

**CHILDHOOD OBESITY AND ITS PREVENTION IN
PRIMARY SCHOOL-AGED CHILDREN: A FOCUS ON
SOUTH ASIAN COMMUNITIES IN THE UK**

By

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ABSTRACT

Childhood obesity is a major global concern but there is little evidence for effective childhood obesity prevention strategies. People of South Asian origin are a specific target group for obesity prevention as they are vulnerable to cardiovascular health effects of obesity. This thesis explores the contextual influences on the development of childhood obesity by presenting two studies; a quantitative analysis of routine datasets explores the association between the school physical activity environment and obesity in children, and a qualitative study explores the beliefs of South Asian community members and other stakeholders about the causes of childhood obesity and potential interventions to prevent it. A process of development of a childhood obesity prevention programme tailored to South Asian communities, guided by the MRC framework for complex interventions is described. The contextual information from the stakeholder focus groups is central to this process. Finally, this thesis examines the potential consequences of obesity in South Asian children by exploring its association with body image. Understanding the psychosocial consequences of obesity in target communities will enable future interventions to be appropriately designed. The findings of this thesis highlight the importance of understanding the cultural context with respect to childhood obesity causes, consequences and intervention.

**DEDICATED TO MY HUSBAND AND CHILDREN;
ARVIND, HEMAL AND ROMA PALLAN**

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STATEMENT OF CONTRIBUTIONS

The majority of the work presented in this thesis arises from the Birmingham health Eating and Active lifestyle for Children Study (BEACHeS), a three year childhood obesity prevention study, funded by the National Prevention Research Initiative. I was one of the BEACHeS study co-investigators and worked alongside the Principal Investigator to develop and oversee all aspects of the study. Specifically, I developed the methodology for the stakeholder focus groups (data presented in chapters 3 and 4), and co-facilitated all focus groups with Dr Peymane Adab (BEACHeS study Principal Investigator). I undertook the analysis of the stakeholder focus group data, with input from Dr Peymane Adab and other members of the BEACHeS study team. I undertook the intervention development process (described in chapter 4) in conjunction with other members of the BEACHeS study team.

The cross-sectional study presented in chapter 5 uses data from the BEACHeS exploratory trial. I assisted in developing the outcome measures undertaken on children and assisted with the data collection. I undertook all the analysis presented in this chapter.

The study presented in chapter 2 uses routine data sources and applies multilevel modelling techniques. I undertook the descriptive analysis, and Dr Alice Sitch, a statistician, undertook the multilevel modelling. I developed the approach to the modelling in conjunction with Alice, and it is my interpretation of the analysis that is presented in this thesis. I am the sole author of this thesis, with supervisory input from Dr Peymane Adab and Professor KK Cheng.

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ABBREVIATIONS

ANGELO	Analysis Grid for Environments Linked to Obesity
BEACHeS	Birmingham healthy Eating and Active lifestyle for CHildren Study
BIA	Bioelectrical impedance analysis
BMI	Body mass index
CADET	Child And Dietary Evaluation Tool
CI	Confidence interval
CT	Computed tomography
DXA	Dual energy x-ray absorptiometry
FSM	Free school meals
HSE	Health Survey for England
ICC	Intra-cluster correlation coefficient
IMD	Index of Multiple Deprivation
IOTF	International Obesity Taskforce
LSOA	Lower super output area
MRC	Medical Research Council
NAFLD	Nonalcoholic fatty liver disease
NCMP	National Child Measurement Programme
NIHR	National Institute for Health Research
NPRI	National Prevention Research Initiative
NSHG	National Study for Growth and Health
OR	Odds ratio
PA	Physical activity
PE	Physical Education
PHAPO	Public Health Approaches to the Prevention of Obesity
RCT	Randomised controlled trial
SCT	Social cognitive theory
SD	Standard deviation
SES	Socioeconomic status
WHO	World Health Organization

OVERVIEW OF THE THESIS

This thesis sits within the arena of childhood obesity and its prevention, but it has a particular focus on obesity in South Asian children living in the UK. The thesis draws largely on data obtained from the Birmingham healthy Eating and Active lifestyle for CHildren Study (BEACHeS), a childhood obesity prevention study, targeting a predominantly South Asian population. Each chapter explores a particular aspect of childhood obesity or its prevention, and the detailed background and specific aims are presented separately in the chapters. A brief overview of each chapter is given here.

Chapter 1

This introductory chapter aims to set the scene for the following chapters by giving an overview of the epidemiology of childhood obesity, and focuses particularly on childhood obesity in South Asian ethnic groups. Childhood obesity prevention and the theoretical approaches to changing behaviours related to obesity are then considered. Finally, a summary of the BEACHeS study is given.

Chapter 2

This chapter uses routinely collected data to describe the prevalence of obesity in primary school-aged children in Birmingham. Multilevel modelling techniques are used to explore the association of overweight and obesity with individual characteristics (including ethnicity), and school characteristics. This has relevance to obesity prevention, as schools are a major setting

for prevention interventions targeting school-aged children, and defining the features of schools that may influence the development of obesity in children will inform future design and delivery of school-based interventions.

Chapter 3

This chapter uses qualitative research methods to explore the beliefs and views on the factors contributing to obesity, among people connected to the schools and South Asian communities participating in the BEACHeS study. A picture of the contextual factors influencing the development of obesity in children from these communities is presented. Understanding the context in this way is of key importance in designing and tailoring interventions for particular communities.

Chapter 4

This chapter describes the development of an intervention programme to prevent obesity in children age 5-7, inclusive of all children but with particular relevance to South Asians. The outputs from a variety of methodologies, and the process used to combine these is described.

Chapter 5

This chapter explores the psychosocial dimension of body image, and its relationship to overweight and obesity in children, using baseline data from the 5-7 year olds in the BEACHeS study. Understanding the potential influence of overweight and obesity on the psychosocial functioning of children is important, particularly in ethnic minority communities

whose social and cultural norms may differ from the general population. Understanding these influences is also relevant to obesity intervention planning, as interventions have the potential to affect psychosocial functioning both positively and negatively.

Chapter 6

This chapter sets the findings of this thesis within the bigger picture of the global problem of obesity. Areas for future research are identified.

1 INTRODUCTION

Childhood obesity is viewed as a major public health issue globally. The problem of childhood obesity with respect to its definition, prevalence, health consequences, aetiology, and prevention are discussed below. The particular issues around childhood obesity in UK South Asian communities are articulated in this chapter, as these communities are the focus of the thesis.

1.1 Defining childhood obesity

1.1.1 *Body Mass Index*

Obesity is a term used to describe the excess accumulation of body fat which puts a person at increased risk of morbidity and premature death.^{1,2} Giving a specific definition of obesity is problematic in that there is no clearly defined point at which body fat becomes excessive. Added to this, body fat is not easy to measure directly, and so for epidemiological purposes, measures of relative weight are often used as a proxy for body fat.³ The most widely used indirect measure of obesity based on relative weight is Body Mass Index (BMI). This is calculated by dividing weight in kilograms by height in metres squared. In Caucasian adults BMI has been shown to provide a reasonable indication of body fat⁴, and has been shown to be a predictor of mortality.⁵ Adults with a BMI of 30-35 kg/m² have a life expectancy of approximately 2 to 4 years less than those with a BMI of 22.5-25 kg/m².⁶ The World Health Organization (WHO) developed a classification of BMI for international use, principally based on its association with mortality; with overweight defined as 25 to 29.9 kg/m², obese as 30-39

kg/m² and morbidly obese as 40 kg/m² and above.¹ A major appeal of BMI, both in epidemiological and clinical settings, is that height and weight measures can be taken with relative ease and speed, in a non-invasive manner. This has led to the widespread use of BMI in a range of settings.

Despite its considerable advantages, BMI does have limitations. The relationship between BMI and body fat has been shown to vary with other factors. For example, the relationship between BMI and body fat is age-dependent, as the proportion of fat to lean mass becomes greater as age increases. BMI will also tend to overestimate body fat in very muscular individuals.⁷ The relationship also varies with ethnicity; South Asian groups have a higher body fat percentage at a given BMI than Caucasians, whereas in African-Caribbeans body fat will be lower.⁷ The particular issues of BMI as a measure of obesity in South Asians is discussed in more detail in section 1.6. Although there is a strong relationship between high BMI and mortality (especially cardiovascular mortality), in a systematic review of cohort studies, Romero-Corral found a J-shaped relationship, with a BMI of 25-29.9 associated with a lower risk of cardiovascular mortality than a normal range BMI, and suggested that this may be due to the inability of BMI to discriminate between fat and lean mass.⁸

1.1.2 BMI in children

The use of BMI to define overweight and obesity in children is much more challenging than in adults as BMI varies with age and sex⁹, and the relationship of BMI to body fat is unclear. It has been suggested that the relative contributions of body fat and fat free mass to BMI have

changed over time in children, resulting in an underestimation of obesity prevalence in epidemiological studies using BMI.¹⁰ Added to this, the relationship between BMI and later morbidity and mortality is less clear in children than in adults in that there are no particular thresholds of BMI above which children have an increased risk.⁹

The considerable changes in BMI with age in children, and its variation by sex has led to the use of BMI reference data to define overweight and obesity in children. There are two main types of reference data; national and international. In the UK, BMI reference percentile curves were derived from height and weight data collected in 1990 on a nationally representative sample of 30,000 children, aged from birth to 23 years.⁹ Similar national reference curves exist for other countries, such as the USA¹¹, Sweden¹², France¹³, Italy¹⁴ China¹⁵ and Hong Kong.¹⁶ These national reference curves are used in two ways; first BMI values in individual children are converted to z-scores, which is the number of standard deviations from the mean BMI for the child's age and sex. This enables comparison of BMI across age and sex. Second, overweight and obesity are defined by using percentile cut offs. In the UK, national guidelines recommend the 91st and 98th percentiles as cut offs for overweight and obesity respectively for clinical practice, but for epidemiological purposes, the 85th and 95th percentiles are recommended.¹⁷ The reason for this difference is the importance of a high specificity in clinical practice (i.e. minimising the number of children that are falsely diagnosed as obese) but the need for a high sensitivity in epidemiological studies, so that the prevalence of obesity is not underestimated.²

Critics of the use of national data to define overweight and obesity in children draw attention to two major issues. First, the wider international use of national reference data poses a problem, as many countries do not have national reference curves and so rely on the UK or USA reference data, which may be very unrepresentative of the country in question. Second, the percentile cut offs for overweight and obesity are arbitrarily chosen, and in contrast to the adult cut off values, do not relate clearly to health consequences. These criticisms led the International Obesity Taskforce (IOTF) to develop an international definition for childhood overweight and obesity based on reference data pooled from 6 countries, Brazil, the UK, Hong Kong, the Netherlands, Singapore and the USA.¹⁸ From this pooled data Cole and colleagues developed quasi-centile curves that are linked to the adult cut offs of 25 and 30 kg/m² for overweight and obesity.

There is ongoing debate with regard to the use of national versus international reference data to define obesity in children. One criticism of the IOTF definition is that the pooled data used to derive the cut offs are from predominantly developed countries and so, whilst more useful than national definitions for international comparisons, it does not adequately represent the developing world. Reilly argues strongly for the use of national reference data, stating that the international definition ignores the likelihood that the relationship between BMI and morbidity is population or ethnic-group specific.^{2;19} He also highlights that when used in British populations, the IOTF definition has much lower sensitivity than the definition based on national reference data, therefore underestimating the prevalence of obesity.²⁰ This effect has also been observed in the Spanish population.²¹ In another study comparing national versus international definitions in a UK population of preadolescent children, the international cut

offs had the effect of creating a large difference in obesity prevalence in boys and girls, compared to the national reference data.²² In addition, although the 85th and 95th percentile definitions based on national reference data were arbitrarily chosen initially, studies of the health outcomes of childhood obesity lend weight to the fact that these definitions are clinically meaningful.²³

1.1.3 Other measures of childhood obesity

Other epidemiological measures of obesity that have been used in adults and children include waist circumference, skinfold thickness and bioelectrical impedance analysis. These are all indirect measures of body fat that are not based on weight.

Waist circumference, usually measured midway between the rib cage and the iliac crest, is an indirect measure of central obesity, and so has an advantage over BMI in that it gives an indication of the distribution of body fat. Both subcutaneous abdominal fat and intraabdominal fat contribute to central obesity and in children waist circumference correlates highly with both types of fat when measured by computed tomography (CT) ($r=0.93$ and 0.84 for subcutaneous abdominal and intraabdominal fat respectively).²⁴ Central obesity is well known to be a risk factor for cardiovascular disease in adults^{25;26}, and waist circumference is associated with cardiovascular risk factors in children and adolescents, such as adverse lipid profiles and increased blood pressure.^{27;28} Percentile curves for waist circumference were developed in 2001 from data obtained from a 1988 sample of 8000 British children age 5-17²⁹, but there are potential issues with using waist circumference as a measure of obesity.

Appropriate cut offs to define overweight and obesity have not been agreed, and the relative proportions of intraabdominal and subcutaneous fat vary with ethnicity³⁰, so that waist circumference measurements will have different implications for morbidity in different ethnic groups. Waist-hip ratio is another measure of central obesity that has been widely used in adults and has been shown to predict both all cause and cardiovascular mortality³¹, but it is of less use in children because it is strongly age dependent and has been shown to be less accurate than waist circumference in measuring abdominal adiposity.³²

Skinfold thickness measurements involve measuring the layer of subcutaneous fat at different sites in the body. Commonly measured sites are triceps, biceps, subscapular and suprailiac skinfolds. Triceps skinfold thickness measures in adolescents and sum of skinfold measures at 4 different sites in children have been shown to be a better screening tool for obesity than BMI.^{33;34} Subscapular, abdominal and suprailiac skinfold measures have been shown to correlate reasonably well with intraabdominal fat in children, although their correlation with subcutaneous fat is higher.³⁰ In adolescents the sum of skinfold measures at 4 sites is better than BMI in predicting body fat in adulthood.³⁵ For a given BMI value, skinfold thickness has been shown to vary by sex and ethnicity and so may be a useful addition to BMI in assessing disease risk in different ethnic groups.³⁶ Published equations are frequently used to derive a value for percentage body fat from skinfold measures, but an issue with this is that the equations are population specific and often inaccurate.³⁷ A major problem with skinfold thickness measures is the poor intra and inter-observer reliability³⁸, and this limits their use in epidemiological studies.

Bioelectrical impedance analysis (BIA) is based on the principle that the electrical conductivity of fat free mass is greater than that of fat mass due to its higher water content³⁹, so equations can be used to derive an estimate of percentage body fat from a measure of electrical impedance through the body.⁴⁰ Body fat estimates from BIA in children have shown good agreement with reference standard measures (dual energy x-ray absorptiometry, DXA)³⁹, and have been shown to be more strongly associated with blood pressure and lipid profiles than BMI and triceps skinfold thickness.⁴¹ BIA measures are an attractive option for epidemiological studies as they are technically straightforward to perform and reliable, and population reference curves for body fat derived from BIA have been developed in recent years.⁴² These reference curves are of limited use, however, because the equations to derive percentage body fat are specific to the models of bio-impedance monitor used, and so cannot be compared to body fat measures from other bio-impedance monitors.

Despite the shortcomings of BMI as a measure of obesity in children, and the advantages of some of the alternatives, it remains the most widely used epidemiological measure of childhood obesity.

1.2 Childhood overweight and obesity prevalence

1.2.1 The global picture

The prevalence of obesity across the world has escalated in the last three decades and is recognised as a global threat to health.⁵ An estimated 300 million adults are obese with a

further 750 million overweight globally.⁴³ This is likely to be a substantial underestimate as the availability and quality of prevalence estimates vary.⁴⁴

Obesity in children has followed the same trend as adults, and the IOTF estimates that 10% of children age 5 to 17 are overweight or obese worldwide. This equates to 155 million children, 30-45 million of which are obese.⁴⁵ The issues with prevalence data in children are compounded by the lack of consensus on defining obesity, which again means that this is likely to be an underestimate. Whilst the highest rates of obesity in children and adults are in developed areas of the world such as North America and Western Europe, developing countries are facing rising rates of obesity and consequently increased incidence of non-communicable disease.⁴⁶ This is particularly seen in countries undergoing rapid socioeconomic growth such as Brazil and China, where the prevalence of overweight and obesity in children and adolescents has risen sharply in recent years.⁴⁵

In the developed world, the USA provides an example of the severity of the obesity problem. In US children, obesity prevalence has risen from 6% in 1980 to 17% in 2008.⁴⁷ In Europe, the trend of childhood obesity is following the US, with prevalence increasing across all European countries.⁴⁸ However, there is a clear North-South gradient with the highest prevalence being in Mediterranean countries, (an estimated 36% of 9 year olds are overweight or obese in Italy).^{45;49}

1.2.2 Childhood obesity prevalence in the UK

In the UK, the prevalence of overweight and obesity in adults has doubled in the last 20 years.⁵⁰ The latest prevalence estimates for England show that 25% of the adult population are obese, with 61% overweight or obese.⁵¹ The economic burden of obesity in England is estimated at £4.2 billion in direct costs and as much as £16 billion to the wider economy.⁵² Long term projections of obesity prevalence suggest that if trends continue, over 50% of all adults will be obese by 2050.⁵² Trends in childhood obesity have followed those in adult obesity. This is considered in more detail below.

1.2.2.1 Monitoring childhood overweight and obesity

Since the early 1970s, national systems have been in place to monitor childhood overweight and obesity levels (using BMI calculated from objective measures of height and weight). The National Study of Health and Growth (NSHG) was set up in 1972 to monitor the growth of school children and ran continuously for 23 years.⁵³ Since 1995, childhood obesity prevalence data has been collected in England through an annual survey of a nationally representative sample of households, the Health Survey for England (HSE)⁵⁴, and equivalent surveys are undertaken in the other UK countries. This routinely collected, high quality data has enabled the epidemiology of childhood obesity over time to be studied in detail.

In 2005 the National Child Measurement Programme (NCMP) was launched in England.⁵⁵ This programme was developed to support the UK government's focus on tackling childhood obesity.^{56;57} This is an annual programme that collects objectively measured height and weight

data through primary schools on all children in reception year (age 4-5) and year 6 (age 10-11). Although the data collected through the NCMP has limitations, as coverage of the programme is far from complete (90% participation in 2008/9⁵¹), it differs from the Health Survey for England in that it is a census and does not rely on sampling.

1.2.2.2 Current childhood obesity prevalence estimates

The most recent estimates of childhood obesity prevalence from the 2008 HSE and 2008/9 NCMP are shown in Table 1.1. Both use the 85th and 95th percentile cut offs of the UK 1990 national reference data⁹ to define overweight and obesity respectively. This shows an increased prevalence of overweight and obesity in the older age groups. Increasing childhood overweight and obesity prevalence with increasing age is well documented across the developed world.^{2;3;58}

Table 1.1: Childhood overweight and obesity prevalence estimates for England in 2008/9

	Age group (years)	Boys			Girls		
		% overweight	% obese	% overweight or obese	% overweight	% obese	% overweight or obese
HSE	2-10	14	14	28	13	13	26
2008	11-15	16	21	36	16	18	34
NCMP	4-5	14	10	24	13	9	22
2008/9	10-11	14	20	34	14	17	31

Sources: Health Survey for England 2008 volume 1: Physical activity and fitness, and National Child Measurement Programme: England, 2008/9 school year^{51;59}

1.2.2.3 Time trends in childhood obesity prevalence

In line with other developed countries, a dramatic increase in childhood obesity prevalence has been seen since the early 1980s in the UK.^{45;60} Stamatakis looked at routine survey data (NSHG and HSE) between 1974 and 2003 and found that the odds ratios for overweight and obesity in 5-10 year old children in 2003 compared to 1974 were 2.7 and 4.3 respectively.⁶¹ A particularly steep increase in prevalence has been seen in the 1990s with an estimated 60% increase in combined overweight and obesity prevalence rates for children age 7-11 in England between 1994 and 1998, and a 150% increase between 1984 and 1998.⁶²

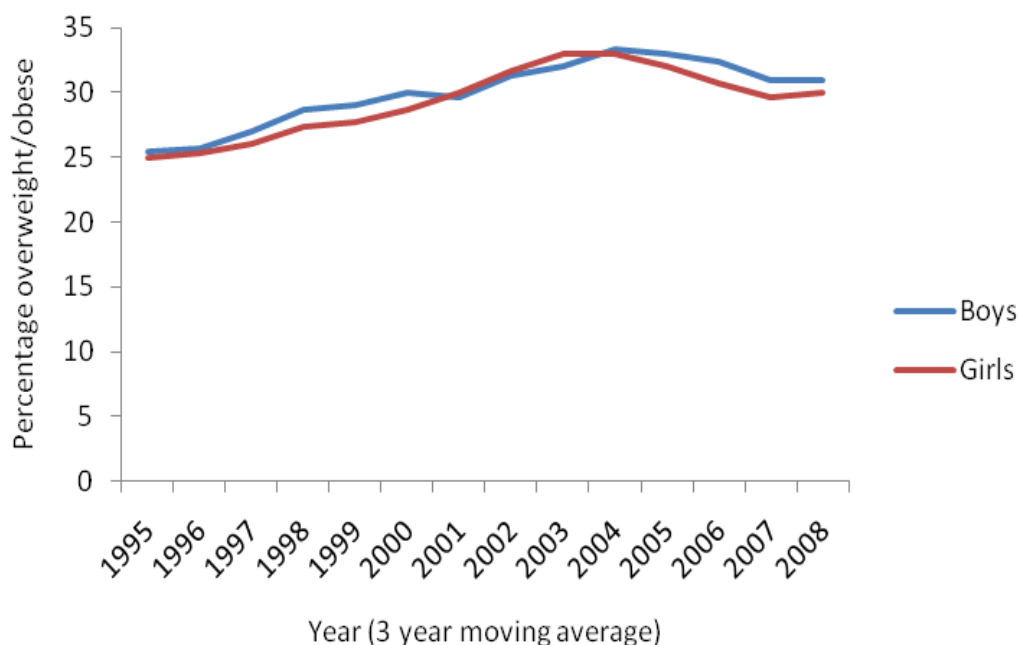
Whilst the vast majority of UK childhood obesity prevalence data is based on overweight and obesity defined by BMI, trends in waist circumference have also been studied. McCarthy looked at cross-sectional surveys of waist circumference in British 11-16 year olds from 1977 to 1997 and found that obesity defined by waist circumference had increased at a greater rate than that defined by BMI.⁶³ This suggests that prevalence trends based on BMI are failing to pick up the trends in central obesity, which may be more meaningful in terms of health outcomes.^{26;27}

In more recent years, the trend in prevalence may be levelling off in the UK. Studies in England and Scotland have reported either a stabilising of or decline in childhood overweight and obesity prevalence rates within the last decade.^{64;65} This is in line with data from the US that shows a stabilising of overall childhood overweight and obesity prevalence between 1999 and 2008.⁴⁷ This does not, however, give the whole picture. Ogden examined the change in

distribution of BMI in US children and found that the distributions have become more positively skewed, especially in boys, so that there are more children at the highest end of the BMI distribution. In other words, while the overall prevalence of childhood overweight and obesity may be stabilising, there is evidence that more children may be at the extreme end of the overweight/obese spectrum.⁴⁷ This change in distribution over time has also been observed in the UK.⁶⁶

Childhood overweight and obesity is clearly a problem that affects both boys and girls, but there is evidence that the prevalence patterns over time in the UK differ between the sexes. In the past (1974 to 1994), prevalence in girls was higher than in boys⁶⁰, but since the mid 90's a greater increase in prevalence has been seen in boys compared with girls.⁶¹ The recent stabilising of prevalence also seems to be more prominent in girls than in boys (Figure 1.1).⁵¹ Projections for 2015 puts obesity prevalence for 2-10 year old boys at 10% compared to 9% for girls.⁵⁸

Figure 1.1: Overweight and obesity prevalence in children age 2-15 in England from 1995 to 2008



Source: Health Survey for England 2008 volume 1: Physical activity and fitness⁵¹

1.2.3 Childhood obesity and socioeconomic status

The relationship between obesity and socioeconomic status (SES) is not consistent across different populations. In the developing world obesity in adults and children is associated with increasing wealth and food availability^{67;68}, but in the developed world this phenomenon is not seen. In fact, in women in developed countries there is a socioeconomic gradient in the opposite direction, that is, women of lower SES are more likely to be overweight and obese. This gradient is not seen in men in developed countries⁶⁷, so the relationship between obesity and SES is clearly complex.

The role of SES in childhood overweight and obesity is poorly understood and the subject of much debate. A study looking at childhood obesity in different income strata in the US found there was a prevalence gradient in adolescents, with the highest levels of overweight and obesity in the low income group, but this gradient was not found in younger children.⁶⁸ In a UK study of adolescents living in London, the relationship of SES, measured by an index of material deprivation based on residential area (Townsend index⁶⁹), with obesity over time was not clear. The highest obesity levels were consistently seen in the most deprived quintile, but there was no clear prevalence gradient across the other deprivation quintiles and the pattern varied over time.⁷⁰ Another study of children age 3-13 in Northern England found a weak positive association between deprivation (measured by the Index of Multiple Deprivation – IMD⁷¹) and obesity, but when obesity was examined on a small area level, pockets of high obesity prevalence were present in both deprived and affluent areas.⁷² A study of 3 year old children, conducted in Wales, did not show a clear relationship between obesity and SES, but suggested that over a 10 year period there was a slight increase in obesity prevalence in those from families of lower SES (measured by the Townsend index) compared to those from families of higher SES, in which obesity levels remained constant.⁷³ In the study of obesity prevalence in children age 5-10 over 3 decades, using NSHG and HSE data, Stamatakis explored two measures of SES; income and occupation of head of the household. Trends in obesity prevalence were shown to increase much more markedly in children from families of lower SES using both indicators, although the statistical relationship between SES and childhood obesity was only of borderline significance.⁶¹ These studies illustrate the complexities of the relationship between obesity in children and SES, and highlight the need

to gain further understanding of the effect of SES in the development of obesity in children and adolescents.

1.2.4 Childhood obesity and ethnicity

Ethnic differences in childhood obesity have been clearly observed in countries such as the US and the UK. In the US, higher obesity levels are seen in Hispanic and African American children compared to white children.^{3;74} In the UK, a higher prevalence of childhood overweight and obesity has been documented in African-Caribbeans and South Asians, particularly boys.^{70;75} The association between ethnicity and childhood obesity is complicated by the close relationship of ethnicity with SES, however, ethnic differences are not fully explained by SES. Furthermore, the relationship between SES and obesity may vary between different ethnic groups.⁷⁶ As this thesis has a particular focus on South Asian children, obesity in this population and its implications are discussed in more detail in section 1.6.

1.3 Tracking of childhood obesity into adulthood

It is well known that obesity in adults is associated with premature mortality and a wide range of morbidity including diabetes, cardiovascular disease, cancers, respiratory and joint problems.^{3;6;77} It is therefore important to understand the relationship between childhood and adult obesity, because if childhood obesity strongly predicts adult obesity, the rising prevalence in children will have far reaching implications for the health of future adult populations. This has led to a wealth of research into the tracking of obesity into adulthood. A systematic review published in 2008 reported that overweight and obese children are at

considerably more risk of becoming overweight or obese adults than healthy weight children (relative risks varied between 2 and 10 for overweight, and were as high as 20 for obese children). Estimates of the proportion of overweight and obese children becoming overweight and obese adults ranged from 34% to 83%.⁷⁸

A longitudinal study in London by Wardle took a more medium-term approach and explored overweight and obesity in the transition period from childhood to adolescence. It was found that overweight/obesity (measured by both BMI and waist circumference) present at the age of 11 was highly likely to persist to the age of 15. In addition, a shift from overweight to obese was seen, although the overall prevalence of overweight and obesity did not change in the cohort over the study period.⁷⁰ Taken overall, the research evidence suggests that childhood obesity, established before adolescence, is a strong risk factor for adult obesity. One can logically conclude from this that preventing the development of obesity in childhood will have the knock-on effect of reducing the likelihood of obesity in adulthood and its related health consequences.

1.4 Health consequences of childhood obesity

1.4.1 Cardiovascular disease

1.4.1.1 Cardiovascular risk factors in childhood

There is epidemiological evidence of an association between overweight and obesity and cardiovascular risk factors in childhood. The Bogalusa Heart study (set in Southern USA) has provided much of this. Freedman explored cardiovascular risk factors in obese versus non-

obese children using a BMI based definition of obesity (obesity was defined as greater than or equal to the 95th percentile, using USA national reference data). Significant odds ratios for hypertension (systolic and diastolic), raised serum lipids and fasting insulin concentrations were reported in both 5-10 year old and 11-17 year old obese children. Approximately 60% of the obese children had at least one cardiovascular risk factor.⁷⁹ A further study on the same cohort of children explored the relationship between central obesity (measured by waist circumference) and cardiovascular risk factors, and observed that waist circumference was associated with adverse serum lipid profiles and raised insulin concentrations independently of height and weight.²⁷ This suggests that in addition to weight, distribution of body fat is important in determining cardiovascular risk in children.

1.4.1.2 Cardiovascular disease in adulthood

Several large, long-term cohort studies have provided evidence for the association between childhood obesity and adult cardiovascular morbidity and mortality. The Harvard growth Study followed up a cohort of adolescents for 55 years and found an increased risk of cardiovascular mortality in men who had been overweight as adolescents (defined as BMI greater than the 75th percentile, using national reference data), but not for women (relative risk was 2.3 for men compared to 0.8 for women). Both men and women who had been overweight in adolescence had increased risk of cardiovascular morbidity.⁸⁰ A large retrospective cohort study of Danish children aged 7-13 reported an increased risk of both fatal and non-fatal cardiovascular events in adulthood with increasing BMI z-score, and noted that this relationship was present across the entire BMI distribution.⁸¹ Follow up of the Bogalusa cohort

over 17 years reported associations between childhood obesity (BMI \geq 95th percentile) and cardiovascular risk factors in adulthood, particularly raised triglyceride and insulin levels, and type 2 diabetes.⁸²

Another large cohort of English and Scottish children aged 2-14 (The Boyd Orr cohort) were followed up over a 57 year period. A linear association between childhood BMI and cardiovascular mortality was observed, and a hazard ratio of 2 was estimated for those with BMI above the 75th percentile compared to those with BMI between 25th and 49th percentiles (UK 1990 reference data).⁸³ A more recent cohort study of Native Americans explored the relationship of obesity and cardiovascular risk factors in childhood with mortality before the age of 55. Premature mortality rates for children with BMI in the highest quartile were twice that of children with BMI in the lowest quartile. This association was in part mediated by hypertension and glucose intolerance in childhood.⁸⁴

What remains unclear is whether the increased risk of cardiovascular outcomes in adulthood can be entirely explained by the persistence of childhood obesity into adulthood, or whether there is additional risk from childhood obesity, independent of the effect of adult obesity. The Harvard Growth Study adjusted for BMI at follow up in the analysis of a subset of participants, and concluded that overweight in adolescence was a risk factor for cardiovascular mortality independent of adult overweight in men, but not women.⁸⁰ In other studies adult weight status data has been unavailable, and so the independent effect of childhood obesity could not be investigated.^{81;83} In the Bogalusa cohort, the increased cardiovascular risk in adults who had been obese as children was almost entirely explained by the tracking of

childhood obesity into adulthood.⁸² In short, the relative contributions of childhood and adult obesity to cardiovascular outcomes have yet to be fully understood.

1.4.2 Paediatric metabolic syndrome and type 2 diabetes

Obesity is a major contributor to metabolic syndrome, which is a clustering of risk factors including deranged lipid profiles, impaired glucose metabolism, hypertension and central adiposity, that predict both type 2 diabetes and cardiovascular disease.⁸⁵ It is estimated to be present in over a quarter of adults in the US.³ This phenomenon is also seen increasingly in children and adolescents, and approximately 4% of all adolescents and 30-50% of obese adolescents in the US are thought to have metabolic syndrome.^{86;87} A small UK study of 100 obese children aged 2-18 found that a third of participants had features of metabolic syndrome.⁸⁸

The relationship between obesity, metabolic syndrome and type 2 diabetes has been well characterised in adult populations⁸⁹, and adults with metabolic syndrome have a fivefold increased risk of developing type 2 diabetes.⁹⁰ As with adults, obesity and metabolic syndrome in children are risk factors for developing type 2 diabetes.⁸⁵ The dramatic rise in prevalence of overweight and obesity in children seen in the last 3 decades has been accompanied by the emergence of type 2 diabetes in young people. In the US, type 2 diabetes is now thought to account for around 30-45% of paediatric diabetes, whereas historically, this proportion was only 5%.^{45;85} The proportion of children with type 2 diabetes who are overweight or obese is approximately 90%, compared to 25% of those with type 1 diabetes.^{45;91} In the UK, the

emergence of type 2 diabetes has been observed, particularly in South Asian ethnic groups.⁹² In a UK survey of paediatric diabetes undertaken in 2000, the proportion of all diabetes attributed to type 2 was less than 1%, and the prevalence of type 2 diabetes in children was estimated at 0.21/100,000.⁹¹ A more recent survey of paediatric diabetes in England in 2009 estimated the prevalence of type 2 diabetes to be 3.0/100,000, which suggests a relatively rapid increase in prevalence in the last decade.⁹³ Both surveys were based on diagnosed cases, so the true prevalence of paediatric type 2 diabetes in the UK is likely to be higher.

A further condition that is linked to obesity, metabolic syndrome and type 2 diabetes in both children and adults is nonalcoholic fatty liver disease (NAFLD). NAFLD is a spectrum of pathology ranging from fatty infiltration of the liver only, to fatty infiltration with inflammation that leads to liver fibrosis and cirrhosis. In children NAFLD is usually asymptomatic.^{3;45} The overall prevalence in children is thought to be 3%, with a quarter to a half of obese children having some degree of NAFLD.⁴⁵ As with type 2 diabetes, certain ethnic groups, particularly South Asians, are more susceptible to NAFLD.³

1.4.3 Respiratory conditions

The association between asthma and obesity in children has been well described. Obesity appears to increase the risk of developing asthma, and worsen established asthma.²³ The incidence of asthma has been seen to increase in parallel with obesity in children in recent decades, and there is some suggestion that there are sex differences in the relationship between childhood obesity and asthma, although findings have not been consistent.^{94;95} Overweight and

obese children with asthma have a greater number of days wheezing, more wheeze on exercise and more acute exacerbations than healthy weight children.⁹⁶ Proposed mechanisms for the effect of obesity include hormonal, immunological, inflammatory and mechanical processes. In addition, lifestyle factors such as poor diet and lack of physical activity are thought to be associated with both asthma and obesity.^{94;95}

Sleep-associated breathing disorders ranging from heavy snoring to obstructive sleep apnoea have also been associated with obesity in children. It is estimated that up to 94% of obese children have abnormal sleep patterns.⁴⁵ In obese children, the severity of sleep disordered breathing is associated with increased fasting insulin levels and appears to predict the presence of metabolic syndrome, even when severity of obesity is accounted for. Conditions such as obstructive sleep apnoea may therefore compound the cardiovascular risk in obese children.⁹⁷

1.4.4 Other physical consequences

In addition to the major health consequences outlined above, numerous other conditions occurring in childhood have been associated with childhood overweight and obesity, affecting multiple organ systems.⁴⁵ The range of physical health consequences in childhood can be seen in Table 1.2. Most of these conditions can also occur in adulthood as a consequence of obesity.

Table 1.2: Physical health consequences of childhood overweight and obesity

Organ system	Condition
Cardiovascular	Hypertension Abnormal lipid profiles Atherosclerosis Left ventricular hypertrophy
Endocrine	Insulin resistance/abnormal glucose metabolism Type 2 diabetes Menstrual abnormalities Polycystic ovary syndrome
Gastroenterological	Nonalcoholic fatty liver disease Gastro-oesophageal reflux Gallstone development
Pulmonary	Asthma Sleep-associated breathing disorders
Orthopaedic	Slipped capital femoral epiphysis Genu valgum Tibia vara Flat feet Low back pain Scoliosis Osteoarthritis
Neurological	Idiopathic intracranial hypertension
Dermatological	Acanthosis nigricans

Sources: Obesity in children and young people: a crisis in public health⁴⁵ and an international consensus statement on childhood obesity⁹⁸

1.4.5 Psychosocial consequences

There has been increasing recognition that the effects of overweight and obesity go far beyond the physical health consequences, and so psychosocial well being and its relationship to overweight and obesity in children has received much attention in recent years. The impact of childhood obesity on aspects of social and psychological functioning are outlined below.

1.4.5.1 Self-esteem

Self-esteem is a psychological term used to describe the balance between a person's achievements and aspirations. It is also believed by many to encompass a social dimension as it depends in part on the views and actions of others towards the person.⁹⁹ Self-esteem correlates with various psychological symptoms such as anxiety, depression and somatisation, particularly in adolescents.¹⁰⁰ Additionally in this age group, self-esteem is associated with risk-taking behaviours, such as smoking and substance use^{101;102} and other health behaviours such as dieting¹⁰³ and physical activity.^{104;105} In children, the relationship between obesity and self-esteem has been extensively studied, and various measures have been used. Some studies have shown an association with obesity and poor global self-esteem, particularly in girls¹⁰⁶, but overall the association is weak.^{45;99} In clinical populations of obese children, although only modest associations have been found overall, there are thought to be subgroups who may be particularly susceptible to low self-esteem.⁹⁹

1.4.5.2 Body dissatisfaction

Body dissatisfaction is closely associated with poor self-esteem and can be viewed as a dimension of global self-esteem.¹⁰⁷ There is a well documented relationship between body dissatisfaction and eating disturbance, such as dieting, binge eating and purging.¹⁰⁷⁻¹⁰⁹ This has led to much interest in the relationship between childhood obesity and body dissatisfaction. In general, a clear relationship exists between childhood overweight and obesity and body dissatisfaction.^{99;107} This has been consistently found in different populations, although some ethnic differences have been observed.¹⁰⁷ Body dissatisfaction and its association with obesity becomes stronger with age and is present in both boys and girls, although it may arise through different mechanisms.^{107;110} The relationship between body dissatisfaction and childhood obesity is considered in more detail in chapter 5.

1.4.5.3 Depression and anxiety

The relationship between childhood obesity and depression is not yet clearly understood. There is some evidence of higher levels of depressive symptoms in clinical samples of obese children compared to healthy weight children, but in community samples, overweight and obese children do not appear to have any greater levels of depression than those of healthy weight.⁹⁹ The direction of the relationship between childhood obesity and depression is also an issue, as longitudinal studies have shown an association between depression in childhood and the subsequent development of obesity.^{45;99} Similarly, the relationship between obesity and anxiety in children is unclear, although again, there is evidence of increased anxiety symptoms in clinical populations of obese children.¹¹¹

1.4.5.4 Stigma and discrimination

The sociological concept of stigma (defined by Goffman as a process by which the reaction of others spoils normal identity¹¹²) has been well recognised in relation to obesity in Western societies, and affects both obese adults and children. There is evidence of stigmatisation of overweight and obese children and adolescents by peers, teachers and parents.¹¹³ Children have been found to negatively stereotype overweight and obese children in several studies.⁴⁵ Various aspects of stigmatisation, such as weight-related teasing and parental criticism, are proposed to be mediators of other psychosocial consequences such as poor self-esteem and body dissatisfaction.¹¹³

1.5 Aetiology of childhood obesity

Obesity results from an imbalance between energy intake and energy expenditure, so that a person is in positive energy balance. This at first seems straightforward, but in order to think about the aetiology of obesity in more depth, there are several issues that need consideration.¹¹⁴ One issue is evidence suggesting that energy intake and energy expenditure are not independent, and so changes in one will produce compensatory changes in the other. For example, a sustained reduction in energy intake results in a reduction in resting and non-resting energy expenditure (maintenance of body weight at 10% below usual weight through under feeding results in a reduction in total energy expenditure of 6-8 kcal per kg fat-free mass per day).¹¹⁵ This is important in terms of intervention, as a reduction in calorie intake may not have the desired effect on obesity levels due to this compensatory effect. Another problem is that both energy intake and energy expenditure in free living people are extremely difficult to

measure, particularly in children, and so relationships between dietary intake and obesity, and physical activity (non-resting energy expenditure) and obesity that one would expect to see in epidemiological studies have not been observed.^{116;117} Therefore the true relationship between aspects of diet, types and intensity of physical activity and obesity in children and adults remains poorly understood.

The imbalance between energy intake and expenditure is the end point of the developmental pathway of childhood obesity, and what is of real interest, particularly when considering intervention to prevent childhood obesity, are the biological and environmental factors that influence this energy balance. The latter influences are particularly hard to identify and measure.¹¹⁴

1.5.1 Biological determinants

A small proportion of obesity (less than 5%) arises from identifiable hormonal, syndromic, neurological, or single gene defect conditions.^{98;118;119} Apart from those with identifiable conditions, it is thought that some children may have a genetic predisposition to obesity, as twin studies have shown a high correlation of BMI in identical twins who have been brought up apart.^{120;121} Prenatal exposures are another area of focus in childhood obesity aetiology. Intrauterine exposure to maternal obesity, maternal gestational diabetes, and birth weight (both low and high) have all been implicated in the development of obesity in childhood.¹¹⁹

1.5.2 Environmental influences

It is widely accepted that genetic and biological factors are important in the aetiology of childhood obesity, but they are not responsible for the exponential increase in prevalence seen worldwide in recent decades. Environmental and societal influences on obesity-related behaviours are responsible for this and so have been a focus for obesity research in recent years.^{122;123} In terms of public health action to reverse the rising prevalence trend, it is crucial to understand the environmental and societal aspects of childhood obesity, and apply this knowledge in the development of prevention strategies. These influences on childhood obesity are discussed in more detail in chapter 3.

1.6 Obesity in South Asians

South Asians (persons originating from the Indian subcontinent) are well recognised to be a vulnerable group with regard to obesity and its health consequences. A study exploring the relationship of BMI to percentage body fat in several Asian ethnic groups found that all groups had a higher percentage body fat for a given BMI compared to Caucasians. Comparisons between the Asian groups showed that Indians have higher body fat at lower BMI levels than Chinese and Malay groups.¹²⁴ In 2003 the WHO held an expert consultation to debate the relevance of the international BMI cut offs for overweight and obesity (25kg/m² and 30kg/m²) in Asian populations, including those from the Indian subcontinent. It was concluded that as Asians have a higher percentage body fat than white counterparts for a given BMI, they are at substantially increased risk of cardiovascular disease and type 2 diabetes, even below the 25kg/m² BMI cut off. The WHO recommended that public health action with

regard to cardiovascular and diabetes risk should be triggered at lower BMI levels in some Asian populations. In addition, in populations predisposed to central obesity, waist circumference should be used in conjunction with BMI to trigger action.¹²⁵ Findings from a subsequent Canadian study support these WHO recommendations. The study explored the relationship between BMI and markers of cardiovascular risk in South Asian, Chinese, Aboriginal and European ethnic groups, and defined BMI cut offs for the different groups based on these markers. Elevated blood glucose and lipids were found at much lower BMI values in South Asians compared to Europeans, and the estimated BMI cut off points for South Asians that correspond to 30 kg/m² in Europeans were 21 and 22 kg/m², based on blood glucose and lipids respectively.¹²⁶

In South Asian adults living in the UK, obesity prevalence defined by BMI is not always reported to be higher than the general population¹²⁷, although one survey in the North of England reported higher overweight levels in Indian and Pakistani adults compared to the white population.¹²⁸ However, the prevalence of central obesity (defined as waist-hip ratio ≥ 0.95 for men and ≥ 0.85 for women) presents a different picture, with considerably higher prevalence of central obesity in all South Asian subgroups compared to whites.^{127;128}

UK South Asians also have a higher prevalence of metabolic syndrome, type 2 diabetes and other cardiovascular risk factors compared to the general population, although there is variation across the different subgroups.¹²⁷⁻¹²⁹ South Asians are reported to have the highest cardiovascular mortality rates among the UK population.¹³⁰

1.6.1 Obesity prevalence in UK South Asian children

Several surveys of childhood overweight and obesity that focus on ethnic differences have been undertaken in the UK, and most have used a BMI based definition of obesity. In a 1997 nationally representative sample of 1800 4-18 year olds, prevalence of overweight and obesity combined (using IOTF cut offs) in Asians was similar to the white and black African-Caribbean groups. When obesity was examined separately however, Asians were around 4 times as likely to be obese than whites.¹³¹ Analysis of the 1999 Health Survey for England data on 5700 children aged 2-20 (using IOTF cut offs) showed higher overweight prevalence in Indian and Pakistani boys compared to the general population (odds ratios of 1.55 and 1.36 respectively). Pakistani girls had a significantly higher prevalence of obesity than the general population (odds ratio of 1.71), however, Bangladeshis had the lowest prevalence of obesity among boys and Indian girls had a lower obesity prevalence than girls in general.⁷⁵ In a survey of younger children aged 5-7 (using national BMI definitions), odd ratios for South Asian boys compared to white boys were 1.77 for overweight and 1.76 for obesity. South Asian girls had lower overweight and obesity prevalence than South Asian boys, and were not significantly different to white girls.¹³²

Another UK study compared waist circumference and waist-hip ratios in South Asian and white children aged 8-11, and found similar mean values in both groups, although when ponderal index was compared (weight/height³), South Asians had a lower mean value.¹³³ In a small study of 130 white and South Asian adolescents, percentage body fat (derived from skinfold thickness equations) and central adiposity (measured by waist-thigh ratio) was

significantly higher in the South Asian group.¹³⁴ A large cross-sectional survey of 5760 children aged 9-10 found that South Asians had a lower mean BMI than white European children, but higher percentage body fat derived from bioimpedance measures, and higher combined skinfold thickness.¹³⁵ These findings indicate that body fat distribution and body fat levels for given BMI values are higher in South Asian children.

1.6.2 Cardiovascular risk in South Asian children

As with South Asian adults in the UK, there is evidence to suggest that the relationship between obesity and increased cardiovascular risk is present in South Asian children. Whincup looked at various cardiovascular risk factors in South Asian and white 8-11 year olds across England and Wales and found that mean insulin, triglyceride and fibrinogen concentrations, and mean heart rate were higher in the South Asian group. In addition, the relationship between obesity and insulin concentrations was much stronger for the South Asian children, suggesting that they are more sensitive to the effects of obesity with respect to developing insulin resistance.¹³³ In a study of 14-17 year olds, a similar pattern was seen between South Asians and whites with regard to insulin resistance and its correlation with body fat. This study also reported more adverse lipid profiles in South Asians compared to whites.¹³⁴ These findings are coherent with the pattern of paediatric type 2 diabetes observed in the UK; whilst overall prevalence is low, South Asian adolescents are nearly 14 times more likely to develop type 2 diabetes than whites.⁹¹ Ethnic differences in the relationship between obesity and blood pressure have also been studied. A large study in London (6500 participants) examined the association between obesity and hypertension in 11-13 year olds, and found both overweight

and obesity to be associated with high systolic and diastolic blood pressure. Comparison of ethnic groups showed overweight and obesity were associated with larger effects on blood pressure in Indian boys, and Indian, Pakistani and Bangladeshi girls, compared to their white counterparts.¹³⁶

In summary, South Asian children living in the UK are a vulnerable group with regard to obesity on two counts; first, some subgroups are more prone to the development of overweight and obesity and in particular, central obesity. Second, South Asian children appear to be more sensitive to the effects of obesity in terms of increased cardiovascular risk.

1.7 Childhood obesity prevention

The alarming global rise in childhood obesity has been accompanied by numerous prevention strategies. These are aimed at multiple levels and range from macro-level policy or environmental change to targeted interventions focusing on individual behaviour change. When considering the evidence on effectiveness of these strategies in reducing childhood obesity, one real issue is that of evaluation. The 'upstream' nature of interventions that tackle the wider social and environmental determinants of childhood obesity makes evaluation problematic. Their impact may be subtle and diffuse, and not easily measurable, especially in terms of obesity outcomes.¹³⁷ Consequently, there has been much more focus on evaluation of interventions that aim to modify behaviour of individuals or well circumscribed groups of children. The result is a wealth of trials of these more proximal interventions, and a large number of systematic reviews which attempt to synthesise the evidence from these trials.

These intervention programmes are often, although not always, multicomponent, and aim to influence food intake, physical activity, sedentary behaviours, or a combination of these. The vast majority of interventions have been delivered in a school setting. The rationale behind this is that in most parts of the world, children compulsorily attend school for a substantial proportion of their lives, and schools provide an organisational structure through which interventions can be delivered.¹³⁸ A whole range of intervention elements have been implemented in schools, including nutrition and physical education, skills building, behaviour modification techniques, extracurricular activities, incentive schemes and modification of the food environment. Involvement of parents and families through schools has also been a feature of some intervention programmes.¹³⁹⁻¹⁴¹

1.7.1 Quality of the evidence

Certain methodological issues of trials which limit their use have been consistently highlighted in systematic reviews. In many cases, both the intervention duration and the follow up period in studies have been short-term.¹⁴⁰⁻¹⁴² In addition, quality issues such as inadequate study power, selection bias, unclear randomisation procedures, lack of valid and reliable measures, and the failure to use cluster randomisation and analysis where appropriate have been highlighted as problems.^{140;141;143-145} Flynn and colleagues undertook a systematic review with a broader approach which aimed to develop best practice recommendations, and pointed out that exclusion of studies solely on the criterion of methodological rigour significantly limits the evidence base, and identification of best practice requires additional consideration of

studies from perspectives other than methodological rigour, such as programme acceptability and integration into the target community.¹⁴⁰

1.7.2 Effectiveness of interventions to prevent overweight and obesity in children

Despite the overwhelming attention on childhood obesity prevention, and the plethora of systematic reviews that attempt to synthesise evidence from the mass of studies, firm conclusions on the effectiveness of interventions are elusive. Summerbell et al. reviewed 22 prevention trials and concluded that most failed to show any impact of the intervention on overweight and obesity, and those most likely to demonstrate any effect were studies with a short-term follow up period.¹⁴¹ Another systematic review of 24 studies by Flodmark and colleagues demonstrated that 8 (33%) of the studies showed a positive effect of the intervention on overweight and obesity outcomes. Flodmark also went on to review 6 high quality systematic reviews (including his own), and combine the findings from these. From this process 39 studies were identified, 15 (41%) of which had positive outcomes in the intervention group compared with the control group.¹⁴⁶ A more positive overall picture was given by Doak et al., who reviewed 25 studies and concluded that interventions resulted in a statistically significant reduction in overweight and obesity outcome in 17 studies (68%).¹⁴⁷

These three reviews give a useful illustration of the uncertainty of the evidence around interventions to prevent childhood obesity, and the difficulty in combining these. A brief comparison of the different methodologies of these reviews helps to explain the variation in findings. The reviews by Summerbell and Flodmark included only those studies where the

primary intention was to prevent overweight, obesity or weight gain^{141;146}, where as the Doak review had a broader approach which included any studies that had a dietary and/or physical activity intervention and performed anthropometric measures at baseline and follow up.¹⁴⁷ The participant age groups included also differed in the reviews, with Doak focusing on school-aged children, and Summerbell and Flodmark including preschool children.

All three reviews required the included intervention studies to have a control group, but only the Summerbell and Flodmark reviews included pilot studies.^{141;146;147} Doak excluded these on the grounds that the pilot studies do not intend to demonstrate statistically significant outcomes. This in part may explain Doak's more positive findings. The three reviews had different inclusion criteria for the length of study follow up, which also may contribute to the variation in results. The Flodmark review only included studies with a year or more follow up period, where as the other two included shorter term studies, although Summerbell made the distinction between short and long-term studies. Summerbell noted that the shorter-term studies (of 3 to 11 months duration) were more likely to report positive intervention effects than those that were a year or longer. It follows then that inclusion of shorter term studies in the Doak review and not in the Flodmark review may explain the higher proportion of studies with positive outcomes.

These differences in methodologies are reflected in the studies included in the systematic reviews, as although they included a similar number, the overlap between the studies is relatively small, with only 8 studies included in all three reviews. All reviews highlighted the lack of high quality studies, and Doak and colleagues drew attention to the fact that in their

review, the studies showing positive effects were more likely to have lower participation rates and smaller sample sizes, and so may have more highly motivated participants that are less representative of the population in general.¹⁴⁷

A significant complication of synthesising evidence of effectiveness from childhood obesity prevention trials is the difficulty in defining and measuring obesity outcomes in children. Doak and colleagues included outcomes based on weight for height measure and skinfold thickness in their systematic review, and in 15 studies that reported both outcomes, 5 demonstrated effectiveness of the interventions according to skinfold measures, but not weight for height measures.¹⁴⁷

Many reviewers have attempted to identify characteristics of intervention programmes that enhance their effectiveness. Some have concluded that effectiveness is associated with duration of the intervention^{145;148;149}, whilst others have failed to find this association.^{146;150;151} School-based interventions that have a degree of parental or family involvement appear to be more effective^{139;148}, but again, this finding is not consistent.¹⁵²

Several reviews have explored the relative effectiveness of interventions aimed at diet, physical activity, or a combination of the two. Again, no clear answers have emerged. Some have reported that combined interventions have a greater impact.^{139;149;150} Brown concluded that school-based intervention programmes are the most promising if they combine dietary and physical activity elements, and reported that findings of studies aimed at increasing physical activity and reducing sedentary behaviours are inconsistent, although may be more successful

in younger children.¹⁵⁰ In contrast, Summerbell found that studies focusing on physical activity alone were more likely to report a significant impact on BMI measures than combined interventions.¹⁴¹

The reality is inevitably more complicated than the simple question of which of these three types of intervention is best (dietary, physical activity or combined). Numerous different types of intervention are covered by these three categories, and each could be delivered in various ways that may influence its effectiveness. In addition, it is unlikely that the components of multifaceted interventions act independently, which makes identification of the most successful elements of prevention even more challenging.

Nevertheless, some have tried to unpick the successful elements of intervention programmes.

A review by Connelly tried to gain more insight into the intervention elements that are most effective in preventing obesity in children by drawing on realistic evaluation techniques¹⁵³, and found that the provision of compulsory physical activity (versus voluntary physical activity) was a feature that distinguished effective from non-effective interventions.¹⁵⁴

DeMattia reviewed 6 prevention studies that incorporated an element targeting sedentary behaviour, and found all studies reported both a reduction in self-reported sedentary activities and an improvement in obesity outcomes.¹⁵⁵ Evidence supporting the effectiveness of dietary interventions in preventing childhood obesity is scarce, although some positive effects on nutritional intake have been reported.^{141;145;150} One particular dietary intervention that has shown a positive impact on childhood overweight and obesity is an initiative to reduce consumption of sugar-sweetened drinks. A British trial demonstrated significant differences in

overweight and obesity in the intervention and control groups after a 12 month intervention to reduce consumption of these drinks in school children¹⁵⁶, but the differences were not sustained after 2 years.¹⁵⁷

The importance of a strong theoretical basis for childhood obesity prevention intervention has been highlighted. Reviews have drawn attention to the fact that many intervention programmes do not have an explicit underpinning theory.^{142;151;158} However, in their 'realistic' approach to a systematic review, Connelly and colleagues looked at the presence of a theoretical basis and intervention effectiveness, but failed to find an association.¹⁵⁴ The role of theory in childhood obesity prevention is discussed in more detail in section 1.8.

Several reviews have noted a differential effect of interventions on boys and girls. In particular, interventions have been reported to be more effective in girls than boys in several high quality studies.^{139;144;150} In a review of school-based obesity prevention programmes, Kropski suggested that girls are more influenced by educational interventions, whilst boys respond more to environmental changes.¹⁴⁴ This sex difference adds yet another dimension to the complexity of obesity prevention in children.

1.7.2.1 Meta-analysis of intervention studies

Meta-analysis of childhood obesity prevention trials presents many difficulties, largely due to heterogeneity in study design, settings, participants, interventions and outcomes.^{139;145;152}

Despite this, some meta-analyses have been undertaken. Katz pooled data from 8 studies of

combined dietary and physical activity interventions on children aged 2-18, and estimated a standard mean difference in body weight of -0.29 (95% CI -0.45 to -0.14) between intervention and control groups.¹³⁹ Gonzalez-Suarez combined 19 studies of school-based interventions on 11-18 year olds and estimated that the odds ratio (OR) for overweight and obesity in the intervention groups, compared to control groups was 0.74 (95% CI 0.60-0.92). Sub-analysis of interventions of longer duration (more than 2 years) estimated the OR to be 0.59 (95%CI 0.37-0.94).¹⁴⁹

To overcome some of the problems of heterogeneity in meta-analysis of obesity prevention studies, Kamath explored four separate behavioural outcomes related to obesity. Significant, but small effect sizes were reported for interventions to increase physical activity, interventions to reduce sedentary activity and interventions to reduce unhealthy dietary behaviour. No significant effect was reported for interventions to increase healthy dietary behaviour. The study also estimated the effect of interventions on BMI but found no significant difference between intervention and control groups.¹⁴⁵

1.7.3 Psychosocial outcomes of childhood obesity prevention interventions

As discussed in section 1.4.5, several psychosocial outcomes are related to childhood overweight and obesity, and so the effect of intervention programmes on these outcomes is of interest, in terms of both potential benefit and harm to psychosocial functioning. Two reviews looking specifically at psychosocial outcomes of childhood obesity prevention studies have both found that data on these outcomes are infrequently collected and rarely published.^{159;160} A

recent systematic review explored childhood obesity prevention studies from 2005 to 2008 and found that only 7 of 53 studies reported a psychosocial outcome measure.¹⁵⁹ The studies that explored these outcomes reported a variety of measures including self-esteem, body dissatisfaction, physical competence, unhealthy eating and weight control behaviours, and social acceptance.^{159;160} With so few studies exploring the psychosocial effects of childhood obesity programmes, it is difficult to draw conclusions, but in general, no differences in these outcomes have been observed between intervention and control groups.^{159;160} What has clearly emerged is the need to evaluate the psychosocial impact of programmes, as not only will this safeguard against potential unintended harm, but may also lead to interventions that have a dual purpose of reducing obesity and improving psychosocial health.

1.7.4 Cost-effectiveness of childhood obesity prevention interventions

Whilst many childhood obesity prevention programmes have been developed and evaluated in terms of effectiveness, there is a glaring gap with regard to economic evaluation. Very few studies have attempted to undertake any analyses of costs.^{141;146} All policy makers operate within a resource-limited environment, and so evidence of cost-effectiveness of these programmes is crucial. Consequently, the research community have called for high quality economic evaluations of childhood obesity prevention programmes in the future.¹⁴¹

1.7.5 Childhood obesity prevention in immigrant populations

Immigrant populations in westernised countries present a particular focus for childhood obesity prevention for several reasons. As discussed, certain ethnic groups, such as South

Asians, are more vulnerable to health consequences of obesity.^{128;129} In addition, the risk of obesity seems to be associated with the length of time families have lived in the country. This has been seen in studies in the US, where childhood obesity is more prevalent in second generation compared to first generation immigrants.¹⁶¹ This suggests that the social and cultural integration that immigrant families undergo influences the development of childhood obesity.

A comprehensive systematic review by Flynn looked at intervention programmes to address childhood obesity in immigrant populations and concluded that very few programmes were developed with specific applicability to these populations.¹⁴⁰ Given the vulnerability of these groups, this represents a concerning gap in childhood obesity prevention research.

Very little childhood obesity prevention research has focused on the UK South Asian immigrant population. A study that is currently in progress in London is the DiEt and Active Living (DEAL) study. This study aims to explore the feasibility and cultural acceptability of interventions to alter dietary and physical activity behaviours in ethnic minority children and families, including South Asians.¹⁶² Other than this study and the Birmingham healthy Eating and Active lifestyle for CHildren Study (BEACHeS), which is described in detail below, no UK childhood prevention studies have targeted South Asians.

In summary, the majority of childhood obesity prevention research has been centred around behavioural modification, and most intervention programmes have been delivered in schools. Interventions have, at best, shown moderate short term changes to overweight/obesity, dietary

or physical activity outcomes, but sustained changes that are likely to have a significant positive health impact in the long term have yet to be demonstrated. It is recognised that childhood obesity prevention needs to occur at multiple levels, including structural, societal and political change, and intervention at this macro-level needs well designed and robust evaluation.¹⁶³ To date, schools have been the major setting for childhood obesity prevention programmes, and whilst it is recognised that to intervene at the broader environmental and societal level, one has to move beyond schools¹³⁸, they still represent a unique setting for comprehensive intervention at the individual behavioural and environmental levels that will potentially reach a high proportion of children over a sustained period of time.¹⁴⁰

1.8 Theoretical approaches to childhood obesity prevention

The common goal of all health promotion strategies is to reduce the risk of ill health by influencing the health-related behaviours of individuals. That said, it is widely recognised that determinants of behaviour go well beyond the individual, and encompass community and wider societal factors, and that health promotion efforts should target these different levels.^{164;165} Consequently, a wealth of theoretical concepts and frameworks that address behavioural determinants at different levels have been employed by those in the field of childhood obesity prevention.¹⁶⁶ These range from individual models of behaviour change to models that encompass structural and political influences on health related behaviours.

1.8.1 Theories of behaviour change

Many psychological models of behaviour change have been developed to explain health related behaviour, and help to explicitly identify opportunities to positively influence behaviour. Theories can be categorised into three broad groups; motivational models, behavioural enactment models and multi-stage models. Motivational models make the assumption that increased motivation will be translated into action, whilst the behavioural enactment models focus on the strategies that help translate motivation into action. Multi-stage models identify processes that facilitate adoption of the desired behaviour and strategies for its maintenance.¹⁶⁷ The common feature of all these models is that they focus on the processes within an individual that lead to the adoption of certain behaviours. Whilst many models incorporate social constructs such as perceived social norms¹⁶⁸ and role models¹⁶⁹, they do not take a broader perspective that embeds the individual and their behavioural choices within a wider physical, political and sociocultural environment. Consequently the focus of interventions underpinned by psychological behaviour change theory is on changing characteristics of the individual, such as knowledge, attitudes and skills, rather than structural change within communities and the wider environment, which in turn will influence individual behaviours.^{170;171}

The most commonly used models to address change in dietary and physical activity behaviours are motivational models such as social cognitive theory¹⁶⁹, theory of planned behaviour¹⁷², and the multi-stage transtheoretical model.¹⁷³ In childhood obesity prevention, many interventions are underpinned by Bandura's social cognitive theory (SCT). In brief, SCT

describes how behaviours are adopted by observational learning and role modelling.¹⁷¹

Bandura described 4 key processes in observational learning; attention, retention, replication and motivation. In SCT, self efficacy (a person's belief in their ability to carry out a particular behaviour) is a key determinant of the way a person behaves.¹⁶⁹

An example of a childhood obesity prevention programme underpinned by SCT is the Pathways programme, aimed at Native American communities in the USA. The Pathways intervention consisted of several components. Two of these, a curricular programme and a family component were designed to encourage behaviour change in the home related to physical activity and healthy eating. These were based on a combination of SCT and information on Native American beliefs and traditions gained from formative research.¹⁷⁴

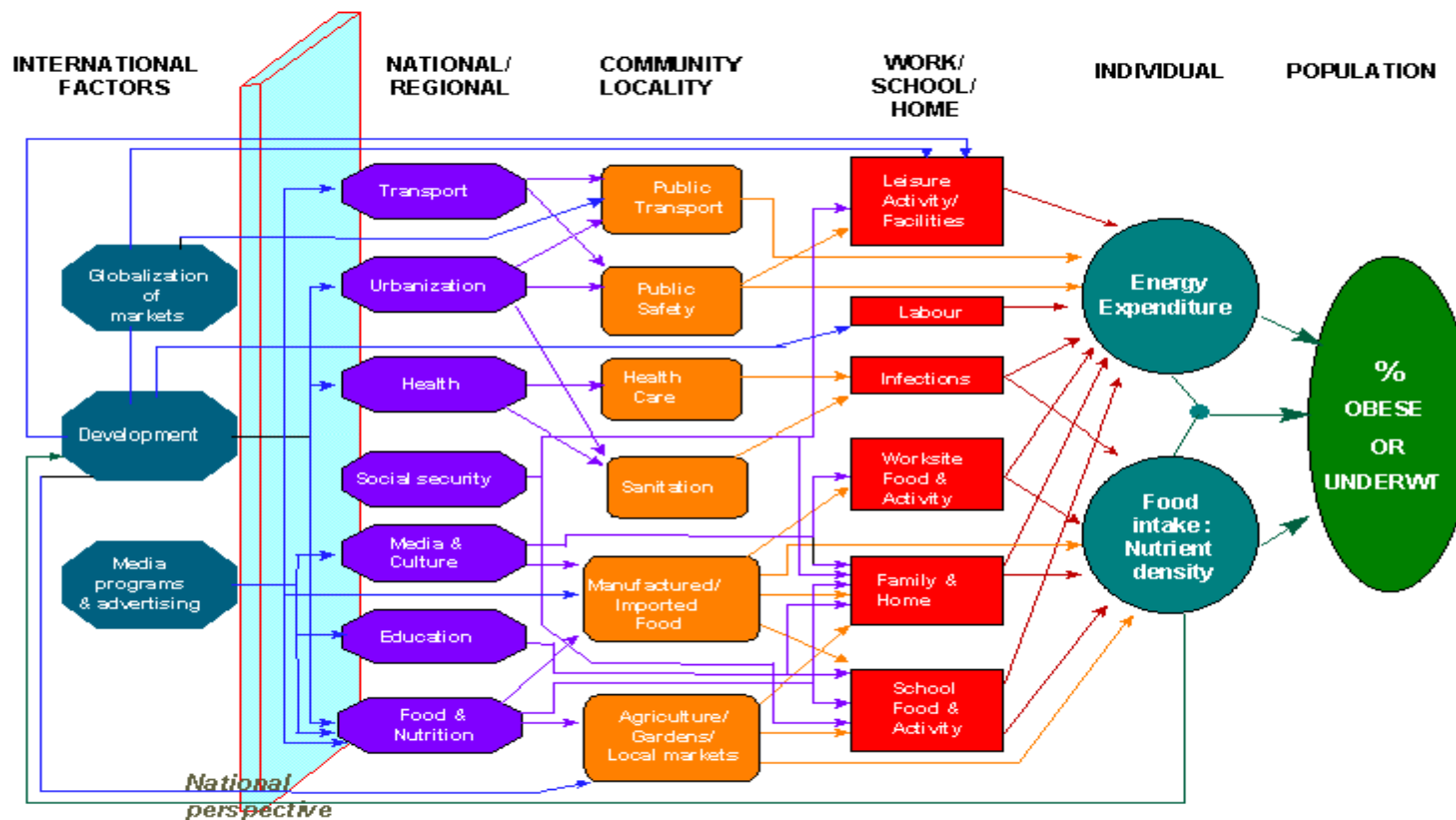
These components aimed to enhance personal characteristics such as knowledge, perception of personal control and dietary and physical activity behaviours. To achieve this, the interventions included the use of role models and demonstrations of healthy behaviours, as well as experience in goal setting, physical activity, development of food preparation skills, and self-monitoring. It is of note, however, that the Pathways intervention programme did not focus entirely on individual behavioural modification, as other elements aimed to alter the physical environment to support behaviour change, such as changing the school food service.¹⁷⁵

1.8.2 Frameworks for environmental change

At the other end of the spectrum are theoretical frameworks that concentrate on structural and environmental change at the community or wider societal level. A conceptual framework for analysis of the environmental influences on obesity was developed by Swinburn and colleagues to aid identification and prioritisation of areas to target for environmental intervention (ANGELO framework- analysis grid for environments linked to obesity). The framework guides users to categorise so called 'obesogenic' environmental influences into four types, physical, economic, political and sociocultural, and consider these categories at both local and macro-levels. Swinburn applied the framework to Pacific Island communities; nutritionists from the Island communities were guided by the framework to identify environmental influences on obesity and then prioritised these for action by considering elements in terms of validity (evidence that the element works), relevance to the local community and changeability.¹²²

The IOTF have also emphasised the importance of structural and political change in the prevention of obesity. The Public Health Approaches to the Prevention of Obesity (PHAPO) Working Group developed the Causal Web (Figure 1.2), which depicts multiple environmental influences on an individual that range from very proximal (e.g. family, home and school) to macro-level factors that are remote from the individual (e.g. transport and education policy, media and culture). The Causal Web also draws attention to the influence of different settings and sectors on the development of obesity and highlights the importance of a multi-sectoral approach to environmental intervention.¹⁶³

Figure 1.2: The Causal Web - developed by the Public Health Approaches to the Prevention of Obesity working group of the IOTF



Modified from Fitenbaugh C, Kumaryika S, Morabia A, Jefferey R, Antipatis V. IOTF website 1999:

Source: International Association for the Study of Obesity newsletter Spring 1999
 (<http://www.iaso.org/newsletter/p10spring99.htm>)

1.8.3 Ecological models

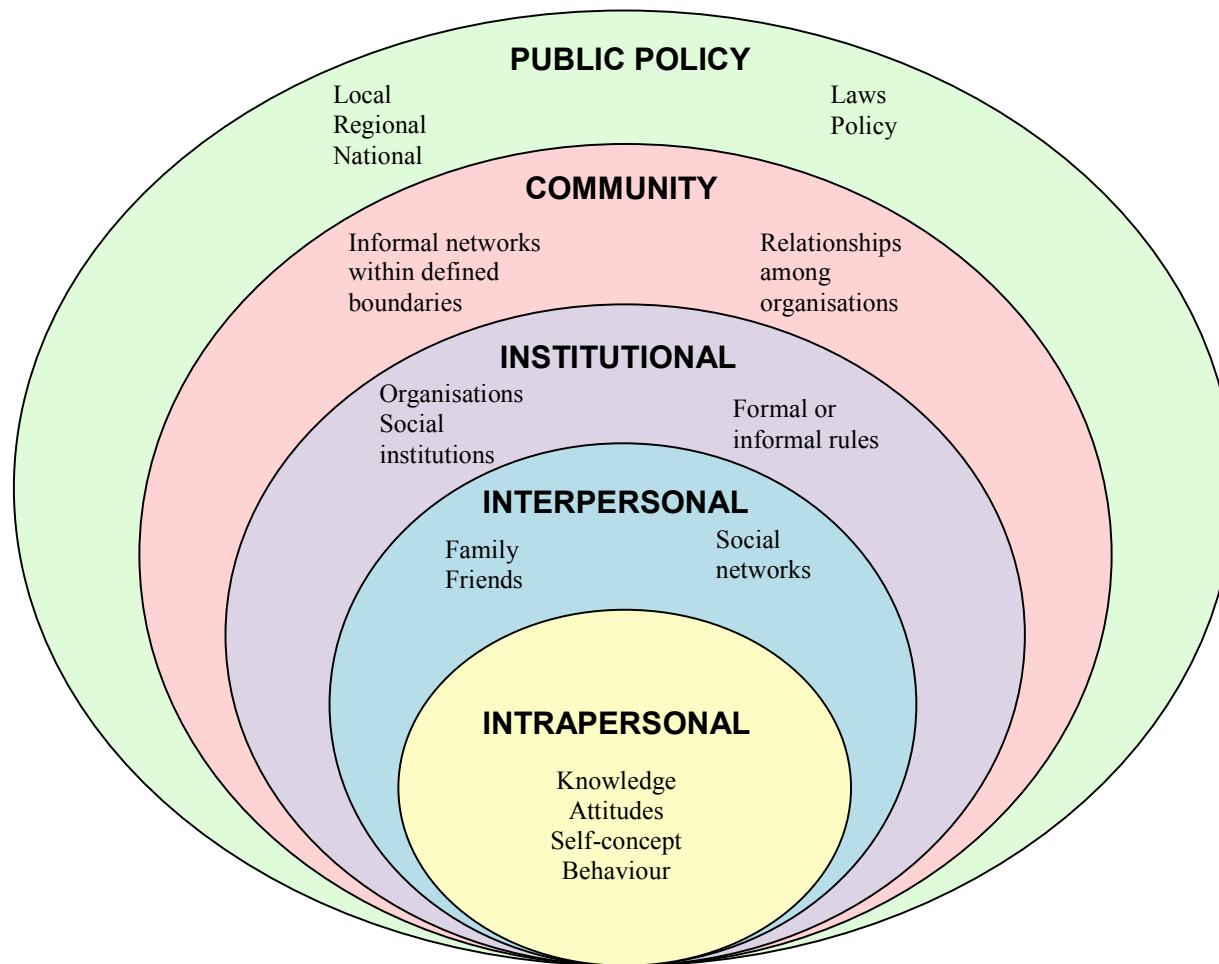
Ecological models are conceptual models that encompass a spectrum of influences on the behaviour of an individual, including individual characteristics, social and community influences, and wider societal influences. McLeroy and colleagues developed an ecological model for health promotion¹⁷⁰ based on Bronfenbrenner's Ecological Systems theory of influences on child development¹⁷⁶ (Figure 1.3). The model depicts five layers of influence on an individual; intrapersonal factors (knowledge, skills, self-concept etc.), interpersonal processes (family, social networks etc.), organisational factors (schools, work places etc.), community factors (geographically, politically or socially defined), and public policy (local and national). A key concept of the ecological model is interdependency between these levels of influence and the dynamic and reciprocal relationship between factors at the different levels.¹⁷⁷

Ecological models such as this facilitate understanding of how environmental and political intervention may affect individual and group behaviours, and are particularly pertinent to addressing issues such as childhood obesity. Ecological models relating to childhood obesity have been developed and are discussed in more detail in chapter 3.

Whilst it is evident that childhood obesity prevention approaches draw on many different theoretical concepts, it can be seen from the research literature that there are still no firm answers as to how we can successfully intervene to prevent children from becoming overweight and obese. In other words, there remains a need to develop a better theoretical understanding of processes involved in the development of childhood obesity so that these can be interrupted by

effective interventions. In their systematic review of childhood obesity prevention, Summerbell and colleagues highlighted the lack of understanding of the interface between the environment and individual behaviour, and called for multifactorial theoretical approaches to intervention, informed by the local knowledge of members of target communities.¹⁴¹

Figure 1.3: An ecological model for health promotion



Source: adapted from McLeroy et al. An ecological perspective on health promotion programs 1988¹⁷⁰

1.9 The Birmingham healthy Eating and Active lifestyle for CHildren Study

The Birmingham healthy Eating and Active lifestyle for CHildren study (BEACHeS) provides the basis for this thesis. This three year study took place from 2006 to 2009, and was funded by the UK National Prevention Research Initiative (NPRI).¹⁷⁸ The study gained ethical approval from the East Birmingham Local Research Ethics Committee. An overview of the study is given here to provide the background for subsequent chapters.

1.9.1 BEACHeS study aim

The study aimed first to develop a childhood obesity prevention intervention that was culturally appropriate to children of South Asian communities, but inclusive of all children. The second aim was to evaluate the developed intervention programme in an exploratory trial to assess its feasibility and acceptability in the target communities and gain a preliminary estimate of effect size.

1.9.2 Setting

The study was set in the UK city of Birmingham. Birmingham is situated in central England and is the UK's second largest city with a population of approximately one million.¹⁷⁹ Birmingham is an industrial city and historically is a place where immigrant communities have settled. The proportion of ethnic minorities is estimated as 34%, and residents from the three largest South Asian ethnic groups (Pakistani, Bangladeshi and Indian) comprise 21% of the Birmingham population.¹⁷⁹ This compares with just 5% of the population of England.¹⁸⁰

1.9.3 Study population

The target population in the BEACHeS study was children aged 5-7, predominantly of South Asian origin. The rationale behind the focus on South Asian children relates to the prevalence of obesity and related health consequences in this population, as outlined in section 1.6. The 5-7 year age group was targeted because adiposity rebound (the increase in body fat that follows a decline in the early childhood years) starts to occur at this age.^{74;181} In addition, children of this age attend school, and so there is an existing infrastructure whereby children, families, and to an extent the wider community can be accessed. Also, school children are potentially subjected to social and cultural influences on the development of obesity that extend beyond the home and family setting, which makes them a particular group to target for obesity prevention.

Primary schools in Birmingham provided the main settings for the study. Using ethnicity data obtained from the Local Authority, all schools with greater than 50% of pupils from the three largest South Asian groups (Bangladeshi, Indian and Pakistani) were identified (52 of 304 schools) and invited to participate. As the BEACHeS study's primary aims were to develop an intervention programme and assess its feasibility and acceptability, a pragmatic decision to include 8 schools in the study was made and no formal sample size calculation was performed. The first 8 schools to respond were recruited into the study. The schools were all in inner city areas of Birmingham, serving materially disadvantaged populations. This is reflected in the proportion of pupils in the schools entitled to free school meals (FSM), compared to the total proportion in England (Table 1.3). This level of material deprivation in the study sample was

expected, as there is a close relationship between socioeconomic disadvantage and certain ethnic communities in the UK. This relationship is particularly apparent in Pakistani and Bangladeshi populations.¹²⁸ The location of the recruited schools in Birmingham is shown in appendix 1.

Table 1.3: Proportion of pupils entitled to free school meals in schools participating in the BEACHeS study

School	Percentage FSM entitlement in 2005
James Watt Primary School	31.9
Anderton Park Primary School	36.3
Heathfield Primary School	39.3
Yew Tree Community School	47.4
Starbank Primary School	49.4
Adderley Primary School	53.8
Christ Church C of E School	66.1
Nansen Primary School	68.1
England	16.0

Source: Birmingham Local Authority and Department of Children, Schools and Families¹⁸²

1.9.4 Study design

The BEACHeS study used the Medical Research Council (MRC) framework for the development and evaluation of complex interventions to improve health^{183;184} to guide development and preliminary evaluation of a childhood obesity prevention intervention. The MRC framework and its use in the development of the BEACHeS study intervention is discussed in more detail in chapter 4. In brief, the framework consists of five phases; theory building, modelling phase, exploratory trial, definitive randomised controlled trial (RCT) and longer-term implementation (see Figure 4.1, in chapter 4). The BEACHeS study design incorporated the theoretical, modelling and exploratory phases of the framework.

1.9.4.1 Theoretical and modelling phases: intervention development

The intervention development phase took place in the first year of the study and incorporated several different methodologies. A description of these methodologies and the intervention development process, together with detail of the final intervention programme, is given in chapter 4. A key aspect of the development process was gaining a theoretical understanding of the factors contributing to childhood obesity in the target communities, so that potential areas for intervention could be identified. This part of the study is reported in detail in chapter 3.

1.9.4.2 Exploratory trial

All children in years 1 and 2 (ages 5-7) were invited to participate in the BEACHeS exploratory trial. Parents of children were approached by letter, distributed through the schools, to give consent for their children to participate in the study. Of 1090 children invited, 574 were recruited (53%). Data on ethnicity were derived from school records, which was supplied by parents at school entry. The mean age of the study sample was 6.5 years (SD 0.6) with an approximately equal gender split (296 boys and 278 girls). The ethnic breakdown of participants was; Pakistani 66.9%, Bangladeshi 14.3%, Indian 4.7%, Black 7.8%, White 2.3%, other 4.0%. Each child's home postcode was used to assign a Townsend deprivation score⁶⁹ based on the 2001 census. Scores were compared to the ranking of Townsend scores assigned to postcode areas within the West Midlands Government Office Region. The majority of this study population (93.5%) lived in postcode areas that were within the most deprived decile for the region. This is concordant with the high percentage of FSM entitlement of the schools (Table 1.3).

A variety of outcome measures (described below) were undertaken on participating children in the 8 schools in the first year of the study. Schools were then allocated to the intervention or control arm. Allocation was not random, but aimed to make the groups comparable, and took into account geographical location so that contamination between schools was minimised. Schools in the intervention arm received the developed programme in the second year of the study, and control schools continued usual practice. Measures were repeated on the children during year 3 of the study.

1.9.4.3 Process measures

Process measures were undertaken during delivery of the intervention programme in year 2 of the study to assess the feasibility and acceptability of the different components. Methods used included questionnaires to children and parents, interviews with key school staff, collection of uptake data, and direct observation of the delivery of intervention components.

1.9.4.4 Outcome measures

Several measures of overweight and obesity were undertaken by trained researchers using validated instruments and standard protocols (appendix 2). These included BMI, calculated from height and weight measurements, waist circumference, skinfold thickness at 5 sites (biceps, triceps, subscapular, suprailiac and thigh), and foot-to-foot bioimpedance. Dietary assessment was undertaken using the Child And Dietary Evaluation Tool (CADET)¹⁸⁵, adapted for use in South Asians. This is a food ticklist, completed for a 24 hour period,

including food and drinks consumed during time spent at school and home. Physical activity was objectively measured over a 5 day period, including a week-end, using Actiheart monitors (combined heart rate monitors and accelerometers).¹⁸⁶

In addition, several psychosocial outcome measures were undertaken to explore both the potential benefits and harms of the intervention programme to the psychosocial functioning of the children. These included two measures of self-concept, validated for use in young children (the Self Description Questionnaire¹⁸⁷ and Pictorial Scale for Perceived Competence and Social Acceptance¹⁸⁸), a measure of health-related quality of life (Pediatric Quality of Life Inventory¹⁸⁹), and an assessment of body image (the Collins Figure Rating Scale¹⁹⁰, adapted by Rand and Resnick¹⁹¹). All psychosocial instruments were administered to the children by trained researchers on a one to one basis.

Data from the measures taken at baseline during the BEACHeS study are used in chapter 5 to explore the relationship between obesity and body dissatisfaction.

1.10 Summary

This chapter has set out the growing problem of childhood obesity, both globally and in the UK. Childhood obesity clearly poses a major threat to health throughout the life course. South Asian children in the UK are a vulnerable group with respect to obesity, as they have a higher risk of central body fat distribution and obesity related health consequences.

To date, the most effective prevention strategies for childhood obesity have yet to be found, but there is recognition by the scientific community and policy makers alike that prevention needs to occur at multiple levels, from targeting individual behaviour to macro-level policy change. The need for in depth and theoretical approaches to intervention development with appropriate and robust methods of evaluation is also acknowledged.

The chapters in this thesis further explore the complex problem of childhood obesity, and contribute to the theoretical understanding of its development and prevention. There is a focus on South Asian communities, as they are an identified target group for the prevention of obesity.

2 OBESITY PREVALENCE IN PRIMARY SCHOOL CHILDREN: THE INFLUENCE OF INDIVIDUAL AND SCHOOL CHARACTERISTICS

In the UK, the escalating prevalence childhood obesity seen over the last three decades is of great national concern. It is forecast that up to 70% of girls and 55% of boys will be overweight or obese by 2050⁵². Given the magnitude of the problem and the implications for population health, much political attention has been directed towards preventing obesity in childhood in the UK.^{56;57}

A key strand of the UK government's strategy to address childhood obesity is the National Child Measurement Programme (NCMP), which was set up to monitor prevalence trends and inform delivery of services for children locally and nationally.⁵⁵ In this chapter, data from the NCMP is used in conjunction with data on school characteristics related to physical activity to explore the relative influences of individual and school factors on the prevalence of childhood obesity. As schools are a key setting for intervention, the findings will inform planning of future school-based prevention programmes.

2.1 Background

As outlined in the introduction, there is very sparse evidence of effective interventions to prevent childhood obesity, and a recognition that the multiple factors that influence the development of childhood obesity are complex and have yet to be fully understood. A more in depth understanding of the factors influencing childhood obesity will ultimately facilitate successful intervention. There is increasing recognition of the influence of local environments

on children's health-related behaviours. Schools are a particular focus as they represent a key environment in which children are situated over a sustained period of time. Added to this, schools are institutions that not only facilitate academic achievement, but place particular expectations and values on their pupils through the influence of school culture.^{192;193}

There is evidence to suggest that the school environment has an independent effect of on children's health-related behaviours. Smoking provides a classic example. Aveyard and colleagues published a series of papers demonstrating the influence of school culture on smoking prevalence. They found that children in schools that provided support and negotiated control were less likely to smoke than children in schools that were more 'laissez-faire'. This effect was independent of individual factors related to smoking such as socioeconomic status.¹⁹⁴ Smoking uptake was also found to be associated with school contextual factors independent of pupil composition.^{195;196}

Extending this to childhood obesity, school culture and contextual factors may have a potential impact on obesity through their influence on children's dietary and physical activity behaviours. Research emerging from the US would support this hypothesis. O'Malley et al. studied the interschool variation of BMI across the States, and found a small proportion of the variation in BMI could be attributed to school characteristics (3%). The authors argued that even though this figure is small, it is significant enough to be noteworthy to policymakers.¹⁹⁷ In another national US study, Li and Hooker explored the effect of school type on BMI and found that public school attendance was associated with higher BMI in children from

households of both high and low socioeconomic status. They found the influence of school type to be larger in children of lower socioeconomic status.¹⁹⁸

In the UK, Procter and colleagues studied a sample of schools in an industrial city with a socioeconomically and ethnically diverse population (Leeds).¹⁹⁹ They looked at the interschool variation in BMI in 4-5 year and 8-9 year old children, and calculated a value added index to quantify the school effect on BMI, thus allowing identification of schools where levels of obesity deviated from what would be expected given the pupil composition. So in effect, this method identified schools that have cultures and environments that positively influence weight status, and conversely, those who adversely influence weight status.

The potential ways which schools can influence either energy intake or energy expenditure (and therefore have an effect on the development of obesity) are numerous. Examples of these include curriculum content, extracurricular programmes, school food provision, provision of physical activity facilities, travel to school, school policies relating to health, professional development of teachers, engagement of the school with parents, and school role-models. School-based childhood obesity prevention studies have targeted many of these pathways but have yet to come up with intervention points that are reproducibly effective.^{139,149-151} In the UK, national policy relating to health in schools has been developed in the last decade to encompass these different aspects, with policies targeting school food, curricular and extracurricular school sports and physical education, and travel to school.²⁰⁰⁻²⁰² It is clear that in order to make interventions targeting schools effective, be it at a local or national level, a

detailed understanding of the school characteristics that have a particular influence on the energy balance equation is necessary.

Some studies have sought to identify relationships between particular school characteristics and BMI. Kubik et al. studied the influence of school culture relating to food, and reported that practices such as using food for rewards, and allowing food and drinks in classes and hallways were associated with a higher BMI, independent of individual level characteristics.²⁰³ Briefel et al. explored the influence of school food environments on children's dietary intake in a nationally representative sample of schools across the primary and secondary age groups in the US, and found a clear link between the availability of energy dense food and sugar-sweetened drinks in schools and the consumption of these by pupils.²⁰⁴ In the same study population, Fox et al. found an association between frequency of energy dense foods offered in school meals and increased BMI z-scores.²⁰⁵

The relationship of school physical activity contexts to childhood obesity have also been explored. A study exploring the relationship of a range of school physical activity characteristics with obesity in a nationally representative sample of US secondary schools found only modest inverse associations for some physical activity characteristics, such as the average number of days per week students take physical education and the proportion of pupils involved in interschool sports, but no associations for the majority.²⁰⁶ Another US study focused on the physical facilities of primary schools, such as the provision of gymnasiums and playgrounds. Although no association of school facilities was found with obesity, the availability of gymnasiums was associated with time spent in physical education per week.²⁰⁷

Taken together, the evidence suggests that the school context does have a significant influence on the development of childhood obesity, but the particular aspects of the school that are mediating this effect are as yet relatively poorly understood, particularly in relation to physical activity.

2.2 Aims

The aim of this chapter is to explore the relative influence of individual factors and school level factors on childhood overweight and obesity, and to estimate proportion of variation in prevalence that can be explained by school characteristics. The association between specific school characteristics related to physical activity and overweight/obesity will also be explored using two routine data sources; the NCMP and an annual school survey.

2.3 Methods

Routine individual and school level data collected in 2006/7 across primary schools in Birmingham was used for this study.

2.3.1 Individual level data

All schools are invited to participate in the annual National Child Measurement Programme (NCMP). All children in reception year (age 4-5) and year 6 (age 10-11) are eligible to be measured and parental consent is obtained on an 'opt out' basis (i.e. parental consent is implied unless parents actively refuse). Trained personnel weighed children in light clothing, without shoes to the nearest 0.1 kg using weighing scales of a specified standard, and

measured heights to the nearest 0.1 cm using a free-standing standing stadiometer²⁰⁸. BMI was calculated using weight (kg)/height (cm)², and standard deviation scores (BMI z-scores) were calculated using the UK 1990 BMI reference curves for children.⁹ Participants were also categorised as overweight, obese or not overweight or obese using the 85th and 95th percentile cut offs for overweight and obese respectively, in line with NMCP guidance.²⁰⁸

Data were obtained from school records on age, gender, ethnicity and home postcode. This school data is supplied by parents at school entry. Home postcodes were linked to UK Indices of Multiple Deprivation (IMD) 2007 scores⁷¹ to provide a measure of deprivation. IMD scores are derived from social, housing and economic indicators, and are assigned to lower super output areas (LSOAs). Birmingham has 641 LSOAs. IMD scores were categorised into quintiles by using cut offs derived from the national ranking of LSOA IMD scores. Parent reported ethnicity was collapsed into 6 groups; white, South Asian, African-Caribbean, Chinese and other Far East groups, mixed ethnicity, and unknown.

2.3.2 School level data

All schools nationally are invited to participate in an annual survey, undertaken as part of the national Physical Education, School Sport and Club Links strategy.²⁰⁹ Data extracted for schools used in this study included: number of minutes per week spent in physical education (PE), proportion of pupils spending at least 2 hours in high quality PE each week, number of sports or physical activities provided by the school in the last year, proportion of pupils participating in intra-school competitive sports, proportion of pupils participating in inter-

school competitive sports, number of sports for which the school has links to clubs, and proportion of pupils participating in sports or clubs linked to the school.

2.3.3 *Statistical analysis*

Data were initially analysed descriptively. Random effects modelling techniques using STATA (v11) were then employed to explore the influence of individual and school characteristics on overweight and obesity in children. Using BMI z-score as the outcome variable, a two-level model was developed with pupils at level 1, nested within schools at level 2. Inclusion of the school as a random effect accounts for the potential correlation of observations from pupils in the same schools. In addition, the proportion of variance in the model attributed to between school differences can be estimated, and both individual and school level variables, and the interaction between them, can be explored as predictors of BMI z-score.

First, modelling was undertaken using data from children in reception and year 6 combined. A null model was constructed with school as a random effect, as the likelihood ratio test statistic for the model was significant at the 0.05 level. The intra-cluster correlation coefficient (ICC) was calculated from the level 1 and level 2 variance estimates of the model ($ICC = \text{level 2 variance} / \text{total variance}$). Level 1 variables (year group, sex, ethnicity and IMD quintile) were then included in the model as fixed effects. Random slopes were fitted for each of the level 1 variables and were retained if they significantly improved the model as judged by the likelihood ratio test (significance= $p < 0.05$). All two way interactions between the level 1

explanatory variables were also tested in the model and retained if they significantly improved the model. Each of the level two variables was then tested individually in the level 1 variable-adjusted model, to gain an estimate of their regression coefficients. To construct the final model, the level 2 variables were added in a stepwise way to the model, and retained in the final model if they significantly improved the fit (likelihood ratio test; $p < 0.05$). All two way interactions between explanatory level 1 and level 2 factors were tested and retained if they significantly improved the model fit.

When adding variables with a significant amount of missing data, it was not possible to perform a likelihood ratio test, so model variances were inspected and the variables were retained if there was a reduction in variance, suggesting that its addition to the model helped to explain the variance.

As the combined model included several interaction terms with year group, and year group as a random effect, multilevel modelling was undertaken separately for reception year and year 6, so the influence of the other variables could be explored more fully in each year group. These separate models were developed in the same way as the combined model.

A sensitivity analysis was undertaken by repeating the modelling including only participants with a BMI z-score within ± 3 standard deviations of the mean to ensure the findings were consistent. As there were no substantial differences, the models constructed with the entire dataset are presented.

2.4 Results

Of the 304 state primary schools in the Birmingham Local Authority area, 296 (97%) participated in the National Child Measurement Programme. Valid height and weight data were obtained from 272 schools (89%, 11,129 pupils) for reception year and 240 schools (79%, 10,152 pupils) for year 6. School level data from the annual survey for the national Physical Education, School Sport and Club Links strategy were obtained for 175 of the schools contributing individual data from reception year (5817 pupils) and 147 of the schools contributing individual data from year 6 (5566 pupils), which is 58% and 48% of all state primary schools in Birmingham respectively. The prevalence of overweight and obesity combined in the study sample was 22.9% and 35.5% for reception and years 6 respectively. Overweight and obesity prevalence by gender, ethnicity and deprivation are shown in Table 2.1 and Table 2.2. Levels of overweight and obesity are substantially higher in year 6 compared to reception year. Overweight and obesity prevalence does not differ much between boys and girls in reception year, but in year 6, there is a greater difference, with boys having a higher prevalence. Overweight and obesity prevalence is higher in the African-Caribbean ethnic group and lower in the Chinese and other Far East ethnic group across both year groups. In the South Asian ethnic group, overweight and obesity prevalence is lower than that in the white population in reception year, but higher in year 6. However, the mean BMI z-score is lower, and the SD greater for South Asians compared to the white ethnic group in year 6, suggesting that the distribution of BMI z-scores is more widely spread. School level data on physical activity indicators for all schools included in the study (196 schools) is summarised in Table 2.3.

Table 2.1: Overweight and obesity prevalence in reception year pupils in Birmingham primary schools

Characteristic (n, %)	Overweight (%)	Obese (%)	Overweight or obese (%)	Mean BMI z-score (SD)
Total (11118)	13.8 (11.8)	1246 (11.2)	2554 (23.0)	0.26 (1.21)
Gender				
Boys (5821, 52.4%)	690 (11.9)	700 (12.0)	1390 (23.9)	0.27 (1.25)
Girls (5297, 47.6%)	618 (11.7)	546 (10.3)	1164 (22.0)	0.25 (1.16)
Ethnicity				
White (4320, 38.9%)	584 (13.5)	440 (10.2)	1024 (23.7)	0.43 (1.00)
South Asian (3467, 31.2%)	328 (9.5)	405 (11.7)	733 (21.1)	0.08 (1.35)
African-Caribbean (807, 7.3%)	106 (13.1)	119 (14.8)	225 (27.9)	0.37 (1.26)
Chinese and other Far East (112, 1.0%)	11 (9.8)	8 (7.1)	19 (17.0)	0.11 (1.22)
Mixed ethnicity (585, 5.3%)	73 (12.5)	59 (10.1)	132 (22.6)	0.35 (1.11)
Unknown (1827, 16.4%)	206 (11.3)	215 (11.8)	421 (23.0)	0.16 (1.29)
IMD quintile* (9530)				
1 (6355, 66.7%)	742 (11.7)	751 (11.8)	1493 (23.5)	0.25 (1.24)
2 (1402, 14.7%)	171 (12.2)	145 (10.3)	316 (22.5)	0.36 (1.09)
3 (1120, 11.8%)	148 (13.2)	110 (9.8)	258 (23.0)	0.33 (1.07)
4 (457, 4.8%)	51 (11.2)	33 (7.2)	84 (18.4)	0.28 (0.96)
5 (196, 2.1%)	23 (11.7)	13 (6.6)	36 (18.4)	0.31 (0.91)

Percentages may not add up to 100 due to rounding of numbers

*1st quintile is most deprived

Table 2.2: Overweight and obesity prevalence in year 6 pupils in Birmingham primary schools

Characteristic (n, %)	Overweight (%)	Obese (%)	Overweight or obese (%)	Mean BMI z-score (SD)
Total (10151)	1430 (14.1)	2182 (21.5)	3612 (35.6)	0.51 (1.31)
Gender				
Boys (5192, 51.2%)	712 (13.7)	1259 (24.3)	1971 (38.0)	0.58 (1.32)
Girls (4959, 48.9%)	718 (14.5)	923 (18.6)	1641 (33.1)	0.43 (1.30)
Ethnicity				
White (4334, 42.7%)	602 (13.9)	831 (19.2)	1433 (33.1)	0.51 (1.19)
South Asian (3034, 29.9%)	406 (13.4)	711 (23.4)	1117 (36.8)	0.43 (1.46)
African-Caribbean (904, 8.9%)	128 (14.2)	231 (25.6)	359 (39.7)	0.67 (1.33)
Chinese and other Far East (115, 1.1%)	19 (16.5)	18 (15.7)	37 (32.2)	0.48 (1.14)
Mixed ethnicity (565, 5.6%)	85 (15.0)	126 (22.3)	211 (37.4)	0.60 (1.25)
Unknown (1199, 11.8%)	190 (15.9)	265 (22.1)	455 (38.0)	0.52 (1.34)
IMD quintile* (8851)				
1 (5751, 65.0%)	777 (13.5)	1332 (23.2)	2109 (36.7)	0.53 (1.35)
2 (1350, 15.3%)	190 (14.1)	291 (21.6)	481 (35.6)	0.56 (1.24)
3 (1115, 12.6%)	167 (15.0)	191 (17.1)	358 (32.1)	0.49 (1.18)
4 (410, 4.6%)	64 (15.6)	61 (14.9)	125 (30.5)	0.31 (1.22)
5 (225, 2.5%)	37 (16.4)	26 (11.6)	63 (28.0)	0.31 (1.13)

Percentages may not add up to 100 due to rounding of numbers

*1st quintile is the most deprived

Table 2.3: Physical activity characteristics of Birmingham primary schools (N=196)

School Physical activity characteristic	Mean (SD)	Median (IQR)
Minutes PE per week	111.01 (17.48)	120 (100.5-120)
% pupils engaging in ≥ 2 hours high quality PE per week	88.52 (22.60)	100 (90.5-100)
Number of sports activities offered by schools	15.47 (4.33)	16 (13-18)
% pupils involved in intra-school competitive sports	44.67 (35.37)	38.5 (16.5-72)
% pupils involved in inter-school competitive sports	28.18 (21.66)	24 (13-39)
Number of sports/activity clubs linked to school	5.33 (5.31)	4 (2-7)
% pupils participating in sports/activity clubs linked to school	30.32 (28.76)	24 (4-47)

2.4.1 *Multilevel modelling with combined reception and year 6 data*

The null model using reception and year 6 data combined showed that there was a significant random effect for school ($\chi^2=139.52$, $p<0.0001$). The ICC was calculated to be 0.017, indicating that only 1.7% of the variation in BMI z-scores can be attributed to between school variation, and the remainder is due to within school variation. The regression coefficients obtained when each of the school level variables were tested in the level 1 adjusted model are presented in Table 2.4. All coefficients, with the exception of the proportion of pupils engaging in at least 2 hours high quality PE per week, were negative, but only the coefficient for number of minutes spent in PE per week was significant. This suggests a trend towards an inverse association of school physical activity attributes with BMI z-score.

The final model is presented in Table 2.5. The only school level variable making a significant contribution to the model was the number of minutes of physical education per week.

Interactions between year group and sex, and year group and ethnicity significantly improved the model fit. Several individual level regression coefficients were statistically significant; year 6 (compared to reception year) was positively associated with increasing BMI z-score, being in the South Asian or unknown ethnic groups was inversely associated with increasing BMI z-score (compared to the white ethnic group), and being in the highest IMD quintiles (statistically significant for 4th quintile and of borderline statistical significance for quintile 5) was inversely associated with increasing BMI z-score (compared to the most deprived quintile). Although the coefficients for the other IMD quintiles were non-significant, there was a trend of the coefficients increasing in magnitude with increasing IMD quintile (i.e. increasing affluence), suggesting that there is a socioeconomic gradient in this population. Coefficients for interactions between year 6 and female sex, year 6 and South Asian ethnicity, and year 6 and African-Caribbean ethnicity were statistically significant. This indicates that the relationships between BMI z-score and sex or ethnicity differs in the two year groups. The regression coefficient for the school level variable 'minutes of physical education' was negative and statistically significant, so after adjustment for other factors, increased time spent in PE per week is associated with decreased BMI z-scores. A random slope for year group also made a significant contribution to the model, indicating that the between school variance is not constant across year groups.

To aid interpretation of the interactions of gender and ethnicity with year group in the model, ethnic and year group-specific estimates of mean BMI z-score were calculated separately for

boys and girls, assuming an IMD score in the most deprived quintile, and attendance at a school offering the mean number of minutes of PE per week. These are plotted in Figure 2.1. It can be clearly seen that BMI z-score is higher for all groups in year 6 compared to reception year. In general, the difference in BMI z-score between reception and year 6 is greater for boys than girls. Considering ethnic group, the steepest increases between reception and year 6 is seen in the African-Caribbean and South Asian groups, so that in year 6, the mean BMI z-score is greater for African-Caribbeans compared to whites, and the gap between the mean scores for South Asians and whites has narrowed.

Table 2.4: Partial regression coefficients for school level variables when tested in models adjusted for individual level factors

School physical activity variables	Reception and year 6 combined model		Reception year model		Year 6 model	
	β (95% CI)	p	β (95% CI)	p	β (95% CI)	p
Minutes PE per week (10 minute increments)	-0.019 (-0.034--0.004)	0.01	-0.026 (-0.046--0.005)	0.02	-0.007 (-0.032-0.016)	0.53
% pupils engaging in ≥ 2 hours high quality PE per week	0.001 (-0.002-0.0004)	0.17	-0.001 (-0.003-0.001)	0.22	-0.001 (-0.002-0.001)	0.55
Number of sports activities offered by schools	-0.006 (-0.012-0.001)	0.08	-0.004 (-0.013-0.004)	0.34	-0.007 (-0.017-0.003)	0.17
% pupils involved in intra-school competitive sports	-0.0004 (-0.001-0.0004)	0.33	-0.001 (-0.002-0.0003)	0.20	-0.0001 (-0.001-0.001)	0.88
% pupils involved in inter-school competitive sports	-0.001 (-0.002-0.0003)	0.16	-0.002 (-0.004--0.0001)	0.04	0.0004 (-0.002-0.002)	0.68
Number of sports/activity clubs linked to school	-0.003 (-0.008-0.003)	0.31	-0.005 (-0.012-0.003)	0.23	-0.001 (-0.009-0.002)	0.82
% pupils participating in sports/activity clubs linked to school	-0.004 (-0.001-0.001)	0.48	-0.001 (-0.003-0.0002)	0.11	0.001 (-0.001-0.002)	0.44

Table 2.5: Multilevel model for reception and year 6 combined with BMI z-score as the dependent variable

	Coefficient β (95% CI)	p
<i>Fixed effects</i>		
Constant	0.676 (0.503-0.849)	<0.001
Individual		
Year 6 ^a	0.153 (0.080-0.227)	<0.001
Female ^b	-0.031 (-0.90-0.029)	0.31
Ethnicity ^{c*}		
South Asian	-0.331 (-0.410--0.253)	<0.001
African-Caribbean	-0.099 (-0.234-0.037)	0.15
Chinese and other Far East	-0.210 (-0.482-0.062)	0.13
Mixed ethnicity	0.0001 (-0.124-0.125)	0.99
Unknown	-0.195 (-0.322--0.067)	<0.01
IMD quintile ^{d†}		
2	-0.019 (-0.079-0.042)	0.55
3	-0.052 (-0.117-0.013)	0.12
4	-0.153 (-0.249--0.057)	<0.01
5	-0.130 (-0.266-0.007)	0.06
Interactions [‡]		
Year 6*female	-0.103 (-0.189--0.017)	0.02
Year 6*South Asian	0.206 (0.089-0.322)	0.001
Year 6*African-Caribbean	0.274 (0.086-0.461)	<0.01
Year 6*Chinese and other Far East	0.054 (-0.339-0.446)	0.79
Year 6*mixed ethnicity	0.113 (-0.064-0.291)	0.21
Year group*unknown ethnicity	0.160 (-0.100-0.419)	0.23
School		
10 minute increments in PE per week	-0.019 (-0.342--0.004)	0.01
<i>Random effects[§]</i>		
	Variance (95% CI)	
School	0.007 (0.003-0.019)	
Year group	0.016 (0.007-0.038)	

Reference groups: ^aReception year, ^bmale, ^cwhite, ^dmost deprived IMD quintile

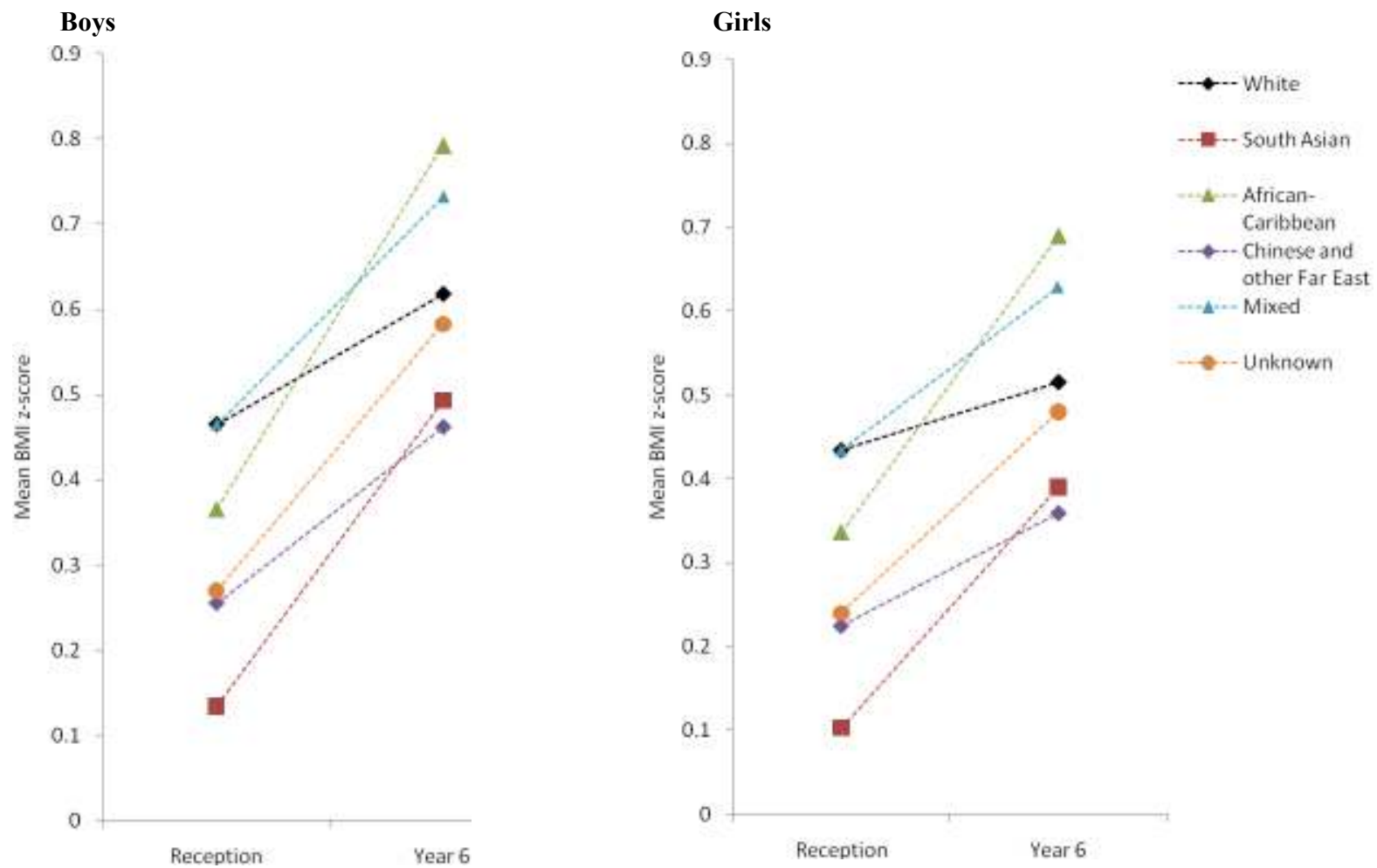
*Wald statistic for ethnicity: $\chi^2=73.88$, $p<0.0001$

†Wald statistic for IMD quintile: $\chi^2=12.35$, $p=0.02$

‡Wald statistic for Year Group-Ethnicity interaction: $\chi^2=18.02$, $p<0.01$

§Likelihood ratio test for multilevel vs. linear regression: $\chi^2=24.98$, $p<0.0001$

Figure 2.1: Ethnic differences in BMI z-score in reception and year 6 children



BMI z-score estimates shown in graphs assume children are in most deprived IMD quintile and attend a school with the mean number of minutes PE per week.

2.4.2 *Multilevel modelling with reception year data*

The null model for reception year again indicated a significant random effect for school ($\chi^2=219.00$, $p<0.0001$), and the ICC was estimated as 0.042, so for reception year, 4.2% of the variation in BMI z-score is between schools. Negative coefficients were obtained for all school physical activity variables when they were tested in the level 1 adjusted model (Table 2.4). The coefficients for time spent in PE per week and proportion of pupils engaged in interschool competitive sports were significant. Again the trend of negative coefficients suggests that other school physical activity attributes may be inversely associated with BMI z-scores in this age group.

The final model for reception year is presented in Table 2.6. As in the combined model, the only school level variable retained was minutes spent in physical education. The interaction between ethnic group and minutes of PE per week was included in the model. With respect to the fixed effects, mixed ethnic group was significantly positively associated with increasing BMI z-score. The coefficient for female sex was non-significant in this model. The regression coefficients for IMD quintiles were non-significant, and there was no particular trend across the quintiles. The coefficient for minutes of PE per week was non-significant, but the interaction term between mixed ethnicity and minutes of PE per week was significant, indicating that increasing time spent in PE may have a greater influence on BMI z-score in the mixed ethnicity group than in other ethnic groups. There were no random effects other than the school effect.

Table 2.6: Multilevel model for reception year with BMI z-score as the dependent variable

	Coefficient β (95% CI)	p
<i>Fixed effects</i>		
Constant	0.563 (0.296-0.829)	<0.001
Individual		
Female ^a	-0.030 (-0.086-0.026)	0.29
Ethnicity ^{b*}		
South Asian	0.009 (-0.489-0.508)	0.97
African-Caribbean	0.496 (-0.301-1.293)	0.22
Chinese and other Far East	-0.901 (-2.294-0.492)	0.21
Mixed ethnicity	1.209 (0.498-1.920)	0.001
Unknown	-0.230 (-1.122-0.661)	0.61
IMD quintile ^{c†}		
2	0.037 (-0.043-0.116)	0.37
3	-0.025 (-0.112-0.062)	0.57
4	-0.074 (-0.204-0.055)	0.26
5	-0.047 (-0.238-0.0145)	0.63
School		
10 minute increments in PE per week	-0.011 (-0.035-0.013)	0.36
Interactions [‡]		
South Asian*10 minute PE increments	-0.031 (-0.077-0.014)	0.18
African-Caribbean*10 minute PE increments	-0.053 (-0.125-0.019)	0.15
Chinese and other Far East*10 minute PE increments	0.066 (-0.063-0.194)	0.32
Mixed ethnicity*10 minute PE increments	-0.110 (-0.174--0.046)	0.001
Unknown ethnicity*10 minute PE increments	0.003 (-0.076-0.083)	0.94
<i>Random effects[§]</i>		
School	Variance (95% CI) 0.024 (0.014-0.041)	

Reference groups: ^a male, ^b white, ^c most deprived IMD quintile

*Wald statistic for ethnicity: $\chi^2=14.87$, p=0.01

†Wald statistic for IMD quintile: $\chi^2=3.22$, p=0.52

‡Wald statistic for Ethnicity-minutes interaction: $\chi^2=14.76$, p=0.01

§Likelihood ratio test for multilevel vs. linear regression: $\chi^2=30.77$, p<0.0001

2.4.3 Multilevel modelling with year 6 data

The null model for year 6 again indicated a significant random effect for school ($\chi^2=15.58$, $p<0.0001$). However, the ICC was very small, 0.009, indicating that only 0.9% of the variation in BMI z-score is between schools. None of the coefficients obtained by adding each of the school physical activity variables to the level 1 adjusted model were significant, but as in the combined and reception year models, most were negative, although their magnitudes were very small (Table 2.4).

The final model, shown in Table 2.7, did not include any school level variables, or interaction terms. With respect to the fixed effects, female sex and the South Asian ethnic group were both significantly inversely associated with increasing BMI z-score. The African-Caribbean group was positively associated with BMI z-score. IMD quintile was inversely associated with increasing BMI z-score, with a general trend of increasing magnitude of regression coefficient with increasing affluence. The associations reached significance for the 4th and 5th IMD quintiles. Other than the school effect, no random effects were included in the model.

Table 2.7: Multilevel model for year 6 with BMI z-score as the dependent variable

	Coefficient β (95% CI)	p
<i>Fixed effects</i>		
Constant	0.623 (0.563-0.683)	<0.001
Individual		
Female ^a	-0.144 (-0.198--0.090)	<0.001
Ethnicity ^{b*}		
South Asian	-0.102 (-0.171--0.032)	<0.01
African-Caribbean	0.132 (0.003-0.231)	<0.01
Chinese and other Far East	-0.058 (-0.305-0.188)	0.64
Mixed ethnicity	0.084 (-0.033-0.201)	0.16
Unknown	0.025 (-0.190-0.240)	0.82
IMD quintile ^{c†}		
2	0.012 (-0.070-0.093)	0.78
3	-0.046 (-0.135-0.043)	0.31
4	-0.230 (-0.368--0.092)	0.001
5	-0.223 (-0.405--0.041)	0.02
<i>Random effects[‡]</i>		
School	Variance (95%CI) 0.013 (0.006-0.028)	

Reference groups: ^a male, ^b white, ^c most deprived IMD quintile

*Wald statistic for ethnicity: $\chi^2=26.49$, $p=0.0001$

†Wald statistic for IMD quintile: $\chi^2=15.90$, $p<0.01$

‡Likelihood ratio test for multilevel vs. linear regression: $\chi^2=9.74$, $p<0.001$

2.4.4 Contribution of individual and school characteristics to the variation in overweight and obesity between schools

Table 2.8 shows the within and between school variances for the combined, reception year, and year 6 null, level 1 variable adjusted, and fully adjusted models. It can be seen in the combined and reception year models, that the between school variation is reduced a little by adjustment for individual factors, but inclusion of the time spent in PE per week reduces the between school variation further. In the reception year model, the proportion of unexplained variation between schools reduces from 4.2% to 3.26% with the addition of individual factors, and to 1.99% with the inclusion of the minutes of PE per week variable and the interaction term between this and ethnicity. For year 6, there is much less variation

between schools, and this remains largely unexplained with the addition of individual factors. School factors were not included in the final model for year 6, and so have no effect.

Table 2.8: Unexplained between and within school variance for the null, individual level variable-adjusted, and final (individual and school level variable-adjusted) multilevel models

	Null model			Model adjusted for individual factors			Final model		
	Between school variance	Within school variance	Unexplained variation between schools	Between school variance	Within school variance	Unexplained variation between schools	Between school variance	Within school variance	Unexplained variation between schools
Reception & year 6 combined	0.027	1.569	1.69%	0.018	1.509	1.18%	0.007	1.350	0.52%
Reception year	0.061	1.391	4.20%	0.045	1.335	3.26%	0.024	1.181	1.99%
Year 6	0.015	1.707	0.87%	0.013	1.681	0.77%	0.013	1.681	0.77%

2.5 Discussion

The prevalence of overweight and obesity in reception year and year 6 children in Birmingham (23% and 36% respectively) is broadly similar to national prevalence estimates in these age groups.⁵⁹ The large increase in prevalence with age, and the higher prevalence in boys in the older age group, is again in keeping with national findings.^{51;59} The multilevel modelling undertaken in this study clearly shows that there is a small but significant percentage of the variation in BMI z-scores that can be attributed to differences between schools. The overall estimate of the between school variation was 1.7%, but when reception and year 6 were looked at separately, it is apparent that the between school variation in BMI z-score is much higher in the younger year group (age 4-5) than the older year group (age 10-11), with estimates of 4.2% and 0.9% respectively (reducing to 3.3% and 0.8% respectively, when individual demographic factors are accounted for). This has important implications in terms of intervention, and suggests that intervention to influence the school environment and culture could have a small but important effect on the prevalence of overweight and obesity in children.

The finding of a greater influence of schools in the younger year group may at first seem counterintuitive, as one might expect the impact of school to be related to the length of time that the child has attended the school. Also, given that reception year is the first year of school, it may seem unlikely that the schools could have a significant influence on overweight and obesity in such a short period of time. However, it is possible that there are differential influences within schools, for example, it is conceivable that in the same

school, the environment for reception year children may be much more conducive to physical activity, with active play facilities, longer playtimes, more active class sessions etc. than the environment for year 6 children, where there may be more of an emphasis on academic attainment and less emphasis on learning through play. Extending this scenario, it is possible that for older children, schools are much more constrained by national standards and targets around academic attainment, and so there is less variation between them in terms of their influence on overweight and obesity. The possible differential influence of schools on different age groups merits further exploration. Another potential explanation for this finding is that the school effect on older pupils is more diluted by influences external to the school environment. For example, older children may chose more sedentary behaviours outside of school, or have more freedom to chose what they eat. Developing a further understanding of the school influences and their interactions with external influences will inform future intervention development.

Several individual characteristics were found to be associated with BMI z-score, including sex, ethnicity and socioeconomic status, but these associations were not consistent across both year groups. Boys are at higher risk than girls of increased BMI z-score at age 10 to 11, but this association is not apparent in 4 to 5 year olds. A socioeconomic gradient was demonstrated in this study, with increasing deprivation levels associated with increasing BMI z-scores, but again, this was only apparent for the older year group. The current evidence for a relationship between socioeconomic status and childhood obesity in the UK is relatively weak^{58;61;72}, so the findings of this study give further support to the existence of this relationship.

A relationship between ethnicity and BMI z-score was observed in this study. In comparison to the white ethnic group, the African-Caribbean group have higher BMI z-scores in year 6, with a steep increase seen between the two year groups. South Asians have lower BMI z-scores than white children, but the gap between the two groups is less in year 6 (Figure 2.1). This is consistent with other UK based research, which found lower mean weight for height measures in 8-11 year old South Asian children compared to their white counterparts, but the same study explored measures of central obesity (waist circumference and waist-hip ratio), and found these to be comparable in South Asian and white children.¹³³ Thus, in terms of health consequences, the lower BMI z-scores for South Asian children may be misleading, and the steep increase seen from reception to year 6 is of particular concern.

Considering the school physical activity attributes, in the majority of cases they did not significantly contribute to the models, but they were consistently found to have negative regression coefficients when tested in the models. This suggests that there is a possible relationship with the school physical activity environment and childhood weight status, but further investigation is needed to define the specific environmental characteristics that have an influence. One physical activity attribute that was consistently found to be associated with BMI z-score was the time spent in physical education per week. This variable significantly contributed to the combined and reception year final models, suggesting it has an influence on the development of obesity, particularly in young children. Furthermore, time spent in PE per week explained some of the variation in BMI z-scores seen between schools (Table 2.8).

The variation between schools demonstrated in this study is in keeping with studies both in the UK and the US.^{197;199} The UK study, undertaken in another industrial city, used data from reception year and year 4 (age 8-9) to calculate the 'value added' by a school with respect to the development of obesity, adjusting for demographic factors. However, the methodology used to calculate the value added index was based on the assumption that the influence of the school is less on the reception year pupils than the year 4 pupils.¹⁹⁹ In the light of the findings from this study, this assumption may not be valid.

This study draws attention to the potential influence of certain physical activity characteristics of schools on childhood overweight and obesity, particularly the amount of time devoted to physical activity. This adds to a growing body of evidence that suggests school physical activity environments are an important focus for intervention, particularly in younger children. A US cohort study explored the effect of increased physical education time on change in BMI as children moved from kindergarten (age 5-6) to first grade (age 6-7), and found a beneficial effect of more physical education, especially in girls. In addition, school-based physical activity interventions have shown promise in reducing overweight and obesity. Two systematic reviews of childhood obesity prevention interventions suggest that school-based physical activity interventions may have an effect, at least in the short-term.^{141;150} A further systematic review identified that interventions which included provision of compulsory aerobic physical activity through schools were more likely to be effective at reducing overweight and obesity prevalence.¹⁵⁴

Although school influences on childhood obesity are important, this study also highlights that most of the variation in childhood weight status is due to influences other than school. A study by von Hippel and colleagues compared the increase in BMI during the school year with the increase during the Summer vacation, and found that the rate of increase was higher in the vacation than in the school term time. They concluded that non-school environments contribute more to overweight than school environments.²¹⁰ In terms of intervention to prevent childhood obesity, it is evident that school-based interventions have to go hand in hand with interventions in community and family settings.

The main limitation of this study is that it is cross-sectional, and so does not allow exploration of the longitudinal effect of the school environment on the development of overweight and obesity. That said, the use of data from the oldest and youngest year groups within primary schools enables comparison of the relative influences of individual factors and schools on older and younger children. Although causality cannot be inferred from observed associations, this study indicates areas for future research in terms of better understanding the school physical activity environment, and identifying specific opportunities for environmental intervention.

Another weakness is that the study concentrates only on school characteristics relating to physical activity. Obviously, there is potential for the school food environment to influence childhood dietary behaviours and therefore the development of overweight and obesity, as observed in other studies.²⁰³⁻²⁰⁵ Therefore, the food environment in schools is likely to explain some of the interschool variation in BMI z-scores seen in this study, and also could

potentially confound some of the relationships observed. Another potential limitation is that there was incomplete data for schools included in the study, so statistical assessment of variables to be included in the final model was not possible. Nevertheless, a large number of schools and children in the study did have complete data (196 schools and 11,383 children) and so were included in the final models, which gives weight to the findings.

Around half of all primary schools in Birmingham provided data on school physical activity characteristics, so it is possible that the schools with missing data differ to those providing data, therefore introducing potential bias. In addition, the school data was self-reported, and no assessment has been made of the validity of the survey. Data on individual characteristics were obtained from a much higher proportion of schools (97%), although coverage within each school may have been incomplete, as parents have the opportunity to decline for their child to participate in the NCMP. It may therefore be that parents of overweight and obese children are more likely to 'opt out' of the programme than parents of healthy weight children. A strength of this study is that BMI was assessed objectively, using a standardised protocol, and although some inter-observer variation is inevitable, all personnel undertaking the measures were required to undergo training, so this should be minimised. The use of BMI as a measure of overweight and obesity in children is also problematic, especially in South Asians, where BMI is a relatively poor indicator of body fat^{134;135}, and so BMI z-score as an outcome may not be the most appropriate indicator of obesity in this multi-ethnic population.

It is evident from this study, that certain characteristics within schools may potentially have an influence on the development of overweight and obesity in school children. Further investigation of the particular characteristics of schools that are related to diet and physical activity, and consequently obesity is warranted. A potential, less measurable factor may be the role of teachers within schools. The idea of teachers acting as role models with regard to healthy eating and physical activity is implicit in healthy schools policy in the UK²¹¹, and is possible that teachers could potentially positively or negatively influence children through their own behaviour, so this is a particular area to be explored in the future.

2.6 Conclusions

This study clearly demonstrates that there is variation between schools with respect to childhood overweight and obesity that is not explained by the demographic mix of the schools. The time devoted to physical education in schools is a potentially significant influence on children's weight status, and other physical activity characteristics may also contribute to reducing overweight and obesity. In the UK, there is national policy in place to ensure at least two hours of physical education per week^{202;209}, but given the findings of this study, this may not go far enough. More research is required to further characterise the aspects of the school physical activity and food environments that influence childhood overweight and obesity, but in the meantime, policymakers should take into account the influence of schools and strive to continue to put in place measures to ensure healthy school environments.

3 CONTEXTUAL INFLUENCES ON THE DEVELOPMENT OF OBESITY IN CHILDREN FROM UK SOUTH ASIAN COMMUNITIES

The study presented in this chapter continues the theme of exploring influencing factors on the development of childhood overweight and obesity. However, the approach and focus of this study differs from chapter 2 in that qualitative research methods are employed to explore the perceived influences on the development of childhood obesity of stakeholders within South Asian communities. The findings presented here are of key importance in providing a theoretical understanding of the problem of childhood obesity within these communities, and were used to inform the development of the BEACHeS study prevention programme. In addition, these findings contribute to a broader theoretical understanding of the development of childhood obesity across different communities, and highlight the importance of context in intervention planning.

3.1 Background

Given the scale of the problem of childhood obesity globally, developing an understanding of the determinants of childhood obesity has been the focus of much research activity in the last few decades. Classical epidemiological approaches, centred on identification of individual risk factors, have traditionally been used to characterise the determinants of ill health and related conditions such as obesity.²¹² However, the concept that characteristics, choices and behaviours are not determined purely by the individual, but are related to the sociocultural structures and practices of the community within which they live, has gained recognition in recent decades. This has led to an increasing focus on the relationship

between context and health, and in particular the relationship between context and individual behaviours or practices that contribute to ill health (poor diet and physical inactivity in the case of obesity).²¹³ The term ‘context’ in itself can be problematic. In research terms it is used in its narrowest sense to refer to ecological risk factors for disease (e.g. the influence of neighbourhood deprivation on health outcomes), but in its broadest sense, the term encompasses the physical, social, cultural and political structures within a particular setting and the relationships between these and the individual.²¹³ It is the latter meaning that is intended when the term ‘context’ is used in this chapter.

The work of Urie Bronfenbrenner represents a major contribution to the theoretical understanding of the relationship between an individual (in Bronfenbrenner’s work; a child) and the context within which they function. Bronfenbrenner proposed the Ecological Systems model, which depicts layers of contextual structures that influence a child, and which in turn are influenced either directly or indirectly by the child’s actions.¹⁷⁶ These structures are termed the micro-, meso-, exo- and macrosystems. Microsystems are the relationships between the child and settings in which they function (e.g. home, school etc.). The interrelationships between these settings (e.g. the interface between home and school) constitute the mesosystem. The exosystem refers to settings that the child may not directly interact with, but have a significant indirect effect (e.g. neighbourhood, parent’s work place etc.). Finally, the macrosystem refers to cultural, societal and institutional values that are manifested in the micro-, meso- and exosystems (e.g. Political systems, social and cultural customs etc.). The Ecological Systems model clearly articulates the complexity and interactions of the contextual structures that a child is embedded in, and acknowledges the

reciprocal nature of the relationships. The model has been the basis for ecological health promotion models that attempt to move away from models that focus on individual behaviour change¹⁷⁰, and reflects strongly in the universally accepted Dahlgren and Whitehead socioeconomic model of health.²¹⁴

Bronfenbrenner's model has given rise to several theoretical models that attempt to conceptualise the development of obesity in childhood. Davison and Birch proposed a contextual model of the development of childhood overweight based on Ecological Systems theory. This depicts child weight status at the centre, surrounded by three concentric circles; child characteristics and risk factors, parenting styles and family characteristics, and finally community, demographic and societal characteristics.²¹⁵ They used the model to review the literature on predictors of overweight in childhood, and concluded that the family was a key structure in the development of overweight, and should therefore be the focus of childhood obesity intervention.

The International Obesity Taskforce (IOTF) proposed the Causal Web model for the development of obesity, which schematically represented the influence of context on individual lifestyle 'choices' (see Figure 1.2).¹⁶³ This has similarities with the Davison and Birch model, as it included local settings (family/home, school etc.) and community and societal influences, but it went further, encompassing national and international contextual factors (media and advertising, urbanisation, globalisation of markets etc.), akin to Bronfenbrenner's macrosystems. The Causal Web differs from Ecological Systems theory in that it attempts to outline causal pathways leading to obesity, but does not represent the

reciprocal nature of the relationships between individuals and contextual factors. Lytle and colleagues recently proposed a conceptual model, based on scientific literature and expert opinion, to guide future research into the causes of childhood obesity.¹²³ Alongside behavioural and biological causal factors, this model outlined contextual factors such as family, home, school and community, but drew the distinction between ‘immutable’ factors (i.e. factors that cannot be changed) and contextual, behavioural and biological factors amenable to change. The wider (macrosystem) contextual factors are largely missing in this model. This was acknowledged by Lytle and colleagues and related to the purpose of the model, which was to outline specific, measureable factors in the aetiological pathway that may provide potential points for intervention.

3.2 Aims

The specific aims of this chapter are to access key contextual data on the development of childhood obesity in UK South Asian communities through consultation with a variety of stakeholders from these communities, and to discuss how this data adds to the existing theoretical understanding of the role of context in the development of childhood obesity.

3.3 Methods

As part of the process of developing a childhood obesity prevention programme (described fully in chapter 4), the BEACHeS study ran focus groups with stakeholders from the 8 participating school communities. The chief aim of the focus groups was to generate and prioritise strategies for preventing childhood obesity in these communities. Focus group

methods were chosen in preference to interviews with participants as it was felt that the interaction within groups would enable opinions and beliefs to be explored more fully.²¹⁶

3.3.1 Participant recruitment

First, stakeholder groups were identified. A stakeholder was defined as any person within the local community who had a connection to primary school-aged children. This broad definition was chosen so that a spectrum of beliefs and opinions could be accessed. The groups identified were; parents, teachers, school catering staff, other school support staff, healthcare professionals (including school nurses), local authority representatives, prominent community members (including school governors and religious leaders), leisure staff, and retail representatives.

Stakeholders were purposively recruited according to these identified groups through staff from the 8 participating schools. Participants of South Asian origin were actively sought as they were deemed to be key informants with respect to the characteristics of South Asian communities.²¹⁷ Parent link workers (support staff in schools who work closely with parents or other family members) were particularly instrumental in identifying potential participants, and those recruited also nominated potential participants. Initial contact was made by letter. If a person expressed an interest they were then contacted by telephone and given further information. Where there were difficulties in written communication (e.g. parents with a first language other than English), information was given verbally through parent link workers. Those who agreed to participate were given a reminder telephone call

in the 2 days prior to the focus group. All participants were offered reimbursement for travelling expenses. We aimed to recruit 6 to 8 participants for each group.

3.3.2 *Focus group process*

The focus groups were run as identity groups (i.e. groups of parents, groups of teachers etc.) to enable discussion of shared experiences, and to ensure that there were no hierarchies within the groups that would inhibit free discussion.^{216,218} Various locations were used, including rooms in schools, university, health and leisure centres. Locations and timings were chosen to afford convenience to participants (e.g. the teachers focus groups were held after school hours). Two moderators ran all focus group sessions together. Both were British, English-speaking females, one of Iranian origin and one of mixed English and Indian origin. A semi-structured schedule to guide the sessions was developed and refined through running two practice groups at the beginning of the study (Table 3.1).

Participants attended two sessions. Initially these were held one to two weeks apart, but it became clear that in order to retain participants for the second session, it was optimal to run both sessions on the same day. All groups were conducted in English except for one group of parents, who were Punjabi speaking. This group was conducted with a parent link worker present, who interpreted all dialogue within the sessions. On arrival at the initial focus group, participants were asked to sign a consent form and complete a short questionnaire asking personal details including age, gender, ethnicity and religious affiliation. All sessions were audio-recorded using digital voice recorders.

The main objectives of session one were to explore perceptions of obesity and beliefs of its causes in childhood, and generate ideas of ways to prevent childhood obesity within the participants' local communities. Participants were first asked to write down things that came to mind when hearing the words 'overweight' and 'obesity'. These were then written on a flipchart and discussed amongst the group. This frequently naturally led onto a discussion around influences on the development of obesity in children, and groups that did not naturally move to this area of discussion were facilitated to do so. Participants were then asked to note down on paper their ideas for how the children could be helped to maintain a healthy weight in their local communities. Ideas were again shared and discussed, and noted down on a flipchart.

The objective of session two was to facilitate the group to prioritise obesity prevention ideas for inclusion in a multifaceted intervention programme. First, participants' intervention ideas were recapped and intervention initiatives that had been evaluated in research studies around the world were presented to participants on a handout (appendix 3). This information was derived from eight systematic reviews^{141;142;146-148;151;152;219}, encompassing 70 studies, and was supplemented with information from published childhood obesity prevention guidelines.^{17;140;220} The interventions identified from the research literature, together with the participants' intervention ideas were displayed on removable cards attached to a display board. The participants were asked to consider the interventions on the board, and prioritise potential elements of an intervention programme in three stages. First, interventions that were considered to be the more important (effective at preventing childhood obesity) were moved to the next display board. Participants then

moved interventions to a third board if they considered them feasible and practical to implement in their communities. Finally, participants were asked to agree on up to 8 interventions that they would include in a final intervention programme. The moving of cards between boards was a fluid process and participants could move cards back and forth as discussions progressed. A summary of the schedules used for sessions one and two are shown in Table 3.1. A two stage focus group process with the aim of participant prioritisation and consensus has been successfully used elsewhere by members of the research team²²¹.

The length of session one ranged from 1 to 1 ½ hours and session two from 1 to 2 hours. Audio recordings were transcribed verbatim, and transcripts were reviewed by the moderators to assess accuracy. Where necessary, moderators referred back to the audio recordings and modified transcripts accordingly. The recording from the Punjabi session was translated by the parent link worker, and then transcribed in the same way.

Table 3.1: Moderator’s schedules for first and second focus group sessions

<p>Session 1: Objectives</p> <ul style="list-style-type: none"> • Explore understanding and perspectives on obesity • Explore ideas on childhood obesity causes (in the local setting) • Gather ideas on interventions to prevent childhood obesity 	<p>Session 2: Objectives</p> <ul style="list-style-type: none"> • Present list of interventions from first focus group • Present additional interventions from the literature • Prioritise potential interventions
<p>Session 1: Process</p> <ol style="list-style-type: none"> 1. Childhood overweight and obesity: is it a problem? Explore overweight and obesity, and related problems/advantages. Explore specifically perceptions of overweight/obesity in children. <ul style="list-style-type: none"> ▪ Exercise: “write on the slips of paper what word or short phrase comes to mind when you hear the words ‘overweight’ and ‘obese’” ▪ Share ideas on flip chart and explore 2. Causes of childhood obesity. Guide participants to think about the causes in the context of their local environments. <ul style="list-style-type: none"> ▪ Explore why people think children become overweight and obese (probe on reasons behind poor diet and lack of physical activity) ▪ Why is childhood obesity increasing ▪ Own experiences of influences on children’s diets and physical activity 3. Preventing childhood obesity. Get participants thinking about measures to encourage children to maintain healthy weights, especially in a local context. <ul style="list-style-type: none"> ▪ Ask participants to think about what measures could help in encouraging children to maintain healthy weight ▪ Hand out slips which can be used to note ideas ▪ Discussion, share ideas and note these on flipchart. Explore: <ul style="list-style-type: none"> ○ Similar concepts/measures ○ Barriers/enablers to implementing locally ○ Own experiences of measures that help change behaviour ○ How participants might be involved in implementing. 	<p>Session 2: Process</p> <ol style="list-style-type: none"> 1. Recap on interventions from previous discussion. Handout a summary of interventions discussed at first session. <ul style="list-style-type: none"> ▪ Does the group feel the summary is representative of discussions ▪ Ask if anyone has further thoughts 2. Presentation of additional interventions from research. Hand out list of intervention components from the literature. Put up board with participants’ ideas and intervention components from the literature. <ul style="list-style-type: none"> ▪ Ask what participants think of the intervention components identified from the literature (how these relate to their ideas) 3. Prioritisation exercises. The group has to prioritise all ideas presented by moving through a series of stages, until they end up with a list of up to 8 ideas to include in an intervention package. <p>Stage 1</p> <ul style="list-style-type: none"> ▪ Ask participants to discuss which of the interventions they think it are <u>most important (effective)</u> to include in an intervention package to encourage healthy weight in children ▪ Move the ideas from the original board to the ‘most important’ board, as directed by the group <p>Stage 2</p> <ul style="list-style-type: none"> ▪ Ask participants to now consider the interventions they think are the <u>most practical and most straightforward to deliver</u> ▪ Move interventions from the ‘most important’ board to the ‘practical’ board, as directed by the group <p>Stage 3</p> <ul style="list-style-type: none"> ▪ Ask participants to discuss and agree on up to <u>8 intervention components</u> to include in a package of activities ▪ Move interventions to the final board, directed by the group ▪ Get group to reflect on the final list.

3.3.3 Data analysis

In order to look specifically at views and opinions on the causes of childhood obesity, a thematic analysis of the first and second focus group sessions from all stakeholder groups was undertaken. Data were initially coded into emergent themes (appendix 4), using the NVivo7 computer package. An iterative inductive process was then undertaken to identify relationships between themes and distil the broad theoretical concepts from the data.²²² As part of this process, common themes across all groups and points of departure between different stakeholder types were identified.

All transcripts were reviewed by the two moderators. Thematic coding was undertaken by one moderator (MP), and emergent themes and relationships between them were reviewed by the second moderator (PA) to ensure that they accurately reflected the focus group discussions. The data and the emergent themes were also fed back to other members of the research team for discussion and consideration.

3.4 Results

3.4.1 Participant characteristics

We convened nine focus groups in a 5 month period in 2007. We ran sessions one and two with all groups, but three of the nine groups attended both sessions on the same day. The identity groups convened are described in Table 3.2. Despite best efforts, for logistical reasons there was heterogeneity within some groups. One group included parents and school support staff together. The moderators felt that this was acceptable as often school support staff are

also parents, and mixing these participants would not introduce any hierarchies that would affect the group dynamic. More problematic was a parent group where a school governor was also present. The moderators were mindful of the potential effect on the group's discussions, but there was no feeling that parent participants deferred to the governor, and the flow of discussion was comparable to the other parent focus group sessions.

In total there were 68 participants. The majority were female (60, 88%). Fifty-five participants (81%) disclosed ethnicity and of these, 30 (55%) were from the three South Asian groups of interest. Forty-seven (69%) disclosed religious affiliation. Table 3.2 shows a breakdown of the participants. It should be noted that not all participants attended both focus group sessions, some attended the only the first session and others attended only the second session, therefore the number of participants shown in the table for session 1 and session 2 differ, and do not total 68.

Table 3.2: Focus group identities and participant characteristics

Identity group	Participants at 1st session[†] (Female:Male)	Participants at 2nd session[†] (Female:Male)	Ethnicity[‡]	Religious affiliation[‡]
Parents (English speaking)	2:1	2:1 (one participant was a School Governor)	1 Bangladeshi 1 Pakistani 1 Yemeni 1 British	3 Muslim 1 Christian
Parents (Punjabi speaking)*	10:0	10:0	10 Pakistani	10 Muslim
Mothers of Pakistani origin (English speaking)*	6:0	6:0	6 Pakistani	6 Muslim
Teachers	3:1	4:1	1 Indian 3 White British 1 White Canadian 1 Black Caribbean	1 Sikh 1 Christian 1 Bahai 1 No affiliation
Parents, school catering and school support staff	4:2	9:0	5 Indian 2 Pakistani 1 White British 1 White Irish	4 Sikh 3 Muslim 1 Christian 1 No affiliation
Catering and school support staff*	7:1	7:1	2 Pakistani 2 White British	2 Muslim 2 Christian 1 No affiliation
Community representatives including school governors	4:0	4:0	2 Indian 2 White British	2 Sikh 1 Christian 1 No affiliation
Health representatives	8:0	6:0	6 White British 1 Black Caribbean	
Local authority, retail and leisure representatives	1:3	1:3	5 White British	2 Christian 3 No affiliation

*First and second sessions on same day

†Some participants attended only first or second sessions when sessions were on different days

‡Not all participants disclosed ethnicity or religious affiliation

3.4.2 Emergent themes on perception of causes of childhood obesity

The two overarching themes emerging as influences on the development of childhood obesity were increased energy intake and decreased energy expenditure, articulated as unhealthy food intake and lack of physical activity. These themes are consistent across a range of contexts from the individual to the macro-level, with participants articulating factors such as food marketing, media influences and the global shift to sedentary lifestyles, in addition to the more proximal factors such as child and parental behaviours. Themes can be broadly grouped into six contexts, although these are not discrete and there is much fluidity between them. These contexts are depicted in Figure 3.1.

Whilst much of the emergent data could be applied to children from all communities, there were some specific cultural contextual factors that serve to explain particular behaviours relating to food intake and physical activity in South Asian communities. For example, close-knit extended families often live in one dwelling, with hierarchical structures that give the grandmother control within the family and significant influence over the diets of the children. Additionally, these older family members are likely to be first generation immigrants who may have experienced environments where food is less available, and so view food differently to people who have always had access to plentiful food. These factors may provide an explanation as to why 'fat' children are viewed as healthy within these communities, and why food is lavished on children as an outward sign of affection. The mothers within these families may wish to feed their children in a more healthy way, but are unable to make this change, as they do not hold the power within the family.

Another example comes from the Islamic communities. These communities have a strong religious identity. Islamic faith leaders have a central role in the community and a significant amount of time is spent at the mosque (place of worship). Children are required to attend mosque daily after school, which has several implications for food and physical activity behaviours. First, time after school is limited to engage in physical leisure activities. Additionally, families are time pressured with regards to preparing and eating an evening meal, and travelling between school, mosque and home. Consequently, energy dense snacks are given to the children between school and mosque, and cars are used for transport. These two examples illustrate the importance of understanding the cultural context in which people are situated. Decisions around food and physical activity that are not the most healthy become a rational course of action when viewed within these contexts.

The themes emerging at the different contextual levels are now discussed in more detail, and are depicted in Figure 3.2. Crucially it can be seen that the interrelationships between the different factors are numerous, multidirectional, and operate across the different contextual levels. Thus from the data a complex network of contextual factors contributing to the development of childhood obesity in UK South Asian communities has been constructed.

Figure 3.1: Emergent contextual levels of influence on the development of childhood obesity

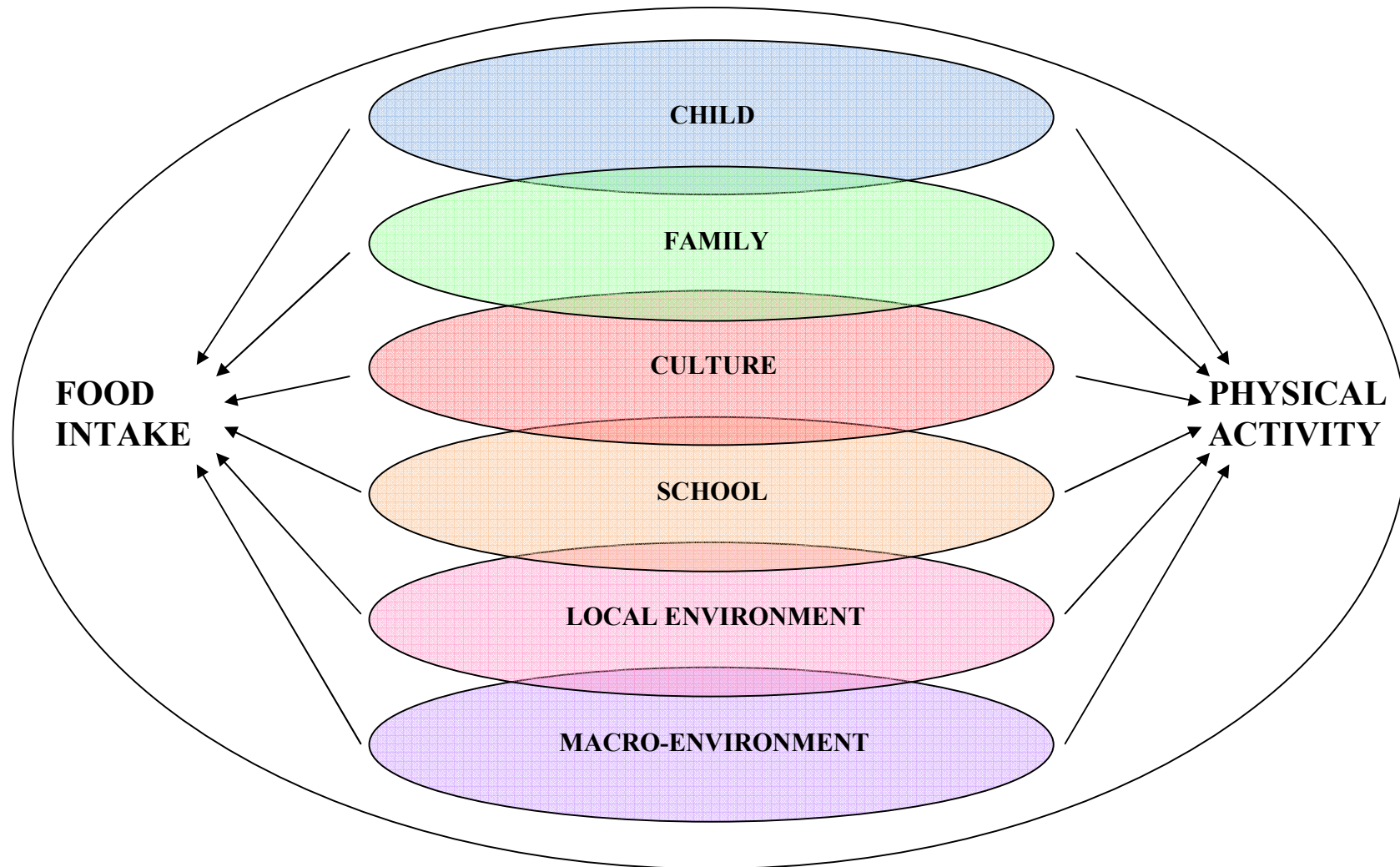
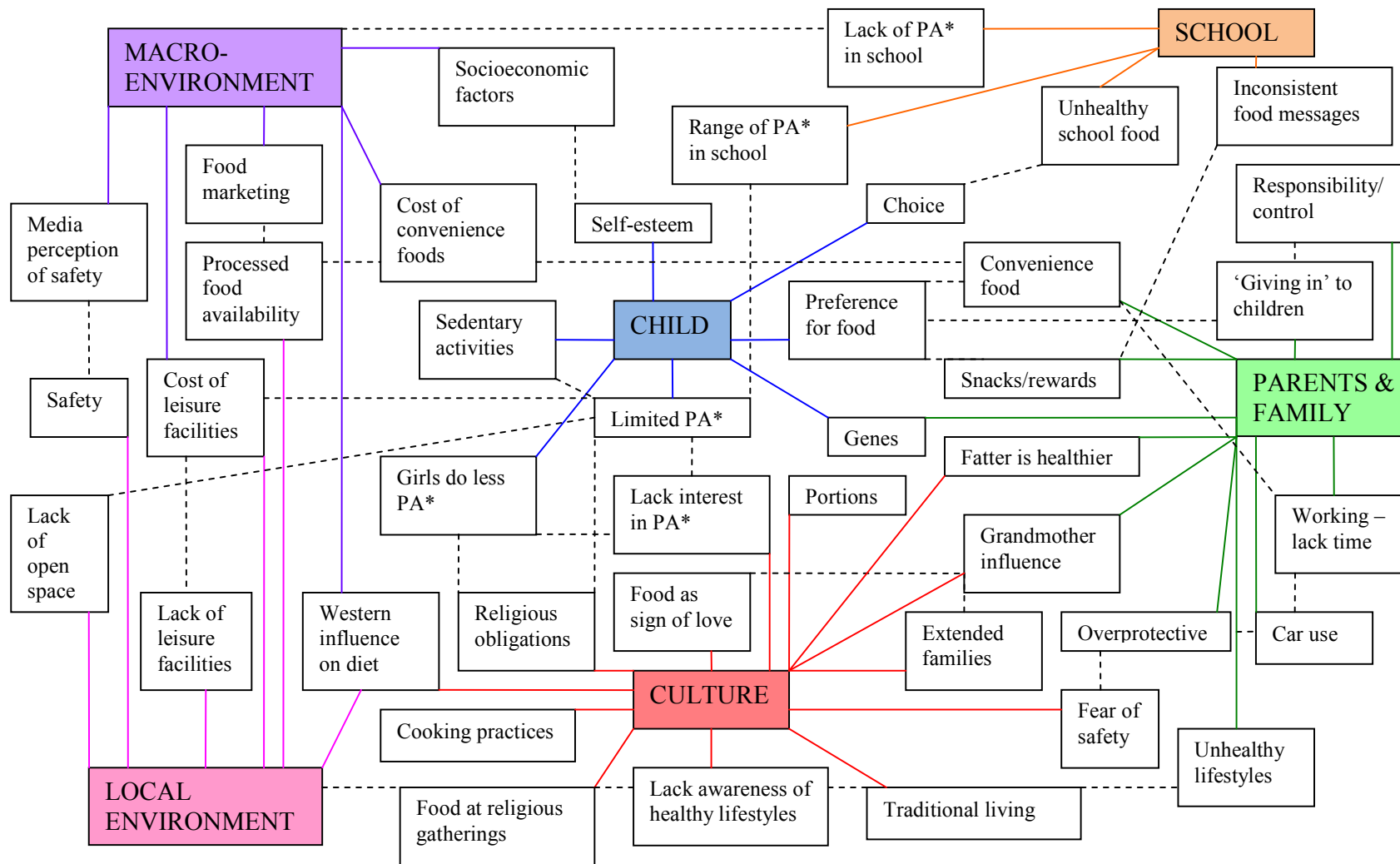


Figure 3.2: Schematic diagram of stakeholders' perceived causes of childhood obesity



*PA=physical activity

3.4.2.1 Unhealthy food intake

Child

The preferences that children have for unhealthy foods such as processed foods, fast foods and snacks high in fat and sugar were cited by all groups as a contributor to obesity. Linked to this was the issue of children being given too much choice. Participants of the school catering staff group drew attention to the fact that children expect to have choice both at home and school.

“It’s difficult to tell the children that, you know, vegetables are good for them, it’s very difficult, because they don’t know what’s good for them, that’s the problem, and they’ll go for stuff which they’ll like the taste of” (mother)

“I actually believe the choice should be reduced and I am very much against so much choice being bombarded at the child” (school catering manager)

Poor self-esteem leading to “comfort eating” emerged as a perceived influence on the development of obesity in the health professionals’, community leaders’ and one group of parents’ discussions. It was thought by some that low self-esteem in overweight children and possibly the external influence of bullying leads to a vicious cycle of comfort eating and therefore more weight gain.

“if they are having psychological difficulties like bullying or any other thing, they may be depressed and then they seek food as a comfort” (community leader)

Parents

Much discussion was generated in all focus groups on the role of parents in a child's diet.

Themes that related closely to the influences of choice and preference described above were parents offering too much choice of foods in the home, and 'giving in' to children's demands for unhealthy food. Potential reasons for 'giving in' behaviour by parents emerged, including parents taking on the role of friend instead of parent, leading to children being in a position of power within the family, and peer pressure on parents to behave in a certain way towards their children.

"it's a lot easier to let your child eat what it wants, it's hard work isn't it to say, no you are actually not going to have that today, you are going to sit down and have..." (school nurse)

"parents will come in [to a shop] and as soon as the child asks for it parents don't think, they will buy it for the children" (mother)

"I'm walking my son home and so is [names of two other parents], and these two decide to pop into the chippie because we have got one just there, which is irritating, and they can buy their children for tea whatever's in the chip shop, and there's me saying no, it's not healthy, we should go home, have a healthy meal, and you will have a treat once a week, then I feel bad because my children feel bad" (mother)

All groups expressed that a contributor to obesity in children was excessive consumption of unhealthy convenience foods, including takeaways, fast foods, unhealthy snacks and fizzy

drinks. Unhealthy food in packed lunches for school, and snacks to and from school were frequently brought up in the focus groups, especially by the teachers and community leaders. Parents identified snacks between meals as an issue, but not unhealthy packed lunches.

“parents meeting them at the gates with chocolate bars and candies that they eat walking along to home” (teacher)

“do you think that the fact that we are adding more processed food to our diet, I know we don't, we make things from healthy like you know, fresh food and stuff, but there are some times that we do bring in more processed foods” (mother)

Linked to the frequency of convenience foods and takeaways in the home was the issue of parents who work and so lack time to prepare meals. This emerged as a contributor to obesity in most groups, but two participants (a member of school catering staff and a leisure centre manager) articulated that this may be less of an issue in the local (materially disadvantaged) South Asian communities where mothers are less likely to work. The following interaction illustrates how knowledge of the local context can dispel prior assumptions, and therefore is crucial to understanding the decisions and behaviours of parents relating to food and physical activity:

“It's more about the time though isn't it, with a lot of parents, they don't have the time to prepare and they don't seem to want to have the time to sit there and prepare the food,

especially when you've been at work all day, and I can be a bit like that myself" (retail representative)

"Again, in this area, if we're talking about this area, no, because it's an extremely large Asian, we're talking about a South Asian population and traditionally the female would be in the house." (leisure centre manager in response to the quotation above)

A factor that was brought up in all the parent focus groups was that of parents themselves having unhealthy lifestyles and poor diets, which are transmitted to the children. This was a much less prominent theme in the other groups. One parent also stated that not all parents provide breakfast for their children and this could be a contributing factor.

"So if we eat healthy then we'll feed our kids the same food, and if we eat junk food our kids will be eating the same food." (mother)

"Like sometimes you can't be bothered to cook at home, and we just go to the shop and get chips and that lot, and end up paying money because you can't...you're lazing around yes." (mother)

Cultural influences within families and communities

There was implicit recognition in all focus groups that discussions relating to South Asians encompassed a heterogeneous group and many influences cited only related to a particular ethnic or religious group.

Cooking practices within South Asian families emerged as a contributor to childhood obesity in all groups. The use of fats and particularly ghee (clarified butter) was frequently commented on, however one South Asian community leader felt that there was a move to using more healthy oils in Asian cooking. Again, this illustrates how assumptions are made about communities that may not necessarily be the case. Portion sizes in Asian families were also cited by participants from the professional and community groups but none from the parent groups. A participating teacher thought that the tendency to large portion sizes in South Asian immigrant families may be due to the difference in availability and cost of food in the UK compared to their original countries.

“we’re looking at South Asian backgrounds aren’t we, it’s probably - they’re used to their own kind of food and they’re used to their traditional meal, and they’re used to their way of cooking it and using the things that are, you know, like the fats, the ghee and butter” (mother)

“when they are in other countries, they only make a smaller portion, so now all of a sudden, wow, it is probably cheaper than what it is back in their country, so that could be adding to their obesity, wow, there’s meat, there is food, and giving kids more instead of less.” (teacher)

The influence of religious practices was commented on in the health and community leader groups. In particular, the obligation of Islamic children and families to attend the mosque each day, leaving little time for the evening meal and other activities. The cultural practice of sharing food at places of worship was also highlighted.

"a lot of the South Asian children in this area come home from school for half an hour and then they are at mosque until 7 or 8 o'clock at night, so there isn't time to sit down and eat a meal." (school nurse)

"in faith groups food is cooked there and sometimes like samosas and pakoras [fried savoury snacks] and unhealthy food is served and I think you know there are so many people that go to the mosques and gurdwaras and temples" (community leader)

Several family characteristics that are frequent among South Asians were articulated as potential contributors to childhood obesity. Two of the parent group discussions brought up the influence of extended families living in the same household and how this can place demands on the parents that in turn disrupt family meal times and preparation of fresh food for children.

"the big families, you can't put them together, because everybody works, they go separate times to eat and things, but if you see like your own family, yeah, you can just put the food on the same I mean table so you can eat with your child and you can talk to him" (mother)

Closely related to this was a theme that was more widely discussed within the groups; the influence of grandmothers on children in South Asian families. Discussions in the health and community leader groups, and two parent groups centred around the power within South Asian families lying with the grandmother, and the pressure placed on the mother to give food to the children, even when not required. Other themes identified by these groups that related to

Asian families were the giving of food to children as a sign of love, and worry about children not eating enough, and being too thin. Both of these factors may be related to the attitude of grandparents towards feeding children. In addition to the influence of grandmothers, one community leader also commented that the fathers often dictate what is eaten and how it is prepared in South Asian households.

"I used to have battles with my in-laws over this, because they, again they thought they were caring and they were showing their love, they would give my children Kit-Kats and chocolates and chips and fried fish fingers, and I had to be very careful, I didn't want to offend them, but at the same time, I had to say look you know, you can't do this" (community leader)

"if my daughters have had one meal and then it was about 6 o'clock they ate I think, I went down to my mum's and when I came back at 8 o'clock they're saying they're hungry again, and so I'm saying 'no you can't eat again because you ate at 6 so you should have something healthy, have a fruit now' so my mother in law's like saying 'no no no give them something to eat, they're hungry and you're shouting at them and you won't let them eat, when kids want food you give them food'" (mother)

"and you get criticised as well if your children are thin. I mean, I get it all the time" (mother)

School

Participants in the community leader group and the leisure, retail and local authority representatives group commented on the influence of food in schools. There was a feeling that

despite the introduction of national standards for healthy school food, school meals were still unhealthy. It was also felt that the wrong messages regarding food were conveyed in schools, for example, using sweets as rewards. A parent also made the comment that teachers who are seen to consume unhealthy food are poor role models for children. In contrast, teachers and health representatives felt that food consumed by children in schools was relatively controlled and the real issue was food consumption in the home.

“That’s something we still get resistance against when we require schools to run a whole school food policy, they still...the last thing that they want to get rid of is the sweet jar and the chocolate” (local authority representative)

"you can offer them [the children] this balance at school, but as soon as they go out, everything is cooked with you know, butter or fat." (teacher)

Local and macro-environment

The professional and community leader groups all identified types of unhealthy food marketing as a major influence on unhealthy food consumption in children. Comments included advertising on the television, internet and in newspapers, fast food leaflets through letterboxes, product placement in shops, giving away toys with fast food meals, and misleading packaging leading the consumer to think that the product is healthy. Only one parent group referred to marketing as an influence and this related to unhealthy food made attractive to children by being linked to popular children’s characters. A catering manager also

thought that food and beverage sponsorship of sports was a significant influence on children, and that the government often conveyed mixed messages relating to food.

“my daughter, from a very early age, saw adverts on TV and when we used to go shopping she wants that, and she wants that, and I think it's as simple as that really, and it's taken in” (local authority representative)

“it's the pictures of the cartoons or, my children say oh that's got Shrek [character from a children's movie], yes, oh let's get that” (mother)

The easy access to ‘junk’ food outlets and the availability of convenience foods were cited by most focus groups, and it was felt that fast food outlets were particularly abundant in the more disadvantaged areas where these South Asian communities are situated. More broadly, participants from several of the professional groups and the community leader group felt that the more unhealthy aspects of the Western diet, such as processed and fast foods, were being incorporated into diets within South Asian communities, resulting in more unhealthy food intake overall.

“It is true, there's too much junk food out there now, it's a quick chip shop, I mean if you've got a local chip shop nearby, you're out of school and straight to the chip shop, even at lunchtimes.” (mother)

“they are losing sometimes, some of the South Asians, some of the best things of their diet and getting things like Karachi fried chicken [a South Asian fast food outlet] and you know which is local to us so they are taking the worst of what you would say, I don’t know what you would call it, the British diet, but you know what I mean” (community leader)

Convenience and fast food was also widely thought to be not only more accessible, but the cheaper option for a meal compared to fresh ingredients. Two participants (a parent and a local authority representative) disagreed with general opinion in their groups and felt that there was good access to cheap fruit and vegetables in the communities in question.

“Also I think food wise, I mean, the healthier foods are dearer, you are paying a vast amount of money for good food, whereas the junk food is much cheaper” (school catering staff)

“Mum says people think about money as well, the fact that on takeaways you are spending a lot of money and like if you were to buy for that price the good foods, you know you get value for money, you feed more people.” (Interpreter translating for Punjabi speaking mother)

3.4.2.2 Lack of physical activity

Child

Two groups of parents and a school catering staff group expressed that physical activity was more of a contributing factor to childhood obesity than diet, but this was not evident in any other groups. Both parents and catering staff have direct responsibility for the diets of

children, and feeding children is often a very emotive issue for parents, so it is unsurprising that these groups shift the emphasis to physical activity. Most groups identified sedentary behaviours as contributing factors, such as television watching, computer use and games consoles. The health group particularly discussed physical activity in obese children and the possible self-consciousness they feel when exercising, leading to another vicious cycle of not exercising and gaining further weight.

“I think the biggest thing at the moment with the 5 to 8 year olds, is actually the physical activity rather than the diet.” (mother)

“But with kids, because their lifestyle is particularly more sedentary than it ever used to be in terms of sitting on computers and playing PSP’s [games consoles] and all the other things where they just sit all day, then it’s, that’s the norm for them whereas the norm was as you were saying, going out to parks and running round and riding their bikes” (school nurse)

Parents

Closely related to the theme of sedentary behaviours in children was the issue of parents not letting their children play outside or walk to places due to anxieties regarding road traffic and the potential threat of strangers. Parent groups particularly raised this as an issue. In addition, participants in two of the parent groups and the leisure, retail and local authority group believed that Asian families in particular had a fear of letting their children go outside.

“I think, one of my perceptions of working with people and the South Asian community is that it's not realised to the extent to which there are additional fears that people have of public spaces and for many people in the South Asian community a lot of parks for instance in Birmingham which are no-go areas. There's fear of dogs, there's fear of people who may use dogs and may set dogs on them, because it has happened once or twice too.” (leisure centre manager)

This quote may relate in part to nature of the neighbourhood (materially disadvantaged), but may also imply that these communities face the additional problem of racial discrimination.

Car use and time pressures on parents were frequently cited as potential contributors to childhood obesity. Use of cars to travel short distances to school was particularly focused on by some parents and school staff, although one school governor pointed out that the majority of the children did walk to her school. Again, parents' work commitments, leading to reduced time to do leisure activities with the children, was discussed in most focus groups. One father felt that some families were more interested in material possessions, such as a good car and house, than investing time in their children.

“one of our problems is that parents were coming literally round the corner and they weren't on their way to work, they were literally, would drive round the corner, drop their children and drive back.” (community leader)

“Yes, what I am saying is that, I feel that parents, some of the parents are more interested in having a better car and a better house rather than having a nice lifestyle, a nice family lifestyle.” (father)

As with unhealthy food intake, most parent groups commented on parental lifestyles in terms of lack of physical activity and sedentary behaviours as a significant influence on the behaviour of children, but this was not articulated in the other groups. One mother felt that parents used televisions and computers as ‘babysitting devices’.

“And also we have unhealthy home lifestyle in a lot of Pakistani, Bangladeshi, I don’t know, maybe they smoke at home, and each of their parents work, they could not take the children out for vacation, and all the day the children are sitting in the home and watching TV.”
(father)

Cultural influences within families and communities

In the parent groups and some other group discussions, it was felt South Asian families are less likely to engage in physical activities, have more sedentary lifestyles, and have greater fear of letting their children outside. There was also a feeling that South Asians lack interest in sports and other physical activities. However a school catering manager and a leisure centre manager both expressed that this was an inaccurate perception. The issue of children and adults from South Asian backgrounds not feeling comfortable undertaking certain physical activities was raised in the parent groups. This particularly related to activities that involved more revealing attire, such as swimming. Several parents and school nurses commented that

this was a particular problem for South Asian girls. The school nurses also felt that South Asian girls lacked interest in, and motivation to undertake physical activities.

“[we need to] try and break this mould of the perception that children are lazy or the perception that a particular group of people don’t like sport which very often is the case, with Asian culture, they think that they don’t want to play football, they don’t want to do a sport, well who says so, you know, and I mean that is just not true” (school catering manager)

“they [South Asians] have this tendency, okay the boys can do anything, but the girls can’t go swimming because they have to dress in front of boys” (mother)

In particular relation to Islamic communities, several groups (school catering, community leaders, health and one parent group) commented that the time for children to undertake physical activities was significantly restricted by the daily requirement to attend the mosque.

“I think some, some communities they haven’t got the time, because they go to the mosque, they haven’t got that time. As soon as they finish school, they have got activities [at the mosque] after school” (school catering staff)

School

The lack of physical activity in schools was cited as a contributor to childhood obesity by two of the parent groups, the community leaders, school catering staff, and the leisure, retail and local authority group. Reasons behind this were suggested, including other priorities within the school curriculum, and health and safety issues. The community leaders group felt that the

range of activities offered in schools was largely limited to competitive sports, which do not appeal to all children.

“I don’t think they get enough exercise full stop in schools anyway, even in the curriculum - they’re just paying lip service in my opinion, exercise and stuff, especially junior schools and infant schools, which is the age that we’re talking about.” (leisure centre manager)

Local and macro-environment

Several groups discussed the fact that there is a lack of open space for children to play in, and this included the absence of school playing fields. One parent also commented on the lack of organised activities in parks and green spaces. In contrast to other groups the community leaders felt that there are accessible green spaces but they are not used as they are not perceived as safe, in part due to stories reported in the media. The leisure, retail and local authority group also felt that the media portrayed local communities as unsafe, and that there was a general perception that there is more road traffic, making local environments unsafe.

“I have certainly been shocked in the area that there is not a huge amount of green space where I work, but there are little bits of park and I have yet to see a young family in there. I have seen teenagers in there and I have seen men with horrible nasty looking dogs, but I haven’t seen the young families” (community leader)

Access to local leisure facilities was discussed in several groups, with common themes being the prohibitive cost of leisure opportunities for many families, and the absence of local leisure and sports facilities.

“I don’t think there is enough outreach work going on within the community, from the Council to the community in letting them know what’s available. Again I don’t think there is very much available in that area, and there should be more made available for those children”

(mother)

Two groups (health and parent groups) felt that society had changed so that physical activity is no longer part of daily life, and this significantly contributed to obesity development. One dietician felt that the weather discourages people from doing physical activity in the UK.

“What it is, is that nowadays to stay a healthy weight, it requires a lot more effort than it did in the old days when we had to use the mangle and we had to walk every day, it’s the effort that’s changed” (dietician)

3.4.2.3 Other factors perceived to affect childhood obesity development

Child and parents

The role of genetics in childhood obesity was brought up in the parent groups and a catering staff group, but not in the other groups. Several participants believed that children can be genetically predisposed to obesity. Interestingly, when the subject of genetics was discussed, two participants challenged this. One parent thought that genes were used as an ‘excuse’ by

parents of overweight children, and a catering manager commented that obesity was not a problem when food was less available in the UK after the second world war.

“In some families unfortunately, you know, the parents are big so the children are genetically big.” (mother)

“it's like my daughter you know, they [siblings] all have the same food, but she is like, you know, she is big, they are just kids you know, they [her siblings] have the same food and they are quite skinny” (school catering staff)

Parental responsibility was also a topic of discussion in the parent groups, and less prominently in other groups. Several parents expressed that a significant contributor to children developing obesity was the failure of parents to take responsibility for their children's dietary and physical activity habits. In addition, it was felt that parents lacked control over their children.

“they [parents] don't take responsibility for the fact that their child [is overweight], they think, ‘oh they will grow up in, whatever, it will all go’, so they don't really think it is their responsibility” (school nurse)

In the above quote, the school nurse has interpreted parental inaction as a lack of responsibility, but in the context of parents perceiving childhood overweight to be something that will resolve with growth, the decision not to act becomes rational.

Cultural influences within families and communities

A theme that was frequently raised in discussions was the lack of awareness of healthy lifestyles in South Asian families and communities. An Islamic faith leader felt that healthy messages were not given any importance by South Asian faith leaders, and so were not disseminated to these communities.

Local and macro-environment

A point put forward by teachers, community leaders, and the leisure, retail and local authority representatives was that of socioeconomic issues taking precedence over healthy lifestyles such as healthy eating and physical activity. These included poverty, unemployment, poor accommodation, domestic violence and other family stresses. In contrast to this, one participant (school catering manager) commented that in general, the UK is an affluent nation and this influenced dietary and physical activity behaviours.

“I suppose therefore if you are, I don’t know poor or whatever, working class, or from - I don’t know what the new terminology is, but - then are you going to be sitting there worrying about what your food intake is and whether you’ve got down to the gym that day, or are you going to be worried about whether you’re going to pay your heating bill, whether your electric’s about to switch itself off” (retail representative)

3.5 Discussion

This study explored and analysed the beliefs of key South Asian community members, and other stakeholders linked to these communities, regarding the contextual factors that influence the development of childhood obesity. There is an increasing number of studies that have undertaken qualitative enquiry into beliefs around the causes of obesity²²³⁻²²⁹, most of which have sought views from particular groups (e.g. parents). This study stands apart as the views of a wider range of stakeholders have been explored. This approach has an advantage in that it has enabled the exploration of a wide range of perceptions and construction of a comprehensive picture of perceived causes of childhood obesity. Therefore, a rounded understanding of the contextual influences on the development of childhood obesity in these communities has been gained.

Overall, participants identified a broad range of causal factors across multiple contextual levels. There was much focus by all stakeholders on the role of parents and family, and many external influences on parents were identified, for example, work commitments limiting time of parents to cook or do leisure activities with children, or safety issues in the local environments leading to keeping children inside and limiting physical activity. Of note is that the family and parent factors were the major topic of discussion in the parent focus groups and these participants also felt that there was an unexploited opportunity to target parents and families for intervention (see chapter 4).

Although the school context was discussed in most groups as a potential contributor to the development of childhood obesity, it featured much less prominently than the family context. School influences did not feature in the teacher or health representative groups. This is possibly due to the increasing national emphasis on the promotion of healthy lifestyles through schools.²⁰⁰⁻²⁰² Participants from these groups identified that schools were fully signed up to the health agenda and so generally did not feel that schools were causal influences in the development of childhood obesity. A more fundamental issue may be that teachers are unwilling to identify school factors as a problem as this is their area of responsibility. This has implications for implementing interventions in a school setting; if teachers feel the problem lies elsewhere, they are less likely to be fully engaged in delivering the intervention. In terms of the wider environmental influences, most groups discussed the local community and environmental context, and professional participants explicitly articulated the wider societal view. In particular, the influence of food marketing was given much attention. Also the influence of material deprivation and social issues was identified by several of the professional participants. Parent participants also articulated wider societal influences implicitly through their stories. For example, the abundance of fast food shops, and the proximity of these to their homes and schools, and the lack of accessible leisure facilities in their local communities were highlighted.

The South Asian cultural context featured throughout all focus group discussions. In addition to the influence of traditional South Asian family structures, there was focus on traditional foods and cooking practices, as well as diet-related social and religious practices. Cultural and religious influences on physical activities were also given prominence in the focus group

discussions. These ranged from logistic issues such as the requirement to attend places of worship restricting time for leisure activities, to the perception that in some communities it is not acceptable for girls to undertake certain activities. In addition, some South Asian participants felt there to be a lack of awareness of what constitutes a healthy lifestyle in these communities. The issue of acculturation was touched on by some participants in terms of the changing diets within South Asian communities. Although the theme of acculturation was not developed further in discussions, it is likely that in the UK, other South Asian lifestyle features are changing in response to the wider Western society, and this in turn has an influence on the development of obesity. The issue of acculturation therefore adds a further dimension to discussions around the cultural context. The prominence of the cultural context and how this links to the family and home, and wider community is clearly visible in Figure 3.2.

The findings of this study resonate with the perceptions of contributors to childhood obesity in various communities across the globe. Themes identified by South Asian community stakeholders, such as child preference, sedentary activities, poor parental role models, lack of time for food preparation and leisure activities, unhealthy school food, lack of and cost of leisure facilities, fast food availability, food marketing and safety have been identified by members of communities from the USA, Canada, Central America, Australia and the UK.²²³⁻

²³² In a systematic review of qualitative studies exploring parents' perceptions of behaviours leading to obesity in children, Pocock and colleagues synthesised the evidence from 21 studies, mostly undertaken in Western countries. They grouped their findings into 6 overarching themes; child factors, family dynamics, parenting, knowledge and beliefs, extrafamilial influences, and resources and environment. Within these broad themes, 32

subthemes were identified which strongly resonate with the emergent themes presented here.²³³ It is clear then, that despite the focus on an immigrant community in a Western country, much of the data emerging from this study fits with the findings of the Pocock review.

One may conclude then that seemingly very different communities have very similar perceived causal influences on the development of childhood obesity. While this may broadly be true, closer examination of the data from this and other studies reveals essential differences that need to be considered when planning prevention interventions. It is only by examining and understanding the particular community contexts that we can begin to see why individuals may behave in a certain way. Without this understanding we may misdirect our intervention efforts and miss the real opportunities for obesity prevention. To develop this point further, some examples are now discussed: A particular characteristic of South Asian communities is the central role of religious practices and customs. While this is not unique, understanding the precise nature of these is a prerequisite for successful intervention. To take a simple example, the provision of more after school clubs is unlikely to influence physical activity levels in a community where the majority of children are obliged to attend mosque every day after school. Another example is provided by considering the family structures within South Asian communities. An intervention with the objective of increasing parenting skills of mothers is unlikely to result in changes to the diets and physical activity behaviours of children in a community where family hierarchies give other family members primary control over the children.

Other studies have also drawn attention to cultural influences.^{223;226;234} In one focus group study of English and Spanish-speaking parents in the USA, Spanish-speaking participants voiced that thinness was traditionally viewed as unhealthy and less attractive, particularly by grandparents. This view was not articulated by the English-speaking participants.²²⁸ In a UK prevention study based in secondary schools with predominantly South Asian pupils, focus groups with pupils and staff explored barriers to healthy lifestyles and revealed some identical issues to this study, such as attendance at mosque limiting time for physical activity and reluctance of girls to undertake physical activity.²³⁵ Understanding these differing cultural contexts and social norms is critical for the development and tailoring of obesity prevention interventions to target communities.

Let us now consider the conceptual models for the development of childhood obesity, and how the views gained from community stakeholders fit with these. Participants were able to think through and articulate the broad range of influences on children with respect to overweight and obesity, and the relationships between them. Whilst the greatest focus was on children and their families (the micro- and mesosystems in Ecological Systems theory), the wider societal influences were discussed at local, national and even international level. Participants also showed a sophisticated understanding of the reciprocal nature of influences operating at different contextual levels, for example, the relationship between parental fears of their child's safety and the portrayal of unsafe environments by the media. The stakeholders' perceptions of childhood obesity causes therefore largely concur with the proposed conceptual models.^{163;215} However, a central finding of this study, along with studies seeking community views in other settings, is the importance of the cultural context. Although the theoretical

models encompass the cultural context to a degree by including factors such as family, community and demographic characteristics, it is not explicitly considered.^{123;215} This is a potential weak point in using these theoretical frameworks to analyse the contextual influences operating in communities targeted for childhood obesity intervention. Hughes and DuMont argued for the use of qualitative research methods, and in particular focus groups, to unlock the cultural knowledge of communities and facilitate development of conceptual frameworks to guide future research within those communities.²³⁶ They emphasised that to impose a conceptual framework on a community runs the risk of omission of constructs that are central to the community's experiences. With this and the findings of this study in mind, I would advocate that cultural and religious norms, values and customs are made explicit in theoretical models of the development of obesity in children. This would guide analysis of communities targeted for intervention, and ensure that contextual information that is crucial to the intervention development and delivery process is not overlooked.

There were a number of limitations in this study. As is common with focus group studies, recruitment of participants proved difficult. Focus groups often had a small number of participants and many did not attend both sessions (Table 3.2). This may have limited the range of discussion and development of themes within the focus groups, however, a variety of community members were purposively sampled, so it is likely that a broad range of views were accessed. The proportion of men participating was very low, and so the views expressed are largely from a female perspective. It is possible, that had the participants been predominantly men, the emergent themes around diet and physical activity, and the roles of the different settings (e.g. school and home) would have been different. This is a potential area

for further exploration. Although we intended to run homogenous identity groups, in practice, some groups were mixed identity, but as we have discussed, the moderators monitored these groups closely to ensure discussion was not inhibited. This study was intended specifically to explore the contextual influences on childhood obesity in South Asian communities, and so we would not expect the specific findings to be generalisable outside of these communities, although as we have emphasised, the importance of the cultural context in the development of childhood obesity could be applied to any community across the globe. The problem with understanding the cultural context of communities is that communities may represent a very heterogeneous group of people. In reality, the cultural context may vary within neighbourhoods, religious groupings or even between families. The subjects of this study (UK South Asians) cannot be regarded as a single community, and whilst some of the emergent contextual data could be applied to all of the communities under study (and beyond), some will only be relevant to specific groups. This is particularly the case with the cultural contextual data.

3.6 Conclusions

The use of focus groups to access the knowledge, views and beliefs of a range of members of a particular community has enabled construction of a detailed picture of the multiple contextual influences acting on children, and the interrelationships between them. The importance of the cultural contextual influences on the development of childhood obesity has been highlighted, and this is supported by research in other communities. Cultural influences need to be explicitly articulated in conceptual models of childhood obesity development, as

this will guide researchers to seek to understand this aspect of context when developing and delivering childhood obesity interventions.

4 DEVELOPMENT OF THE BEACHES CHILDHOOD OBESITY PREVENTION PROGRAMME

Despite the widespread prevalence of childhood obesity and the significant implications of this on population health, solutions to this problem are as yet elusive. As discussed in chapter 1, intervention studies have, at best, shown marginal short term changes to obesity or related behavioural outcomes. The numerous systematic reviews of childhood obesity prevention interventions draw the same depressing conclusion: more research in this area is needed.^{141;142;150;152} The landmark systematic review by the Cochrane collaboration called for a focus on intervention development, and the use of qualitative methods to access information from relevant local community members to inform intervention design.¹⁴¹

In this chapter, the development of a childhood obesity prevention programme targeting 5-7 year old children, with a particular focus on South Asians is described. Use of the theoretical and modelling phases of the MRC framework for complex interventions^{183;184} to guide the development process is discussed.

4.1 Background

4.1.1 Developing and evaluating complex interventions to improve health

Complex interventions comprise a number of components that may act independently and interdependently.¹⁸³ There are many examples of such interventions within healthcare, though behavioural change interventions such as those to prevent childhood obesity extend far wider, to include schools, local communities and early years settings.

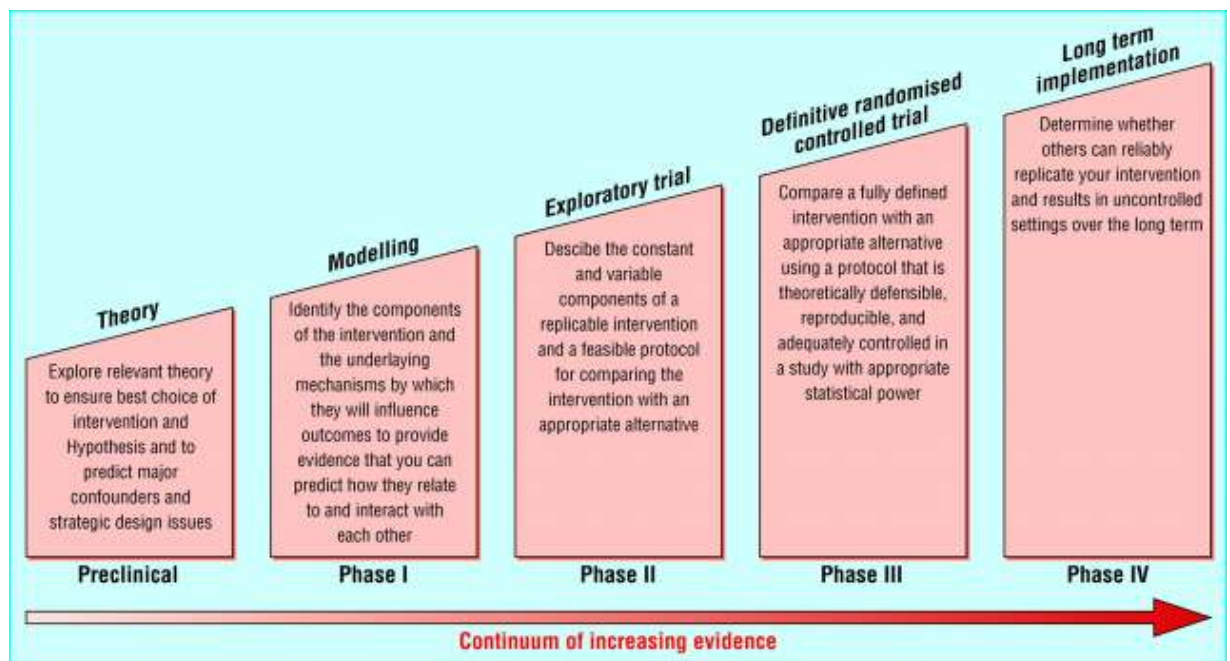
There is increasing recognition of the difficulties in evaluating complex interventions, especially the limitations of using study designs such as randomised controlled trials (RCTs), which are traditionally regarded as the ‘gold standard’ for evaluating technologies such as new drugs.¹⁸⁴ RCTs give little insight into which parts of a complex intervention are effective, and do not take into account context. The Medical Research Council (MRC) identified the need for a different approach and constructed a framework for the development and evaluation of complex interventions.^{183;184} The purpose of this was to more clearly define intervention components and their interdependencies through processes of theory building, modelling and piloting, so that this in turn could inform design of a definitive trial. The stages outlined in the framework were akin to the sequential phases employed in the development of drugs (Figure 4.1).

Since its development in 2000, the MRC framework has been used to guide the design and evaluation of several complex health interventions. Examples include development of diabetes self management programmes^{237;238}, secondary prevention interventions for coronary heart disease and stroke²³⁹⁻²⁴¹, programmes of care for patients with life-threatening conditions such as cancer or multiple sclerosis^{242;243}, and an intervention to support carers of stroke sufferers.²⁴⁴

Application of the MRC framework has varied greatly, particularly the theoretical and modelling phases (preclinical and phase I), with a range of different methodologies employed. Some case studies describe in detail the development process that are guided by these two

phases^{241;243;245}, and it is clear that processes are iterative and occur simultaneously. The MRC has recently refined the framework to reflect this.²⁴⁶

Figure 4.1: UK Medical Research Council Framework for the development and evaluation of complex interventions to improve health



Reproduced from Framework for design and evaluation of complex interventions to improve health. Campbell M., Fitzpatrick R., Haines A., Kinmonth A.L., Sandercock P., Spiegelhalter D. et al. 321: 694-696, BMJ 2000, with permission from BMJ Publishing Group Ltd.

4.1.2 *Developing complex interventions to prevent obesity*

The interventions developed so far using the MRC framework predominantly target specific patient groups, and sit firmly within the healthcare arena. Community-level health promotion programmes such as childhood obesity prevention initiatives are not confined to the healthcare

setting, but are often subject to evaluation in RCTs. Despite this, as Summerbell and colleagues highlighted¹⁴¹, there are few studies that focus on the intervention development process, and to date, no studies that have explicitly used the MRC framework for this.

Two previous childhood obesity prevention trials that have attempted to tailor interventions to target communities through a detailed intervention development process are the Pathways study^{174;247} and the Dutch Obesity Intervention in Teenagers study (DOiT).²⁴⁸ The Pathways study, targeting American Indian children, used mixed methods in a formative research process to identify the risk behaviours for obesity, and the sociocultural influences on these behaviours. This information was then linked to theoretical constructs to develop an intervention programme.^{174;247} The DOiT study, based in the Netherlands, developed an adolescent obesity prevention programme using an intervention mapping procedure^{248;249}, combining scientific evidence, needs of the study population and theoretical constructs.

4.2 Aims

The specific aim of this chapter is to describe the methodologies used to develop the BEACHeS study childhood obesity prevention programme, and the process used to combine these. Additionally, use of the MRC framework for complex interventions in guiding the intervention development process is examined. The final design of the intervention programme that was piloted in the BEACHeS exploratory trial is outlined.

4.3 Development of the intervention: theoretical and modelling phases

The methodologies employed for these phases were a review of the literature on childhood obesity prevention, focus groups with local stakeholders, an expert group meeting, a review of existing resources in the participating communities, and a theoretical mapping process. Each of these is discussed in turn.

4.3.1 Review of the literature

This had two main aims. First, to identify the complex interventions previously evaluated in obesity prevention studies and deconstruct them into their component parts. Second, to review the evidence of effectiveness of the different interventions. The resulting information was used at multiple points in the intervention development, providing an evidence-based foundation for this process. The identified intervention components and processes were summarised into meaningful groups which were subsequently used in stakeholder focus groups (see chapter 3 and appendix 3). Information on intervention effectiveness was not used in the focus groups, as it was recognised that effectiveness of a multi-component intervention may depend in part on synergistic effects between the different elements.

Given the volume of research within the field, the focus was to identify systematic review articles and guidelines on childhood obesity prevention. The Cochrane, MEDLINE and the National Institute for Health Research (NIHR) Centre for Reviews and Dissemination databases were searched. In addition, the following websites were searched; National Institute for Health and Clinical Excellence, NIHR Health Technology Assessment Programme,

Scottish Intercollegiate Guidelines Network, and Swedish Council on Health Technology Assessment. Eight systematic reviews were identified as relevant^{141;142;146-148;151;152;219}, encompassing 70 studies in total.

Variation in the inclusion criteria, and also the year that the systematic reviews were undertaken, resulted in a wide variation in the number of studies included in each review (9 to 46 studies), with 47% (33/70) of the total number of studies only included in one review. The age range of participants in included studies differed, with the narrowest age range of 6-19 years¹⁴⁷ and the widest of 0-22 years.¹⁵² Two reviews focused on school based interventions only^{147;151}, whereas others included family and community based interventions. The majority included only studies with the primary aim of preventing overweight and obesity in children but 3 reviews had a broader approach and included studies where obesity prevention was not the primary aim.^{142;147;152} Four reviews included prevention programmes targeted at high risk populations^{142;147;152;219}, whereas the other reviews included only intervention studies aimed at a whole population. All reviews included studies with BMI and/or another measure of body fat (skinfold thickness or waist circumference) as outcome measures. The types of intervention programmes included in the reviews were targeting diet, physical activity, sedentary behaviours, or a combination of these.

Despite the wide variation in included studies, the findings from the eight systematic reviews were relatively consistent. The main findings related to the relatively poor quality of studies overall and the lack of studies with long-term follow up data. The majority of reviews concluded that most interventions showed some positive effect on obesity-related behaviours

such as food intake, physical activity or sedentary behaviours, but the effects on measures of overweight and obesity were, at best, modest. Some reviews concluded that the characteristics of effective interventions could not be determined^{141;146}, whilst others indicated that certain types of interventions were the most promising. Four reviews suggested that interventions which include a component targeting sedentary behaviours such as television viewing is a potentially effective approach^{147;148;151;219}, and one review concluded that parental involvement may increase effectiveness of an intervention. There were some conflicting findings, for example one review reported that interventions of longer duration were more likely to be effective¹⁴⁸, but another reported that briefer interventions were associated with larger effect sizes.¹⁵²

A range of intervention components were extracted from the systematic reviews to present to participants in the stakeholder focus groups. Childhood obesity prevention guidelines and other reviews were also used to supplement the resulting information to ensure that a broad range of interventions were identified.^{17;140;220} The identified components were classified according to the setting for delivery, and the activity process (Table 4.1).

Table 4.1: Classification of intervention processes for childhood obesity intervention

Setting	Broad description of intervention process	Type of environment targeted*
Family	Activities for family	physical/sociocultural
	Educational materials aimed at families	physical/sociocultural
	Motivational interventions and incentives to promote healthy behaviour in family	economic/sociocultural
	Campaigns aimed at families	political
	Develop parenting skills	sociocultural
School: Curricular interventions	Alter physical education provision	physical/political
	Increase physical activity provision	physical/political
	Increase nutrition education	political
	Increase general health education	political
	Work on self-esteem	sociocultural
School: Extra-curricular interventions	Motivational interventions to influence behaviour change	economic/sociocultural
	Media promotion of healthy diet and physical activity	political
	Lunchtime /after school/ holiday clubs	physical
	Encourage healthy travel to school	physical/sociocultural
	Competitions/rewards to promote healthy behaviours	economic
School: Food provision	Increase nutritional value of school meals	physical
	Improve provision of and access to healthy food in school	physical
School: Other	School action plans/ policies related to health	political
	Professional development for teachers	political/sociocultural
	Involve children in school changes	political
Community	Adult role models/school ‘champions’	sociocultural
	Provide sessions for all community members	physical
	Work with local shops	political/economic

*As defined by the Analysis Grid for Environments Linked to Obesity¹²²

4.3.2 Focus groups with stakeholders

We recruited key adult stakeholders from the 8 school communities taking part in the BEACHEs study to participate in focus groups. A detailed description of participant

recruitment and the two stage focus group process is given in chapter 3. The overall aim of each focus group session was to reach consensus on up to 8 intervention components that participants would like to see included in an intervention programme in their local communities, taking account of relative importance and feasibility.

In addition to the analysis described in chapter 3, a different analytical technique was used to examine the data generated through participant interaction during the prioritisation process. Data on the range of ideas for childhood obesity prevention, barriers and facilitators to intervention, and the balance given to importance and feasibility of each component were extracted from the transcripts. The analysis was undertaken jointly by the two moderators of the focus group sessions (MP and PA). A framework for extracting the data was developed prior to analysis (appendix 5), which enabled extraction of the data on interventions emerging at different points during the focus group process. In this way we identified interventions that were suggested, those that were prioritised as important, practical, or both, and those that were in the final priority list. The intervention data was categorised in the same way as data from the literature review (Table 4.1). In addition, the framework enabled key contextual information on settings for interventions, and potential barriers to delivery of interventions within participants' local communities to be captured. This analytical approach was more deductive than most qualitative analytical techniques, but it is recognised that this is an appropriate approach to analysis when undertaking applied qualitative research such as this, that has preset aims and objectives.²⁵⁰

An additional four focus groups were run with 26 boys and girls (age 6-7) in one of the schools participating in the BEACHeS study. Intervention ideas generated by the adult focus groups were presented to the participants to explore their acceptability to children. Each group considered a particular area of intervention, these were; food in school, food out of school, physical activity in school and physical activity out of school. Children were initially asked to take turns in holding a teddy bear, and during their turn, state their favourite food or activity (depending on the topic the group were focusing on). Children were then asked which foods/activities they thought were good for their health, and which were less good for their health. Following this, participants were asked to pretend it was their job to get children to eat more healthy food or do more healthy activities (in or out of school, depending on the group), and write down or draw ideas of how they might do this. Finally, children were supplied with two voting cards (a happy face and a sad face to indicate whether they liked or disliked the idea of the intervention), and asked to vote on a series of intervention ideas that had frequently been prioritised in the adult focus groups by holding up one of the two cards. The intervention ideas were presented both verbally, and with a visual aid (a card held up for the group to see with both a simple written explanation and a picture of the intervention). The overall outcome of the voting for each intervention was summarised for the group by sticking a coloured dot on the intervention card that indicated either 'a good idea', 'a bad idea' or 'in between'. The focus group schedules can be seen in appendix 6.

Field notes were kept during the focus groups. These, together with the children's pictures and the outcomes of the voting exercise were examined to gauge how well received the interventions would be with children.

In order to draw general conclusions around intervention from the focus groups, the data from the different groups was collated for the different intervention settings and categories.

4.3.3 Findings from stakeholder focus groups

4.3.3.1 Targeting families

Interventions aimed at families and parents emerged as important across all focus groups. Many participants reported that the focus of childhood obesity interventions should move from schools to the family, as schools were saturated with health interventions and families were the key to influencing children of this age. Most groups recognised that schools provide a gateway to targeting parents (especially mothers), and so provide a channel through which family interventions can be delivered. A key group who did not express this view was the teacher's group. Some of these participants felt that it would be best to target families away from schools, as there was little capacity for schools to take on this wider remit. Many groups felt that accessing fathers and extended family members was important but acknowledged that this was extremely difficult.

"It comes down to the parents doesn't it?...whatever the school does... whether it's fruit or break snacks or lunchtime, I think it's excellent. But after that when I take them home, you know, the school doesn't know what's been put down there" (parent)

"you could offer classes in healthy eating and such like, or do keep fit and also, or something with parents, but you only get a very small amount that are coming in and you are putting in a

lot of time and resource into educating a few, it's getting them in, getting at them from other channels rather than just through school, and that's where it's difficult isn't it, it's getting to people, which is where you are so limited.” (teacher)

Health based education and activities for families, and more broadly, interventions to increase parenting skills emerged as priorities for several, and were considered important by almost all groups. Participants felt that these component themes were closely linked, and there was emphasis on educational interventions aiming to confer skills, rather than knowledge. Written educational materials were felt to be largely ineffective in the target population. Several groups expressed that delivery of educational activities for families through schools would be feasible, although delivering interventions to address the broader remit of parenting skills was acknowledged by some to be more resource intensive. Health based educational activities for families and parents were popular with the children’s focus groups.

“It's educating the parents, I think that's vital. And not in the form of just giving them notes, because most of them won't be able to read or write, I think it's going to the community, going to schools, somebody who speaks the language, interpretations of different lifestyles and different types of things, I think that would help a lot” (parent)

“if you had a parents day, where they actually brought their parents in with them, and they had like a cooking class, or classes done about healthy eating, where the parents were there with the children, learning the same things that the children are learning about food” (parent)

4.3.3.2 School setting for physical activity intervention

School based interventions were discussed across all focus groups, and it was widely recognised, particularly among the professional groups, that there was much ongoing activity related to healthy behaviours, partly linked to UK national directives (e.g. healthy school food standards, Healthy Schools Programme^{200,201}). Participants felt that new initiatives should be coherent with other school demands.

"well the healthy schools standard is a cyclical thing now, it is moving forward,... so I think as far as promoting a healthy lifestyle, schools are doing a pretty good job." (teacher)

"It has to be effortless, well planned, popular, sustainable, possible to embed in school practice and school life, not require too much staff time, not rely on volunteers" (leisure representative)

The majority of focus groups prioritised intervention components related to increasing physical activity within the school day. These were widely perceived to be both important and feasible. There were many specific suggestions, including curricular activities, physical activity homework, and extracurricular structured activities outside of class times.

Opportunities for this type of intervention were identified, such as building on existing school physical activity schemes, and the potential of involving parents. Interestingly, the teacher's group identified the opportunity to increase physical activity in schools in this way, and included this in their final priority list. This is somewhat inconsistent with the data that

emerged from this group on the contextual factors influencing the development of childhood obesity (chapter 3), as they thought schools had relatively little influence. The idea of more “fun” physical activity in school was well received in the children’s focus groups.

“one thing you can look at is, if they’re at school and they’ve just had this lunch, you’ve got like this hour, in theory, where you’ve got them, someone being paid to supervise them, it’s all organised. So the lunch hour and the break hour it would be maybe to look at introducing games... to get the kids out of the dinner halls, get them outside, then get them playing.” (retail representative)

Provision of physical activities out of school time was felt to be important across most groups and was frequently in the final priority list. Accessibility to organised activities in terms of location, timing, cost, and range in terms of cultural acceptability and interests were perceived as important. There were mixed opinions on the feasibility of delivering out of school activities. Particular barriers raised in the focus groups related to religious practices. Low acceptability of sportswear, especially swimwear for women and girls from the Islamic faith was identified as an issue. Participants also drew attention to the daily requirement of attending mosque school after regular school for local Muslim children, which limits time for other activities (chapter 3 offers a fuller discussion of this emergent theme). After school physical activities were nevertheless popular with children.

“from a Muslim background like myself, I can’t take my children swimming because I just don’t feel comfortable” (mother)

"When you say after school activities, we have after school clubs in school, but children don't want to go because they know they've got mosque and they haven't got time to go to activities"
(mother/school support staff)

4.3.3.3 School setting for dietary intervention

Improving the nutritional value of school meals and access to healthy foods in school was frequently discussed across the focus groups. Participants expressed mixed views on the importance of these, with some feeling that it is very important and others feeling that this is relatively unimportant compared to addressing food intake out of school. Some professional participants identified that national policy was being implemented to address the nutritional content of food in schools.

"I totally and absolutely agree that it [nutritional content of school meals] is important, but is it, is it good enough as it is and are we just not talking about what they get at lunchtime, we are talking about what they get before and after school. So of course it is important but I just feel that it is happening already" (community representative)

4.3.3.4 Use of incentives

Rewards for healthy behaviours were frequently suggested. This was seldom seen as important and was in the final priority list for few groups, but it was highly rated in discussions on feasibility, and was a popular idea with children.

“Rewards for healthy lunch boxes, that is something that is really easy to do, we find a nice sticker, you do not have to do anything else, I've got healthy lunch box stickers and they work a treat” (school-community liaison representative)

4.3.3.5 Involving children

Much discussion was generated around involving children in the planning of delivery of interventions through mechanisms such as school councils. The consistent message was that it is both important and feasible to involve children in this way.

“that is why involving children in the changes [is important], you know hopefully you can encourage them to decide not to go and have their ice cream after school or whatever.”

(health representative)

4.3.3.6 Role models

The importance of adult role models in influencing healthy behaviour was a repeated theme. Potential role models included parents, teachers, celebrities, and faith leaders.

“I know that a sporting hero, you know, if someone came along, it doesn't matter who... and said you have to eat more beans, they would do it” (teacher)

Given the predominantly Muslim population and the time spent at mosque by many of the families, faith leaders were a particular focus of discussion.

“there are so many people that go to the mosques and gurudwaras and temples and what have you and that is the way to access all these people and the children so working with the faith groups would be important I think.” (community leader)

4.3.3.7 Community setting for intervention

There was a general perception that the community setting provided an unexploited opportunity. The provision of low cost physical activity and healthy eating sessions locally for children, families, and other community members, were suggested as potential interventions.

“if there were people that were running community activities that could gather a group of boys in the park, and say, come on let's do a free activity” (parent)

There was also acknowledgement of the many opportunities and facilities available locally which families were not aware of and could be better signposted.

“showing families the parks we have, you know, canal walks and things like that.” (leisure representative)

Delivering interventions in the community was prioritised by several groups. Some groups prioritised delivery through faith organisations, but there was recognition that engaging faith leaders with the health agenda could prove very challenging, as the quote below illustrates.

Children did not find the idea of health or physical activity sessions delivered through mosques appealing.

“The most unfortunate thing is like Bangladeshi and Pakistani, a lot of mosques the Imams, they are not British, you know trained in this country. They just came from the villages, the majority of them” (Islamic faith leader)

4.3.3.8 General barriers to intervention

In addition to some of the more specific barriers to intervention that are described in the sections above, themes emerged around more general barriers to childhood obesity prevention. These relate closely to the contextual influences on the development of obesity in children (described in chapter 3). The expectations of children in the modern UK society was repeatedly discussed. For example, children expect to have a choice of food in the home and in school, and extensive access to sedentary activities such as television and computers. The following quote refers to the provision of healthy meals in schools and illustrates how the expectations and behaviours of children may undermine the desired effect of an intervention.

“I was at a school the other day and they were saying that they serve pizza once a week and that’s the day that all the kids turn up with their lunch money...and they come with their packed lunches on other days...kids aren’t stupid, they want to eat the pizza” (retail representative)

Cultural norms within South Asian communities were thought to pose specific (described above) and general barriers to successful intervention. Practical barriers such as language was perceived to make family and community intervention more challenging, but a more fundamental barrier identified was the perception within these communities that overweight children are healthy children, and underweight children are of more concern. Some participants felt that without addressing this issue, it would be very difficult to engage parents in any intervention, but it was acknowledged that influencing cultural norms such as this would be an extremely difficult task.

"there is definitely a cultural thing, like we can't let our children go hungry you know, they have got to be full, to be full is healthy" (mother)

"and I think if we are looking at the Asian community, we have, the Asian community has this thing that they have got to feed their children" (community leader)

Another barrier to parental engagement that was repeatedly discussed was the issue of time. Most participants felt that parents have very little time to attend educational sessions or activities, or to take their children to do activities.

"It's lack of time as well, the more kids you've got you have to take time out for everything because your life is so busy, you've got other children as well and you have to concentrate everywhere, you've got the household to do as well, and it's just too much" (mother)

A further perceived barrier was the cost of commodities such as healthy food and leisure time activities. Most focus group discussions highlighted the importance of cost, and the potential impact this has on certain behaviours.

"some parents might not be able to afford to pay [for sports clubs], if they have got, say, three children, and they can't pay for three because they can only pay for the one" (school catering staff)

"Buying a massive sack of chips is what, like two pounds? And going out and buying something healthy would actually cost you far more." (Retail representative)

The major barrier identified for the school setting was the curricular pressures within schools and the numerous competing priorities that school staff have to contend with. The quotes below illustrate this point, but in addition, the quote from a teacher alludes to the fact that teachers may take the view that it is not their responsibility to deliver certain types of intervention.

"the problem is that the obvious place for putting education in place is within the school, but you are very limited it's not our job to educate the parents" (teacher)

"the teachers you know, they have got other things to do in the evenings and in terms of preparation and marking, and they don't want to be running all these clubs" (health representative)

The role of health professionals in childhood obesity prevention was notably largely absent from focus group discussions. One group of catering staff and parents felt that health professionals could be unhelpful and give mixed messages to families, and that they often did not have a good understanding of South Asian cultural norms.

"I personally believe that when it comes to the health our, you are talking about your health visitors and your nurse or whoever you go to see, they do not help. As a first time parent, I mean, the things that they talk about, particularly about your cultural food " (parent)

Although participants of the health professionals focus group acknowledged their current role in childhood obesity prevention, they did not identify an extended role for themselves in future interventions, and prioritised interventions at the school and community level involving delivery by school staff and community members. This presents a potential barrier to providing interventions through health professionals, as they are unlikely to engage in delivering interventions if they feel that there is limited benefit to expanding their current roles.

In summary, the emergent themes around interventions to prevent childhood obesity from the stakeholder focus groups were; the importance of targeting parents and families, but with a focus on experiential learning; the scope for increasing physical activity within schools, but not necessarily by increasing curricular physical education time; and the potential to work with faith groups, although engagement with these may prove very difficult. The importance of the provision of healthy food in schools was acknowledged, but given the national policy

addressing this, the general perception was that enough was being done already, and the focus of intervention to address food intake should be in the home. Several global barriers to intervention emerged, including the expectations of children, cultural norms, parents' time pressures and competing priorities in schools.

4.3.4 Expert group

An expert group was established to advise on different aspects of the study. The group consisted of nutritional and physical activity epidemiologists, a dietician, a Primary Care Trust obesity programme manager, experts in behavioural epidemiology, experts in ethnic minorities research, a paediatrician, health psychologists with an interest in physical activity, an academic with expertise in qualitative research methods and a representative from the schools health education unit of the local authority.

The main role of the group was to consider the focus group data, the existing literature, and to some extent the available local resources and advise on the components to be included in the final programme. The collated focus group data for the different intervention categories were presented to the group. Key contextual data obtained from the focus groups was also summarised for the expert group.

After consideration of the focus group data, the experts decided that an important step in the intervention development process was to define a set of underlying principles to guide its design and delivery. The principles agreed on were; development of an inclusive (i.e. suitable

for all ethnic groups) sustainable intervention, a focus on developing practical skills, delivery of the intervention in a predominantly verbal format, and involvement of children in the implementation planning.

The group then agreed a shortlist of intervention processes to be considered for the final programme. These were; educational activities for families that aim to confer practical skills, including general parenting skills, increasing provision of physical activity within the school day, including encouraging healthy travel to school, and provision of lunchtime and after school activities, possibly involving parents. The group also suggested that walking interventions would be worth considering, as they perceived them to be both effective and practical. The group felt that rewards could be linked to some of these components. Use of community settings for intervention delivery was supported, but there was concern that focusing on particular faith groups would be against the principal of inclusivity.

4.3.5 Review of local resources

The BEACHeS research team undertook an extensive review of facilities, resources and opportunities related to healthy eating and physical activity in the participating communities. This included discussion with school staff, extended schools co-ordinators, local Primary Care Trusts, the Local Educational Authority, internet searches and walking and driving around the local communities. The purpose was to enable the intervention programme to build on existing resources, and thus make it more relevant to local communities and more sustainable.

There were many ongoing initiatives implemented by the health, education and voluntary sectors, and other organisations. The local Primary Care Trusts had obesity strategies in place, which include prevention at the primary, secondary and tertiary levels. Examples of primary prevention initiatives include food skills courses for parents, provision of gym equipment in schools, a dedicated dietician working with schools, and the opportunity for older children (age 9-10) to attend healthy eating and physical activity courses at a local Premier League Football Club. Examples within the education sector include the development of extended schools programmes, the implementation of active travel to school plans, and the training of lunchtime supervisors as play leaders. Initiatives from the voluntary sector and other organisations included cooking workshops, training programmes for community walk leaders and a variety of clubs, activities and training programmes linked to sports, provided by a regional commercial organisation (Sportwise).²⁵¹

4.3.6 Mapping to the ANGELO framework

The Analysis Grid for Environments Linked to Obesity (ANGELO framework, discussed in chapter 1)¹²², guided the development of the intervention throughout the process (Figure 4.2). Intervention processes identified from the research literature, and interventions suggested in the focus groups were mapped to the framework, as well as components included in the final programme. This ensured that the developed programme addressed all aspects of the local environment. The intervention processes identified from the literature (Table 4.1) spread across all four environment types (physical, political, economic and sociocultural), although the economic environment was the least represented. The interventions discussed in the

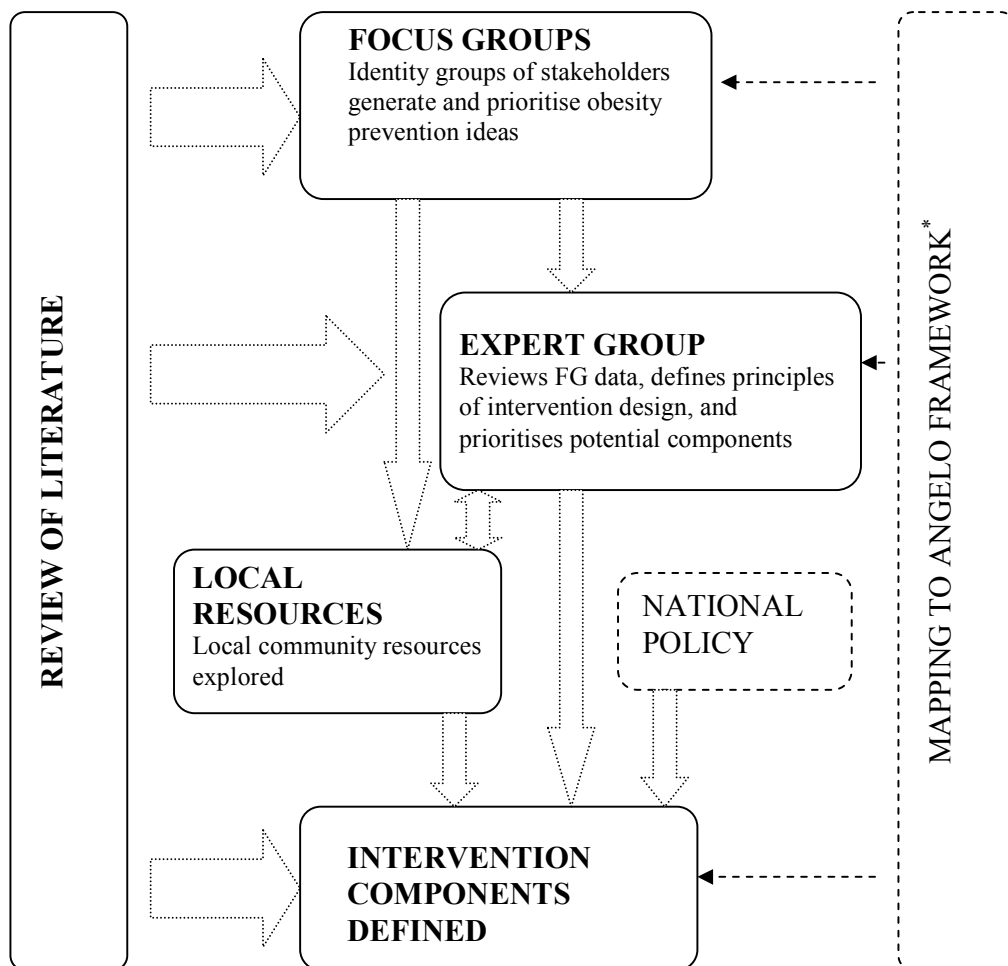
stakeholder focus groups again spread across the four environment types, but the prioritised interventions addressed the physical, political and sociocultural environments more frequently than the economic environment. In the final intervention programme, all environment types are addressed, but it can be seen in Table 4.2 that there is greatest emphasis on the physical environment.

4.3.7 The process of intervention development

The diverse range of methodologies employed presented a challenge of how to combine the resulting information to inform intervention design. In undertaking the different methodologies, several important factors were identified that needed consideration within the development process. First, we recognised that the contextual information from the stakeholder focus groups was of key importance, so relative weight was given to this data. The expert group had a central role in defining a set of guiding principles. One of the principles defined was that of sustainability, and so the local resource review on which to base the intervention components assumed importance. It is of note, however, that it was primarily the findings from the stakeholder focus groups, and not the availability of existing resources that directed the choice of components to include in the intervention programme. As described, the research evidence on childhood obesity prevention provided a core of information which ran through the development process, and similarly the ANGELO framework guided the process throughout.

In addition, this study was undertaken at a time of great political focus on childhood obesity, and much national policy around healthy behaviours has been implemented in recent years.^{200;201;209} We recognised the need for coherence with these policies, but also the importance of developing a programme that was incremental to the ongoing national activity. The development process is schematically represented in Figure 4.2. As in other studies^{241;243;245}, the process was iterative, and evolved with the emergence of findings from the various methodologies.

Figure 4.2: Processes undertaken in the theoretical and modelling phases of intervention development



* Analysis Grid for Environments Linked to Obesity¹²²

4.4 The BEACHeS intervention programme

The final intervention programme consisted of two broad processes; increasing children's physical activity levels through school, and increasing skills of parents and families through activity based learning. Local available resources that were in keeping with these processes were identified and adapted to define the following components:

- Increasing children's physical activity
 - Structured activities introduced within the school day
 - An incentive scheme to encourage children to undertake more physical activities out of school (allowing choice of type and time of activity)
 - Attendance at a 'Villa Vitality' day, providing interactive learning and opportunities for physical activity and healthy eating, delivered by an iconic sport institution (Aston Villa Football Club; an English Premier League club).
- Increasing skills of families through activity based learning
 - Healthy eating and cooking workshops run through school for parents, or parents and children
 - Information signposting local leisure opportunities with week-end "taster" sessions for families
 - Community walking programmes through training of walk leaders.

A more detailed description of the intervention programme is given in Table 4.2.

Table 4.2: Intervention components included in the BEACHeS intervention programme

Intervention component	Aim	Description	Environment addressed*	
Increasing children’s physical activity through school	Physical activities within the school day	To increase the overall amount of time that children are physically active within the school day	Three elements introduced into schools: 1. ‘Wake Up Shake Up’: a short organised daily dance or exercise routine to music 2. Organised playground activities at lunch times through the training of play leaders 3. ‘Take 10’: teaching resource which links 10 minutes physical activity to curricular subjects.	physical political
	Incentive scheme to encourage physical activity out of school	To increase the amount of time outside of school hours that children spend doing leisure activities with a physical element	Children receive a sticker collection card from school and information on local participating sports and leisure venues. Each time a child attends a venue, they collect a sticker. The child with the most stickers in each school receives a prize.	economic
	Attendance at a course run by a Premier League Football Club	To encourage physical activity and a healthy diet by delivering positive health-related messages through an iconic sporting institution	School classes attend a ‘Villa Vitality’ day. Half the day is spent with Football Club coaches, exercising and learning football skills, and the other half of the day is an interactive learning session on healthy eating and healthy lifestyles.	physical political sociocultural
Increasing skills of families through activity-based learning	Cooking courses for family members	To increase healthy cooking skills and confidence of family members, and influence the family’s nutritional intake	Five week courses on healthy cooking are delivered through schools to parents or other family members, some courses include children. Healthy recipes are distributed to support the course content.	physical Sociocultural
	Information on local leisure opportunities and week-end “taster” sessions for families	To equip parents and families with the knowledge and skills to undertake physical activities with their children in their leisure time	Parents are given information on local sporting and leisure venues and events. They are invited through schools to bring their children to different physical activity taster sessions run on Saturdays. Activities range from cricket and football, to archery, climbing and dry-slope skiing. There is no cost for the activities and transport is provided.	physical sociocultural (economic)
	Training walk leaders to initiate community walking programmes	To increase walking by families and other community members through organised leisure walks lead by a community member	Community volunteers are recruited through schools to become trained walk leaders. Training is provided to equip volunteers to organise and lead walks in their local community.	physical sociocultural

*As defined by the Analysis Grid for Environments Linked to Obesity¹²²

4.5 Discussion

4.5.1 Use of the MRC framework for complex interventions

In this chapter I have presented use of the theoretical and modelling phases of the MRC complex intervention framework^{183;184} in developing a childhood obesity prevention intervention. The primary purpose of the original framework was to guide researchers in explicitly addressing some of the challenges surrounding complex intervention development and evaluation. Since the onset of the BEACHeS study, the MRC have updated their guidance²⁴⁶, bringing to the fore the need for even greater attention to the early phase development work. Specifically, this updated guidance recognises the importance of local contexts, the need for an iterative approach and a greater emphasis on developing a prospective theoretical understanding of how the intervention will achieve the desired outcome.

To date, the MRC framework has mainly been used to guide interventions in healthcare. We used the framework to develop a community-wide intervention. Our experience confirmed that the local context is of great importance. We gained rich data on local context from the stakeholder focus groups, for example, the religious practices of the majority of the study population, and the importance of extended families (discussed in detail in chapter 3), and this greatly shaped the intervention design. Contextual information also influenced decisions of the expert group. Therefore the emphasis given to eliciting contextual information in the updated MRC guidance is fully supported.

On the other hand, the need for considering local context brings up the important question of transferability of an intervention to different settings. Hawe and colleagues argue that a complex intervention can be standardised and transferable if it is the function and process of the intervention (e.g. mechanisms to increase children's physical activity in school) that are standardised rather than the components (e.g. a specific curricular activity). This enables interventions to be delivered in different ways taking into account local context.²⁵² This approach necessitates a strong theoretical understanding of the change mechanisms and an understanding of local context at each intervention site. Having undertaken this intervention development study, I would argue that this is a viable approach. Data emerging from the stakeholder focus groups around intervention in their local communities resonates with qualitative data revealed in other settings. For example, the Australian 'Weight of Opinion' study reported that teachers believed that there was a role for schools in preventing obesity but that the most significant influence comes from families.²³⁰ Therefore, the theoretical development of mechanisms of change to prevent childhood obesity may be transferable, but in order to define and implement the specific components, local contextual information is essential, and this is highlighted strongly by the emergent contextual data from the focus groups that is presented in chapter 3.

Findings around the perceived barriers to obesity prevention, both from this study and the research literature also highlight the need to consider both the factors inhibiting healthy behaviours and context within which they occur. For example, barriers to childhood obesity prevention such as lack of parental time repeatedly emerges in the literature.^{227-229;233}

However, this barrier can only be addressed if precise nature of the constraints on parental

time are understood. Data presented in chapter 3 enables us to understand that mothers are less likely to be time constrained by work commitments, but have other obligations such as looking after extended families or attendance at places of worship. In contrast, in a North American study of predominantly white middle class school children, perceived time constraints related strongly to the work commitments of parents.²²⁷ It is clear that different approaches would be required to overcome the barrier of parental time pressures in these two communities.

The iterative development process that was undertaken enabled us to implicitly gain a theoretical understanding of change pathways, and use this to drive intervention development. A weakness of this approach is that we did not prospectively articulate this theory. Given the emphasis on theory in the updated MRC guidance and based on our experience, we feel that there is merit in the use of a theory driven approach to intervention development and evaluation, such as Connell and Kubisch's Theories of Change²⁵³ or Pawson and Tilley's Realistic Evaluation.¹⁵³ Prospective use of these approaches would have strengthened intervention design by explicitly outlining the avenues through which expected outcomes would be achieved. This in turn would help determine the evaluation methodology.

4.5.2 Specific issues regarding the development process

A central part of the development process was eliciting beliefs and opinions from local stakeholders. Limitations relating to participant recruitment has been discussed in chapter 3. With respect to the focus group process, we asked participants to consider and prioritise their

own intervention ideas alongside those from the literature. We recognise that there was potential for participants to give greater weight to either the interventions from the literature or their own ideas, but in practice, this was not the case. In general, there was a large overlap between participants' ideas and those presented, and participants did not appear to favour either in the prioritisation process.

The validity of deconstructing multi-component interventions, and considering components separately could be challenged, given that the effects of a complex intervention may be greater than the sum of its parts. However, the exploratory and prioritisation processes that the participants were guided through enabled them implicitly to consider individual components and synergies between them in their own local contexts, thus contributing to the theoretical understanding of change pathways.

The method used to analyse the focus group data relating to intervention was based on that of another study that undertook a two stage stakeholder focus group process incorporating a prioritisation exercise.²²¹ The analytical process was most akin to the framework approach, developed by Ritchie and Spencer for applied policy research.²⁵⁴ The Framework approach is a relatively explicit and structured approach designed to enable research teams to undertake qualitative analysis in a time-constrained environment, where clearly defined objectives need to be fulfilled. An approach similar to Framework was appropriate for this study, as there were specific objectives to fulfil and there was a need to manage the data in a transparent way, so that it could be shared and understood by a wider team (the expert group). A potential weakness of the approach used is that it focuses the analysis on answering the set objectives

and so may miss some unexpected findings emerging from the data that do not directly relate to these objectives. However, this data was also analysed in a more inductive way (thematic analysis, described in chapter 3) to explore the contextual influences on the development of childhood obesity, and so the findings from the two analytical approaches complement each other.

An important group of stakeholders in the study were the children themselves, and a small group of children participated in focus groups so that children's acceptability of potential interventions could be explored. This was a useful exercise and influenced the development of the prevention programme to a degree, but was not extensive enough. Development of a focus group process in conjunction with a researcher with expertise in qualitative research in young children, and undertaking a greater number of focus groups would have enabled a more in depth exploration of children's views on healthy eating and physical activity interventions.

The ANGELO framework was applied at various stages in the intervention development process. The ANGELO framework has been used for a variety of purposes, ranging from use as an assessment tool for environmental influences on obesity¹²², to forming part of a process for developing obesity prevention community action plans.²⁵⁵ Application of the ANGELO framework typically involves identification of 'obesogenic' environmental aspects, followed by a quantitative process in which these are ranked in terms of factors such as validity (importance), relevance and changeability.¹²² In this study, the ANGELO framework did not form part of the stakeholder focus group process. Instead, more qualitative and exploratory methods were employed as it was felt that this would enable a greater depth of understanding

of the local environment and would not restrict the stakeholders to having to consider their communities and local environments in a certain way. The ANGELO framework was applied to the data obtained from the focus groups, and so enabled consideration of the emergent themes around intervention in terms of the different environment types. It was also applied to the final intervention programme, and so the role of the framework was mainly to provide a way of ensuring that all aspects of the environment were considered at the various stages of the development process.

Design of the intervention programme could have been strengthened by further consultation with local stakeholders following the expert group discussion and review of local resources. This would have enabled greater focus on local context, especially with regard to intervention implementation. The implementation experience and process evaluations of the exploratory study of the BEACHeS intervention will also provide valuable information to enable further modelling of the intervention.

Arguably, the intervention components prioritised in the focus groups and ultimately included in the intervention programme, could have varied depending on factors such as the mix of focus group participants or the experts recruited. However, the information relating to the local context gained from the stakeholder focus groups (particularly the identification of causal influences on obesity and barriers to successful intervention) and the review of existing local resources were crucial in the detailed planning of the programme components and delivery of these within the local communities, and this would have been the case regardless of the choice of components in the final programme.

4.6 Conclusions

The process undertaken in the BEACHeS study for the theoretical and modelling phases of the MRC complex intervention framework has led to the development of an intervention founded within existing research evidence, but also taking into account the local context and lay beliefs. The result is an intervention programme to prevent childhood obesity that is tailored to South Asian communities in the UK, but also intervention processes that could be more widely applied. The intervention development process balanced pragmatism with theory driven approaches, leading to a tailored programme that can be tested within an exploratory trial.

5 BODY IMAGE, BODY DISSATISFACTION AND WEIGHT STATUS IN SOUTH ASIAN 5 TO 7 YEAR OLD CHILDREN

The numerous short and long-term physical consequences of childhood obesity are well known, and are the primary drivers for the focus on prevention and treatment of obesity in children. However, as outlined in chapter 1, the adverse psychosocial consequences are also potentially significant and there is a need to understand these in detail. This is particularly important when it comes to the planning of interventions to address childhood obesity. A detailed understanding of psychosocial functioning in the target populations will enable the wider potential effects of the intervention (be they positive or negative) to be considered and taken into account in its design and delivery.

This chapter explores one particular psychosocial dimension that is known to be associated with overweight and obesity^{99;107}, body image perception and dissatisfaction, and its relationship with weight status in the children of communities targeted for intervention by the BEACHeS study.

5.1 Background

Body image was defined by Schilder in the 1930s as 'the picture of our own body which we form in our own mind'.²⁵⁶ It is clear, however, from emergent research in the field, that body image is a multidimensional concept, incorporating neurological, psychological and sociocultural elements, and the complexity of the construct is not reflected in Schilder's definition.²⁵⁷ Body image is viewed as central to many aspects of human functioning,

including emotions, thoughts, behaviours and relationships. Therefore, the effect of body image on quality of life is potentially extensive.²⁵⁷

Much of the research into body image has been in the field of eating disorders. There are two types of disturbance of body image; perceptual and attitudinal. Perceptual disturbance relates to over or underestimation of body size, and attitudinal disturbance involves dissatisfaction with body shape or size.²⁵⁸ Perceptual and attitudinal body image distortion correlates with increased psychological distress and disordered eating¹⁰⁸, and body image distortion is a diagnostic criterion for both anorexia and bulimia nervosa.²⁵⁹ Obesity is also recognised as part of the spectrum of conditions related to disordered eating, and with the escalation of the obesity problem, its relationship to body image and dissatisfaction has become a focus of research.^{108;109}

Body dissatisfaction in older children and adolescents has been extensively studied and a consistent positive relationship with weight status has been found across many different cultural communities.²⁶⁰⁻²⁷¹ In younger age groups the association is less clear. Relatively little is known about body image development in children, and most studies in this area involve small, predominantly white samples. A negative attitude towards a fat body shape has been observed in children as young as 4²⁷², although the emergence of actual body dissatisfaction appears to be sometime after this, becoming more pronounced in middle childhood and early adolescence.^{107;273} In a US study looking at the weight concerns and body dissatisfaction in 5 year old girls, Davison et al. found an association with body dissatisfaction and weight status, but overall, body dissatisfaction was relatively infrequent in this age group.²⁷⁴ In a

longitudinal study of the same cohort no significant differences in weight concern and body dissatisfaction were found when comparing normal weight and overweight at age 5, but by age 9 the differences were highly significant.^{275;276}

Significant longitudinal associations between weight status in childhood and later body dissatisfaction have also been found. Several studies report that overweight or obesity in childhood or adolescence predicts body dissatisfaction at a later stage in both sexes.^{265;266;269;275;277;278} Body dissatisfaction in turn is linked to later weight status and associated behaviours. Body dissatisfaction in adolescence has been associated with excess weight gain in the following years^{279;280}, and with later unhealthy behaviours such as binge eating, unhealthy dieting, decreased physical activity and unhealthy weight control behaviours.²⁸¹ In addition, early childhood body dissatisfaction in girls has been found to be associated with later maladaptive eating attitudes and dieting.²⁷⁶

Sex differences in body dissatisfaction and how it relates to weight status have been found, although these differences appear to emerge after the age of 8.¹⁰⁷ Body dissatisfaction is prevalent in boys and girls, and both sexes tend to desire to be thinner if overweight, but in underweight children, boys are more likely to be dissatisfied than girls.¹¹⁰ Studies suggest that in boys, although weight concern is a mediator of body dissatisfaction, importance is also attached to having big muscles^{268;269;282} and therefore boys are more likely to desire a larger body size than girls.

Variation in body dissatisfaction and its relationship with weight status by ethnic group has also been studied. Unsurprisingly, the influence of ethnicity on body dissatisfaction is complex and interacts with other factors, such as societal, media and peer influences.^{107;261;270;271;283} Some patterns have nevertheless emerged. African-American children are more likely to indicate their ideal body size as larger, and overweight African-American children are more likely to be satisfied with their bodies than their white counterparts^{107;283;284}, although this is not consistent across all settings. For example, in a study conducted in North Carolina, the association between body dissatisfaction and weight status in African-American girls was comparable to white girls.²⁷⁰ An Australian study comparing childhood obesity across different ethnic groups found that obese children from the Pacific Islands and Middle Eastern regions had significantly lower levels of body dissatisfaction than their Caucasian and Asian peers.²⁸⁵ Body image in Native American Indian children has also been studied, as these communities have a high prevalence of obesity and diabetes.²⁸⁶ Body dissatisfaction was prevalent in these children, and was positively associated with weight status.^{261;265} These findings contrast with previous beliefs that obesity is culturally acceptable in these populations. This highlights the complexity of the relationships between ethnicity, culture, body image and weight.

Little research into body dissatisfaction and its association with weight status in South Asians living in the UK has been undertaken, despite the fact that they are a particular target group for the prevention of obesity. A better understanding of ethnic and cultural norms related to obesity among this heterogeneous community is essential for planning interventions. One British study of adolescents of differing ethnic backgrounds found that the association of body

fatness with body dissatisfaction was greatest in South Asians, compared to black African-Caribbean and white ethnic groups.²⁶⁷ However, whether this association holds true for younger children is not known.

5.2 Aims

This chapter aims to explore body image and dissatisfaction and their relationship to weight status in the children recruited to the BEACHeS study. Ethnic, age and sex differences in the relationship between body image and weight status are also explored in this heterogeneous study sample. This will enable further understanding of the psychosocial functioning of younger children and how this may be influenced by weight status in the different ethnic subgroups. This in turn will inform future approaches to obesity prevention and management in children from these ethnic groups.

5.3 Methods

5.3.1 Participants

Participants for this study were all children participating in the baseline measures of the BEACHeS exploratory trial. A detailed account of the recruitment of study participants is given in section 1.9. In brief, 574 children aged 5-7 participated, 296 boys and 278 girls. For this study, ethnicity was categorised in 4 groups, Bangladeshi, Indian, Pakistani and other, and the proportions in these groups were 14.3%, 4.7%, 66.9% and 14.1% respectively. As outlined in section 1.9, the great majority of participants live in areas of material deprivation.

5.3.2 *Measurement of weight status*

Trained researchers undertook height and weight measurements using the same instruments throughout and standardised procedures. Height was measured to the nearest 0.1 centimetre using a Leicester height measure. Weight was measured to the nearest 0.1 kilogram using a Tanita TBF 300 MA body composition analyser, with the children wearing light indoor clothing and no shoes. BMI was calculated by the formula; weight (kg)/height (m)² and standard deviation scores (BMI z-scores) derived using the age and sex specific UK National 1990 BMI percentiles reference data.⁹ Children were also categorised into underweight, healthy weight, overweight and obese, according to the UK 1990 reference data, using the 2nd, 85th and 95th percentiles to define these categories. This is in line with the definitions used in national programmes to monitor childhood obesity prevalence.^{54;55}

5.3.3 *Measurement of body image*

A figure rating scale, developed by Collins¹⁹⁰ and adapted by Rand and Resnick¹⁹¹ was used to assess body image and body dissatisfaction. There were male and female sets of drawings, consisting of 9 prepubescent figures ranging from very underweight (value = 1) to very overweight (value = 9). Researchers also had two versions of the drawings showing paler and darker skin colour, and selected the most appropriate version for each child (Figure 5.1). Children were asked; “Which picture looks the most like you look?”, and “Which picture shows the way you want to look?” to assess ‘self’ and ‘ideal self’ respectively (with scores ranging from 1 to 9 for each). A body dissatisfaction score was derived by subtracting the ‘ideal self’ from the ‘self’ score, with dissatisfaction scores ranging from -8 through to +8.

Thus a negative score indicated the child perceived him/herself as thinner than ideal, a zero score that they were satisfied, and a positive score that he/she perceived themselves as more overweight than ideal. Children were also shown the paler and darker figure drawings mixed together in no particular order (18 drawings in total) and asked; “Which picture shows the way you think is best for girls/boys to look?” to assess ‘ideal other child’. The 3 day test-retest reliability coefficients of the instrument developed by Collins are as follows: 0.71 for perceived self image, 0.59 for ideal self image and 0.38 for ideal other child.¹⁹⁰

5.3.4 Procedure

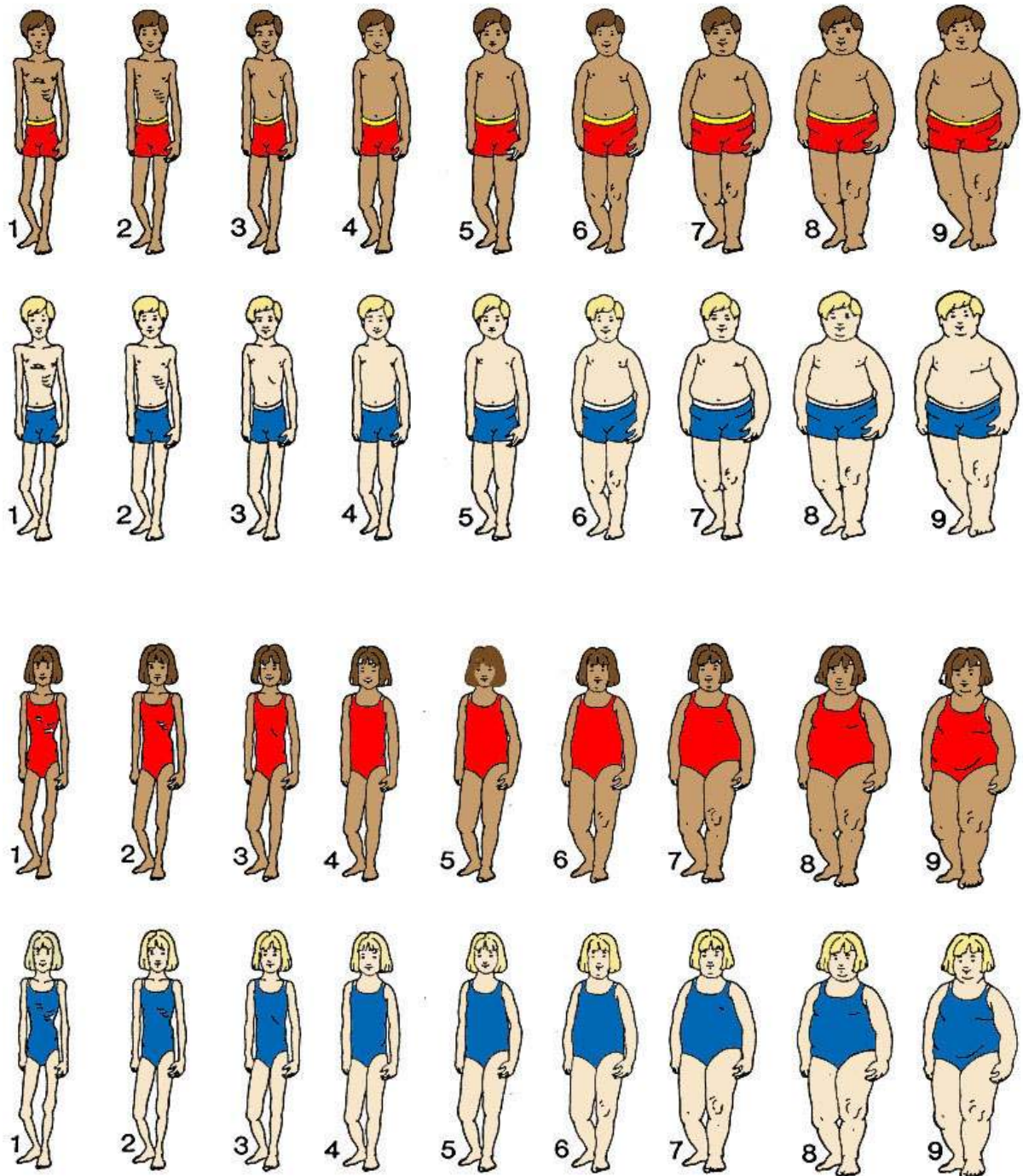
Data collection took place from December 2006 to May 2007. On the day of data collection, small groups of children (4) were taken from class to a separate room, and rotated around four data collection stations, consisting of either physical measures, or psychosocial instruments. Children were with researchers on a one-to-one basis at each station.

5.3.5 Analysis

Analysis was undertaken using the STATA (version 11) statistical package. Data were analysed descriptively to determine the study sample characteristics. The outcome variables explored were perception of self, perception of ideal self, perception of ideal other, and body dissatisfaction scores. Multiple regression analyses were performed for each of the outcome variables, with weight status, sex, age and ethnicity included as independent variables. For the multiple regression analyses, two alternative variables were used for weight status; BMI z-score and binary weight category (not overweight/obese versus overweight/obese).

Multivariate analysis stratified by gender was also undertaken to explore differences in body image and weight status between the sexes. Regression diagnostic tests were performed to check no assumptions were violated.

Figure 5.1: The Collins children's Figure Rating Scale, adapted by Rand & Resnick^{190;191} (pale and dark skin colour versions for use in the BEACHeS study)



5.4 Results

5.4.1 Weight status

The mean BMI z-score for the sample was 0.03 (SD 1.38). One fifth of participants were either overweight or obese (20.2%), with girls significantly more likely to be both overweight and obese (16.3% boys and 24.4% girls were overweight or obese, Table 5.1). There were no significant differences in overweight and obesity prevalence across different ethnic groups and age groups.

Table 5.1: Weight status of study sample by sex, age and ethnicity

	Number (%) underweight	Number (%) healthy weight	Number (%) overweight	Number (%) obese
Total	15 (2.6)	440 (77.2)	42 (7.4)	73 (12.8)
Sex*				
Boys	5 (1.7)	242 (82.0)	17 (5.8)	31 (10.5)
Girls	10 (3.7)	198 (72.0)	25 (9.1)	42 (15.3)
Age†				
Age 5	2 (1.4)	107 (75.4)	12 (8.5)	21 (14.8)
Age 6	8 (2.7)	230 (77.7)	20 (6.8)	38 (12.8)
Age 7	5 (3.8)	103 (78.0)	10 (7.6)	14 (10.6)
Ethnicity‡				
Bangladeshi	0 (0.0)	60 (74.1)	8 (9.9)	13 (16.1)
Indian	0 (0.0)	24 (88.9)	0 (0.0)	3 (11.1)
Pakistani	14 (3.7)	297 (77.8)	23 (6.0)	48 (12.6)
Other	1 (1.3)	59 (73.8)	11 (13.8)	9 (11.3)

* $\chi^2 = 8.56$ (df = 3), p = 0.04

† $\chi^2 = 2.89$ (df = 6), p = 0.82

‡ $\chi^2 = 14.63$ (df = 9), p = 0.10

5.4.2 *Perception of body image (self)*

The median self image score for the total sample was 4 (IQR=2-5). The distribution of scores was similar across sexes (Table 5.2), age, and ethnic groups, except the Indian subgroup, which had a lower median score (M=3, IQR 1-4). The obese group had a higher median score than other categories (M=5, IQR=4-5). The distribution of scores in the overweight/obese group compared to the non-overweight group is shown in Table 5.3.

Multiple regression models indicated that lower BMI z-score (or not being overweight/obese) was significantly associated with lower self perception scores (thinner self image) (Table 5.4 and Table 5.5). Ethnicity and sex were also significantly associated with self perception, with the Indian subgroup and female sex associated with thinner self perception scores. The magnitudes of the associations were small. Analysis stratified by sex found that the association between weight status and self perception was only significant for girls. The association of Indian ethnicity with thinner self perception scores was only significant in boys (Table 5.6 and Table 5.7).

5.4.3 *Perception of ideal self*

The median score for ideal self was lower than that for self image (M=3, IQR=2-5). Girls had a lower median score than boys. Distribution of scores by sex is shown in Table 5.2 and did not differ greatly across age and ethnic groups, although Indians had the lowest IQR (M=3, IQR=1-4). In contrast with the self image scores, the obese category had the lowest median

score for ideal self image (M=2, IQR=1-4). The distribution of scores by weight category is shown in Table 5.3.

Multiple regression models showed that adjusted for other factors, increasing BMI z-score (or being overweight/obese) was significantly associated with lower ideal self scores (thinner shapes) (Table 5.4 and Table 5.5), and on stratified analysis, this finding was consistent in both sexes (Table 5.6 and Table 5.7). Increasing age and female sex were also significantly associated with lower ideal self scores. Analysis by sex showed a significant association with age only in boys. Again, the magnitudes of the associations were small, particularly for age.

5.4.4 Perception of ideal (other) child

The distribution of scores for perception of ideal other child were similar to that for ideal self (M=3, IQR=2-4). Again, girls compared with boys, and Indians compared with other ethnic groups, had the lowest median scores. No major difference in distribution of scores between weight categories was present (Table 5.3).

Multiple regression models showed that increasing BMI z-score was significantly associated with lower ideal other score but there was no significant association with binary weight category (Table 5.4 and Table 5.5). Female sex and increasing age were significantly associated with lower ideal other child scores (thinner shapes), but for age, this association was very weak. Stratified analysis showed the significant association between BMI z-score

and ideal other score was consistent in both sexes, but the association between age and ideal other was only significant in boys (Table 5.6 and Table 5.7).

Interestingly, the colour of the image chosen for ideal other child was inconsistent with the child's ethnic group in the majority of cases (380/572, 66.5% chose a colour that was inconsistent with their ethnic classification). In the South Asian groups, only 31% (152) chose a darker skinned figure. There was no significant variation in this proportion between sexes, weight categories, or the South Asian ethnic subgroups. The majority of white children chose a paler skinned figure for ideal other child, although 3 of 13 chose a darker skinned figure. Discordance between colour chosen for ideal other child and ethnic group was not associated with body dissatisfaction.

5.4.5 Body dissatisfaction

The mean body dissatisfaction score for the study sample was 0.26 (SD 2.41). Eighteen percent were satisfied with their body size, 37.3% perceived themselves as too thin, and 44.7% as too fat (Table 5.8). Mean scores across weight categories differed significantly ($F=14.51$, $p<0.001$), with the overweight and obese having higher dissatisfaction scores than the healthy and underweight categories.

Multiple regression analyses indicated that adjusted for other factors, increasing body dissatisfaction score was associated with increasing BMI z-score (or overweight/obese) and increasing age. There was no significant association with sex or ethnic subgroup (Table 5.4

and Table 5.5). Stratified analysis revealed the relationship of body dissatisfaction with weight status to be consistent across the sexes, but the association with age was present only in boys (Table 5.6 and Table 5.7).

Table 5.2: Distribution of perceived self, ideal self and ideal other child scores by sex

Figure rating score	Number (%) choosing score for 'self' image		Number (%) choosing score for 'ideal self' image		Number (%) choosing score for 'ideal other' image	
	Boys	Girls	Boys	Girls	Boys	Girls
1 (thinnest)	42 (14.2)	63 (22.7)	55 (18.7)	78 (28.2)	34 (11.5)	50 (18.1)
2	23 (7.8)	32 (11.6)	25 (8.5)	42 (15.2)	52 (17.6)	74 (26.7)
3	34 (11.5)	39 (14.1)	43 (14.6)	45 (16.3)	55 (18.6)	56 (20.2)
4	73 (24.8)	54 (19.5)	70 (23.8)	54 (19.5)	67 (22.7)	47 (17.0)
5	86 (29.2)	67 (24.2)	55 (18.7)	39 (14.1)	47 (15.9)	35 (12.6)
6	18 (6.1)	18 (6.5)	24 (8.2)	14 (5.1)	15 (5.1)	3 (1.1)
7	12 (4.1)	0 (0.0)	6 (2.0)	1 (0.4)	7 (2.4)	3 (1.1)
8	1 (0.3)	0 (0.0)	2 (0.7)	3 (1.1)	6 (2.0)	4 (1.4)
9 (fattest)	6 (2.0)	4 (1.4)	14 (4.8)	1 (0.4)	12 (4.1)	5 (1.8)

Table 5.3: Distribution of perceived self, ideal self and ideal other child scores by weight status

Figure rating score	Number (%) choosing score for 'self' image		Number (%) choosing score for 'ideal self' image		Number (%) choosing score for 'ideal other' image	
	Non-overweight	Overweight/obese	Non-overweight	Overweight/obese	Non-overweight	Overweight/obese
1 (thinnest)	90 (19.8)	15 (13.0)	89 (19.7)	44 (38.3)	64 (14.1)	20 (17.4)
2	50 (11.0)	5 (4.4)	55 (12.1)	12 (10.4)	100 (22.0)	23 (20.0)
3	58 (12.8)	15 (13.0)	72 (15.9)	16 (13.9)	81 (17.8)	30 (26.1)
4	101 (22.3)	25 (21.7)	95 (21.0)	28 (24.4)	89 (19.6)	25 (21.7)
5	116 (25.6)	35 (30.4)	82 (18.1)	10 (8.7)	71 (15.6)	11 (9.6)
6	21 (4.6)	15 (13.0)	34 (7.5)	4 (3.5)	16 (3.5)	2 (1.7)
7	10 (2.2)	2 (1.7)	6 (1.3)	1 (0.9)	8 (1.8)	2 (1.7)
8	0 (0.0)	1 (0.9)	5 (1.1)	0 (0.0)	9 (2.0)	1 (0.9)
9 (fattest)	8 (1.8)	2 (1.7)	15 (3.3)	0 (0.0)	16 (3.5)	1 (0.87)

Table 5.4: Linear regression models to examine predictors for perceived self, ideal self, ideal other and body dissatisfaction scores (BMI z-score as weight predictor variable)

Variable	Perceived self (Adjusted R ² = 0.06, F = 6.16 (df = 6), p<0.0001)		Perceived ideal self (Adjusted R ² = 0.10, F = 11.45 (df = 6), p<0.0001)		Perceived ideal other (Adjusted R ² = 0.06, F = 6.80 (df = 6), p<0.0001)		Body dissatisfaction (Adjusted R ² = 0.09, F = 10.88 (df = 6), p<0.0001)	
	β (95% CI)	p	β (95% CI)	p	β (95% CI)	p	β (95% CI)	p
BMI z-score	0.21 (0.10-0.31)	<0.001	-0.33 (-0.44--0.22)	<0.001	-0.18 (-0.29--0.07)	0.002	0.54 (0.40-0.67)	<0.001
Female*	-0.60 (-0.89--0.31)	<0.001	-0.78 (-1.0--0.47)	<0.001	-0.69 (-0.99--0.39)	<0.001	0.18 (-0.20-0.56)	0.36
Increasing age (months)	0.004 (-0.02-0.02)	0.73	-0.03 (-0.05--0.004)	0.02	-0.03 (-0.05--0.004)	0.02	0.03 (0.003-0.06)	0.03
Indian†	-0.90 (-1.67--0.13)	0.02	-0.43 (-1.24-0.37)	0.29	-0.68 (-1.48-0.11)	0.09	-0.47 (-1.48-0.54)	0.36
Pakistani	-0.03 (-0.4-0.39)	0.88	0.03 (-0.41-0.48)	0.88	0.07 (-0.37-0.51)	0.75	-0.07 (-0.63-0.49)	0.80
Other	-0.09 (-0.63-0.46)	0.75	0.28 (-0.28-0.85)	0.33	-0.25 (-0.81-0.31)	0.39	-0.37 (-1.08-0.34)	0.31

Reference is male (*), Bangladeshi (†)

Table 5.5: Linear regression models to examine predictors for perceived self, ideal self, ideal other and body dissatisfaction scores (overweight/obese vs. not overweight/obese as weight predictor variable)

Variable	Perceived self (Adjusted R ² = 0.05, F = 5.56 (df = 6), p<0.0001)		Perceived ideal self (Adjusted R ² = 0.08, F = 8.71 (df = 6), p<0.0001)		Perceived ideal other (Adjusted R ² = 0.05, F = 5.59 (df = 6), p<0.0001)		Body dissatisfaction (Adjusted R ² = 0.06, F = 7.14 (df = 6), p<0.0001)	
	β (95% CI)	p	β (95% CI)	p	β (95% CI)	p	β (95% CI)	p
Overweight/obese*	0.63 (0.26-0.99)	0.001	-0.85 (-1.23--0.46)	<0.001	-0.35 (-0.73-0.03)	0.07	1.47 (0.99-1.96)	<0.001
Female†	-0.63 (-0.92--0.33)	<0.001	-0.75 (-1.06--0.44)	<0.001	-0.68 (-0.99--0.38)	<0.001	0.13 (-0.26-0.52)	0.52
Increasing age (months)	0.003 (-0.02-0.02)	0.78	-0.02 (-0.05--0.003)	0.03	-0.02 (-0.05--0.003)	0.03	0.03 (<0.001- 0.06)	0.05
Indian‡	-0.93 (-1.70--0.16)	0.02	-0.37 (-1.19-0.44)	0.37	-0.63 (-1.43-0.17)	0.12	-0.55 (-1.58-0.47)	0.29
Pakistani	-0.07 (-0.50-0.35)	0.73	0.11 (-0.34-0.56)	0.63	0.12 (-0.32-0.56)	0.59	-0.19 (-0.75-0.38)	0.51
Other	-0.12 (-0.67-0.42)	0.66	0.34 (-0.23-0.92)	0.24	-0.22 (-0.78-0.35)	0.46	-0.47 (-1.19-0.26)	0.21

Reference is not overweight/obese (*), male (†), Bangladeshi (‡)

Table 5.6: Linear regression analysis stratified by sex to examine predictors for perceived self, ideal self, ideal other and body dissatisfaction scores (BMI z-score as weight predictor variable)

Boys

Variable	Perceived self (Adjusted R ² = 0.03, F = 2.97(df = 5), p = 0.01)		Perceived ideal self (Adjusted R ² = 0.09, F = 6.52 (df = 5), p <0.0001)		Perceived ideal other (Adjusted R ² = 0.03, F = 2.54 (df = 5), p = 0.03)		Body dissatisfaction (Adjusted R ² = 0.11, F = 8.28 (df = 5), p <0.0001)	
	β (95% CI)	p	β (95% CI)	p	β (95% CI)	p	β (95% CI)	p
BMI z-score	0.13 (-0.01-0.28)	0.07	-0.41 (-0.56--0.25)	<0.001	-0.15 (-0.31-0.002)	0.05	0.54 (0.35-0.73)	<0.001
Increasing age (months)	0.01(-0.02-0.04)	0.45	-0.03 (-0.06-0.0004)	0.05	-0.03 (-0.06--0.004)	0.03	0.04 (0.003-0.08)	0.03
Indian*	-1.54 (-2.55--0.53)	0.003	-0.30 (-1.42-0.82)	0.60	-0.66 (-1.77-0.44)	0.24	-1.24 (-2.62-0.14)	0.07
Pakistani	-0.25 (-0.82-0.32)	0.39	0.15 (-0.48-0.79)	0.64	0.007 (-0.62-0.63)	0.98	-0.41 (-1.19-0.37)	0.31
Other	-0.12 (-0.86-0.61)	0.74	0.38 (-0.43-1.19)	0.36	-0.55 (-1.35-0.25)	0.18	-0.50 (-1.50-0.50)	0.32

*Reference is Bangladeshi

Girls

Variable	Perceived self (Adjusted R ² = 0.03, F = 2.82 (df = 5), p = 0.02)		Perceived ideal self (Adjusted R ² = 0.02, F = 1.92 (df = 5), p = 0.09)		Perceived ideal other (Adjusted R ² = 0.02, F = 2.18 (df = 5), p = 0.06)		Body dissatisfaction (Adjusted R ² = 0.07, F = 5.22 (df = 5), p = 0.0001)	
	β (95% CI)	p	β (95% CI)	p	β (95% CI)	p	β (95% CI)	p
BMI z-score	0.30 (0.13-0.46)	<0.001	-0.22 (-0.38--0.06)	0.01	-0.21 (-0.37--0.05)	0.01	0.51 (0.31-0.72)	<0.001
Increasing age (months)	-0.004 (-0.04-0.03)	0.81	-0.02 (-0.05-0.01)	0.29	-0.01 (-0.05-0.02)	0.35	0.01 (-0.03-0.05)	0.53
Indian*	-0.03 (-1.22-1.17)	0.97	-0.70 (-1.87-0.47)	0.24	-0.74 (-1.91-0.42)	0.21	0.67 (-0.83-2.17)	0.38
Pakistani	0.22 (-0.41-0.86)	0.49	-0.12 (-0.75-0.50)	0.69	0.16 (-0.45-0.78)	0.60	0.35 (-0.05-1.15)	0.39
Other	-0.08 (-0.90-0.74)	0.85	0.08 (-0.72-0.88)	0.85	0.13 (-0.66-0.93)	0.74	-0.16 (-1.18-0.87)	0.76

*Reference is Bangladeshi

Table 5.7: Linear regression analysis stratified by sex to examine predictors for perceived self, ideal self, ideal other and body dissatisfaction scores (overweight/obese vs. not overweight/obese as weight predictor variable)

Boys

Variable	Perceived self (Adjusted R ² = 0.02, F = 2.44 (df = 5), p = 0.03)		Perceived ideal self (Adjusted R ² = 0.08, F = 4.45 (df = 5), p <0.001)		Perceived ideal other (Adjusted R ² = 0.02, F = 2.09 (df = 5), p = 0.06)		Body dissatisfaction (Adjusted R ² = 0.07, F = 5.19 (df = 5), p = 0.0001)	
	β (95% CI)	p	β (95% CI)	p	β (95% CI)	p	β (95% CI)	p
Overweight/obese*	0.27 (-0.28-0.82)	0.34	-1.25 (-1.87--0.63)	<0.001	-0.39 (0.99-0.21)	0.21	1.52 (0.75-2.79)	<0.001
Increasing age (months)	0.01 (-0.02-0.04)	0.40	-0.03 (-0.07--0.003)	0.03	-0.04 (-0.07--0.01)	0.02	0.05 (0.01-0.08)	0.02
Indian†	-1.59 (-2.60--0.58)	0.002	-0.21 (-1.35-0.92)	0.71	-0.62 (-1.72-0.49)	0.27	-1.38 (-2.78-0.03)	0.06
Pakistani	-0.29 (-0.86-0.28)	0.32	0.25 (-0.40-0.89)	0.45	0.05 (-0.58-0.68)	0.88	-0.54 (-1.34-0.26)	0.18
Other	-0.17 (-0.90-0.56)	0.65	0.49 (-0.34-1.31)	0.25	-0.50 (-1.30-0.30)	0.22	-0.65 (-1.67-0.37)	0.21

Reference is not overweight/obese (*),Bangladeshi (†)

Girls

Variable	Perceived self (Adjusted R ² = 0.03, F = 2.95 (df = 5), p = 0.01)		Perceived ideal self (Adjusted R ² = 0.01, F = 1.31 (df = 5), p = 0.25)		Perceived ideal other (Adjusted R ² = 0.003, F = 1.17 (df = 5), p = 0.32)		Body dissatisfaction (Adjusted R ² = 0.06, F = 4.37 (df = 5), p < 0.001)	
	β (95% CI)	p	β (95% CI)	p	β (95% CI)	p	β (95% CI)	p
Overweight/obese*	0.92 (0.43-1.40)	<0.001	-0.52 (-0.99--0.04)	0.03	-0.34 (-0.82-0.14)	0.17	1.43 (0.82-2.05)	<0.001
Increasing age (months)	-0.01 (-0.04-0.02)	0.52	-0.01 (-0.04-0.02)	0.46	-0.01 (-0.04-0.02)	0.55	0.001 (-0.04-0.04)	0.94
Indian†	0.001 (-1.20-1.20)	0.99	-0.70 (-1.88-0.47)	0.24	-0.73 (-1.91-0.44)	0.22	0.70 (-0.81-2.22)	0.36
Pakistani	0.18 (-0.45-0.82)	0.57	-0.08 (-0.70-0.54)	0.80	0.22 (-0.41-0.84)	0.50	0.26 (-0.54-1.06)	0.52
Other	-0.10 (-0.91-0.72)	0.82	0.08 (-0.73-0.88)	0.85	0.12 (-0.68-0.93)	0.77	-0.17 (-1.21-0.86)	0.74

Reference is not overweight/obese (*),Bangladeshi (†)

Table 5.8: Body dissatisfaction by sex, age, ethnicity and weight status

	Number (%) perceives self as to thin	Number (%) satisfied	Number (%) perceives self as too fat
Total	212 (37.3)	102 (18.0)	254 (44.7)
Sex*			
Boys	116 (39.5)	57 (19.4)	121 (41.2)
Girls	96 (34.7)	48 (17.3)	133 (48.0)
Age†			
Age 5	59 (41.3)	30 (21.0)	54 (37.8)
Age 6	111 (37.5)	46 (15.5)	139 (47.0)
Age 7	42 (31.8)	29 (22.0)	61 (46.2)
Ethnicity‡			
Bangladeshi	25 (30.9)	18 (22.2)	38 (46.9)
Indian	15 (55.6)	1 (3.7)	11 (40.7)
Pakistani	140 (36.7)	77 (20.2)	165 (43.2)
Other	39.5 (32)	11.1 (9)	49.4 (40)
Weight category§			
Underweight	4 (26.7)	4 (26.7)	7 (46.7)
Healthy weight	186 (42.5)	80 (18.3)	172 (39.3)
Overweight	11 (26.2)	9 (21.4)	22 (52.4)
Obese	11 (15.1)	9 (12.3)	53 (72.6)

* $\chi^2 = 2.72$ (df = 2), p = 0.26

† $\chi^2 = 6.37$ (df = 4), p = 0.17

‡ $\chi^2 = 11.04$ (df = 6), p = 0.09

§ $\chi^2 = 33.03$ (df = 6), p < 0.001

5.5 Discussion

Findings from this study clearly indicate that a significant relationship exists between weight status and body image/body dissatisfaction in 5 to 7 year old South Asians in the UK. The significant association between weight status and self image perception indicates that at this young age, children have some self-awareness about their weight status, although the magnitude of the association was small. The finding that self image perception is associated with weight status only in girls implies that they may be more aware of their body shape than boys at this age, although overweight and obese boys and girls appear to have similar levels of body dissatisfaction. The relationship of thinner perceived ideal self, perceived ideal other and higher body dissatisfaction with increasing age was only present in boys, which may suggest that age 5-7 is a particular period of change for boys with respect to body image perception, but not for girls.

A clear statistically significant association between increasing weight status and body dissatisfaction was found in this study, which persisted even after adjustment for sex, age and ethnicity in multivariate models. There has been little exploration of body dissatisfaction and weight status in such young children. Several studies based on a small sample (<200) of mostly white girls in Pennsylvania have shown an association that becomes clearer with increasing age, such that by the age of 8-9, the association between weight and body dissatisfaction is firmly established.²⁷⁴⁻²⁷⁶ In this larger, mixed sex sample, the association was clearly present in boys and girls, which suggests that the association is established at a very young age in both sexes.

The relationship between body dissatisfaction and weight status did not differ by sex in this population. Other studies have reported sex differences in body dissatisfaction in children, but these differences have been found from age 8 onwards.^{107;278;287;288} Findings from this study therefore suggest that difference in body dissatisfaction and its relationship with weight between boys and girls is not apparent in early childhood but may become established in the preadolescent period. There is also the possibility that sex differences are less pronounced in UK South Asian groups compared to other populations studied. A study of body dissatisfaction in Malaysian adolescents found greater body dissatisfaction in Chinese girls than Chinese boys but no sex differences in Malay or Indian adolescents.²⁸⁹

Weak but significant associations between female sex and lower scores for perceived self and perceived ideal self were found, indicating that on average, girls chose thinner figures than boys for self and ideal self. The sex difference in ideal self is coherent with previous findings that boys generally desire larger body sizes than girls, as they attach importance to being muscular, or stronger.^{268;269;282;288} Although most previous studies exploring sex differences in body image looked at older age groups, one Australian qualitative study explored body image in 5-6 year olds, and found a sex difference in perceptions of the ideal body shape, with girls desiring thinner images.²⁹⁰

In general there were little marked ethnic subgroup differences in body image perception or body dissatisfaction. The Indian subgroup did appear to be slightly different to the other South Asian groups with regard to self image, with Indian ethnicity being associated with thinner self image scores (in boys). The number of subjects in this particular group were small (n=27), which makes interpretation of this finding difficult, but the potential

differences between Indians and other South Asian groups merit further exploration. It is intuitive that the psychosocial functioning of the Indian ethnic group may be different to Pakistani and Bangladeshi groups as cultural norms are markedly different. For example, religious beliefs and practices are important influences in all three ethnic groups, but the Pakistani and Bangladeshi groups differ to the Indian group as they are predominantly Muslim. Previous studies looking at different ethnic populations of older children have reported differences in body image and body dissatisfaction, although the findings have not always supported prior assumptions about the ethnic groups under study.^{261;265;267;270;289} Findings in this population hint at possible ethnic differences, which may become more pronounced with age. Further study in this age group comparing the South Asian groups to other ethnic groups, including white British is needed to investigate the influence of ethnicity in more detail.

The perceived cultural norms of the UK South Asian population that overweight is acceptable, even desirable²⁹¹ (see qualitative findings from the BEACHeS study in chapter 3), may lead one to hypothesise that there would be no association between weight and desire to be thinner in South Asian children, but given this study's findings, this is clearly not the case. Even if the association between increasing weight and body dissatisfaction, desiring to be thinner, is weak, the findings demonstrate that the association exists, and this does appear to be consistent with research findings in other populations. A stronger association between body fat and body dissatisfaction was found in an adolescent sample of UK South Asians compared to whites and black African-Caribbeans.²⁶⁷ A further study found a desire for thinness in preadolescent British Asian girls that was comparable to that of Caucasian girls.²⁹²

Although perception of skin colour was not the main focus of this study, the finding that the majority of South Asians and other ethnic groups with darker skin colour chose a pale skinned figure for their perception of the ideal other child warrants some attention. Skin colour preference has been studied in non-white populations of children and adolescents, but mainly in relation to preferences for the colour of their own skin.^{293;294} A USA study of 8-10 year old children from immigrant Puerto Rican families found that the great majority of children were happy with their skin colour and only 16% expressed a desire for a different skin colour (only 50% of these desired lighter skin).²⁹³ A Canadian study of South Asian-Canadian female students found that this group wanted lighter skin colour, but not necessarily white skin colour.²⁹⁴ The finding in this study relates to the more abstract idea of the 'ideal other child', so it does not necessarily follow that those children who chose a different skin colour to themselves for ideal other child desire their own skin colour to be different. This finding further illustrates the complexities of body image perception in young children and flags up a potential area for further investigation.

The findings of this study add to the existing body of knowledge on weight status and body image for a number of reasons. Firstly, this is the largest study to explore the association in such a young age group, and to include both sexes. The study has also focused on a large immigrant group in the UK that is known to be at risk of obesity and its health consequences.¹²⁸ Another strength of the study is that I have begun to explore the differences in weight status and body image in different South Asian ethnic groups, and again, given the cultural differences between the South Asian ethnic groups, it is important that South Asians are not regarded as one homogeneous group. Attempting to understand the psychosocial functioning of South Asian children in relation to obesity is crucial when

developing future interventions to reduce obesity in this group. From a developmental perspective we are aware that preschool children have some awareness of body shape, and so when considering intervention with the aim of preventing obesity, even in children as young as 5, it is necessary to fully understand how obesity may affect a child's body image so that interventions can be developed that are sensitive to this, and may ultimately enhance a child's well being by increasing body satisfaction. In South Asian children it is especially important to understand this aspect of psychosocial functioning, given the potential conflicting family, community and wider societal influences that they may be subjected to.

The study could have been strengthened further by including white British and other ethnic groups, as well as having participants from across the socioeconomic spectrum to enable comparison of young South Asian children with other ethnic groups and to explore the influence of socioeconomic status on the relationship between weight status and body dissatisfaction. Another potential issue is the measure of body dissatisfaction. This was derived from self image and ideal self image, and makes the assumption that a child is dissatisfied with their body if their chosen ideal figure differs from their perceived self. However, this is not necessarily the case and children may have range of body shapes that they find socially acceptable, as demonstrated by Rand and Resnick.¹⁹¹ It may therefore be slightly misleading to measure body dissatisfaction on a linear scale. Even with this in mind, the findings from this study clearly demonstrate a relationship between overweight, obesity and body dissatisfaction.

5.6 Conclusions

The findings of this study support the idea that even at a young age children have an awareness of their body image, and have desires to be different body shapes, with children of increasing weight experiencing higher levels of body dissatisfaction and desire to be thinner. This suggests that children as young as 5 are subjected to societal influences, such as the media^{295,296}, that portray the thin ideal. In South Asian children, matters are further complicated as it is possible that these pervasive societal influences create conflict with traditional family and community values related to body image. These findings have implications for childhood obesity prevention. The design and delivery of intervention programmes aimed at reducing obesity in preadolescent age groups should take into account the existence of body dissatisfaction and its relationship to overweight and obesity. Interventions targeting South Asian children living in the UK need to pay particular attention to the psychosocial functioning of South Asian children and the potential internal conflicts they may face. With this approach, interventions will minimise potential harm to children and may have more beneficial outcomes, not only in terms of reducing obesity, but also by maximising psychosocial health. With regard to the BEACHeS childhood obesity prevention programme, the findings of this cross-sectional study, together with analyses of follow up data from the exploratory trial on body image and dissatisfaction, will inform further refinement of the intervention design and implementation to safeguard and potentially improve psychosocial health.

6 CONCLUSIONS

6.1 Obesity prevention in context

It is evident that obesity represents one of the biggest threats to health in recent times, and the global epidemic has yet to reach its plateau. The burden of disease from adult overweight and obesity is enormous, with 58% of type 2 diabetes, 21% of ischaemic heart disease, 39% of hypertensive disease, 12% of colon cancer and 8% of breast cancer attributed to increased BMI ($>21\text{kg/m}^2$) globally.⁴³ Obesity at the age of 40 has been estimated to reduce life expectancy by 6-7 years, which is similar to the effect of smoking on life expectancy.²⁹⁷

Consideration of the extensive nature of these obesity related morbidities, and the associated reduction in life expectancy, sharply focuses one's mind on the potential impact of effective prevention strategies. If current trends continue, obesity prevalence in the UK is projected to increase to 60% in men and 50% in women by 2050 with a societal cost of almost £50 billion per year.⁵² Every step taken to prevent obesity, no matter how small, could have a potentially significant effect on this trajectory, and a substantial impact on the associated health and economic costs.

The obesity epidemic in developing countries gives even more cause for concern, and further highlights the need for effective and coordinated prevention strategies. Absolute poverty, undernutrition and communicable diseases are still commonplace in these countries, contributing to high infant mortality and reduced life expectancy, but in addition, the economic and nutritional transitions that developing countries are undergoing

have resulted in a rise in overweight and obesity and related morbidity and mortality.⁴⁶ Thus these countries have a double disease burden. Prevention of obesity in developing countries needs to go hand in hand with continued public health efforts to tackle poverty and communicable disease.

A major hindrance to effective prevention is that as yet, we are far from understanding the aetiology of obesity, and despite many advances in recent years, we are only just beginning to unpick the complex web of contributory factors. It is widely understood that both intrinsic (genetic and biological) and extrinsic (behavioural and environmental) factors contribute to a positive energy balance that results in overweight and obesity, and that these factors exert their effect throughout the life course, from the prenatal period to the end of life.^{298;299}

Whilst it is essential to further develop our understanding of the underlying biological mechanisms of obesity, a focus on biology alone is unlikely to lead us to success in reversing the obesity epidemic. Successful prevention and treatment hinges on effective manipulation of behaviours at the individual level that influence energy balance. This can only be achieved if the wider influences on individual behaviour are understood and addressed. The implications are therefore that preventative efforts need to occur throughout life, starting from the preconceptual period, and need to occur at multiple levels, from the individual through to the wider societal level, and ultimately at a global level.

6.2 What this thesis adds

This thesis has explored various aspects of obesity and its prevention in younger school children and has largely concentrated on the South Asian ethnic community within the UK. Whilst the focus has been specific, the findings of the studies within this thesis contribute more widely to the understanding and prevention of childhood obesity. Through the analysis of routinely collected data in schools, I have demonstrated that the school environment has a small but potentially significant influence on the development of obesity, and this may be mediated in part through the amount of school time devoted to physical education. The implications of this are that the school is an important setting for intervention, and the endeavour to further understand which aspects of the school environment can be manipulated to change obesity related behaviours should continue. However, these findings also demonstrate that the influence of the school environment, whilst important, is only a small part of the picture with regard to environmental influences on the energy balance in children. Therefore, in terms of prevention, other settings and environments also need to be targeted.

The exploration of community members' perceptions of causes of childhood obesity gives an in depth understanding of the particular contextual influences operating within UK South Asian communities. This type of information is invaluable in terms of developing and delivering prevention programmes targeting these communities. The importance of understanding the cultural context is brought out in this study. For example, an emergent theme from the community member's focus group discussions was the perception that underweight is more of a problem in children, and overweight children are viewed as healthy.

Despite this, participants recognised the importance of a healthy diet and physical activity, and so it becomes apparent that in order to engage these communities in an intervention, the focus needs to be on healthy lifestyles and not on obesity prevention. This highlights the point that cultural influences need to be understood and taken into account when designing and planning interventions to address obesity in all communities. The data from the community focus groups also capture some of the wider societal and global influences that need to be addressed in addition to family and local community influences.

The childhood obesity prevention programme development described in this thesis provides an example of a process undertaken to try and develop a theoretical understanding of how best to intervene to prevent obesity in a target community, and use this to inform design of an intervention programme. The early phases of the MRC framework for complex intervention development (theoretical and modelling) guided us to develop a deeper theoretical understanding of the problem of childhood obesity in the South Asian community, and assess which interventions were likely to have the biggest impact. Having applied the MRC framework in a process of intervention development, a potential criticism is that the framework only guides researchers to undertake the theoretical and modelling phases of complex intervention development, but does not give much guidance in how to undertake them. This leaves researchers with a somewhat blank page with regard to theoretical development and modelling of a particular complex intervention. This in part may be due to the fact that the term 'complex intervention' encompasses a multitude of programmes, services or initiatives, addressing an extremely wide range of health-related issues. In their updated guidance in 2008, the MRC acknowledged the wide variation in

complex interventions and attempted to better define the characteristics that make an intervention complex. They also reemphasised the importance of the early development phases and provided case studies to illustrate how these phases could be undertaken³⁰⁰, which is more helpful than the initial MRC guidance for researchers embarking on complex intervention development. In this thesis, several methodologies were developed and undertaken for the theoretical and modelling phases of intervention development. Whilst all methodologies provided useful information, the data obtained from the stakeholder focus groups was central to both of these phases.

The exploration of overweight and obesity and one particular aspect of psychosocial functioning (body image) yielded somewhat surprising results. The finding that obesity is related to increased body dissatisfaction in South Asian children as young as 5 years old contrasts with prior knowledge around body image and cultural norms within these communities, and raises the issue of conflict of cultural and societal norms within immigrant communities such as UK South Asians. An understanding of the psychological consequences of obesity is essential, as we can then begin to explore how interventions to address obesity may affect an individual's psychological health either positively or negatively. To this end, it is crucial to assess psychosocial outcomes when evaluating obesity interventions. The findings of the study described in this thesis highlights the point that psychosocial constructs are culturally defined, and so their relationship to obesity may vary in different communities and populations. It is therefore important to understand these relationships in the different communities targeted for obesity prevention.

6.3 Future directions for research and action

There is a need for continued research into the aetiology of obesity, from the biological, behavioural and environmental perspectives, and importantly there needs to be cross-disciplinary work to attempt to delineate the interactions between the various causal factors. Due to the complexity of the aetiological factors and their interrelationships, the challenge of understanding the causes of obesity is immense, and the causal influences may differ to some extent in various target groups, but the more we can try and unravel these factors, the better our chances of successful prevention and treatment of obesity.

Whilst much work has been done in the field of obesity prevention and treatment, we are as yet far from finding a solution. In parallel with the research into aetiology, continued efforts are needed to develop and evaluate interventions that aim to influence the environmental, behavioural and biological aetiological factors. It is critical that our lack of understanding of aetiology does not hinder our efforts to find effective measures to address obesity. Biological intervention may contribute to addressing the obesity problem, but change in biology does not explain the exponential increase in obesity prevalence globally. Similarly, intervention to address behaviours at an individual level has a place in obesity prevention and management, but will not provide the solution alone. The major focus of obesity prevention has to be addressing the obesogenic environment, and changing it in a way that supports individuals to adopt healthy behaviours.

It is essential that environmental intervention to prevent obesity is undertaken at multiple levels, and is coordinated with behavioural and biological interventions. An example of a co-ordinated, multi-level public health strategy is given by the UK measures to reduce

smoking, where environmental interventions such as taxation and the banning of smoking in the workplace have been employed alongside behavioural and biological interventions, such as school-based education, smoking cessation services and pharmacological treatments. These interventions have been responsible for a substantial reduction in smoking prevalence. It must be noted, however, that the problem of obesity is far more complex than smoking, as it has complex underlying biological mechanisms, and results from behaviours and lifestyles that are central to the sociocultural customs of our societies. Therefore, the challenge of identifying effective interventions at multiple levels, and joining these up to form a coordinated public health strategy is huge.

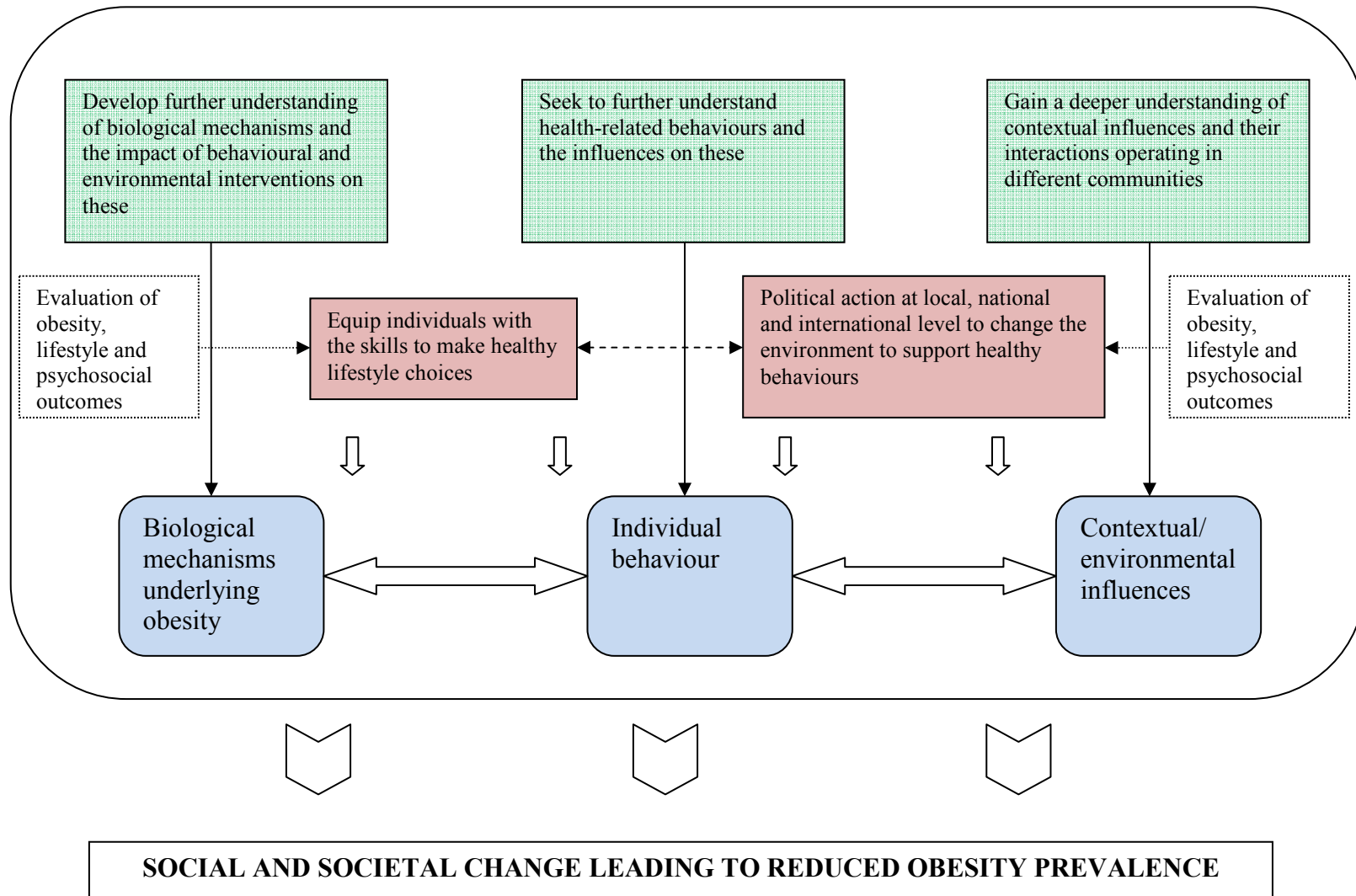
A particular challenge of obesity prevention is that of evaluation. Part of the reason for the focus on behavioural childhood obesity prevention intervention in the research literature is that these types of interventions lend themselves more to evaluation of obesity outcomes than political interventions at the community or societal level. It is clear however, that these population level political interventions are needed if we are going to significantly influence the environment, and so the development of robust policy evaluation methods is urgently required. In addition, the approach to evaluation of obesity intervention at all levels needs to be holistic, and look at wellbeing outcomes such as psychological health, as well as lifestyle and obesity outcomes.

Another major challenge of environmental intervention is that a solution in one community may not necessarily be a solution in another. The role of context and how this influences the way we intervene to address obesity is an area of research that should continue to be developed. The extent to which interventions can be transferred between settings is

unknown, but is an important issue, particularly as most obesity prevention research is undertaken in Western countries, but the need for effective prevention is global.

To sum up, we still have some way to go in understanding the environmental and other influences on the development of obesity in children and adults, and developing effective interventions that change obesity related behaviours. If we continue the aetiological and prevention research in parallel, across the biological, behavioural and environmental disciplines, then we will make small changes, which taken together, will lead to social and societal change that will optimally result in a reversal of the obesity epidemic in the coming decades (Figure 6.1).

Figure 6.1: Obesity and its prevention: areas for research and action







7 APPENDICIES

Appendix 1: Location of schools participating in the BEACHeS study within Birmingham City Council area





BIRMINGHAM



Intervention schools

-  Anderton Park Primary School
-  James Watt Primary School
-  Nansen Primary School
-  Yew Tree Community School

Control Schools

-  Adderley Primary School
-  Heathfield Primary School
-  Christ Church C of E School
-  Starbank Primary School

Appendix 2: Standard Operating Procedures for undertaking anthropometric measures on children participating in the BEACHeS study

General Points

If a child is distressed by any of the measures or refuses to have them done, stop immediately and return the child to class. Inform their teacher and note details on the child's record sheet.

Classroom assistant who brings children from class should take them to the toilet first.
4 children at any one time, depending on how many researchers are available.

Administrator checks name, date of birth and gives ID, put sticker on child and write ID on data collection sheet.

Height Measurement

- Shoes and socks/tights to be taken off.
- Place heels, buttocks and shoulders to upright of Leicester Height Measure.
- Weight should be evenly distributed on both feet
- Move indicator touching top of head, but not pressing down.
- Make sure head is on a level looking forward (not tilted up or down).
- Explain actions and breathing and tell child to leave heels on floor.
- Hold head up under child's ears and ask child to breath in – the level should move up.
- Reading is made to the nearest 0.1cm.
- Record reading on form

If child has posture problem, e.g. bow legs, arthritis, kyphosis make note in comments column.

Weight and Bioimpedance Measurement

- Children should be wearing light indoor clothing.
- Shoes and socks to be taken off.
- If child is wearing tights record this.
- If child has not been to the toilet prior to measurement session, also record.
- Pockets should be emptied of heavy items, e.g. purse, keys, money.
- Switch machine on.
- Enter 0.0 for clothes weight if showing Pt.
- If showing a minus number, check stability, and compensate, as all readings will be lower. If necessary move scales to another part of room. Use carpet tile.
- **Children not to step on scales until instructed.**
- Enter male or female and standard (not athletic).

- Enter age in years; if aged 5 or 6 enter 07, otherwise enter correct age (e.g. 07, 08 or 09).
- Enter height in cm
- Step on scales, checking that heels and feet cover both metal pads.
- If feet unable to cover electrodes change to weight only mode.
- If electrical connection poor, try a drop of water on electrodes.
- Obtain standard printout (impedance recording is needed from printout).
- Write ID and date of birth, date and time on printout and staple to form/give to Sheila/support staff.
- If error messages occur repeatedly press 'weight only' button, to obtain weight.
- Write weight on paper, as no printout will be obtained, & note in comments box.

Error Messages:

- E 01: Abnormal impedance compared to height and weight.
E.g. problem with electrode contact, feet dirty, calluses, poor contact.
Action: use a drop of water on pads.
Or body fat ratio exceeds the measuring capacity- unable to proceed.
- E-11 Measurement impossible because of excessive vibration or electrical noise.
Action: Use in another place.
- E-12, 13, or 14. Machine requires adjustment
- E-16 Impedance measurement unstable,
Action: improve conductivity by cleaning feet, placing water on electrodes

- No printout: Action: No. of print outs selected is >0.
Correct brand of paper is used
Paper roll is in correct position
No jam present

Paper does not come out: Check that paper is not jammed.

- P-End displayed: Action: put in new roll
Check paper advances properly
Paper Release Lever is not in 'Up' position

Uuuu is displayed/power has been turned off during measurement:
Do not place anything or stand on scales before starting measurement.

---- is displayed: Maximum weight capacity has been exceeded.

Feed key not functioning:

- No. of printouts selected is 0
- Weight scale mode is selected
- Use Body Fat Measurement Mode and select >0 for number of printouts.

Waist Circumference

- Light clothing is worn, with the waistline exposed.
- A flexible non-stretchable tape measure is used.
- Child should be standing erect, arms loosely at sides, feet together.
- The measurement is at the halfway point between 10th rib and iliac crest, measure and mark.
- The tape should be horizontal all the way round, check clothes are not caught in tape measure.
- Ask patient to breathe in, then out, take measurement now, no compression to be used.
- Repeat for 2 measurements i.e. reapply tape, results should be within 0.5cm, record both.

Skinfold Measurements

Take all measurements on non-dominant side therefore ask child to hold pen and write.
Position needle at 0 every time a measure is done.

Stand the child up.

Do not measure through clothes; get help to hold t-shirt up/take off if sleeves are tight.

Measurements will be done on triceps, biceps, suprailiac, subscapular and thigh areas

Make sure it is just skin and not muscle being pinched

Warn child that there will be a 'pinch' (do sample test on hand)

Measure twice to obtain within 0.4 of the readings, otherwise do four readings.

Support calliper only whilst taking the reading, but keep the skin pinched whilst waiting for needle to stop moving.

Record all.

Biceps and Triceps

Mark the midpoint of the arm using a tape measure from the elbow (olecranon point) to the shoulder (acromium point) for biceps and triceps

Child to put hands by sides and palms facing front for biceps and back for triceps.

Pinch the skin longitudinally 1cm above the mark, and place the callipers horizontally.

Release the callipers but hold the skin fold.

Take reading when needle has settled

Subscapular.

Child stands erect, holding arms near to side, shoulders and arms are to be relaxed.

Request help to hold up T-shirt.

Check you are measuring on the correct side, looking from the back!!

Locate the lower edge of the scapula on the non-dominant side. Hold a skin fold at 45 degrees to the horizontal, extending down in an imaginary line towards the elbow of the same side.

Jaws of callipers are placed perpendicular to fold 1 cm lateral to fingers.

Suprailiac

Child stands erect, holding arms near to side, arms slightly away from sides.

The measurement is in the anterior axillary line just above the iliac crest. The skin is aligned 45 degrees to the horizontal parallel to the iliac crest.

Thigh

Wherever possible roll trousers up the leg. If trousers are too tight around upper leg or if tights are worn, check that child has underwear on. If child is not wearing underwear and trousers cannot be pulled up, do not do measurements.

Skinfold: Child stands erect with feet together and weight shifted to dominant foot. The measurement is taken on the non-dominant side on the anterior (front) aspect of the thigh, midway between the proximal border of the patella (knee cap) and inguinal crease (crease at top of thigh). Take a vertical pinch 1cm above the mid-point of the thigh (as marked with skin pen), place callipers at mid-point of thigh with jaws perpendicular to the length of the fold. Whilst child has thigh exposed take circumference measure (see below):

Circumference: Taken to nearest 0.1cm using a flexible, non-stretchable tape measure with child in light indoor clothing and exposing relevant parts as needed to undertake measurement. Taken at the mid-point of the thigh on the non-dominant side (as marked with skin pen for above skinfold), with child standing erect with legs slightly apart. Repeat for 2 measurements i.e. reapply tape, results should be within 0.5cm, record both.

Appendix 3: Handout summarising childhood obesity prevention intervention components that have been evaluated in previous research studies



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INTERVENTION COMPONENTS FOR PREVENTING OBESITY IN CHILDREN

SETTING	INTERVENTION COMPONENT	EXAMPLE OF IMPLEMENTING COMPONENT
Family	Activities for family	<ul style="list-style-type: none"> • <i>Cooking demonstrations and food tasting/nutrition workshops</i> • <i>Physical games for families to participate in,</i> • <i>Family “fun” nights/workshops with healthy theme</i> • <i>‘Homework’ to promote family activities</i> • <i>Physical activity sessions for parents</i>
	Educational materials aimed at families	<ul style="list-style-type: none"> • <i>Providing families with:</i> <ul style="list-style-type: none"> - <i>meal plans, recipes</i> - <i>calendars with nutrition tips</i> - <i>leaflets on physical activity, nutrition & reducing sedentary behaviour</i>
	Motivational interventions and incentives to promote healthy behaviour in family	<ul style="list-style-type: none"> • <i>Encourage/support whole family to modify their behaviour:</i> <ul style="list-style-type: none"> - <i>target setting, providing cues and prompts, monitoring and feedback</i> - <i>rewarding (e.g. TV time for physical activity)</i> - <i>individual and group meetings and discussion sessions</i> • <i>Food home packs sent to parents to encourage healthy food</i> • <i>Interactive internet programme aimed at modifying eating and physical activity behaviour</i>
	Campaigns aimed at families	<ul style="list-style-type: none"> • <i>Reduce car use campaign</i>

SETTING	INTERVENTION COMPONENT	EXAMPLE OF IMPLEMENTING COMPONENT
		<ul style="list-style-type: none"> • <i>Turn off the TV campaign</i>
	Develop parenting skills	<ul style="list-style-type: none"> • <i>Education on importance of parental role modelling,</i> • <i>Provide guidance for parents/guardians on diet and eating patterns in children</i> • <i>Provide guidance on encouraging children to do a broad range of activities</i> • <i>Empowerment education to promote healthy mealtime environment</i>
Community	Provide sessions for all community members	<ul style="list-style-type: none"> • <i>Cooking/nutrition sessions</i> • <i>Non-competitive physical activity sessions</i>
	Work with local shops	<ul style="list-style-type: none"> • <i>Food demonstrations, healthy recipe cards, tasting booths in local shops</i>
School: Curricular interventions	Alter physical education provision	<ul style="list-style-type: none"> • <i>Provide more fitness-based, non-competitive physical education</i> • <i>Provide a wider range of physical education (e.g. dance, drama)</i>
	Increase physical activity provision	<ul style="list-style-type: none"> • <i>15 minutes walking before classes start or during school day,</i> • <i>5 minute exercise breaks in the classroom throughout the day</i> • <i>Sessions of structured, non-competitive physical activity undertaken in break and lunchtimes</i> • <i>Guest PE/fitness instructor</i>
	Increase nutrition education	<ul style="list-style-type: none"> • <i>Classroom sessions on food composition,</i> • <i>Relating calories consumed to effort required to burn them off,</i> • <i>Information on drinking water, sugar-sweetened drinks</i> • <i>Hands on learning about growing food</i>
	Increase general health education	
	Work on self-esteem	<ul style="list-style-type: none"> • <i>Self-esteem activity workshop</i>
	Motivational interventions to influence behaviour change	<ul style="list-style-type: none"> • <i>Classroom sessions on goal setting, self-monitoring, self-reinforcement</i> • <i>Food, travel or activity diaries and classroom discussion</i> • <i>Peer support network</i>

SETTING	INTERVENTION COMPONENT	EXAMPLE OF IMPLEMENTING COMPONENT
		<ul style="list-style-type: none"> •Self/parental monitoring of sedentary activities to reinforce message •Pedometers to monitor and set goals (increase by x steps/day) •School report cards to inform parents of child's weight
School: Extra-curricular interventions	Media promotion of healthy diet and physical activity	<ul style="list-style-type: none"> •Posters in schools promoting physical activity and healthy eating •Promotional signage (e.g. posters) of healthy foods •Signposting healthy foods in tuck shops/canteen
	Lunchtime /after school/ holiday clubs	<ul style="list-style-type: none"> •Non-competitive physical activity (e.g. dance, drama), •Food tasting •Cooking skills
	Encourage healthy travel to school	<ul style="list-style-type: none"> •Walking bus (organised route to school so that children walk to school escorted) •School travel co-ordinators, liaising with local authority to develop school travel plan •Offering bike servicing in schools
	Competitions/rewards to promote healthy behaviours	<ul style="list-style-type: none"> •Healthy snack contests, •Fruit snacks as rewards, •Rewards for time spent doing physical activities •Quizzes and competitions to reinforce healthy messages •Behaviour coupons and prizes
School: Food provision	Increase nutritional value of school meals	<ul style="list-style-type: none"> •Increase fruit and vegetable content, and decrease fat, salt, sugar content •Alter portion sizes •Train food service staff
	Improve provision of and access to healthy food in school	<ul style="list-style-type: none"> •Increase availability and appeal of fruit/vegetables, •Favourable pricing of fruit/vegetables, other healthy food •Change content and display of tuck shops, •Increase provision of drinking water and discourage sugar-sweetened

SETTING	INTERVENTION COMPONENT	EXAMPLE OF IMPLEMENTING COMPONENT
		<i>drinks</i> <ul style="list-style-type: none"> •Provide healthy kiosks in school •Provide healthy school breakfast •Local greengrocers providing fruit to school •Farm to school programmes (local produce delivered to school)
School - other	School action plans/ policies related to health	<ul style="list-style-type: none"> •Written school policy to limit availability of unhealthy foods/ban fizzy drinks •Require children to engage in minimum 30 mins activity a day
	Professional development for teachers	<ul style="list-style-type: none"> •Train teachers on behaviour change skills and behavioural choices •Promote more walking, less standing/sitting for teachers •Training for teachers by nutritionist and PE specialist
	Involve children in school changes	<ul style="list-style-type: none"> •Children paint markings on school playground in bright colours (hopscotch, snakes & ladders, fun trail etc) •Develop school garden (grow vegetables)
	Adult role models/school 'champions'	

Appendix 4: Thematic coding framework relating to beliefs on causes of childhood obesity, generated from analysis of the BEACHeS study stakeholder focus group data

Diet	Access to healthy food	
	Child preferences	
	Choice	
	Cooking practices	
	Cost of food	
	Cultural influences	
	Food marketing	
	Portion sizes	
	School food	
	Time for meal preparation	
	Unhealthy food	Processed food
		Snacks
Physical activity	Appearance	
	Cultural differences	Gender differences
	Facilities	
	Lack of exercise in school	
	Motivation	
	Parents competing priorities	
	Safety	
	Sports & competition	
Genetic factors		
Lifestyles		
Parental expectations and behaviours	Parental peer pressure	
Role models		
Sedentary behaviour		
Self perception		
Social issues		

Appendix 5: A priori framework for analysis of the BEACHeS study stakeholder focus group data relating to childhood obesity prevention

Code	Setting	Positive or negative comment on settings	Intervention component (note intervention components generated by group vs. those from literature)	Specific examples suggested by group	ANGELO framework category	Prioritised as important (also note if actively not thought important)	Prioritised as practical (also note if actively not thought practical)	In final priority list (also note if discussed for final priority list but rejected)	Barriers identified	Facilitators identified	Note any conflict surrounding component/example in group
FAM											
FAM Act			Activities for family		Physical/socio-cultural						
FAM Ed			Educational materials aimed at families		Physical/socio-cultural						
FAM Mot			Motivational interventions and incentives to promote healthy behaviour in family		Economic/socio-cultural						
FAM Cam			Campaigns aimed at families		political						
FAM Skills			Develop parenting skills		socio-cultural						
COM											
COM Sess			Provide sessions for all community members		Physical						
COM Shop			Work with local shops		Political/economic						
SC											
SC PE			Alter physical education provision		Physical/political						
SC PA			Increase physical activity provision		physical/political						
SC NE			Increase nutrition education		Political						
SC HE			Increase general		political						

Code	Setting	Positive or negative comment on settings	Intervention component (note intervention components generated by group vs. those from literature)	Specific examples suggested by group	ANGELO framework category	Prioritised as important (also note if actively not thought important)	Prioritised as practical (also note if actively not thought practical)	In final priority list (also note if discussed for final priority list but rejected)	Barriers identified	Facilitators identified	Note any conflict surrounding component/example in group
			health education								
SC SE			Work on self-esteem		sociocultural						
SC Mot			Motivational interventions to influence behaviour change		economic/ sociocultural						
SE											
SE Media			Media promotion of healthy diet and physical activity		political						
SE Club			Lunchtime /after school/ holiday clubs		physical						
SE travel			Encourage healthy travel to school		physical/ sociocultural						
SE Reward			Competitions/rewards to promote healthy behaviours		economic						
SF											
SF Meals			Increase nutritional value of school meals		physical						
SF Prov			Improve provision of and access to healthy food in school		physical						
SO											
SO Plans			School action plans/ policies related to health		political						
SO PD			Professional development for teachers		political/ sociocultural						
SO			Involve children in		political						

Code	Setting	Positive or negative comment on settings	Intervention component (note intervention components generated by group vs. those from literature)	Specific examples suggested by group	ANGELO framework category	Prioritised as important (also note if actively not thought important)	Prioritised as practical (also note if actively not thought practical)	In final priority list (also note if discussed for final priority list but rejected)	Barriers identified	Facilitators identified	Note any conflict surrounding component/example in group
Child			school changes								
SO Champ			Adult role models/school 'champions'		sociocultural						

Appendix 6: Schedules for BEACHeS study focus groups with children, exploring views on interventions to encourage children to adopt more healthy behaviours

Introduction (5 mins)

The lead facilitator will introduce herself and other facilitators to the whole class. She will then go on to explain the purpose of the session and the ground rules:

- Thank you to everybody for taking part today
- We are going to spend the next hour talking about ways of being healthy
- *Would anyone like to tell us what they think are the things that make us healthy? (encourage responses from the children and praise all ideas. Hopefully healthy eating and physical activity will be mentioned, but if not introduce these as ways of being healthy, and try and relate them to what has already been said)

*NB: If short of time, just introduce healthy eating and physical activity as ways of staying healthy.
- We are going to get into 4 groups and talk a little bit more about eating healthy food, and doing activities and exercise to stay healthy
- When we are in our groups we want you all to tell us your ideas. You may have different ideas to others in your group and that is great, there are no right or wrong answers, and this is not a test, it is a chance to have some fun and talk about your ideas
- We will be listening to what you say and writing some things down, but we will only write down what is said, not who has said it. Nothing that you say will be told to anyone else in school.

Group work (40 mins)

The lead facilitator should then organise the groups, and all facilitators need to help to make sure the classroom is set up for the 4 groups. If possible each group should be round a central table, all pupils, the facilitator and assistant should have a chair, and it is important to make sure all pupils are placed so that they are equally included in the group.

Each group will concentrate on one of the following areas:

- Food in school
- Physical activity in school
- Food at home or outside of school
- Activities and exercise outside of school

The basic schedule for the group work is:

1. Specific ground rules:
 - Everyone in the group has a chance to say what they think
 - Try and only speak one at a time
 - There is no need to put up your hand to speakGet children to write their name on a label and stick it on themselves – help if necessary
2. Warm up questions (5 mins)
3. Main exercise: this should involve discussion and getting the children to draw their ideas (15 mins)
4. Evaluation of prioritised ideas from adult FGs using voting cards (15 mins):
 - Go through the list of ideas and show the visual aids for each idea as you go through them. You need to make sure that the children have an understanding of each idea, if in doubt, check their understanding.
 - Give out voting cards to each child, explain that you are going to hold up each card again and ask the children to vote with their voting cards; ask them to hold up one colour card if they think it is a good idea, and another colour card if they think it is not a good idea. To try and minimise children copying each other, ask them to hold up their choice of card all at the same time on the count of 3.
 - At the end of each voting round, decide if the group think it is a good idea overall, a bad idea over all or in between. Have 3 different coloured dot stickers available that correspond to good bad or in between and ask a volunteer to stick a dot on the card, depending on the outcome of the vote.
 - Go through this voting process for each of the cards. Make sure the number of good and bad votes are noted down for each card.
 - When this is finished, thank the children for taking part and explain that the children will be able to hold up their drawings for the rest of the class to see.
 - Conclude the group work, and say that the children will get an opportunity to hold their drawings up for the rest of the class to see at the end.

General points for group facilitators:

- Use your first name and position yourself on a level with the children

- Encourage all children to express their views, either verbally or through drawing
- Make sure materials for drawing are shared out to all group members
- Do not force a child to say something if they are uncomfortable
- Try and clarify what a child means if it is not clear
- Make sure you or your assistant make notes on what is said, and try and write down comments verbatim if possible. The number of votes in the second exercise for each idea presented also needs to be recorded.

Finishing off (5 mins)

To finish off the lead facilitator can bring the class together at the end and ask each group in turn to hold their pictures up so the rest of the class can see them.

The Facilitator should then thank the children for taking part and explain that these ideas will help us to find ways of helping school children keep more healthy.

The children can then be given a small gift for taking part.

SPECIFIC FOCUS GROUP SCHEDULES:

Food in school – 40 mins

Start by explaining the specific ground rules for the group (described in the general schedule).

Allow 5 mins for questions 1-3:

1. We will start by going round the group and saying our first names and what our favourite food is (use teddy bear to aid this, getting children to pass the bear to each other and speak when they are holding the bear).
2. What foods do you think are good for us (our health)?
3. What foods do you think are less good for us (our health)?

In the above questions, try and draw all participants into the discussion, facilitator can go round the group if necessary.

Allow approx. 15 mins for question 4:

4. We are now going to think about the food we eat in school. Suppose it was your job to get children in school to eat healthy food, how would you get them to eat this sort of food, such as (can give examples of healthy food at this point)?

Explain to the children that they can think about this question, and talk about what they think, as well as using the felt tips and paper to draw or write their ideas. Repeat the question, or rephrase if necessary.

Once the children have finished drawing, go round the group and get the children to talk about their drawings.

Allow approx. 15 mins for question 5:

5. We are now going to think about some of the ideas that teachers and parents and other adults had when we asked them about helping children to be healthier.

Now go through the voting exercise described in the general schedule.

Physical activity in school – 40 mins

Start by explaining the specific ground rules for the group (described in the general schedule).

Allow 5 mins for questions 1-3:

1. We will start by going round the group and saying our first names and what our activity is (explain that this may be a sport, game, pass time, or hobby etc.) - Use teddy bear to aid this, getting children to pass the bear to each other and speak when they are holding the bear.
2. What activities or pass times do you think help keep us healthy?
3. What activities or pass times do you think are less good for our health?

In the above questions, try and draw all participants into the discussion, facilitator can go round the group if necessary.

Allow approx. 15 mins for question 4:

4. We are now going to think about the activities we do in school. Suppose it was your job to get children in school to do more healthy activities, how would you get them to do this?

Clarify what you mean by healthy activities, e.g. say 'healthy activities are anything that you have to use your bodies for, such as sports and exercise, but also walking, running and dancing'.

Explain to the children that they can think about this question, and talk about what they think, as well as using the felt tips and paper to draw or write their ideas. Repeat the question, or rephrase if necessary.

Once the children have finished drawing, go round the group and get the children to talk about their drawings.

Allow approx. 15 mins for question 5:

5. We are now going to think about some of the ideas that teachers and parents and other adults had when we asked them about helping children to be healthier.

Now go through the voting exercise described in the general schedule.

Food at home or outside of school – 40 mins

Start by explaining the specific ground rules for the group (described in the general schedule).

Allow 5 mins for questions 1-3:

1. We will start by going round the group and saying our first names and what our favourite food is (use teddy bear to aid this, getting children to pass the bear to each other and speak when they are holding the bear).
2. What foods do you think are good for us (our health)?
3. What foods do you think are less good for us (our health)?

In the above questions, try and draw all participants into the discussion, facilitator can go round the group if necessary.

Allow approx. 15 mins for question 4:

4. We are now going to think about the food we eat at home and outside of school. Suppose it was your job to get children to eat healthy food when they are not in school, how would you get them to eat this sort of food, such as (can give examples of healthy food at this point)?

Explain to the children that they can think about this question, and talk about what they think, as well as using the felt tips and paper to draw or write their ideas. Repeat the question, or rephrase if necessary.

Once the children have finished drawing, go round the group and get the children to talk about their drawings.

Allow approx. 15 mins for question 5:

5. We are now going to think about some of the ideas that teachers and parents and other adults had when we asked them about helping children to be healthier.

Now go through the voting exercise described in the general schedule.

Activities and exercise outside of school – **40 mins**

Start by explaining the specific ground rules for the group (described in the general schedule).

Allow 5 mins for questions 1-3:

1. We will start by going round the group and saying our first names and what our activity is (explain that this may be a sport, game, pass time, or hobby etc.) - Use teddy bear to aid this, getting children to pass the bear to each other and speak when they are holding the bear.
2. What activities or pass times do you think help keep us healthy?
3. What activities or pass times do you think are less good for our health?

In the above questions, try and draw all participants into the discussion, facilitator can go round the group if necessary.

Allow approx. 15 mins for question 4:

4. We are now going to think about the activities we do when we are not at school. Suppose it was your job to get children to do more healthy activities when they are not at school, how would you get them to do this?

Clarify what you mean by healthy activities, e.g. say 'healthy activities are anything that you have to use your bodies for, such as sports and exercise, but also walking, running and dancing'.

Explain to the children that they can think about this question, and talk about what they think, as well as using the felt tips and paper to draw or write their ideas. Repeat the question, or rephrase if necessary.

Once the children have finished drawing, go round the group and get the children to talk about their drawings.

Allow approx. 15mins for question 5:

5. We are now going to think about some of the ideas that teachers and parents and other adults had when we asked them about helping children to be healthier.

Now go through the voting exercise described in the general schedule.

Appendix 7: Presentations and papers arising from the work of this thesis

Conference presentations

Pallan M. Birmingham healthy eating and active lifestyle for children study. *Annual Conference of the Faculty of Public Health* 2007, June, Eastbourne, UK.

Hiam L., Pallan M., Adab P. Obesity and body dissatisfaction: is there an association? *Annual Conference of the Faculty of Public Health* 2007, June, Eastbourne, UK.

Pallan M., Adab P. Causes of childhood obesity: an exploration of societal perceptions. *UK Society for Behavioural Medicine Annual Meeting* 2009, December, Southampton, UK.

Adab P., Pallan M., Mohammadpour-Ahranjani B., Al-Muraikhi A. Preventing childhood obesity: the role of context in developing an intervention aimed at school children: a symposium. *Annual Conference of the International Society of Behavioral Nutrition and Physical Activity* 2010, June, Minneapolis, USA.

Papers submitted to peer-reviewed journals

Pallan M.J., Adab P., Parry J.M., Cheng K.K. Development of a childhood obesity prevention programme: The BEACHeS study (submitted to *Critical Public Health*).

Pallan M.J., Hiam L.C., Duda J.L., Adab P. Body image, body dissatisfaction and weight status in South Asian children: a cross-sectional study (submitted to *BMC Public Health*).

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