T. I. A. (2004) Maternal prepregnant body mass index, duration of breastfeeding, and timing of complementary food introduction are associated with infant weight gain. *American Journal of Clinical Nutrition,* **80**, 1579–1588.

Ball, K. & Kenardy, J. (2002) Body weight, body image, and eating behaviours: relationships with ethnicity and acculturation in a community sample of young Australian women. *Eating Behaviors*, **3**, 205-16.

Ball, K. & Crawford, D. (2005) Socioeconomic status and weight change in adults: a review. *Social Science and Medicine*, **60**, 1987-2010.

Banchonhattakit, P., Tanasugarn, C., Pradipasen, M., Miner, K.R. & Nityasuddhi, D. (2009) Effectiveness of School Network for Childhood Obesity Prevention (SNOCOP) in Primary Schools of Saraburi Province, Thailand. *Southeast Asian journal of tropical medicine and public health*, **40**, (4), 816- 834.

Bandura, A. (1986) *Social Foundations of Thought and Action: A Social Cognitive Theory.* Englewood Cliffs, NJ, Prentice Hall.

Baranowski, T., Hearn, M. (1997) Families and health behaviour change. Chapter 8. In: Gochman, D. (ed). *Handbook of Behavioural Medicine Research*. New York, Plenum. P303-323.

Baranowski, T., Cullen, K.W. & Baranowski, J. (1999) Psychosocial correlates of dietary intake: Advancing Dietary Intervention. *Annual Review of Nutrition*, **19**, 17-40.

Baranowski, T., Davis, M., Resnicow, K., Baranowski, J., Doyle, C., Lin, L.S., Smith, M. & Wang, D.T. (2000) Gimme 5 Fruit, Juice and Vegetables for Fun and Health: Outcome Evaluation. *Health Education and Behavior*, **27**, 96. doi:10.1177/109019810002700109.

Baranowski, T., Baranowski, J., Cullen, K.W., deMoor, C., Rittenberry, L., Hebert, D. & Jones, L. (2002a) 5 a Day Achievement Badge for African-American Boy Scouts: Pilot Outcome Results. *Preventive Medicine*, **34**, 353-363.

Baranowski, T., Cullen, K.W., Nicklas, T., Thompson, D. & Baranowski, J. (2002b) School-based obesity prevention: A Blueprint for Taming the Epidemic. *American Journal of Health Behavior*, **26**, (6), 486-493.

Baranowski, T., Baranowski, J., Cullen, K.W., Marsh, T., Islam, N. & Zakeri, I. (2003) Squire's quest! Dietary outcome evaluation of a multimedia game. *American Journal of Preventive Medicine*, **24**, 52-61.

Baranowski, T. (2006) Advances in Basic Behavioural Research Will Make the Most Important Contributions to Effective Dietary Change Programs at this Time. *Journal of the American Dietetic Association*, **106**, (6), 808-811.

Barker, D.J.P., Eriksson, J.G., Forsen, T. & Osmond, C. (2002) Fetal origins of adult disease: strength of effects and biological basis. *International Journal of Epidemiology*, **31**: 1235–1239.

Bartfay, W.J. & Bartfay, E. (1994) Promoting health in schools through a board game. *West Journal of Nursing Research*, **16**, 438-446.

Barton, B.A., Eldridge, A.L., Thompson, D., Affenito, S.G., Striegel-Moore, R.H., Franko, D.L., Albertson, A.M. & Crockett, S.J. (2005) The Relationship of Breakfast and Cereal Consumption to Nutrient Intake and Body Mass Index: The National Heart, Lung, and Blood Institute Growth and Health Study. J*ournal of the American Dietetic Association*, **105**, (9), 1383-1389.

Becker, D.M., Yanek, L.R., Koffman, D.M. & Bronner, Y.C. (1999) Body image preferences among urban African Americans and whites from low income communities. *Ethnicity and Disease*, **9**, (3):377–386.

Bener, A. (2006) Prevalence of obesity, overweight and underweight in Qatar adolescents, *Food Nutrition Bulletin*, **27**, 1 39-45.

Benjelloun, S. (2002) Nutrition transition in Morocco. *Public Health Nutrition*, **5**, (1A):135–140.

Bennett, G.G. & Wolin, K.Y. (2006) Satisfied or unaware? Racial differences in perceived weight status. *International Journal of Behavioural Nutrition and Physical Activity*, **3**:40.

Bere, E., Veierod, M.B. & Klepp, K. (2005) The Norwegian school fruit programme: evaluating paid vs. no-cost subscriptions. *Preventive Medicine*, **41**, 463-470.

Berenson, G.S., Wattingney, W.A., Tracy, R,E., Newman III, W.P., Srinivasan, S.R., Webber, L.S., Dalferes, E.R. & Strong, J.P. (1992) Atherosclerosis of the aorta and coronary arteries and cardiovascular risk factors in persons aged 6 to 30 years and studied at necropsy (the Bogalusa Heart Study). *American Journal of Cardiology*, **70**, 851-858.

Bergmann, K.E., Bergmann, R.L., Von Kries, R., Bohm, O., Richter, R., Dudenhausen, J.W. & Wahn, U. (2003) Early determinants of childhood overweight and adiposity in a birth cohort study: role of breast-feeding. *International Journal of Obesity*, **27**: 162–172.

Berkey, C.S., Rockett, H.R., Field, A.E., Gillman, M.W., Frazier, A.L., Camargo, C.A. Jr. & Colditz, G.A. (2000) Activity dietary intake, and weight changes in a longitudinal study of preadolescent and adolescent boys and girls. *Pediatrics*, **105**, E56.

Berkey, C.S., Rockett, H.R., Gillman, M.W., et al. (2003) Longitudinal study of skipping breakfast and weight change in adolescents. *International Journal of Obesity and Related Metabolic Disorders*, **27**:1258–66.

Biddle, S.J.H., Gorely, T. & Stensel, D.J. (2004) Health-enhancing physical activity and sedentary behaviour in children and adolescents. *Journal of Sports Sciences*, **22**, 679-701.

Billson, H., Pryer, J.A. & Nichols, R. (1999) Variation in fruit and vegetable consumption among adults in Britain. An analysis from the dietary and nutritional survey of British adults. *European Journal of Clinical Nutrition*, **53**, 946-52.

Bindler, R. & Bruya, M. (2007) The school nurse as navigator of the school health journey: developing the theory and evidence for policy. *Primary Health Care Research and Development*, **8**, (3), 226-234.

Bingham, S.A. (1991) Limitations of the Various Methods for Collecting Dietary Intake Data. *Ann Nutr Metab*, **35**,117-127.

Birnbaum, A.S., Lytle, L.A., Story, M., Perry, C.L. & Murray, D.M. (2002) Are Differences in Exposure to a Multicomponent School-Based Intervention Associated with Varying Dietary Outcomes in Adolescents? *Health Education & Behavior*, **29**, (4), 427-443.

Bleich, S.N., Cutler, D., Murray, C. & Adams, A. (2008) Why Is the Developed World Obese? *Annual Review of Public Health*, **29**: 273-295

Bouchard, C. & Tremblay, A. (1997) Genetic influences on the response of body fat and fat distribution to positive and negative energy balances in human identical twins. *Journal of Nutrition*, **127** (Supple 5), 943S-947S.

Boule, N.G., Kenny, G.P., Haddad, E., Wells, G.A. & Sigal, R.J. (2003) Meta-analysis of the effect of structured exercise training on cardiorespiratory fitness in type 2 diabetes mellitus. ***Diabetologia***. **46**(8):1071–1081.

Bowman, S.A., Gortmaker, S.L., Ebbeling, C.B., Pereira, M.A. & Ludwig, D.S. (2004) Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. *Pediatrics*, **113**: 112–118.

Bray, G.A. & Popkin, B.M. (1998) Dietary fat intake does affect obesity. *American Journal of Clinical Nutrition*, **68**, 1157-73.

Bray, G.A., Nielsen, S.J. & Popkin, B.M. (2004) High fructose corn sweetners and the epidemic of obesity. *American Journal of Clinical Nutrition*, **79**, 537-43.

Brener, N.D., Burstein, G.R., DuShaw, M.L., Vernon, M.E., Wheeler, L. & Robinson, J. (2001) Health Services: Results from the School Health Policies and Programs Study 2000. *Journal of School Health*, **71**, (7), 294-304.

Brener, N.D., Wheeler, L., Wolfe, L.C., Vernon-Smiley, M. & Caldart-Olson, L. (2007) Health Services: Results from the School Health Policies and Programs Study 2006. *Journal of School Health*, **77**, (8), 464-485.

Britton, J.A., Gammon, M.D., Kelsey, J.L., Brogan, D.J., Coates, R.J., Schoenberg, J.B., Potischman, N., Swanson, C.A., Stanford, J.L. & Brinton, L.A. (2000) Characteristics associated with recent recreational exercise among women 20 to 44 years of age. *Women's Health*, **31**, 81-96.

Brown, T. & Summerbell, C. (2008) Systematic review of school-based interventions that focus on changing dietary intake and physical activity levels to prevent childhood obesity: an update to the obesity guidance produced by the National Institute for Health and Clinical Excellence. *Obesity Reviews*, **10**, 110-141.

Brunton, G., Thomas, J., Harden, A., Rees, R., Kavanagh, J., Oliver, S., Shepherd, J. & Oakley, A. (2005) Promoting physical activity amongst children outside of physical education classes: A systematic review integrating intervention studies and qualitative studies. *Health Education Journal*, **64**, 323-338.

Brussaard, J.H., van Erp-Baart, M.A., Brants, H.A., Hulshof, K.F. & Lowik, M.R. (2001) Nutrition and health among migrants in The Netherlands. *Public Health Nutrition*, **4**: 659–664.

Budd, G.M. & Volpe, S.L. (2006) School-based obesity prevention: Research, Challenges and Recommendations. *Journal of School Health*, **76**, (10), 485-495.

Bush, P.J., Zuckerman, A.E., Taggart, V.S., Theiss, P.K., Peleg, E.O. & Smith, S.A. (1989) Cardiovascular risk factor prevention in black school children: The 'Know your body' evaluation project. *Preventive Medicine*, **16**, 215-27.

Buttriss, J.L. (1997) Food and nutrition: attitudes, beliefs and knowledge in the United Kingdom. *American Journal of Clinical Nutrition*, **65**, (Suppl 6), S1985-1995.

Caballero, B., Clay, T., Davis, S.M., Ethelbah, B., Holy Rock, B., Lohman, T., Norman, J., Story, M., Stone, E.J., Stephenson, L. & Stevens, J. (2003) Pathways: a school-based, randomised controlled trial for the prevention of obesity in American Indian schoolchildren. *American Journal of Clinical Nutrition*, **78**, 1030-8.

Caballero, B. (2005) A nutrition paradox: underweight and obesity in developing countries. *New England Journal of Medicine*, **352**, (15), 1514-1516.

Cale, L. & Harris, J. (2005) Physical activity promotion interventions, initiatives, resources and contacts. In: L.Cale & J. Harris, (eds). Exercise and Young People. Issues, *Implications and Initiatives* (p232-70). Basingstoke, Palgrave Macmillan.

Cale, L. & Harris, J. (2006) Interventions to promote young people's physical activity: Issues, implications and recommendations for practice. *Health Education Journal*, **65**, 320-337.

Campbell, K., Waters, E., O'Meara, S., Kelly, S. & Summerbell, C. (2002) Interventions for preventing obesity in children. *Cochrane Database Syst Rev* 2002; **2**: D001871.

Campbell, M., Fitzpatrick, R., Haines, A. (2000) Framework for design and evaluation of complex interventions to improve health. *British Medical Journal*, **321**, 694-6.

Candib, L.M. (2007) Obesity and Diabetes in Vulnerable Populations: Reflections on Proximal and Distal Causes. *Annals of Family Medicine*, **5** (6), 547-556.

Canoy, D. & Buchan, I. (2007) Challenges in Obesity Epidemiology. *Obesity Reviews*, **8** (Supple. 1), 1-11.

Communities and local government. (2007) *The New Performance Framework for Local Authorities and Local Authority Partnerships: Single Set of National Indicators*.(online). Available at:<http://www.communities.gove.uk/documents/localgovernment/pdf/505713.pdf>(Accessed 16th November, 2009)

Contento, I.R., Manning, A.D. & Shannon, B. (1992) Research perspective on school-based nutrition education. *Journal of Nutrition Education*, **24**:247–60.

Contento, I.R. (1995) The effectiveness of nutrition education and implications for nutrition education policy, programs and research – A review of research. *Journal of Nutrition Education*, **27**, 279-418.

Corbett, R.W. & Lee, B.T. (1992) Nutriquest: a fun way to reinforce nutrition knowledge. *Nurse Education*, **17**, 33-35.

Corbin, C.B., Pangrazi, R.P. & Welk, G.J. (1995) A response to 'The horse is dead: Let's dismount'. *Pediatric Exercise Science*, **56** (5), 4-8.

Cramer, P. & Steinwert, T. (1998) Thin is good, fat is bad: How early does it begin? *Journal of Applied Developmental Psychology*, **19** (3), 429-451.

Crawford, D. & Baghurst, K.I. (1990) Diet and health – a national survey of beliefs, behaviours and barriers to change in the community. *Australian Journal of Nutrition and Dietetics*, **47**, 97-104.

Crespo, C.J., Ainsworth, B.E., Keteyian, S.J., Heath, G.W. & Smit, E. (1999) Prevalence of physical inactivity and its relation to social class in U.S. adults: results from the Third National Health and Nutrition Examination Survey, 1988-1994. *Medicine, Sports and Exercise*, **31**, 1821-7.

Crespo, C.J., Smit, E., Andersen, R.E., Carter-Pokras, O. & Ainsworth, B.E. (2000) Race/ethnicity, social class and their relation to physical inactivity during leisure time:results from the third national health and Nutrition Examination Survey, 1988-1994. *American Journal of Preventive Medicine*, **18**, 46-53.

Cullen, K.W., Bartholomew, L.K., Parcel, G.S. & Kok, G. (1998) Intervention Mapping: Use of theory and data in the development of a fruit and vegetable nutrition program for Girl Scouts. *Journal of Nutrition Education*, **30**, 188-195.

Cullen, K.W., Watson, K., Baranowski, T., Baranowski, J.H. & Zakeri, I. (2005) Squire's quest: intervention changes occurred at lunch and snack meals. *Appetite*, **45**, 148-151.

Curtis, P. (2008) The experiences of young people with obesity in secondary school: some implications for the healthy school agenda. *Health and Social Care in the Community*, **16**, (4), 410-418.

Cutting, T.M., Fisher, J.O., Grimm-Thomas, K. & Birch, L.L. (1999) Like mother, like daughter: familial patterns of overweight are mediated by mothers' dietary disinhibition. *American Journal of Clinical Nutrition*, **69**, 608-613.

Dabelea, D., Hanson, R.L., Lindsay, R.S., Pettitt, D.J., Imperatore, G., Gabir, M.M., Roumain, J., Bennett, P.H. & Knowler, W.C. (2000) Intrauterine exposure to diabetes conveys risks for type 2 diabetes and obesity: a study of discordant sibships. *Diabetes*, **49**: 2208–2211.

Dalmeny, K., E. Hanna, and Lobstein T. (2004). Broadcasting bad health-Why foodmarketing to children needs to be controlled. *Journal of the HEIA*, **11**; (1-2): 10-46.

Davidson, F. (2006) Childhood obesity prevention and physical activity in schools. *Health Education*, **107**, (4), 377-395.

Davidson, M. & Knafl, K.A. (2006) Dimensional analysis of the concept of obesity. *Journal of Advanced Nursing*, **54**, (3):342–350.

Davis, A. & Jones, L. (1996) Environmental constraints on health: Listening to children's views. *Health Education Journal*, **55** (4), 363-374.

Davis, M., Baranowski, T., Resnikow, K., Baranowski, J., Doyle, C., Smith, M., Wang, D.T., Yaroch, A. & Herbert, D. (2000) Gimme 5 fruit and vegetables for fun and health: process evaluation. *Health Education and Behaviour*, **27**, 201-12.

Davison, K.K. & Birch, L.L. (2001) Childhood overweight: a contextual model and recommendations for future research. *Obesity Reviews*, **2**, (3), 159-171.

Davison, K.K. & Birch, L.L. (2002) Obesigenic families: parents' physical activity and dietary intake patterns predict girls' risk of overweight. *Int J Obes*, **26**: 1186–1193.

Davison, K.K., Francis, L.A. & Birch, L.L. (2005) Re-examining Obesigenic Families: Parents' obesity-related behaviours predict girls' change in BMI. *Obesity Research*, **13** (11), 1980-1990.

Davison, K.K., Werder, J.L. & Lawson, C.T. (2008) Children's active commuting to school: current knowledge and future directions. *Preventive Chronic Diseases*, **5**, (3), A100.

de-Graft, & Aikins, A. (2005) Healer shopping in Africa: new evidence from rural-urban qualitative study of Ghanaian diabetes experiences. *BMJ*, **331**(7519):737.

de Onis, M. & Blossner, M. (2000) Prevalence and trends of overweight among preschool children in developing countries. *American Journal of Clinical Nutrition*, **72**, 1032-1039.

Dietz, W.H. Jr, & Gortmaker, S.L. (1985) Do we fatten our children at the television set? Obesity and television viewing in children and adolescents. *Pediatrics*, **75**: 807–812.

Dietz, W.H. (1998) Health consequences of Obesity in Youth: Childhood Predictors of Adult Disease. *Pediatrics*, **101**, (Supple 3) 518-525.

DiGuiseppi, C., Roberts, I. & Li, L. (1997) Influence of changing travel patterns on child death rates from injury: trend analysis. *BMJ*, **314**: 710–713.

Dishman, R.K., Motl, R.W., Saunders, R., Felton, G., Ward, D.S., Dowda, M. & Pate, R.R. (2004) Self-efficacy partially mediates the effect of a school-based physical-activity intervention among adolescent girls. *Preventive Medicine*, **38**, 628-636.

Dixey, R., Heindl, I., Loureiro, I., Perez-Rodrigo, C., Snel, J. & Warnking, P. (1999) *Healthy eating for young people in Europe. Nutrition education in Health Promoting Schools*. Copenhagen; European Network of Health Promoting Schools, 1999.

Doak, C. (2002) Large-scale interventions and programmes addressing nutrition-related chronic diseases and obesity: examples from 14 countries. *Public Health Nutrition*, **5**, (1A), 275-277.

Doak, C.M., Visscher, T.L.S., Renders, C.M. & Seidell, J.C. (2006) The prevention of overweight and obesity in children and adolescents: a review of interventions and programmes. *Obesity Reviews*, **7**, 111-36.

Docherty, D. & Bell, R. (1990) Fitness testing: Counterproductive to a healthy lifestyle? *CAHPER Journal*, **56**, (5), 4-8.

Dyck, R.F., Klomp, H. & Tan, L. (2001) From "thrifty genotype" to "hefty fetal phenotype": the relationship between high birthweight and diabetes in Saskatchewan Registered Indians. *Canadian Journal of Public Health. Revue Canadienne de Sante Publique*, **92**(5):340–344.

Ebbeling, C.B., Feldman, H.A., Osganian, S.K., Chomitz, V.R., Ellenbogen, S.J. & Ludwig, D.S. (2006) Effects of decreasing sugar-sweetened beverage consumption on body weight in adolescents: a randomized controlled pilot study. *Pediatrics*, **117**:673-80.

El-Hazmi, M.A. and Warsy, A.S. (2002)A comparative study of prevalence pf overweight and obesity in children in different provinces of Saudi Arabia, *J. Trop Pediatrics*, **48**, (3), 172-7.

Ello-Martin, J.A., Ledikwe, J.H. & Rolls, B.J. (2005) The influence of food portion size and energy density on energy intake: implications for weight management. *American Journal of Clinical Nutrition*, **82**, 236S-41S.

Engwicht, D. (1993) *Reclaiming our Cities and Towns: Better Living with less Traffic*. Philadelphia, New Society Publishers.

Erikkson, J., Forsen, T., Osmond, C. & Barker, D. (2003) Obesity from Cradle to Grave. *International Journal of Obesity*, **27**, 722-727.

Fahlman, M.M., Dake, J.A., McCaughtry, N. & Martin, J. (2008) A pilot study to examine the effects of a nutrition intervention on nutrition knowledge, behaviours, and efficacy expectations in middle school children. *Journal of School Health*, **78**, (4), 216-222.

Farooqui, I.S. & O'Rahilly, S. (2000) Recent advances in the genetics of severe obesity. *Archives of Diseases in Childhood*, **83**, 31-34.

Fisher, J.O., Rolls, B.J. & Birch, L.L. (2003) Children's bite size and intake of an entrée are greater with large portions than with age-appropriate or self-selected portions. *American Journal of Clinical Nutrition*, **77**, 1164-70.

Flodmark, C.E., Marcus, C. & Britton, M. (2006) Interventions to prevent obesity in children and adolescents: a systematic literature review. *International Journal of Obesity*, **30**, 579-89.

Flores, R. (1995) Dance for Health: Improving Fitness in African American and Hispanic Adolescents. *Public Health Reports*, **110**, (2), 189-193.

Flynn, M.A., McNeil, D.A., Maloff, B., Mutasingwa, D., Wu, M., Ford, C. & Tough, S.C. (2006) Reducing obesity and related chronic disease risk in children and youth: a synthesis of evidence with 'best practice' recommendations. *Obesity Reviews*, **7**, (Suppl 1), 7-66.

Ford, E.G., Vander Veur, S.S. & Foster, G.D. (2007) Obesity Prevention in School and Group Child Care Settings. In: S. Kumanyika & R.C. Brownson, (eds) *Handbook of Obesity Prevention: A resource for Health Professionals*. New York, Springer. p 349-376.

Fox, K.R., Cooper, A. & McKenna, J. (2004) The school and promotion of children's health-enhancing physical activity: perspectives from the United Kingdom. *Journal of Teaching Physical Education*, **23**, 338-58.

Fox, M.K., Reidy, K., Karwe, V. & Ziegler, P. (2006a) Average Portions of Foods Commonly Eaten by Infants and Toddlers in the United States. The Journal of the American Dietetic Association, 106 (Suppl 1), S66-76.

Fox, M.K., Devaney, B., Reidy, K., Razarindrakoto, C. & Ziegler, P. (2006b) Relationship between portion size and energy intake among infants and toddlers: Evidence of Self-Regulation. *The Journal of the American Dietetic Association*, **106** (Suppl 1), S77-83.

Freedman, D.S., Khan, L.K., Dietz, W.H., Srinivasan, S.R. & Berenson, G.S. (2001) Relationship of Childhood Obesity to Coronary Heart Disease Risk Factors in Adulthood: The Bogalusa Heart Study. *Pediatrics*, **108** (3), 712-718.

French, S.A., Perry, C.L., Leon, G.R. & Fulkerson, J.A. (1996) Self-esteem and change in body mass index over 3 years in a cohort of adolescents. *Obesity Reseach*, **4**: 27–33.

French, S.A., Story, M., Neumark-Sztainer, D., Fulkerson, J.A. & Hannan, P. (2001) Fast food restaurant use among adolescents: associations with nutrient intake, food choices and behavioural and psychosocial variables. *International Journal of Obesity and Related Metabolic Disorders*, **25**, 1823-33.

French, S.A., Story, M., Fulkerson, J.A. & Hannan, P. (2004) An environmental intervention to promote lower-fat food choices in secondary schools: Outcomes of the TACOS Study. *American Journal of Public Health*, **94**, (9), 1507-1512.

Garner, D.M. (1985) Latrogenesis in anorexia nervosa and bulimia nervosa. *International Journal of Eating Disorders,* **4**, 348-63.

Gelhar, M. & Regmi, A. (2005). "Factors shaping global food markets." In Regmi, A. and M. Gehlhar (eds.) *New Directions in Global Food Markets* Agriculture Information Bulletin, Number 794, Washington, D.C.

Gentles, D., Metcalf, P., Dyall, L., et al.(2007) Metabolic syndrome prevalence in a multicultural population in Auckland, New Zealand. *New Zealand Medical Journal*, **120**, (1248):U2399.

Gillman, M.W., Rifas-Shiman, S.L., Camargo, C.A. Jr., Berkey, C.S., Frazier, A.L., Rockett, H.R., Field, A.E. & Colditz, G.A. (2001) Risk of overweight among adolescents who were breastfed as infants. *JAMA*, **285**: 2461–2467.

Giskes, K., Turrell, G., Patterson, C. & Newman, B. (2002) Socio-economic differences in fruit and vegetable consumption among Australian adolescents and adults. *Public Health Nutrition*, **5**, 663-9.

Gordon-Larsen, P., Adair, L.S. & Popkin, B.M. (2002) Ethnic differences in physical activity and inactivity patterns and overweight status. *Obesity Research*, **10**, 141-9.

Gortmaker, S.L., Dietz, W.H., Sobol, A.M. & Wehler, C.A. (1987) Increasing pediatric obesity in the United States. *American Journal of Diseases in Childhood*, **141**, (5):535-40.

Gortmaker, S.L., Must, A., Sobol, A.M., Peterson, K., Colditz, G.A. & Dietz, W.H. (1996) Television viewing as a cause of increasing obesity among children in the United States, 1986-1990. *Archives of Pediatric and Adolescent Medicine*, **150**, 356-62.

Gortmaker, S.L., Peterson, K., Wiecha, J., Sobol, A.M., Dixit, S., Fox, M.K., Laird, N. (1999) Reducing obesity via a school-based inter-disciplinary intervention among youth: Planet Health. *Archives of Pediatric and Adolescent Medicine*, **153**, 409-18.

Gortmaker, S.L., Cheung, L.W., Peterson, K.E., Chomitz, G., Cradle, J.H., Dart, H., Fox, M.K., Bullock, R.B., Sobol, A.M., Colditz, G., Field, A.E. & Laird, N. (1999) Impact of a school-based interdisciplinary intervention on diet and physical activity among urban primary school children: Eat well and keep moving. *Archives of Pediatric and Adolescent Medicine*, **153**, 975-83.

Gregory, J. & Lowe, S. (2000) *National Diet and Nutritional Survey: Young People Aged 4–18 Years*, **Vol. 1**: *Report of the Diet and Nutrition Survey*. The Stationery Office: London.

Gremillion, H. (2005) The cultural politics of body size. *Annual Reviews of Anthropology*, **34**:13–32.

Guo, S.S., Roche, A.F., Chumlea, W.C., Gardner, J.D. & Siervogel, R.M. (1994) The predictive value of childhood body mass index values for overweight at age 35 years. *American Journal of Clinical Nutrition*, **59**, 810-9.

Haines, J., Neumark-Sztainer, D. & Thiel, L. (2007) Addressing Weight-Related issues in an elementary school: What do students, parents, and school staff recommend? *Eating Disorders,* **15**, 5-21.

Hammersley, M. (2005) *Troubles with triangulation*. Paper presented at Mixed Methods Workshop, ESRC, Research Methods Programme, Manchester, October.

Hanes, S., Vermeersch, J. & Gale, S. (1984) The national evaluation of school nutrition programs: program impacts on dietary intake. *American Journal of Clinical Nutrition*, **40**, 390-413.

Hanley, A.J., Harris, S.B., Gittelsohn, J., Wolever, T.M., Saksvig, B. & Zinman, B. (2000) Overweight among children and adolescents in a Native Canadian community: prevalence and associated factors. *American Journal of Clinical Nutrition*, **71**: 693–700.

Hardy, R., Wadsworth, M. & Kuh, D. (2000) The influence of childhood weight and socioeconomic status on change in adult body mass index in a British national birth cohort. *International Journal of Obesity*, **24**, 725-734.

Harper, L.V. & Sanders, K.M. (1975) The effect of adult's eating on young children's acceptance of unfamiliar foods. *Journal of Experimental Child Psychology*, **20**, 206-14.

Harper, C. & Wells, L. (2007) *School Meal Provision in England and Other Western Countries: A Review*. (online). Available at:<http://www.schoolfoodtrust.org.uk>(Accessed 16th November, 2009)

Harrell, J.S., McMurray, R.G., Bangdiwala, S.I., Frauman, A.C., Gansky, S.A. & Bradley, C.B. (1996) Effects of a school-based intervention to reduce cardiovascular disease risk factors in elementary-school children: The Cardiovascular Health in Children (CHIC) study. *Journal of Pediatrics*, **128**, (6), 797-805.

Harrison, M., Burns, C.F., McGuinness, M., Heslin, J. & Murphy, N.M. (2006) Influence of a health education intervention on physical activity and screen time in primary school children: 'Switch Off-Get Active'. *Journal of Science and Medicine in Sport*, **9**, 388-394.

Harrop, A. & Palmer, G. (2002) *Improving Breakfast Clubs: Lessons from the Best*. New Policy Institute, London, UK.

Hawkes, C (2004) *Marketing food to children: The Global regulatory environment*, Geneva: World Health Organisation.

Hawkes, C. (2006) Uneven dietary development: linking the policies and processes of globalization with the nutrition transition, obesity and diet-related chronic diseases. *Globalization and Health*, **2**:2-4.

Hernandez, B., Gortmaker, S.L., Colditz, G.A., Peterson, K.E., Laird, N.M. & Parra-Cabrera, S. (1999) Association of obesity with physical activity, television programmes and other forms of video viewing among children in Mexico city. *International Journal of Obesity,* **23**: 845–854.

Hill, J.O. & Prentice, A.M. (1995) Sugar and body weight regulation. *American Journal of Clinical Nutrition* **62** (Suppl), 264S-74S.

Hill, J.O. & Trowbridge, F.L. (1998) Childhood obesity: future directions and research priorities. *Pediatrics*, **101** (3), 570-4.

Hill, J.O. & Peters, J.C. (1998) Environmental contributions to the obesity epidemic. *Science*, **280** (5368), 1371-1374.

Holm, V.A., Cassidy, S.B., Butler, M.G., Hanchett, J.M., Greenswag, L.R., Whitman, B.Y., Greenberg, F. (1993) Prader-Willi syndrome: consensus diagnostic criteria. *Pediatrics*, **91**, 398-402.

Hopper, C.A., Gruber, M.B., Munoz, K.D. & Herb, R.A. (1992) Effect of including parents in a school-based exercise and nutrition program for children. *Res Q Exerc Sport*, **63**, (3), 315-321.

Hughes, S.O., Power, T.G., Fisher, J.O., Mueller, S. & Nicklas, T.A. (2005) Revisiting a neglected construct: Parenting styles in a child-feeding context. *Appetite*, **44**, 83-92.

Institute of Medicine of the National Academies (2004) *Preventing Childhood Obesity. Health in the Balance. Executive Summary*. The National Academies Press, Washington, DC.

IOTF data based on population-weighted estimates from published and unpublished surveys, 1990-2002 (latest available) using IOTF-recommended cut-offs for overweight and obesity (online). Available at:<http://www.iotf.org> (Accessed 1st October, 2009).

IRINnews (2009) Africa: *Fighting the 'double whammy' of obesity and hunger.* (online) Available at:<http://www.IRINnews.org> (Accessed on 8th October, 2009)

Jago, R. & Baranowski, T. (2004) Non-curricular approaches for increasing physical activity in youth: A review. *Preventive Medicine*, **39**, (1), 157-163.

Jahns, L., Siega-Riz, A.M. & Popkin, B.M. (2001) The increasing prevalence of snacking among U.S. children and adolescents from 1977 to 1996. *Journal of Pediatrics*, **138**, 493-8.

James, J., Thomas, P., Cavan, D. & Kerr, D. (2004) Preventing childhood obesity by reducing consumption of carbonated drinks: cluster randomised controlled trial. *BMJ*, **328**, 1237.

James, J., Thomas, P. & Kerr, D. (2007) Preventing childhood obesity: two year follow-up results from the Christchurch obesity prevention programme in schools (CHOPPS) BMJ (online). Available at:<http://www.bmj.com> Cited as: *BMJ*, doi:10.1136/bmj.39342.571806.55 (published 2nd August, 2007). (Accessed on 3rd November, 2009).

Jansen, A. & Tenney, N. (2001) Seeing mum drinking a 'light' product: Is social learning a stronger determinant of taste preference acquisition than caloric conditioning? *European Journal of Clinical Nutrition*, **55**, 418-422.

Jiang, J., Xia, X., Greiner, T., Wu, G., Lian, G., Rosenqvist, U. (2007) The effects of a 3-year obesity intervention in schoolchildren in Beijing. *Child: care, health and development*, **33**, (5), 641-646.

Johnson, S.L. (2002) Children's Food Acceptance Patterns: The interface of ontogeny and nutrition needs. *Nutrition Reviews*, **60** (5), S91-94.

Juarbe, T.C. (1998) Cardiovascular disease-related diet and exercise experiences of immigrant Mexican women. *West Journal of Nursing Research*, **20**, (6):765–782.

Kafatos, A., Manios, Y. & Moschandreas, J. (2005) Preventive Medicine and Nutrition Clinic Universaity of Crete Research Team. Health and nutrition education in primary schools of Crete: follow-up changes in body mass index and overweight status. *European Journal of Clinical Nutrition*, **59**, 1090-1092.

Kahn, E.B., Ramsey, L.T., Brownson, R.C., Heath, G.W., Howze, E.H., Powell, K.E., Stone, E.J., Rajab, M.W., Corso, P. & the Task Force on Community Preventive Services. (2002) The effectiveness of Interventions to increase physical activity. *American Journal of Preventive Medicine*, 22, (4S), 73-106.

Kain, J., Uauy, R., Vio, A.F., Cerda, R. & Leyton, B. (2004) School-based obesity prevention in Chilean primary school children: methodology and evaluation of a controlled study. *International Journal of Obesity*, **28**, 483-493.

Katsanis, N., Lupski, J.R., Beales, P.L. (2001) Exploring the molecular basis of Bardet-Biedl syndrome. *Human Mol Genet*, **10**, 2293-2299.

Kealey, K.A., Peterson, A.V. Jr., Gaul, M.A. & Dinh, K.T. (2000) Teacher training as a behaviour change process: principles and results from a longitudinal study. *Health Education & Behavior*, **27**, 64-81.

Kearney, J.M. & McElhone, S. (1999) Perceived barriers in trying to eat healthier-results of a pan-EU consumer attitudinal survey. *British Journal of Nutrition*, **81** (Supple 2), S133-137.

Kelder, S.H., Perry, C.L., Lytle, L.A. & Klepp, K-I. (1995) Community-wide youth nutrition education: long-term outcomes of the Minnesota Heart Health Program. *Health Education Research*, **10**, (2), 119-131.

Kemper, H.C., Post, G.B., Twisk, J.W., van Mechelen, W. (1999) Lifestyle and obesity in adolescence and young adulthood: results from the Amsterdam Growth and Health Longitudinal Study (AGAHLS). *International Journal of Obesity*, **23** (Suppl 3), S34-40.

Kim, S., Moon, S. & Popkin, B.M. (2000) The nutrition transition in South Korea. *American Journal of Clinical Nutrition*, **71**, 44-53.

Kimm, S.Y., Glynn, N.W., Obarzanek, E., Kriska, A.M., Daniels, S.R., Barton, B.A. (2005) Relation between the changes in physical activity and body-mass index during adolescence: A multicentre longitudinal study. *Lancet*, **366**, (9482), 301-307.

Klesges, R.C., Haddock, C.K., Stein, R.J., Klesges, L.M., Eck, L.H. & Hanson, C.L. (1992) Relationship between psychosocial functioning and body fat in preschool children: a longitudinal investigation. *J Consult Clin Psychol*, **60**: 793–796.

Kohl, H.W. & Hobbs, K.E. (1998) Development of physical activity behaviours among children and adolescents. *Pediatrics*, **101**, 549-554.

Krassas, G.E., Tzotzas, T., Tsametis, C. & Konstantinidis, T. (2001) Determinants of body mass index in Greek children and adolescents. *J Pediatr Endocrinol Metab*, **14** (Suppl. 5): 1327–1333.

Kropski, J.A., Keckley, P.H. & Jensen, G.L. (2008) School-based obesity prevention programs: An evidence-based review. *Obesity*, **16**, (5), 1009-1018.

Kubik, M.Y., Lytle, L.A., Hannan, P.J., Perry, C.L. & Story, M. (2003) The association of the school food environment with dietary behaviours of young adolescents. *American Journal of Public Health*, **93**, (7), 1168-1173.

Kubik, M.Y., Story, M. & Davey, C. (2007) Obesity prevention in schools: Current role and future practice of school nurses. *Preventive Medicine*, **44**, 504-507.

Lake, J.K., Power, C. & Cole, T.J. (1997) Child to adult body mass index in the 1958 British birth cohort: Associations with parental obesity. *Archives of Diseases in Childhood*. **77**, 376-381.

Lake, A. & Townshend, T. (2006) Obesogenic Environments: exploring the built and food environments. *The Journal of the Royal Society for the Promotion of Health*, **126**, (6), 262-267.

Landman, J. & Cruickshank, J.K. (2001) A review of ethnicity, health and nutrition-related diseases in relation to migration in the United Kingdom. *Public Health Nutrition*, **4**, (2B):647–657.

Latner, J.D. & Stunkard, A.J. (2003) Getting worse: The stigmatization of obese children. *Obesity Research*, **11** (3), 452-456.

Lauderdale, D.S. & Rathouz, P.J. (2000). Body mass index in a US national sample of Asian Americans: effects of nativity, years since immigration and socioeconomic status. *International Journal of Obesity and Related Metabolic Disorders*, **24**, 1188-94.

Lazaar, N., Aucouturier, J., Ratel, S., Rance, M., Meyer, M. & Duche, P. (2007) Effect of physical activity intervention on body composition in young children: influence of body mass index status and gender. *Acta Pediatrica*, **96**, 1315-1320.

Lee, Y., Mitchell, D.C., Smiciklas-Wright, H. & Birch, L.L. (2001) Diet quality, nutrient intake, weight status, and feeding environments of girls meeting or exceeding recommendations for total dietary fat of the American Academy of Pediatrics. *Pediatrics*, **107** (6), e95.

Lee, M.C., Orenstein, M.R. & Richardson, M.J. (2008) Systematic review of active commuting to school and children's physical activity and weight. *Journal of Physical Activity and Health*, **5**, (6), 930-949.

Lee, J.M., Appugliese, D., Kaciroti, N., Corwyn, R.F., Bradley, R.H. & Lumeng, J.C (2007) Weight status in young girls and the onset of puberty. *Pediatrics*, **119**, 624-630.

Lewis, C.E., Smith, D.E., Wallce, D.D., Williams, O.D., Bild, D.E. & Jacobs, D.R., Jr. (1997) Seven-year trends in body weight and associations with lifestyle and behavioural characteristics in black and white young adults: The CARDIA study. *American Journal of Public Health*, **87**, (4), 635-642.

Li, M., Li, S., Baur, L.A. & Huxley, R.R. (2008) A systematic review of school-based intervention studies for the prevention and reduction of excess weight among Chinese children and adolescents. *Obesity Reviews*, **9**, 548-559.

Lissau, I. & Sorensen, T.I. (1994) Parental neglect during childhood and increased risk of obesity in young adulthood. *Lancet*, **343**: 324–327.

Livingstone, M.B.E., McKinlay, M., Robson, P.J. & Moran, *A. (2002) Development and Evaluation of an Interactive Multimedia CD ROM for the Promotion of Nutrition Education in Secondary School Children*. London, Food Standards Agency.

Lobstein, T., Baur, L., Uauy, R. (2004) Obesity in children and young people: a crisis in public health. *Obesity Reviews*, **5** (Suppl 1), 4-85.

Lowe, C.F., Horne, P.J.,Bowdery, M.A., Egerton. C., and Tapper, K., (2001) Increasing chiuldren's consumption of fruit and vegetables, *Public Health Nutrition*, **4**, (2a), 387.

Lowe, C.F., Horne, P.J., Tapper, K., Jackson, M., Hardman, C.A. Woolner, J., (2002) *Changing the nation's diet: A programme to increase children's consumption of fruit and vegetables, End of Project report*: University of Bangor, Wales.

Lowe, C.F., Horne, P.J., and Hardman, C. (2007) *Changing the nation's diet: A programme to increase children's consumption of fruit and vegetables: Working Paper number 5*, University of Wales, Bangor.

Ludwig, D.S., Peterson, K.E., Gortmaker, S.L. (2001) 'Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis' *The Lancet*, **357**, 505-508.

Luepker, R.V., Perry, C.L., McKinlay, S.M., Nader, P.R., Parcel, G.S. & Stone, E.J. (1996) Outcomes of a field trial to improve children's dietary patterns and physical activity. The Child and Adolescent Trial for Cardiovascular Health. CATCH collaborative group. *JAMA*, **275**, 768-76.

Lynch, E., Liu, K., Spring, B., Hankinson, A., Wei, G.S. & Greenland, P. (2007) Association of ethnicity and socioeconomic status with judgments of body size: The Coronary Artery Risk Development in Young Adults (CARDIA) Study. *American Journal of Epidemiology*, **165**, (9):1055–1062.

Lytle, L.A. & Achterberg, C.L. (1995) Changing the diet of America's children: what works and why? *Journal of Nutrition Education*, **27**: 250-60.

Lytle, L.A., Jacobs, D.R., Perry, C.L. & Klepp, K. (2002) Achieving physiological change in school-based intervention trials: what makes a preventive intervention successful. *British Journal of Nutrition*, **88**, 219-21.

Mamalakis, G., Kafatos, A., Manios, Y., Anagnostopoulou, T. & Apostolaki, I. (2000) Obesity indices in a cohort of primary school children in Crete: a six year prospective study. *International Journal of Obesity and Related Metabolic Disorders*, **24**, 765-771.

Manios, Y., Moschandreas, J., Hatzis, C. & Kaftos, A. (1999) Evaluation of a health and nutrition education program in primary school children of Crete over three-year period. *Preventive Medicine,* **28**, 149-59.

Manios, Y., Moschandreas, J., Hatzis, C. & Kafatos, A. (2002) Health and nutrition education in primary schools of Crete: changes in chronic disease risk factors following a 6 year intervention programme. *British Journal of Nutrition*, **88**, 315-324.

Mason, V. (1995) Young People and Sport in England, 1994; *The Views of Teachers and Children*: London, Sports Council.

Matthews, K.A., Abram, B., Crawford, S., Miles, T., Neer, R., Powell, L.H. & Wesley, D. (2001) Body mass index in mid-life women: Relative influence of menopause, hormone use and ethnicity. *International Journal of Obesity*, **25**, 863-73.

Mazzocchi, M., Traill, W.B. & Shogren, J.F. (2009) *Fat Economics; Nutrition, Health, and Economic Policy*. London; Oxford University Press.

McDermott, R., O'Dea, K., Rowley, K., Knight, S. & Burgess, P. (1998) Beneficial impact of the homelands movement on health outcomes in central Australian aborigines. *Australia and New Zealand Public Health*, **22**, 653-658.

McKee, R., Mutrie, N., Crawford, F. & Green, B. (2007) Promoting walking to school: results of a quasi-experimental trial. *Journal of Epidemiology and Community Health*, **61**, (9), 818-823.

McPherson, R.S., Hoelscher, D.M., Alexander, L.D.M., Scanlon, K.S. & Serdula, M.K. (2000) Dietary Assessment Methods among School-Aged Children: Validity and Reliability. *Preventive Medicine*, **31**, (2), S11-S33.

Mendoza, J.A., Levinger, D.D. & Johnston, B.D. (2009) Pilot evaluation of a walking school bus program in a low-income urban community. *BMC Public Health*, **9**, 112. doi: 10.1186/1471-2458-9-122.

Michie, S. & Abraham, C. (2004) Interventions to Change Health Behaviours: Evidence-based or Evidence-inspired? *Psychology & Health*, **19**, (1), 29- 49.

Michie, S., Johnston, M., Francis, J., Hardeman, W. & Eccles, M. (2008) From Theory to Intervention: Mapping Theoretically Derived Behavioural Determinants to Behaviour Change Techniques. *Applied Psychology*, **57**, (4), 660-680.

Michie, S., Jochelson, K., Markham, W.A., Bridle, C. (2009) Low-income groups and behaviour change interventions: a review of intervention content, effectiveness and theoretical frameworks. *Journal of Epidemiology and Community Health*, **63**, 610-622.

Mishra, G., Ball, K., Arbuckle, J. & Crawford, D. (2002) Dietary patterns of Australian adults and their association with socioeconomic status: results from the 1995 National Nutrition Survey, *European Journal of Clinical Nutrition*, **56**, 687-93.

Monteiro, C.A., Mondini, L., de Souza, A.L. & Popkin, B.M. (1995) The nutrition transition in Brazil. *European Journal of Clinical Nutrition*, **49**, 105-113.

Monteiro, C.A., Benicio, M.H.D.A., Mondini, I. & Popkin, B.M. (2000) Shifting obesity trends in Brazil. *European Journal of Clinical Nutrition*, **54**, 342-346.

Moore, L.L., Lombardi, D.A., White, M.J., Campbell, J.L., Oliveria, S.A. & Ellison, R.C. (1991) Influence of parents' physical activity levels on activity levels of young children. *Journal of Pediatrics*, **62**, 384-389.

Moore, L. (2001) *Are Fruit Tuck Shops in Primary Schools Effective in Increasing Pupils' Fruit Consumption? A Randomised Controlled Trial*. London, Food Standards Agency.

Morris, S. (2006) Body mass index and occupational attainment. *Journal of Health Economics*, **25**, 347-364.

Moyers, P., Bugle, L. & Jackson, E. (2005) Perceptions of School Nurses Regarding Obesity in School-Aged Children. *The Journal of School Nursing*, **21**, (2) 86-93.

Mrdjenovic, G. & Levitsky, D.A. (2003) Nutritional and energetic consequences of sweetened drink consumption in 6 to 13-year-old children. *Journal of Pediatrics*, **142**:604-10.

Muller, M.J., Asbeck, I., Mast, M., Langnase, K. & Grund, A. (2001) Prevention of obesity – more than an intervention. Concept and first results of the Kiel Obesity Prevention Study (KOPS) *International Journal of Obesity*, **25**, (Supple 1) S66-74.

Mulvihill, C., Rivers, K., Aggelton, P. (2000) *Physical Activity 'At Our Time'*. London, Health Education Authority.

Mulvihill, C. (2000) A qualitative study investigating the views of primary-age children and parents on physical activity. *Health Education Journal*, **59**, 166-179.

Murphy, J.M., Pagono, M.E., Nachmani, J., Sperling, P., Kane, S. & Kleinman, R.E. (1998) The relationship of school breakfast to psychosocial and academic functioning: cross-sectional and longitudinal observations in an inner-city school sample. *Archives of Pediatric & Adolescent Medicine*, **152**, 899-907.

Muzzo, S., Burrows, R., Cordero, J. & Ramirez, I. (2004) Trends in Nutritional Status and Stature Among School-Age children in Chile. *Nutrition*, **20**, 867-872.

Nader, P.R., Sallis, J.F., Abramson, I.S., Broyles, S.L., Patterson, T.L., Senn, K., Rupp, J.W. & Nelson, J.A. (1992) Family-based cardiovascular risk reduction education among Mexican- and Anglo-Americans. *Family and Community Health*, **15**, (1), 57-74.

Nader, P.R., Stone, E.J., Lytle, L.A., Perry, C.L., Osganian, S.K., Kelder, S., Webber, L.S., Elder, J.P., Montgomery, D., Feldman, H.A., Wu, M., Johnson, C., Parcel, G.S. & Luepker, R.V. (1999) Three-year maintenance of improved diet and physical activity: the CATCH cohort. Child and Adolescent Trial for Cardiovascular Health. *Archives of Pediatric and Adolescent Medicine*, **153**, 695-704.

Nanan, D.J. (2002) The obesity pandemic: implications for Pakistan. *JPMA J Pak Med Assoc*, **52**(8):342–346.

National Child Measuring Programme (2005) online results. (online). Available at:< http://www.ncmp.ic.nhs.uk/> (Accessed 30th November, 2009)

National Institute for Health and Clinical Excellence (2006) *CG43 obesity: full guideline section 3 – prevention: evidence statements and reviews* (online). Available at:<http://guidance.nice.org.uk/CG43> (Accessed 9th November, 2009)

Nelson, M. (2003) Dietary Surveys. Measurement of Food Intake. *Encyclopedia of Food Sciences and Nutrition*, p1869-1876.

Neumark-Sztainer, D., Story, M., Perry, C. & Casey, M.A. (1999a) Factors influencing food choices of adolescents: findings from focus-group discussions with adolescents. *Journal of the American Dietetic Association*, **99**: 929–937.

Neumark-Sztainer, D., Story, M. & Harris, T.R. (1999b) Beliefs and attitudes about obesity among teachers and school health care providers working with adolescents. *Journal of Nutrition Education*, **31**, (1), 3-9.

Neumark-Sztainer, D., Story, M., Hannan, P.J., Tharp, T. & Rex, J. (2003a) Factors associated with changes in physical activity. A cohort study of inactive adolescent girls. *Archives of Pediatric and Adolescent Medicine*, **157**, 803-810.

Neumark-Sztainer, D., Story, M., Hannan, P.J., Stat, M. & Rex, J. (2003b) New Moves: a school-based obesity prevention program for adolescent girls. *Preventive Medicine*, **37**, 41-51.

Nicklas, T.A., Bao, W., Webber, L.S. & Berenson, G.S. (1993) Breakfast consumption affects inadequacy of total dietary intake in children. *Journal of the American Dietetic Association*, **93**, 886-891.

Nicklas, T.W., Johnson, C.C., Myers, L., Farris, R.P., Cunningham, A. (1998) Outcomes of a high school program to increase fruit and vegetable consumption: Gimme 5 – A fresh nutrition concept for students. *Journal of School Health*, **68**, 248-53.

Nicklas, T.A., Baranowski, T., Cullen, K.W. & Berenson, G. (2001) Eating Patterns, Dietary Quality and Obesity. *Journal of the American College of Nutrition*, **20** (6), 599-608.

Nielsen Media Research (1998). *Nielsen Report on Television*. New York, NY

Ogden, C.L., Flegal, K.M., Carroll, M.D. & Johnson, C.L. (2002) Prevalence and trends in overweight among US children and adolescents, 1999–2000. *JAMA*, 288: 1728–1732.

O'Neil, C. & Nicklas, T.A. (2002) Gimme 5: An innovative, school-based nutrition intervention for high school students. *Journal of the American Dietetic Association*, **102**, (3), S93-96.

Ong, K. K., Emmett, P. M., Noble, S., Ness, A., Dunger, M. D. & the ALSPAC Study Team (2006) Dietary energy intake at the age of 4 months predicts postnatal weight gain and childhood body mass index. *Pediatrics*, **117**, 503–508.

Oria, M. & Sawyer, K. (2007) *Joint U.S.-Mexico Workshop on Preventing Obesity in Children and Youth of Mexican Origin: Summary*. Washington, D.C.; The National Academies Press.

Orme, J. (1991) Adolescent young women and exercise: too much of a struggle? *Education and Health*, **9**, 76-80.

Osganian, S.K., Ebzery, M.K., Montgomery, D.H., Nicklas, T.A., Evans, M.A., Mitchell, P.D., Lytle, L.A., Snyder, M.P., Stone, E.J., Zive, M.M., Bachman, K.J., Rice, R. & Parcel, G.S. (1996) Changes in the Nutrient Content of School Lunches: Results from the CATCH Eat Smart Food Service Intervention. *Preventive Medicine*, **25**, 400-412.

Ozanne, S.E., Fernandez-Twinn, D. & Hales, C.N. (2004) Fetal growth and adult diseases. *Semin Perinatol*, **28**, (1), 205-210.

Parcel, G.S., Perry, C.L., Kelder, S.H., Elder, J.P., Mitchell, J.P., Lytle, L.A., Johnson, C.C. & Stone, E.S. (2003) School climate and the institutionalisation of the CATCH program. *Health Education and Behaviour*, **30**, (4), 489-502.

Paeratakul, S., Popkin, B.M., Ge, K., Adair, L.S. & Stevens, J. (1998) Changes in diet and physical activity affect the body mass index of Chinese adults. *International Journal of Obesity*, **22**, 424-31.

Park, H-K. (2008) Nutrition policy in South Korea. *Asia Pacific Journal of Clinical Nutrition*, **17**, (S1), 343-345.

Parmenter, K., Waller, J. & Wardle, J. (2000) Demographic variation in nutrition knowledge in England. *Health Education Research*, **15**, 163-74.

Parsons, T.J., Power, C., Logan, S. & Summerbell, C.D. (1999) Childhood predictors of adult obesity: a systematic review. *International Journal of Obesity and related Metabolic Disorders*, **23** (Suppl 8), S1-107.

Patterson, B.H., Harlan, L.C., Block, G. & Kahle, L. (1995) Food choices of whites, blacks and Hispanics: data from the 1987 national Health Interview Survey. *Nutrition and Cancer*, **23**, 105-19.

Perez-Rodrigo, C. & Aranceta, J. (1997) Nutrition education for school-children living in a low income urban area in Spain. *Journal of Nutrition Education*, **29**, 267-73.

Perez-Rodrigo, C. & Aranceta, J. (2001) School-based nutrition education: lessons learned and new perspectives. *Public Health Nutrition*, **4** (1A), 131-139.

Perry, C.L., Bishop, D.B., Taylor, G., Murray, D.M., Mays, R.W., Dudovitz, B.S., Smyth, M. & Story, M. (1998) Changing Fruit and Vegetable Consumption among Children: The 5-a-Day Power Plus Program in St. Paul, Minnesota. *American Journal of Public Health*, **88**, (4), 603-609.

Perry, C.L., Bishop, D.B., Taylor, G.L., Davis, M., Story, M., Gray, C., Bishop, S.C., Mays, R.A.W., Lytle, L.A. & Harnack, L. (2004) A randomised school trial of environmental strategies to encourage fruit and vegetable consumption among children. *Health Education and Behavior*, **31**, (65), 65-76.

Perusse, L., Chagnon, Y.C., Weisnagel, J. & Bouchard, C. (1999) The human obesity gene map: the 1998 update. *Obesity Research*, **7**, 111-129.

Pollitt, E. & Matthews, R. (1998) Breakfast and cognition: an integrative summary. *American Journal of Clinical Nutrition*, **67**, 804S-813S.

Popkin, B.M. (1994) The nutrition transition in low-income countries: an emerging crisis. *Nutrition Reviews*, **52**, 285-298.

Popkin, B.M. (1998) The nutrition transition and its health implications in lower income countries. *Public Health Nutrition*, **1**, 5-21.

Popkin, B.M. & Udry, J.R. (1998) Adolescent obesity increases significantly in second and third generation US immigrants: the National Longitudinal Study of Adolescent Health. *Journal of Nutrition*, **128**, 701-706.

Popkin, B., Horton, S. & Kim, S. (2001) *The Nutrition Transition and Prevention of Diet-Related Chronic Diseases in Asia and the Pacific*. Asian Development Bank Nutrition and Development Series No 6. Asian Development Bank: Manila, 2001.

Popkin, B.M. (2001) The nutrition transition and obesity in the developing world. *Journal of Nutrition*, **131**, 871S-873S.

Popkin, B.M. & Du, S. (2003) Dynamics of the nutrition transition toward the animal foods sector in China and its implications: a worried perspective. *Journal of Nutrition*, **133**, 3898S-90S.

Popkin, B.M. & Nielsen, S.J. (2003) The sweetening of the world's diet. *Obesity Research*, **11**, 1135-1132.

Popkin, B.M. (2005) The implications of the nutrition transition for obesity in the developing world. In: D. Crawford & R.W. Jeffery (eds). *Obesity Prevention and Public Health*, New York, Oxford University Press. (p 75-98).

Popkin, B. & Ng, S.W. (2006) *The Nutrition Transition in High and Low-Income Countries: What are the Policy Lessons?* Invited paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18, 2006.

Power, C. & Jefferies, B.J. (2002) Fetal environment and subsequent obesity: a study of maternal smoking. *International Journal of Epidemiology*, **31**: 413–419.

Powers, A.R., Struempler, B.J., Guarino, A. & Parmer, S.M. (2005) Effects of a Nutrition Education Program on the Dietary Behavior and Nutrition Knowledge of Second-Grade and Third-Grade Students. *Journal of School Health*, **75**, (4), 129-133.

Prentice, A.M. & Jebb, S.A. (2003) Fast foods, energy density and obesity: a possible mechanistic link. *Obesity Reviews*, **4**: 187–194.

Prentice, A.M. (2006) The emerging epidemic of obesity in developing countries. *International Journal of Epidemiology*, **35**, 93-99.

Price, J.H., Desmond, S.M. & Stelzer, C.M. (1987) Elementary school principals' perceptions of childhood obesity. *Journal of School Health*, **57**, 367-70.

Price, J.H., Desmond, S.M., Ruppert, E.S. & Stelzer, C.M. (1987) School nurses' perceptions of childhood obesity. *Journal of School Health*, **57**, 332-336.

Price, J.H., Desmond, S.M. & Ruppert, E.S. (1990) Elementary school principals' perceptions of childhood obesity. *Health Education*, **57**, 332-6.

Public Health Research, Education and Development Program (2001) *The Effectiveness of School-Based Interventions in Promoting Physical Activity and Fitness Among Children and Youth: A Systematic Review*, Public Health Research, Education and Development Program, Hamilton.

Puhl, R. & Brownell, K.B. (2001) Bias, discrimination and obesity. *Obesity Research*, **9**, (12), 788-805.

Qotba, H., Al-Isa,A.N. (2007) Anthropometric measurements and dietary habits of schoolchildren in Qatar, *Int J of Food Sciences and Nutrition*, **58**, (1), 1-5.

Raitakari, O.T., Porkka, K.V., Taimela, S., Telama, R., Rasanen, L. & Viikari, J.S. (1994) Effects of persistent physical activity and inactivity on coronary risk factors in children and young adults. The Cardiovascular Risk in Young Fins Study. *American Journal of Epidemiology*, **140**, 195-205.

Ravelli, G.P., Stein, Z.A. & Susser, M.W. (1976) Obesity in young men after famine exposure in utero and early infancy. *New England Journal of Medicine*, **295**: 349–353.

Rees, R., Kavanagh, J., Harden, A., Shepherd, J., Brunton, G., Oliver, S. & Oakley, A. (2006) Young people and physical activity: a systematic review matching their views to effective interventions. *Health Education Research*, **21**, (6), 806-825.

Reilly, J.J., Montgomery, C., Jackson, D., MacRitchie, J. & Armstrong, J. (2001) Energy intake by multiple pass 24 hr recall and total energy expenditure: a comparison in a representative sample of 3-4 year-olds. *British Journal of Nutrition*, **86**, 601-605.

Reilly, J.J., Methven, E., McDowell, Z.C., Hacking, B., Alexander, D., Stewart, L. & Kelnar, C.J.H. (2003) Health Consequences of Obesity. *Archives of Diseases in Childhood*, **88**, 748-752.

Resnicow, K., Cohn, L., Reinhardt, J., Cross, D., Futterman, R., Kirschner, E., Wynder, E.L. & Allegrante, J.P. (1992) A three-year evaluation of the 'Know your body' program in inner-city schoolchildren. *Health Education Quarterly*, **19**, 463-80.

Resnicow, K., Smith, M., Baranowski, T., Baranowski, J., Vaughan, R. & Davis, M. (1998) 2 year tracking of children's fruit and vegetable intake. *Journal of American Dietetic Association*, **98**, 785-9.

Reynolds, K.D., Franklin, F.A., Binkley, D., Raczynski, J.M., Harrington, K.F., Kirk, K.A. & Person, S. (2000) Increasing the fruit and vegetable consumption of fourth-graders: Results from the High 5 Project. *Preventive Medicine*, **30**, 309-319.

Riddell, T., Jackson, R., Wells, S., Braoad, J. & Bannink, L. (2007) Assessing Maori/non-Maori differences in cardiovascular disease risk and risk management in routine primary care practice using web-based clinical decision support: (PREDICT CVD-2). *New Zealand Medical Journa*l, **120**, (1250):U2445.

Riddoch, C., Savage, J.M., Murphy, N., Cran, G.W. & Boreham, C. (1991) Long term health implications of fitness and physical activity patterns. *Archives of Diseases in Childhood*, **66**, 1426-1433.

Robinson, T.N. (1999) Reducing Children's Television Viewing to Prevent Obesity: A Randomised Controlled Trial. *JAMA*, **282**, (16) 1593-1567.

Robinson, T.N. (2001) Television viewing and childhood obesity. *Pediatric Clincics of North America*, **48**, 1017-1025.

Rodgers, D.V., Johnson, S.R., Tshann, J.M., Chesterman, E.A. & Mellin, L.M. (2001) The evaluation of a school-based obesity prevention program among fourth grade students. (online). Available at:<http://www.just-for-kids.org/links.htm.> Accessed 26th October, 2009.

Rolls, B.J., Engell, D. & Birch, L.L. (2000) Serving portion size influences 5 year old but not 3 year old children's food intakes. *Journal of the American Dietetic Association*, **100**: 232–237.

Roos, E., Lahelma, E., Virtanen, M., Prattala, R. & Pietinen, P. (1998) Gender, socioeconomic status and family status as determinants of food and behaviour. *Social Science and Medicine*, **46**, 1519-29.

Ross, S. (1995) "Do I really have to eat that?" A qualitative study of school children's food choices and preferences. *Health Education Journal*, **54**, 312-21.

Rowland, T.W. (1995) The horse is dead: Let's dismount. *Pediatric Exercise Science*, **7**, 117-20.

Rowland, D., DiGuiseppi, C., Gross, M., Afolabi, E. & Roberts, I. (2003) Randomised Controlled Trial of siet specific advice on school travel patterns. *Archives of Diseases in Childhood*, **88** (1), 8-11.

Ruangdaraganon, N., Kotchabhakdi, N., Udomsubpayakul, U., Kunanusont, C. & Suriyawongpaisal, P. (2002) The association between television viewing and childhood obesity: a national survey in Thailand. *Journal of the Medical Association of Thailand*, **85** (Suppl. 4): S1075–S1080.

Rush, E., Schutz, Y., Obolonkin, V., Simmons, D. & Plank, L. (2006) Are energy drinks contributing to the obesity epidemic? *Asia Pac J Clin Nutr* **15**:242-4.

Sahota, P., Rudolf, M.C., Dixey, R., Hill, A.J., Barth, J.H. & Cade, J. (2001) Randomised controlled trial of primary school based intervention to reduce risk factors for obesity . *British Medical Journal*, **323**, (7230), 1029-1032.

Sallis, J.F., Simons-Morton, B.G., Stone, E.J., Corbin, C.B., Epstein, L.H., Faucette, N., Ianotti, R.J., Killen, J.D., Klesges, R.C., Petray, C.K., Rowland, T.W. & Taylor, W.C. (1992) Determinants of physical activity and interventions in youth. *Medicine and Science in Sports and Exercise*, **24**, (Supple 6), S248-257.

Sallis, J.F., McKenzie, T.L., Alcaraz, J.E., Kolody, B., Faucette, N. & Hovell, M.F. (1997) The effects of a 2-year physical education programme (SPARK) on physical activity and fitness in elementary school students. American Journal of Public Health, **87**, (8), 1328-1334.

Sallis, J. & Owen, N. (1999) *Physical activity and behavioural medicine*. Sage Publications, London.

Sallis, J.F., McKenzie, T.L., Conway, T.L., Elder, J.P., Prochaska, J.J., Brown, M., Zive, M.M., Marshall, S.J. & Alcaraz, J.E. (2003) *Environmental Interventions for Eating and Physical Activity*, **24**, (3), 209-217.

Salmon, J., Ball, K., Crawford, D., Booth, M., Telford, A., Hume, C., Jolley, D. & Worsley, A. (2005) Reducing sedentary behaviour and increasing physical activity among 10-year old children: overview and process evaluation of the 'Switch-Play' intervention. *Health Promotion International*, **20**, (1), 7-17.

Sawaya, A.L., Dallal, G., Solymos, G., de Sousa, M.H., Ventura, M.L., Roberts, S.B. & Sigulem, D.M. (1995) Obesity and malnutrition in a shantytown in the city of Sao Paulo, Brazil. *Obesity Research*, **3** (Suppl. 2): 107S–115S.

Schroeder, D.G., Martorell, R. & Flores, R. (1999) Infant and child growth and fatness and fat distribution in Guatemalan adults. *American Journal of Epidemiology*, **149**: 177–185.

Schwartz, M.D. & Brownell, K.D. (2004) Obesity and body image. *Body Image*, **1**, 43-56.

Seidell, J.C. (2000) Obesity, insulin resistance and diabetes – A worldwide epidemic. *British Journal of Nutrition*, **83**, S5-8.

Serdula M.K., Ivery, D., Coates, R.J., Freeman, D.S., Williamson, D.F. & Byers, T. (1993) Do obese children become obese adults? A Review of the literature. *Preventive Medicine*, **22**, 167-177.

Shahar, D., Schultz, R., Shahar, A. & Wing, R. (2001) The effect of widowhood on weight change, dietary intake and eating behaviour in the elderly population. *Journal of Ageing and Health*, **13**,186-99.

Sharma, M. (2006) International school-based interventions for preventing obesity in children. *Obesity Reviews*, **8**, 155-167.

Shaw, M. (1998) Adolescent breakfast skipping: an Australian study. *Adolescence*, **33**, 851-861.

Shaya, F.T., Flores, D., Gbarayor, C.M. & Wang, J. (2008) School-Based Obesity Interventions: A Literature Review. *Journal of School Health*, **78**, (4), 189-196.

Siega-Riz, A.M., Popkin, B.M. & Carson, T. (1998) Trends in breakfast consumption for children in the United States from 1965 to 1991. *American Journal of Clinical Nutrition*, **67**: 748S–756S.

Silverman, B.L., Rizzo, T.A., Cho, N.H. & Metzger, B.E. (1998) Long-term effects of the intrauterine environment. *Diabetes Care*, **21** (Suppl. 2): B142–B149.

Simpson, D. (2001) The impact of breakfast clubs on pupil attendance and punctuality. *Research in Education*, **66**, 76-83.

Singh, A.S., Mulder, C., Twisk, J.W.R., van Mechelen, W. & Chinapaw, M.J.M. (2008) Tracking of childhood overweight into adulthood: a systematic review of the literature. *Obesity Reviews*, **9**, 471-488.

Sloan, S., Gildea, A., Stewart, M., Sneddon, H. & Iwaniec, D. (2008) Early weaning is related to weight and rate of weight gain in infancy Child Care, *Health and Development*, **34**, (1), 59–64.

Smith, F. & Barker, J. (1997) *Profile of Provision 'the expansion of out of school childcare*'. Department of Geography and Earth Sciences with the Kid's Clubs Network, Brunel, UK.

Smith West, D., Bursac, Z., Quimby, D., Prewitt, T.E., Spatz, T. & Nash, C. (2006) Self-reported sugar-sweetened beverage intake among college students. *Obesity Research*, **14**:1825-31.

Sobal, J. & Stunkard, A.J. (1989) Socioeconomic status and obesity: a review of the literature. *Psychology Bulletin*, **105**, 260 – 75.

Sokol, R.J. (2000). The Chronic Disease of Childhood Obesity: The sleeping giant has awakened. *The Journal of Pediatrics*, **136** (6), 711-713.

Spiegel, S.A. & Foulk, D. (2006) Reducing overweight through a multidisciplinary school-based intervention. *Obesity Research*, **14**, 88-96.

Sports Council for Wales (1994) *A Matter of Fun and Games: Children's Participation in Sport*. Cardiff, Sports Council for Wales.

Srinivasan, S.R., Frontini, M.G. & Berenson, G.S. (2003) Longitudinal changes in risk variables of insulin resistance syndrome from childhood to young adulthood in offspring of parents with type 2 diabetes: The Bogalusa Heart Study. *Metabolism*, **52**: 443–453.

Stang, J.S., Story, M. & Kalina, B. (1997) School-based weight management services: perceptions and practices of school nurses and administrators. *American Journal of Health Promotion*, **11**, 183-185.

Steinbeck, K.S. (2001) The importance of physical activity in the prevention of overweight and obesity in childhood: a review and an opinion. *Obesity Reviews*, **2**, 117-30.

Shemilt, I., Harvey, I., Shepstone, L., Swift, L., Reading, R., Mugford, M., Belderson, P., Norris, N., Thoburn, J. & Robinson, J. (2004) A national evaluation of school breakfast clubs: evidence from a cluster randomised controlled trial and an observational analysis. *Child: Care, Health and Development,* **30**, (5), 413-427.

Shepherd, J., Harden, A., Rees, G., Brunton, G., Garcia, J., Oliver, S. & Oakley, A. (2006) Young people and healthy eating: a systematic review of research on barriers and facilitators. *Health Education Research*, **21**, (20), 239-257.

Simon, C., Wagner, A., Platat, C., Arveiller, D., Schweitzer, B., Schlienger, J.L. & Triby, E. (2006) ICAPS: a multilevel program to improve physical activity in adolescents. *Diabetes Metabolism*, **32**, 41-49.

Sorkou, I., Al-Qallaf, K., Al-Shamali, N., Hajia, Al-Qal, B., (2003) Childhood obesity in Kuwait, prevalence and trends, *Family Medicine*, **35**, (7), 463-4.

Steyn, K., Bourne, L., Jooste, P., Fourie, J.M., Rossouw, K. & Lombard, C. (1998) Anthropometric profile of a black population in the Cape Peninsula in South Africa. *East Afr Med J*, **75**: 35–40.

Stockley, L. (2001) Toward public health nutrition strategies in the European Union to implement food based dietary guidelines and to enhance healthier lifestyles. *Public Health Nutrition*, **4**, (2), 307-324.

Stone, E.J., McKenzie, T.L., Welk, G.J. & Booth, M.L. (1998) Effects of physical activity interventions in youth: Review and synthesis. *American Journal of Preventive Medicine*, **15**, (4), 298-315.

St-Onge, M.P., Keller, K.L. & Heymsfield, S.B. (2003) Changes in childhood food consumption patterns: a cause for concern in light of increasing body weights. *American Journal of Clinical Nutrition*, **78**: 1068–1073.

Story, M., Mays, R.W., Bishop, D.B., Perry, C.L., Taylor, G., Smyth, M. & Gray, C. (2000) 5-a-day Power Plus: Process evaluation of a multicomponent elementary school program to increase fruit and vegetable consumption. *Health Education and Behavior*, **27**, 187-200.

Story, M., Sherwood, N.E., Himes, J.H., Davis, M., Jacobs, D.R., Cartwright, Y., Smyth, M. & Rochon, J. (2003) An After-School Obesity Prevention Program for African-American Girls: The Minnesota GEMS Pilot Study. *Ethnicity & Disease*, **13**, S1-54.

Stratton, G. (2000) Promoting children's physical activity in primary school: an intervention study using playground markings. *Ergonomics*, **43**, (10), 1538-1546.

Stratton, G. & Leonard, J. (2002) The effects of playground markings on the energy expenditure of 5-7 year old school children. *Pediatric Exercise Science*, **14**, 170-180.

Strauss, R.S. (1997) Effects of intrauterine environment on childhood growth. *British Medical Bulletin*, **53**: 81–95.

Strauss, R.S. (2000) Childhood Obesity and Self-esteem. *Pediatrics*, **105** (1), e15.

Stunkard, A.J., Foch, T.T. & Hrubec, Z. (1986) A twin study of human obesity. *JAMA*, **256**: 51–54.

Summerbell, C.D., Waters, E., Edmunds, L.D., Kelly, S., Brown, T. & Campbell, K.J. (2005) Interventions for preventing obesity in children (review). *The Cochrane Library, Issue 3*.

Swinburn, B., Egger, G. & Raza, F. (1999) Dissecting obesogenic environments: the development and application of a framework for identifying and prioritising environmental interventions for obesity. *Preventive Medicine*, **29**, (6), 563-70.

Swinburn, B. & Egger, G. (2002) Preventive strategies against weight gain and obesity. *Obesity Reviews*, **3**, (4), 289-301.

Tam, C.S., Garnett, S.P., Cowell, C.T., Campbell, K., Cabrera, G. & Baur, L.A. (2006) Soft drink consumption and excess weight gain in Australian school students: results from the Nepean study. *International Journal of Obesity*, **30**:1091-3.

Tansey, G. & Worsley, T. (1995) T*he Food System. A Guide*. London, Earthscan.

Taylor, W.C., Yancey, A.K., Leslie, J., Murray, N.G., Cummings, S.S. & Sharkey, S.A. (1999) Physical activity among African American and Latino middle school girls: consistent beliefs, expectations and experiences across two sites. *Womens' Health*, **30**, 67-82.

Taylor, R.W., McAuley, K.A., Barbezat, W., Strong, A., Williams, S.M. & Mann, J.I. (2007) APPLE Project: 2-y findings of a community-based obesity prevention program in primary school-age children. American *Journal of Clinical Nutrition*, **86**, 735-42.

The Audit Commission. The Healthcare Commission and The National Audit Office. (2006) *Tackling Child Obesity – First Steps*, The Stationery Office, London.

Thirlaway, K. & Upton, D. (2009) The Psychology of Lifestyle: *Promoting Healthy Behaviour*. Oxon; Routledge.

Thompson, F.E. & Subar, A.F. (2001) Dietary Assessment Methodology. In: Coulston, A.M., Rock, C.L. & Monsen, E.R. (eds) *Nutrition in the Prevention and Treatment of Disease*. London, Elsevier Science Ltd, p3-30.

Tones, K (1997) Beyond the randomised controlled trial: A Case for 'Judicial Review'. *Health Education Research*, **12** (2), i-iv.

Troiano, R., Flegal, K., Kuczmarski, R., Campbell, S. & Johnson, C. (1995) Overweight prevalence and trends for children and adolescents: The national health and nutrition examination surveys 1963-1991. *Archives of Pediatric and Adolescent Medicine*, **149**, 1085-1091.

Toschke, A.M., Koletzko, B., Slikker, W. Jr., Hermann, M. & von Kries, R. (2002) Childhood obesity is associated with maternal smoking in pregnancy. European Journal of Pediatrics, **161**: 445–448.

Trost, S.G., Owen, N., Bauman, A.E., Sallis, J.F. & Brown, W. (2002) Correlates of adults' participation in physical activity: review and update. *Medicine, Science, Sports and Exercise*, **34**, 1996-2001.

Trost, S.G., Sallis, J.F., Pate, R.R., Freedson, P.S., Taylor, W.C. & Dowda, M. (2003) Evaluating a Model of parental influence on youth physical activity. *American Journal of Preventive Medicine*. **25** (4), 277-282.

Uauy, R., Albala, C. & Kain, J. (2001) Obesity trends in Latin America: transiting from under- to overweight. *Journal of Nutrition*, **131**: 893–899.

Uauy, R. & Kain, J. (2002) The epidemiologic transition: the need to incorporate obesity prevention into nutrition programmes. *Public Health Nutrition*, **5**: 223–229.

UNICEF Global Database on Malnutrition, updated September 2001. (online). Available at:<http://www.childinfo.org/eddb/malnutrition/database2.htm> (Accessed 1st October, 2003).

United Nations (1995) *World Urbanisation Prospects: The 1994 revisions*. New York, United Nations.

United States Department of Agriculture (1999) *Time for School Breakfast: Healthy Eating Helps you Make the Grade*. USDA, Washington, WA, USA.

Urbick, B., Jack, V., Westerhof, A. & Katz, B. (1999) Good nutrition for UK youth: *Bridging the gap between adults and children*. June 1999. Surrey: CKC, Leatherhead Food Research Association, 1999.

U.S. Department of Transportation, Federal Highway Administration, Research and Technical Support Center (1997). *Nationwide Personal Transportation Survey*. Federal Highway Administration: Lantham, MD.

Vanhala, M., Vanhala, P., Kumpusalo, E., Halonen, P. & Takala, J. (1998) Relation between obesity from childhood to adulthood and the metabolic syndrome: population based study. *British Medical Journal,* **317**, 319-320.

Van Sluijs, E.M.F., McMinn, A.M. & Griffin, S.J. (2007) Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. *British Medical Journal*. Available at:<http://www.bmj.com> Cited as: BMJ, doi:10.1136/bmj.39320.843947.BE (accessed 10th June, 2008)

Vartanian, L.R., Schwartz, M.B. & Brownell, K.D. (2007) Effects of soft drink consumption on nutrition and health: A systematic review and meta-analysis. *American Journal of Public Health*, **97**:667-75.

Visscher, T.L.S. & Seidell, J.C. (2001) The Public Health Impact of Obesity. *Annual Review of Public Health*, **22**, 355-375.

von Kries, R., Koletzko, B., Sauerwald, T., von Mutius, E., Barnert, D., Grunert, V. & von Voss, H. (1999) Breast feeding and obesity: Cross sectional study. *BMJ*, **319**: 147–150.

Wake, M., Hesketh, K. & Waters, E. (2003) Television computer use and body mass index in Australian primary school children. *Journal of Paediatric Child Health*, **39**: 130–134.

Walker, S.P., Gaskin, P.S., Powell, C.A. & Bennett, F.I. (2002) The effects of birth weight and post natal linear growth retardation on body mass index, fatness and fat distribution in mid and late childhood. *Public Health Nutrition*, **5**: 391–396.

Wang, Y., Ge, K. & Popkin, B.M. (2000) Tracking of body mass index from childhood to adolescence: a 6-y follow-up study in China. *American Journal of Clinical Nutrition*, **72**: 1018–1024.

Wardle, J., Parmenter, K. & Waller, J. (2000) Nutrition knowledge and food intake. *Appetite*, **34**, 269-75.

Wardle, J. (2007) *Eating Behaviour and Obesity*. Short Science Review. Foresight Tackling Obesities: Future Choices. Obesity Reviews, **8** (s1), 73-75. (online). Available at:<http://www.foresight.gov.uk> (Accessed 3rd August, 2008).

Warren, J.M., Henry, C.J.K., Lightowler, H.J., Bradshaw, S.M. & Perwaiz, S. (2003) Evaluation of a pilot school programme aimed at the prevention of obesity in children. *Health Promotion International*, **18**, (4), 287-96.

Watt, R.G. & Sheiham, A. (1996) Dietary patterns and changes in inner city adolescents. *Journal of Human Nutrition and Dietetics*, **9**, 451-61.

Watt, R. & Sheiham, A. (1997) Towards an understanding of young people's conceptualization of food and eating. *Health Education Journal*, **56**, 340-9.

Webb, K.L., Lahti-Koski, M., Rutishauser, I., Hector, D., Knezevic, N., Gill, T., Peat, J.K. & Leeder, S.R. (2006) Consumption of 'extra' foods (energy-dense, nutrient-poor) among children aged 16-24 months from western Sydney, Australia. *Public Health Nutrition*, **9** (8), 1035-1044.

Weschler, H., Devereaux, R., Davis, M. & Collins, J. (2000) Using the school environment to promote physical activity and healthy eating. *Preventive Medicine*, **31** (Supple), S121-137.

Whincup, P.H., Gilg, J.A., Papacosta, O., Seymour, C., Miller, G.J., Alberti, K.G. & Cook, D.G. (2002) Early evidence of ethnic differences in cardiovascular risk: cross sectional comparison of British South Asian and white children. *BMJ*, **324**: 635.

Whitaker, R.C., Wright, J.A., Pepe, M.S., Seidel, K.D. & Dietz, W.H. (1997) Predicting obesity in young adulthood from childhood and parental obesity. *New England Journal of Medicine*, **337**: 869–873.

Whitaker, R.C. & Dietz, W.H. (1998) Role of the prenatal environment in the development of obesity. *Journal of Pediatrics*, **132**: 768–776.

Whitmore Schanzenbach, D. (2005) "Does the Federal School Lunch Program Contribute to Childhood Obesity?" *Journal of Human Resources*, **44**, (3): 684-709.

Wiecha, J.L., Sobol, A.M., Peterson, G.E. & Gortmaker, S.L. (2001) Household television access: Associations with screen time, reading and homework among youth. *Ambulatory Pediatr*, **1**: 244–251.

Wilson, D.K., Evans, A.E., Williams, J., Mixon, G., Sirard, J.R. & Pate, R. (2005) A preliminary test of a student-centred intervention on increasing physical activity in underserved adolescents. *Annals of Behavioral Medicine*, **30** (2) 119-124.

Wolfe, W.S., Campbell, C.C., Frongillo, E.A. Jr., Haas, J.D. & Melnik, T.A. (1994) Overweight schoolchildren in New York State: prevalence and characteristics. *Am J Public Health*, **84**: 807–813.

Woolfe, J. & Stockley, L. (2005) Nutrition Health Promotion in Schools in the UK: Learning from Food Standards Agency Funded Schools Research. *Health Education Journal*, **64**, 229-246.

World Cancer Research Fund (1997) *Food, nutrition and the prevention of cancer: a global perspective*. American Institute for Cancer Research, Washington, D.C.

WHO Euro-EC-CE (1993) *The European Network of Health Promoting Schools*. Copenhagen: WHO European Region.

WHO (1997) *Obesity- preventing and managing the global epidemic*. Rep. WHO consult. Obes. WHO/NUT/NCD/98.1. World Health Organisation, Geneva, Switzerland.

WHO (1998). *World Health Organization Global School Health Initiative*, Fact Sheet No. 92. World Health Organization: Geneva. Revised June1998 (online). Available at:<http://www.who.int/inf-fs/en/fact092.html> (Accessed 1st October, 2009).

World Health Organisation (2000). *Technical Report Series 894. Obesity: Preventing and Managing the Global Epidemic: Report of a WHO consultation*. World Health Organisation: Geneva, 2000.

World Health Organization (2003). Technical report Series 916. *Diet, Nutrition and the Prevention of Chronic Diseases*. Geneva: Joint FAO/WHO Expert Consultation; 2003.

Wrieden, W., Peace, H., Armstrong, J. & Barton, K. (2003) *A Short Review of Dietary Assessment Methods Used in National and Scottish Research Studies*. Briefing paper prepared for: Working Group on Monitoring Scottish Dietary Targets Workshop, September, 2003.

Yager, A. & O'Dea, J.A. (2005) The role of teachers and other educators in the prevention of eating disorders and child obesity: what are the issues? *Eating Disorders*, 13, 261-78.

Yajnik, C. (2000) Interactions of perturbations of intrauterine growth and growth during childhood on the risk of adult-onset disease. *Proceeding of the Nutrition Society*, 59: 257–265.

Yajnik, C.S. (2004) Early life origins of insulin resistance and type 2 diabetes in India and other Asian countries. *Journal of Nutrition*, **134**, (1), 205-210.

Young, L.R. & Nestle, M. (2002) The contribution of expanding portion sizes to the US obesity epidemic. *American Journal of Public Health*, **92**: 246–249.

Young, T.K., Martens, P.J., Taback, S.P., Sellers, E.A., Dean, H.J., Cheang, M. & Flett, B. (2002) Type 2 diabetes mellitus in children: prenatal and early infancy risk factors among native Canadians. *Archives of Pediatric and Adolescent Medicine*, **156**: 651–655.

Zimmet, P.Z., McCarty, D.J. & de Courten, M.P. (1997) The global epidemiology of non-insulin-dependent diabetes mellitus and the metabolic syndrome. *J Diabetes Complications*, **11**, (2):60–68.

Zizza, C., Siega-Riz, A.M. & Popkin, B.M. (2001) Significant increase in young adults' snacking between 1977-78 and 1994-96 represents a cause for concern! *Preventive Medicine*, **32**, 303-10.

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