ADIPOSITY IN BRITISH PAKISTANI AND WHITE BRITISH SCHOOL CHILDREN AGED 7-11 YEARS LIVING IN MIDDLESBROUGH, UK: ASSOCIATIONS WITH ETHNICITY, GENERATION, AND BIRTH WEIGHT

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ADIPOSITY IN BRITISH PAKISTANI AND WHITE BRITISH SCHOOL CHILDREN AGES 7-11 YEARS LIVING IN MIDDLESBROUGH (UK): ASSOCIATIONS WITH ETHNICITY, GENERATION, AND BIRTH WEIGHT

Emily J. Henderson

ABSTRACT

People of South Asian ethnicities in the UK are at a high risk of obesity and related illnesses. This thesis tests predictions derived from the developmental origins literature regarding adiposity in British Pakistanis in middle childhood. Based on previous research, it was predicted that British Pakistani children would be more adipose and have lower birth weights compared to white British children. It was also predicted that second generation British Pakistani children would be more adipose and have lower birth weights than the third generation. White British children (n=211) and British Pakistani children (n=137), including second generation (n=82) and third generation (n=51), aged 7-11 years were measured for body mass index (BMI), waist circumference, triceps and subscapular skinfold thicknesses, blood pressure, and resting heart rate. Birth weight data were collected from one hospital in Middlesbrough (n=184). In addition, a pilot study was conducted on lifestyle, which explored potential differences in British Pakistani children's lifestyle that may affect adiposity. Dietary data (n=30) were gathered by multiple-pass recall interviews. Physical activity data were collected by accelerometry (n=27) and also by multiple-pass recall interviews (n=30). A questionnaire was developed for the lifestyle pilot to gain an understanding of parents' (n=24) knowledge and practices of healthy lifestyles. Focus group interviews were conducted in one school with children (n=18), which explored children's knowledge and practices of healthy lifestyles. The same focus groups also explored the issue of child participation in the study to understand different motivations between ethnicities and sexes.

Compared to white British children, British Pakistani children were significantly fatter by standard deviation scores for triceps ($p=0.003$) and subscapular skinfolds ($p<0.000$), but not by BMI ($p=0.599$) or waist circumference ($p=0.253$). British Pakistani children had significantly lower birth weights ($p<0.001$), and were more frequently classified as low birth weight ($p=0.01$) and small-for-gestational age ($p<0.001$). These results may support the foetal origins hypothesis, which is that early life influences can adversely affect later health, by linking foetal development with adiposity in childhood. There was a higher proportion of overfat by subscapular skinfold thickness ($p<0.001$) in second generation British Pakistani boys compared to the third generation. The two generation groups did not differ significantly in any measure of birth weight. The lifestyle pilot sub-study suggests that differences in lifestyle patterns may exist between the British Pakistani and white British families who participated, and it could provide a basis for a full study on this topic. Methods implemented in public health research should reconsider using the body mass index alone as a predictor of body fatness, especially in populations including British Pakistanis. Qualitative methodologies should be used to inform study design as a way of illuminating complex and interrelated issues such as obesity and ethnicity.

Adiposity in British Pakistani and White British school children aged 7-11 years living in Middlesbrough (UK): Associations with ethnicity, generation, and birth weight

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TABLES

FIGURES

DECLARATION

The material in this thesis represents the original work of the author. A paper reporting results taken from the pilot study has been published (Henderson EJ, Atherton H, Weir R and Pollard TM (2005) Intergenerational differences in body composition in 8-9 year old British Pakistani children: A pilot study. *Society, Biology and Human Affairs* 70: 23-34). I was solely responsible for the data collection, analysis, and drafting of the manuscript.

The length of this thesis is 56,456 words.

STATEMENT OF COPYRIGHT

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PREFACE

This Ph.D. thesis examines factors associated with obesity in a sample of British Pakistani and white British children. The factors investigated include ethnicity, migration, growth and development, sex, socio-economic status, diet, and physical activity. The primary aim is to assess differences in adiposity between the following groups: 1) British Pakistani and white British children, and 2) second generation and third generation British Pakistani children.

Anthropometric methods were used to assess differences in central and general adiposity between the two study comparison groups to assess for differences fat patterning in their body in each group. Birth weight data (n=184) extracted from hospital records are used to test for an association between poor foetal development in early life and elevated adiposity in middle childhood. A pilot sub-sample was conducted on the topic of lifestyle. Data (n=30) were collected to explore potential differences in adiposity between British Pakistani and white British children, and between second and third generation British-born Pakistani children. Dietary data were collected by multiple pass recall interview, and physical activity were obtained by accelerometry and multiple pass recall interview. Focus group interviews (n=18) were conducted with children, and questionnaires filled out by parents to gain an understanding of their knowledge and practices of health lifestyles. Focus groups were also conducted in one school (n=18) on the topic of child participation in the study to understand different motivations between ethnicity and gender. Participant observations are included in the analysis of child participation.

Chapter 1 provides a review of the literature on the unique position of British Pakistanis in the current obesity epidemic, a theoretical basis of the thesis, and a background of the study population. Chapter 2 presents a review of quantitative methods for assessing adiposity, diet and physical activity, and of qualitative methods used to explore attitudes and behaviours relating to obesity and participation in the study. In Chapter 3 I describe the methods of data collection and analysis employed by this study. Chapters 4-7 test my hypotheses regarding differences in adiposity in British Pakistani and white British children. Chapter 4 presents the anthropometric differences between British Pakistani and white British children. Chapter 5 presents the anthropometric differences second generation and third generation British Pakistani children. Chapter 6 presents data from the sub-study on birth records including differences in birth weight between the two study groupings. Chapter 7 is a pilot sub-study of lifestyle, exploring potential differences between British Pakistani and white British children, and second and third generation British Pakistani children. Focus groups presented in Chapter 8 were conducted with British Pakistani and white British girls and boys in order to gain an understanding of their experiences of the study and how that might have influenced their participation. Finally, Chapter 9 summarises the findings and their implications for adiposity health in the British Pakistani community.

CHAPTER 1: ADIPOSITY AS A MULTI-FACTORIAL HEALTH ISSUE

Obesity is a pressing health concern, the aetiology for which is difficult to pinpoint given the numerous factors that can be attributed to it. On a global scale, there are currently more than 1 billion overweight adults, with at least 300 million clinically obese, and an estimated 17.6 million children under five are overweight or obese (World Health Organization 2009). In Britain there has been an upward trend in obesity rates over the past few decades. By 2050 the prevalence of obesity is predicted to be 60% in adult men, 50% in adult women and 25% in children (Foresight 2007). To lower obesity rates, the Department of Health (2008) has focused efforts on childhood obesity in particular, and sets its goal for 2020 to 'have reduced the proportion of overweight and obese children to 2000 levels'. However, there are methodological issues that need to be taken into consideration to ensure all groups in the UK population are adequately addressed. Obesity can be defined by many different methods that are not always easy to compare. There is no universal measure that reliably defines obesity across all human populations, and many methods have been validated mostly in European ethnic groups. Thus, epidemiological efforts may inadvertently overlook risk in vulnerable groups.

People of South Asian descent living in Britain are shown to have high rates of obesity (the storage of excess fat) and associated illnesses, such as diabetes and cardiovascular diseases, that exceed the national averages (Department of Health 2001a; 2005; Whincup et al 2002; Lear et al 2003; Saxena et al 2004; Misra et al 2004; Ehtisham et al 2005). Even though South Asians in general have been studied extensively on the topic (see Deurenberg, Deurenberg and Guricci 2002; Yajnik 2002; Yajnik et al 2002; Yajnik et al 2003; Misra et al 2004; Misra, Wasir, and Vikram 2004; Vikram et al 2006; Misra et al 2007), the cause for the particular plight in this population is not altogether clear, and as a result public health efforts are limited (Khunti, Kumar, and Brodie 2009). Some of the underlying factors that are often considered are genetics, socio-economic forces, cultural behaviours, lifestyle, urbanisation, and developmental origins (Hattersley and Took 1999; Parsons et al 1999; Lobstein, Baur, and Uauy 2004; Hales and Barker 1992; 2001). The latter factor is an area of research that has flourished over the past two decades, and has presented convincing evidence that chronic adult illnesses, such as coronary heart disease, and obesity have origins in foetal and infant development (Barker 1986; Barker

1989a; Hales and Barker 1999; 2001; Gluckman and Hanson 2004). There is a pressing need to better understand the underlying factors that influence adiposity.

This thesis considers adiposity as a multi-factorial health issue, and investigates ethnicity, migration, development, sex, socio-economic status, and lifestyle factors of diet, physical activity, and parental influence as causal factors. The investigation focuses on British Pakistani children in particular, using white British children as a reference population, and also compares second generation and third generation British Pakistani children. The population sample is from Middlesbrough, a small city in the north east of England, with particularly high rates of obesity. There is a moderately sized minority population of British Pakistanis in Middlesbrough that, despite 'over researching' of British Pakistanis in other parts of the UK, has gone relatively understudied.

This chapter will provide a review of the literature on the unique position of British Pakistanis in the current obesity epidemic, a theoretical basis with which to contextualise the epidemiological aims of the study, and a background on British Pakistanis in Middlesbrough. The first section of this chapter sets out to define obesity and adiposity, and highlights the importance of obesity research by reviewing the morbidities associated with obesity, in particular how they relate to South Asians. Section 1.2 explains the theories of the field of developmental origins of disease research, and how the hypotheses have been used to test for developmental origins of adiposity. Section 1.3 considers lifestyle factors, including diet, physical activity, and parental influences on health related behaviours. A background of the study population is provided in Section 1.4. It provides a brief history of the city of Middlesbrough, including the immigration of British Pakistanis. Finally, this chapter summarises the study's hypotheses.

1.1 Adiposity and South Asians

1.1.1 Adiposity, co-morbidities, and causes

Obesity is defined as excess storage of triglyceride in adipocytes, which is often associated with illnesses, and therefore measures for obesity should adequately predict adiposity (Norgan 2005).

Overweight and obesity can be classified by various means, with the body mass index (BMI) as the most ubiquitous method employed. BMI is a calculation of mass over height squared (kg/m^2) and is used to predict adiposity stored generally throughout both the periphery and centre of the body. Obesity can also be established using methods that predict central adiposity, such as waist circumference and skinfold thicknesses (SFTs). Central adiposity is excess storage of fat in the trunk and abdominal areas preferentially over storage of fat in the peripheral limbs, and it includes abdominal adiposity. The term 'adiposity' is used here synonymously with the word 'fatness' as a means to include all methods that assess body fatness.

Adiposity, and centralised storage of adiposity in particular, is a key indicator of risk for metabolic syndrome, defined by a clustering symptoms, which include insulin resistance, hyperlipidemia (excess fatty acids in bloodstream), and hypertension (Reaven 1988; Reaven 1993; Oken and Gillman 2003; Janssen, Katzmarzyk, and Ross 2004). Metabolic syndrome can be present in absence of adiposity, and is thought by some researchers that insulin resistance is the factor which unifies the various factors associated with metabolic syndrome (Eckel, Grundy, and Zimmet 2005). This is the case where normal amounts of insulin are too inadequate to produce a normal response from fat, muscle, and liver cells to assist the uptake of glucose (Reaven 1988; Reaven 1993). As a result, the body will create higher quantities of insulin in order to maintain glucose homeostasis, leading to hyperinsulinemia and an increase in risk for type 2 diabetes and cardiovascular diseases. Insulin resistance in type 2 diabetes caused either by impaired insulin receptors, insufficient insulin production, or production of abnormal insulin can lead to a marked build-up of plasma glucose (Grundy et al 2004; Alberti, Zimmett, and Shaw 2005). Cardiovascular disease is also defined by a clustering of symptoms, including dyslipidemia, hypertension, and high cholesterol, which is thought to be related to the vasodilatation effect of insulin, and effect on triglyceride production in the liver, as very low density lipoproteins (Isomaa et al 2001).

The associations between obesity and various illnesses have been well established (Power, Lake, and Cole 1997; Zwiarer et al 2002; Reilly et al 2003), and the focus of study has since moved to identifying the causal mechanisms involved in obesity related pathogenesis. Adipose tissue has come to be considered as an endocrine organ, acting as an active metabolic tissue. Adipocyte production of cytokines, which are signalling proteins and peptides secreted by immune cells, plays an intricate role in co-morbidities associated with adiposity. Examples of cytokines produced by adipose tissue, more specifically called adipokines, include leptin, adiponectin, interleukin-6, and angiotensionogen. These molecules and many others are associated with inflammatory and anti-inflammatory responses which can then affect the pathways associated with obesity related morbidities. For example, in the insulin-resistance related inflammatory response, proinflammatory cytokines alter insulin signalling by inactivating insulin receptor substrates proteins, which aid insulin in binding to cytokine receptors (Antuna-Puente et al 2008). Infiltration of the white blood cells called macrophages into adipose tissue is a feature of low grade inflammation, and is associated with adiposity as BMI correlates positively and strongly with the number of macrophages (Antuna-Puente et al 2008). Macrophage infiltration is a source of the adipokines IL-6 and TNF-α, which induce insulin resistance in adipocytes (Antuna-Puente et al 2008). The amount of fat stored on the body is thought to be related to the regulatory systems which influence these cellular functions (Wabtisch 2002), but the location of fat storage may be more influential in the inflammatory response. For example, higher levels of inflammatory markers associated with subclinical inflammation are found in British South Asians when compared white Britons, with central adiposity as a contributing factor (Chambers et al 2001; Somani et al 2006; Pollard, Nunez-de la Mora, and Unwin 2008b). Furthermore, centralised adiposity causes high levels of free fatty acids, glucose, and hormones to be released from intra-abdominal fat cells into the portal circulation (Malina 2004). This biological state is likely to affect the metabolic pathways leading to insulin resistance and cardiovascular disease (Garrow and James 1998; Malina 2004).

In addition, physical activity and diet can have effects on health that are independent of adiposity. The decrease in lean tissue that comes as a result of low physical activity levels could be responsible for observed insulin resistance in obese people, as skeletal muscle is responsible in part for uptake of glucose (Reaven 1988; Reaven 1993). Furthermore, physically unfit children are found to have higher plasma levels of total cholesterol, triglyceride, low-density lipoprotein-C, lower high density lipoprotein C, after controlling for body mass and body fat (Pǎrízková and Hills 2001). Poor diet, such as those rich in fat, salt and sugar, is also indentified as factor, leading to atherosclerosis and hypertension (Pǎrízková and Hills 2001).

In summary, the relationship between adiposity and poor health is complex, with some factors not being directly related to adipose tissue, such as physical inactivity. The amount of fat stored on the body is very relevant, as demonstrated in the case of free circulating fatty acids, but it is specific to abdominal fat. Taking into consideration as well that there are adipokines specific to abdominal adipose tissue, the current line of inquiry indicates centralised storage of fat is the potentially strongest contributing mechanism of adiposity's ill effect on health.

1.1.2 Adiposity in South Asian populations

It is common in research for South Asians (including a family history from India, Bangladesh, Pakistan, or Sri Lanka) to be grouped together rather than analysed separately (e.g. Kalhan et al 2001; Margetts et al 2002; Saxena et al 2004; Fischbacher, Hunt, and Alexander 2004; Anderson et al 2005; Ehtisham et al 2005; Balakrishnan et al 2008). There has been substantially more research on adiposity and co-morbidities in people of Indian descent than any other South Asian group; hence much of what is termed 'South Asian' often includes data from studies on Indians. Data show British Indians tend to report better overall health than British Pakistanis or Bangladeshis, which is likely due in part to their higher educational and socio-economic status (Department of Health 2001; Office of National Statistics 2002a). Information regarding the particularly high adiposity rates found in British Pakistanis might be overlooked when viewed only as British South Asians, exacerbating their already serious health risks (Bhopal et al 1999). In spite of this, the numerous studies into South Asians as a group allow for comparisons with South Asian ethnic groups (Gatrad, Birch, and Hughes1994; Bhopal 1999; Department of Health 2001; 2005; Fischbacher, Hunt, and Alexander 2004; Yoon et al 2006). They have also acted as a starting point in researching the unique ethnic and cultural factors contributing to health of people originating from this region. It is nonetheless crucial to separate the very large category of 'South Asian' into smaller classifications—such as by country—in order to understand the factors influencing more population-specific health issues.

Data on adiposity in British Pakistani primarily comes from the Department of Health's Health Survey for England. It found in 2004 that 28% of British Pakistani women had generalised obesity (BMI >30 kg/m^2) compared to 23% for the general population of adults aged 16 and older (Department of Health 2005). Only 15% of British Pakistani men were considered generally obese, which was 8% below the figures found for the general population. Figure 1.1 summarises the prevalence of raised waist circumference in men (≥102 cm) and women (≥88 cm), which used the definitions of abdominal obesity from the US National Cholesterol Education Program (NCEP 2001). British Pakistani women had nearly two thirds higher prevalence of raised waist circumference compared to the general population, whereas British Pakistani men were on par. The case for British Pakistanis highlights the necessity for analysing adiposity also in terms of fat patterning, as central adiposity can lie unnoticed behind a relatively low or healthy BMI.

Considering data on South Asian groups, the Department of Health's values likely underreport obesity in British Pakistanis. For any given BMI, South Asians tend to have more body fat compared to people of European ethnicities (Kalhan et al 2001; McKeigue 1991; Yajnik 2002; Yajnik et al 2002; Yajnik et al 2003). At BMIs classified as healthy using ethnically European reference populations, markedly high body fat has been detected in adult Indians (Deurenberg, Deurenberg and Guricci 2002; Snehalatha, Viswanathan, and Ramachandran 2003). Waist circumference and other methods of assessing central adiposity have been studied more closely in recent years as they are shown to be stronger indicators of co-morbidities than BMI (McCarthy 2006; Freedman et al 1999; Janssen, Katzmarzyk, and Ross 2004), especially in South Asians (Misra et al 2007; WHO 2004). Kalhan et al (2001) found American South Asian adults ages 18-30 years, including Pakistani Americans, were fatter centrally than European Americans by the sum of suprailiac and abdominal skinfold thicknesses (SFTs), but not for BMI or peripheral SFTs. McKeigue et al (1991) found mean waist-hip ratios and central skinfolds were higher in British South Asians compared to white Britons living in London. Clinical conditions associated with adiposity, such as dyslipidemia and hyperglycemia, are also present in South Asians at lower BMIs relative to European ethnic groups (Whincup et al 2002; Lear et al 2003; Saxena et al 2004; Misra et al 2004; Ehtisham et al 2005).

Health Survey for England 1999 and 2004 do not show any dissimilarity for mean BMI between 2-15 year old British Pakistani girls and boys and the general population. In 1999, the mean BMIs for children were 17.8 kg/m^2 for British Pakistani boys, 17.8 kg/m^2 for the general population of boys, 18.4 kg/m^2 for British Pakistani girls, and 18.1 kg/m^2 for the general population of girls (Department of Health 2001). Results from 2004 are more or less similar, with mean BMIs for the children being 18.8 for British Pakistani boys, 18.3 for the general population of boys, 18.1 for British Pakistani girls, and 18.7 for the general population of girls (Department of Health 2005). In 1997, Kelly et al did not observe differences in BMI between British Pakistani boys and girls ages 5-11 years, but sex differences were observed around 12 years of age. Starting around this age in girls, mean BMI rose above the 50th percentile and mean BMI in boys settled between the 25th and 50th percentile. This observed bifurcation between sexes is supported by other data for British Pakistani adolescents and adults (Saxena et al 2004; Department of Health 2005), and is explained by the tendency in girls to increase fat tissue and boys to increase muscle tissue at puberty.

Data on South Asian children of varying ages support these findings in British Pakistanis. British South Asian 5-7 year olds were found to be 27% more overweight and 45% obese than white British children by BMI (Balakrishnan, Webster, and Sinclair 2008). A study comparing children ages 9-10 years found that South Asian children had lower measures for BMI and waist circumference than their white counterparts, but they also demonstrated higher body fat by bioimpedance and higher combined SFTs (Nightingale et al 2009). In a cohort of 14-17 year olds, which included British Pakistanis in a South Asian comparison group, British South Asian boys and girls were fatter than their white British counterparts, as measured by triceps and subscapular SFTs, waist circumference, and dual-energy x-ray absorptiometry (Ehtisham et al 2005). This relationship may be present at birth. Indian newborn babies were found to be fatter by subscapular SFTs and smaller by waist circumferences compared to English newborns, and they were also hyperinsulinemic (Yajnik et al 2002; Yajnik et al 2003). Studies have identified risk of obesity-related co-morbidities in South Asian children (Yajnik et al 2002; Whincup et al 2002; Misra et al 2004; Vikram et al 2006; Ghosh 2007), and SFTs and waist circumference have been shown to be stronger indicators of co-morbidities in post-pubertal Asian Indian children than BMI (Misra et al 2004). Risk factors such as hyperinsulinemia were found in subjects defined to be within a healthy range of obesity, including BMI, waist circumference, and SFTs, similar to findings in adults discussed above.

Establishing risk for obesity-related illnesses amongst South Asians is a methodological challenge. The International Obesity Task Force (IOTF) (2000) method uses international populations and combines cut-off points from a variety of countries. The World Health Organization and the IOTF (2000) have proffered cut-offs for BMI and waist circumference specifically for South Asian and South East Asian adults based on their estimated abilities to predict associated risks. However, these cut-off points have been debated, with claims that more large-scale comparison studies need to be conducted before regional or national trends can be assessed (World Health Organisation and International Obesity Task 2004). This approach has also been criticised because it may not be fully representative of populations that are particularly susceptible, such as South Asians (Misra, Wasir, and Vikram 2004). It has been proposed that reference populations for BMI and waist circumference should be developed and specific to South Asian children and adults (World Health Organisation and International Obesity Task Force 2000; Deurenburg et al 2002; Lear et al 2003; Snehalatha, Viswanathan, and Ramachandranet al 2003; Misra et al 2004; Misra, Wasir, and Vikram 2005; Kelishadi et al 2007).

1.1.3 Adiposity, ethnicity, and socio-economic status

The categorization of human populations by ‘race’ or ‘ethnicity’ over the centuries has involved an impossibly wide range of human attributes and its use is problematic. The use of ethnicity as a means of grouping people has a history of being imposed rather than self-defined, often limiting its definition to common ancestry or inherent biological qualities (Cohen 1974). The category of ethnicity can be better used as a way of unifying various identities held by a group of people, including beliefs about religion and gender, values, class, and acceptable behavioural norms (Wallman 1986). Alam and Husband (2006) argue that ethnicity be defined broadly and allow for flexibility, as identity exists in multitude within the individual, and will shift in response to ever-changing environments. The Pakistani caste system, which relates more to family kinship than specific occupations, is another example of a division of people that could be considered an ethnic grouping (Shaw 2000). Dividing people into ethnic groups can lead to marginalisation and exclusion from parts of society, including health interventions; however, it is also argued that in the context of health studies it may be relevant to use standardised classifications of ethnicity as a way of addressing health inequalities (Bhopal 2007).

British Pakistanis and Bangladeshis are the poorest ethnic minorities in Britain, with 60% of the estimated one million of them classified in the low-income bracket in 2001/2002 (Office of National Statistics 2002b). Disparities in health status between ethnic groups are frequently attributed to an inherent consequence of ethnicity; however socio-economic disadvantages may have a greater influence on childhood and adult obesity (Lobstein, Baur, and Uauy 2004). For a long time it has been recognised that social class or socio-economic status (SES) is strongly associated with health outcomes (Townsend and Davidson 1982), and more recently associations in abundance are found between SES and obesity (defined by BMI) and related illnesses (see reviews by Power et al 2003; Tabacchi et al 2007; Wang and Beydoun 2007). Behaviour stemming from cultural or religious beliefs can also affect health in terms of health seeking behaviour and the way a particular group might navigate the health care system (Ahmed 1993). For example, inadequate attention paid to low literacy rates or sense of propriety amongst British South Asians by health institutions can compromise patient care (Bhopal and White 1993). Racial discrimination and racism are thought by some to be at the root of poorer health experienced amongst ethnic minority groups, possibly as a result of social disadvantage and psychological harm (Karlsen and Nazroo 2002). Such beliefs or experiences unique to various ethnic groups can in turn influence patterns of diet and physical activity, affecting adiposity and related illnesses.

There are many studies of British South Asians that find socio-economic status and ethnicity influence adiposity (Johnston et al 1991; Kinra 2000; Riste et al 2001; Bhopal et al 1999; Saxena et al 2004; Loucks at al 2006; Wardle et al 2006; Whitaker et al 2006); however their conclusions are far from consistent. Some studies find obesity is associated with both SES and ethnicity (Bhopal et al 2002; Wardle et al 2006), or that SES affects obesity but ethnicity does not (Johnston et al 1991; Kinra 2000; Riste et al 2001; Loucks at al 2006), and others find that only ethnicity is associated with obesity (Saxena et al 2004; Whitaker et al 2006). Some studies have only assessed the relationship between ethnicity and obesity and not considered SES (Whincup et al 2002; Ehtisham et al 2005). It is difficult to compare such studies due to great differences in methodological approaches to assessing obesity, ethnicity and SES (Section 2.2.1). Reviews of other multi-ethnic populations have found such inconsistencies (Tabacchi et al 2007;

Wang and Beydoun 2007).

Research into Western populations overall demonstrates an inverse relationship between obesity and SES, whereby people with higher SES tend to be at a lower risk for adiposity and people with a lower SES tend to be at a higher risk (Sobal and Stunkard 1989; Tabacchi et al 2007; Wang and Beydoun 2007). Indeed, national data demonstrate that in general British Indians were of a higher SES and had a lower prevalence of adiposity compared to British Pakistanis and Bangladeshis (Office of National Statistics 2002b; Department of Health 2005). However, the relationship between obesity and SES is not always inverse. For example, a meta-analysis of obesity in the US found that the prevalence of obesity increased as SES decreased amongst all ethnicities studied; however an exception was found in African American girls and women where the relationship was positive (Wang and Beydoun 2007). Distinctive interactions exist between socio-economic status, ethnicity, and sex, and underscore the importance of considering population specific data when assessing obesity.

1.2 Developmental Origins of Adiposity

The discipline of evolutionary medicine presupposes that humans in general are adapted to a Palaeolithic existence, which involved the energy-intensive hunting and gathering means of procuring food (Trevathan, Smith and McKenna 2008). Research into early origins of human health and disease uses the framework that our human adaptations are carried over from our evolutionary past into our modern world (Trevathan, Smith and McKenna 2008). This suggests that humans are adapted to a lifestyle with relatively intense physical activity, and diets consisting mainly of very low fat proteins and a wide variety of fresh fruits and vegetables (Eaton and Konner 1985). Human physiology is therefore maladapted to westernised and urbanised lifestyles, including factors that promote a positive energy balance through a combination of energy-dense diets and physical inactivity; what has come to be known as an obesogenic environment (Godfrey and Juilien 2005; Fall et al 2001; Bellisari 2008). As a consequence of this ‘mismatch’, humans have experienced what are sometimes known as diseases of civilisation, including metabolic syndrome, type 2 diabetes and cardiovascular diseases (Eaton et al 1988; Eaton et al 1999; Gluckman and Hanson 2004). The following section explores such evolutionary explanations of human disease in consideration of the unique health profile of British South Asians, with a particular focus on adiposity.

1.2.1 Thrifty genotype hypothesis

It has been postulated that all humans have a predisposition to a degree of plasticity in storing and utilising energy sources. Human genetic traits are thought to be adapted to the lifestyle humans experienced in the Palaeolithic era, which constituted a hunting-and-gathering mode of living and energy supplies were sometimes scarce (Eaton and Konner 1985). Neel (1962) proposed that the thrifty genotype was selected for in individuals who were more efficient in storing fat because they were more successful in conditions of food scarcity. The thrifty genotype hypothesis has since been further developed over the years, for example with a shift of emphasis from the efficient storage of energy to efficient energy utilisation; but it maintains the basic principle that a genetic adaptation that is beneficial in one environment can become detrimental in a different environment (Neel 1999). More specifically, the thrifty genotype of efficient fat storage only becomes pathological once lifestyle rapidly changes from a nutrient-scarce to a nutrient-abundant environment.

By the reasoning of the thrifty genotype hypothesis, there will be an even stronger genetic predisposition for diabetes in certain ethnic groups if there is a strong selection within the population. For example, early anthropological research into obesity and diabetes focused on post-World War II Pacific Island groups because this population had significantly elevated rates of diabetes and adiposity (Zimmet et al 1997). Records from European exploration of the islands beginning in the early nineteenth century describe series of typhoons and hurricanes that repeatedly damaged the islanders’ food sources and led to decimation in population (Segal 1989). It is thought these conditions imposed a selective pressure such that individuals who better survived periods of starvation were more likely to perpetuate this thrifty gene. As a result of regular contact with Western cultures after World War II, people began driving cars more often, engaging in less manual labour, and eating pre-packaged food high in caloric, sugar, salt, and fat content. This shift in lifestyle correlates with observed increase in rates of obesity and diabetes (Zimmet et al 1997; Bennett 1999). It is supposed that certain Pacific Islanders groups’ genetic adaptations to efficient energy utilisation led to the dramatically high incidences of diabetes and co-morbidities. The observation that certain populations appear to be more predisposed to diabetes than others has been attributed by the fetal insulin hypothesis in part to a high genetic propensity to insulin resistance (Hattersley and Took 1999).

1.2.2 Thrifty phenotype hypothesis

Early epidemiological studies established a correlation between early life environment and health in later life. Place of birth was correlated with infant mortality and cardiovascular diseases using national statistics from England and Wales in an analysis by Barker and Osmond (1986). They found that the majority of neonatal deaths during 1912-1917 occurred in areas identified with social deprivation, including factors such as poor nutrition and overcrowding. Prior research in Scandinavia, the United States, and London confirmed such findings (Marmot 1964; Forsdal 1977; Buck and Simpson 1982). It was also observed that individuals with restricted foetal and infant growth presented with metabolic and cardiovascular diseases in later life (Barker and Osmond 1986; Barker 1987; 1989 a, b, c; 1990; 1991; Osmond 1990). These observations indicated that certain adult illnesses originate from early life experiences, and led to the development of the foetal origins hypothesis (Barker 1989). It was postulated that the foetus is ‘programmed’ to change its physiological structure or function during critical periods in development in response to poor early life conditions (Lucas 1991). This alteration would then predispose the foetus to pathologies later in life, such as cardiovascular diseases, if the nutrient-poor foetal environment is mismatched with a nutrient-abundant postnatal environment.

Diminished growth of the foetus *in utero*, termed intrauterine growth retardation, can be determined by a low birth weight, defined as less than 2.5kg, or by small-for-gestational age, which is birth weight adjusted for gestational age and sex (World Health Organisation 2003). Birth weight can be used as a proxy for intrauterine growth retardation because it has been correlated with stunting of internal organ and muscle tissue as determined by ultrasonography imaging of the foetus *in utero* (Padoan et al 2004; Lampl, Kuzawa, and Jeanty 2002). Birth weight, however, can only be used as an indicator of growth because it does not factor for the specific body systems that have undergone growth restriction, which is a key to understanding metabolic-related illnesses (Barker 2001). Birth weight is not considered to be an ideal proxy of intrauterine growth retardation, but it is often used because it is easily measured, frequently recorded, and useful in large-scale epidemiological studies.

In consideration of the evidence, Hales and Barker (1992) developed the thrifty phenotype hypothesis, which proposes that poor prenatal and postnatal nutrition adversely affects growth and development to the extent that it results in a vulnerability to type 2 diabetes. Specifically, it was theorised that amino acid deficiency leads to growth restriction in pancreatic islets of Langerhans and the associated insulin secreting beta cells, which sense and respond to the availability of nutrients. Adverse influences on beta cell development can impair their size, structure, and function, and were postulated as a cause of reduced glucose tolerance and diabetes. The critical window in the development of a thrifty phenotype is the time during foetal growth through infancy. It is thought that a susceptibility to type 2 diabetes and cardiovascular diseases can be established during this time in development (Lucas 1991; Hales and Barker 1992). For example, the peripheral organs, including skeletal muscles and the brain, and central organs, such as the intestines and the heart, develop at separate times and specialise *in utero*. In this instance, a thrifty phenotype of efficient energy storage abdominally would result if the foetus' growth is restricted during the critical development period of central organs.

Hales and Barker (2001) updated the thrifty phenotype hypothesis to include mounting evidence associating maternal effects during foetal development and postnatal growth with adult health. Maternal influences such as short stature, low weight, and low BMI appear to play a vital role in development, and have been associated with lower birth weights in the babies (Barker 1994; Fall et al 1998; Ong et al 2000; Yajnik 2000; Yajnik 2002; Margetts et al 2002; Snethen et al 2007). Other factors known to influence foetal growth and development include gestational age, parity, sex, and genetics (Salsberry and Reagan 2008). Genetic factors are thought to influence a portion of foetal growth, but the uterine environment seem to be most influential, and few genes have yet to be isolated in such cases (Barker 2001). Another example of a maternal effect on foetal development is how the placenta in relatively smaller women is able to restrict the foetus from developing to a size beyond her ability for childbirth (Barker 2001). Hales and Barker (2001) theorised that the mother provides a 'forecast of the nutritional environment' in order to prepare the foetal metabolism for a postnatal life of poor nutrition.

Rapid postnatal growth in growth restricted foetuses was also considered as a major cause of adiposity and associated illnesses in Hales and Barker's (2001) revision of the thrifty phenotype hypothesis. It is thought that the body can recover from impediments in growth by redirecting growth to its original trajectory, and more specifically that a small size at birth can result in an acceleration of linear and adipose growth, a process described as catch-up growth (Tanner 1978). Studies have found that children who experienced intrauterine growth retardation tend to show higher levels of adiposity than their peers during middle childhood, which is considered to be around 5-10 years old (Fisch, Bilek, and Ulstrom 1975; Maffeis, et al 1994; Guillaume et al 1995; Duran-Tauleria, Rona, and Chinn 1995; Malina, Katamarzyk, and Beunen 1996; Bavdekar et al 1999; Williams and Poultan 1999; Blake et al 2000; Forsen et al 2000; Okusun et al 2000; Ong et al 2000; Parsons, Power, and Manor 2001; Kuh et al 2002; Yajnik 2002; von Kries et al 2002; Kensara et al 2005; Labayen et al 2006; Rugholm et al 2005; Rogers et al 2006; Massiera, Guesnet, and Aihaud 2006; Karaolis-Dancker, et al 2006; 2008; Elia et al 2007; Adair 2007; Mardones, et al 2008; Kain et al 2009). Children tend to grow more adipose tissue relative to linear growth during ages 8-10 in order to prepare energy stores for pubertal growth and development, a process which may occur earlier in the case of early onset of puberty (Wabtisch 2002). Hales and Barker (2001) suggest that pancreatic endocrine cells that have been damaged by growth restriction *in utero* are overburdened during periods of accelerated growth, and that this state can lead to adverse health conditions in future, such as insulin resistance and elevated adiposity. According to the thrifty phenotype hypothesis, once damage has been done during the critical window, the groundwork has already been laid for the chain reaction of abdominal adiposity, type 2 diabetes, and cardiovascular diseases in future.

Further research into the influence of prenatal and postnatal growth and development on adiposity in later life considers prior life course models of epidemiology, including work by Panter-Brick and Worthman (1999) and Kuh and Ben-Shlomo (2004). Since the thrifty phenotype hypothesis was first presented, a vast literature has supported the earlier observation that rapid growth early in postnatal development in people with lower birth weights predicts adiposity in childhood and adulthood (Whincup 1997; Ong et al 2000; Yajnik 2000; Yajnik 2002; Ong et al 2006; McCarthy et al 2007). McCarthy et al (2007) found that the best determinant of adult obesity is rapid weight gain during approximately 1.5-5 years of age, by BMI, and measurements of central adiposity including waist circumference, sagittal abdominal diameter, and waist-to-height ratio. The study included weight measurements at fourteen different ages from birth to 5 years of age, and therefore was able to predict a fine-tuned estimate of the critical age of adiposity growth.

Studies into the relationship between low birth weight and adiposity in later life often focus on South Asian populations. South Asia has a prevalence of 27.1% of low birth weight babies, which is the highest globally and nearly double the world percentage of 15.5% (United Nations Children's Fund and World Health Organization). Babies born in India are lighter and thinner (i.e. with lower ponderal index) compared to babies in UK (United Nations Children's Fund and World Health Organization 2004). A longitudinal study comparing Indian children in Pune, India with white British children in Southampton, UK found that Indian babies were lighter, shorter, and fatter, and that rapid postnatal growth in the smaller Indian babies was associated insulin resistance at 4 years of age (Yajnik 2002). While Indian babies are 'thin' (i.e. smaller proportioned) compared to white British babies, Yajnik and colleagues have found that Indian babies had similar levels of fat mass but lower fat-free mass, a phenotype termed as 'thin-fat', and found to be present at birth (Yajnik 2000; 2003; Yajnik et al 2002). Glucose uptake occurs widely in muscle, so a deficiency in fat-free mass would prevent sufficient uptake of glucose, and could result in insulin resistance. Singhal et al (2003) correlated lowered birth weight with higher fat mass and elevated adiposity. Kuzawa (1998) suggests this phenotype is a response to an immediate need for energy in a nutrient-scarce environment. By using a life course model of South Asians, Yajnik (2002) found that maternal factors influenced intrauterine growth, paternal genetics drove postnatal growth, and rapid postnatal growth and urban environments influence the high risk of insulin resistance and type 2 diabetes in South Asians.

1.2.3 Developmental origins of health and disease

The work reviewed above by Barker and colleagues has led to a body of literature on the topic of early origins of disease hypothesis, which is currently referred to as developmental origins of health and disease (Gluckman and Hanson 2004). This research built upon the thrifty phenotype hypothesis by exploring whether the observed relationship is adaptive or merely a decline in adult health as a consequence of poor early development.

1.2.3.1 Predictive adaptive response model

Gluckman and Hanson (2004) developed the predictive adaptive response model in light of the wealth of studies correlating poor foetal environment with metabolic syndrome and cardiovascular diseases, as reviewed above and in Simmons (2005). The adaptive response model predicts that the foetus prepares for a nutrient-scarce environment by decreasing fat-free mass, increasing fat mass for energy stores, and increasing access to the more readily available abdominal energy stores (Baker et al 2008). An immediate adaptive response is defined as a reduction in foetal growth in response to poor intrauterine conditions which only has a benefit to survival of the foetus. To be considered a predictive adaptive response, reduced foetal growth must have a functional purpose in the long-term, such as an increased sensitivity of adipose cells in the abdomen for uptake of fat stores in postnatal life (Gluckman et al 2005). Such a response would in effect predict the future needs of the individual in order to achieve long term benefits.

The predictive adaptive response model is substantiated in research correlating low birth weight with low fat-free mass (Hediger et al 1998; Li et al 2003; Singhal et al 2003). A decrease in fat-free mass growth *in utero* may be favourable for the mother and child under nutrient-scarce environmental conditions because it results in a lowered basal metabolic rate in the foetus and requires fewer nutrients (Singhal et al 2003). The uptake of glucose occurs widely in skeletal muscle, so if muscle mass is under-developed, an excess of plasma glucose can result from unprocessed glucose. In an energetically abundant environment foetuses with this particular physiology can compensate by producing excess insulin, and start the dangerous cycle of hyperinsulinemia and later type 2 diabetes and cardiovascular diseases risks discussed previously in Section 1.1.2.

1.2.3.2 Developmental damage model

An increase in adiposity and shifts in metabolism found in individuals born small may simply be the result of tissue damage *in utero* and nothing to do with any adaptive significance (Gluckman and Hanson 2004; Gluckman et al 2005; Kuzawa 2005). The developmental damage model predicts diminished growth throughout the foetus, in particular of the brain, fat-free mass, and fat mass. In essence this model serves as the developmental origins of health and disease null hypothesis (Baker et al 2008). A systematic review of the predictive adaptive response and the developmental damage models by Baker et al (2008) does not find evidence to clearly support one model over the other. Most studies reported some combination of either decreased fat-free mass, increased fat mass, or increased abdominal fat in the low birth weight baby. The use of birth weight as an indicator of diminished foetal growth may not be enough to distinguish an immediate and a predictive response.

1.2.4 Intergenerational phenotypic inertia

According to the thrifty phenotype hypothesis and the predictive adaptive response model, the foetus should receive a signal with information about the environment experienced by its mother. The predictive adaptive response model suggests that adaptation *in utero* benefits the individual in foetal life and throughout the individual lifespan. Based on research from developmental biology, Kuzawa (2005) asserts that developmental adaptations can be inherited over generations by a mechanism that does not alter the genome, as is done in genetic adaptation by natural selection. Kuzawa theorises that a foetus receives a signal from its mother about its mother’s environment during her life time, as well as the environments of several generations of mothers before her. The benefit of an intergenerational mode of adaptation is that the time scale for a response would be intermediate between genetic and developmental adaptations, because the phenotype remains relatively stable over multiple generations at a time. Hence, intergenerational phenotypic inertia would help the individual to respond to a changeable environment by linking non-heritable (i.e. not genetic) information about several generations of information.

The mechanism might, however, have detrimental effects if there were a sudden long-term change in the environment. As discussed above, the phenotype of a lower birth weight would be induced in nutrient-scarce environments in order to metabolically benefit the individual in prenatal and postnatal life. An environmentally induced phenotype relating to metabolic function would have been beneficial during the evolution of *Homo sapiens* during the Pleistocene epoch. Geological records show during this time, sub-Saharan Africa underwent fairly abrupt shifts in ecology, occurring in periods as frequently as decades (Potts 1996). Such changes in environments would have affected availability of foods. Kuzawa argues that mother's birth weight may serve as a better signal of environmental conditions to the foetus rather than maternal nutrition because nutrition is affected by small shifts in the environment such as seasonal and regional variations. Kuzawa cites a previous hypothesis that states that the intrauterine conditions that a mother is able to offer children are dependent upon the intrauterine conditions she experienced as a foetus (Ounsted and Ounsted 1968). It is thus suggested that a mother's life-long nutritional experiences may serve as a signal of her environmental conditions to her foetus, which in turn would influence the intrauterine conditions of her female children, and extend over generations through the female line.

Considering low birth weight is common in countries with high prevalence of under-nourishment, it is logical to predict that migration to more nutrient-abundant environments will increase birth weight (United Nations Children's Fund and World Health Organisation 2008). However, it is known that maternal nutrition during gestation does not necessarily significantly affect foetal growth, evidenced by findings that birth weight is not completely determined by maternal nutrition (reviewed by Kuzawa 2005). A systematic review of thirteen studies by Kramer (2000) of mostly developing countries found only modest increases in birth weight after protein and energy supplementation to pregnant women. A study of British South Asians demonstrates that first generation (South Asian born) and second generation (British born) babies had birth weights lower than the national UK average, and no trend appeared to indicate that birth weight would increase in successive generations (Margetts et al 2002). Similarly, Harding, Rosato, and Cruickshank (2004) found no differences in birth weight between first generation and second generation British Pakistanis. The retention of the phenotype of lower birth weight over generations despite changes in nutrition may be the result of physiological damage a mother experienced in her own foetal development (Drake and Walker 2004), but it is possibly the result of intergenerational phenotypic inertia.

Kuzawa (2005; 2008) furthers his hypothesis by suggesting that epigenetic modification, which controls expression of genes, is the mechanism used to signal to the foetus about the environment over generations (Jablonka and Lamb 1998). The field of nutrigenomics finds evidence of patterns of DNA methylation, which is a process that controls the expression of genes. These patterns of gene expression, or 'imprints', can be modified by certain nutrients and passed down over generations (Waterland and Jirtle 2004; Gallou-Kabani and Junien 2005). For example, it has been speculated that genes operating on the size of blood flow to the uterus could be targeted by nutritional cues and altered on the epigenetic level (Gluckman and Hanson 2004).

In combination with the thrifty phenotype hypothesis, Kuzawa's hypothesis predicts a slow increase in birth weight and healthier adult outcomes over generations in studies of migrants from nutrient-scarce to in more nutrient-rich environments. Similarly, a decrease in generalised and central fat deposition will indicate phenotypic changes over generations, although the change is likely to be small.

1.3 Lifestyle

The understanding of the aetiology of obesity in nutritional, sport and medical sciences derives from the basic energy model, which assumes the equilibrium between calorie intake and calorie output is out of balance. However in the case of children in particular, definitive conclusions about the causes of obesity are difficult given the limitations of methodology and low success from intervention studies (Gutin et al 2000). Nonetheless, diet and physical activity are likely to be key contributing factors.

1.3.1 Diet

Over the past decade, research shows that British children are eating higher frequencies of obesogenic foods, such as added-sugar drinks and high fat savoury snacks (Food Standards Agency 2000; Buttriss 2002). The Department of Health has responded to the rise in childhood obesity by initiating several dietary schemes for schools and families to follow. The NHS Plan recommends five portions a day of fruits and vegetables which has met with some success (Department of Health 2000). The Fruit and Vegetables at school scheme provides one portion of fruit or vegetable at school to young children at no cost (Department of Health 2001b).

There has been some research into the diets of British Pakistani and British South Asians (Department of Health 2005). The Health Survey for England 2004 obtained data on consumption of fruit and vegetables. It found that in general females and British Pakistanis ate more fruit and vegetables. The general population of adults ages 16 years and older consumed 3.3 and 3.6 portions per day for men and women, respectively, while British Pakistanis men consumed 4.3 portions per day (OR 1.47 SE 0.14) and British Pakistani women consumed 4.0 portions per day (OR 1.19 SE 0.11). In the same Survey of children aged 5-15 years, British Pakistani boys consumed 3.0 portions per day while the general population of boys ate 2.5 portions per day (OR 1.62 SE 0.31), and British Pakistani girls consumed 3.0 portions per day compared to the 2.6 portions consumed by the general population of girls (OR 1.39 SE 0.35). The Health Survey for England 2004 demonstrated that British Pakistani men and women were less likely to consume dietary fat than the general population (OR 0.84 SE 0.04; OR 0.91 SE 0.04, respectively) (Department of Health 2005). Data on dietary fat in children were not reported. Brock et al (2009) found that British South Asian primary school age children ate more calories, fat, and protein than white British children. This observed difference in children consuming more obesogenic foods than their parents may suggest generational changes in South Asian diets.

Generational changes in diet can be expected in immigrant families because diets will naturally vary with new influences and limitations in the availability of traditional foods (Anderson and Lean 1995; Anderson et al 2005; Mellin-Olsen and Wandel 2005). A study comparing migrants and second generation British South Asian women in Glasgow found that the first generation tended to eat foods that were more atherogenic (promoting cardiovascular diseases), including high amounts of saturated fats (Anderson et al 2005). A comparison of diets in 9-11 year old Pakistani children living in Pakistan (Rawalpindi and Mirpur) and Britain (Bradford) found significant differences in reported types of food and nutrient intake (Edwards et al 2006). The children in Bradford were more likely to consume obesogenic foods such as those with added-sugar and fast foods, and less likely to eat healthful foods such as vegetables. Thus there exist some data that supports the prediction that migration from South Asian countries to Britain has an impact on diet.

1.3.2 Physical activity

Physical activity has been identified as an important factor to help prevent or reverse the poor health effects of adult obesity, type 2 diabetes and cardiovascular diseases (Gortmaker et al 1999; Gortin and 2000). The Department of Health (2007) recommends that children engage in a minimum of 60 minutes of moderate-to-vigorous physical activity (MVPA) per day as prevention against obesity and related illnesses in adulthood; however nation-wide children are becoming less physically active each year (Riddoch et al 2007; Sport England 2008). For example, in 11 year old British children only 2.5% were found to achieve at least 60 minutes of MVPA per day, with 5.1% from boys 0.4% from girls (Riddoch et al 2007).

The Department of Health conducts the Health Survey for England and collects data on physical activity practices and levels in minority ethnic groups by self-report for adults and parent-report for children. It found that British Pakistani adults (after adjustments for age) reported less than the recommended minimum of 30 minutes of moderate-to-vigorous physical activity for at least five days per week (Department of Health 2004a; Department of Health 2005). An estimated 15% of British Pakistani women achieved the recommendation compared to 25% of the general population of women. Out of British Pakistani men, 27% reported having achieved the recommendation compared to 37% of the general population of men. Similarly, the same Survey of 2-15 year olds found British Pakistani girls were the least likely out of any ethnic group or general population of children to achieve the recommended hour of moderate-to-vigorous physical activity every day. It was observed that 36% of British Pakistani girls achieved the recommendation compared to 61% of the general population of girls. British Pakistani boys achieved 60%, similar to the general population proportion of boys of 69%.

A systematic literature review of twelve studies on children and adults found British South Asians, including British Pakistani adults, engaged in lower amounts of physical activity compared to white Britons (Fischbacher et al 2004). Duncan et al (2008) found that British South Asian children reported less time spent in moderate-to-vigorous physical activity than white British children, also finding overall that South Asian girls were the least active compared to the British South Asian boys and white British children. Using questionnaires in a population of British children ages 11-16 years, Khunti et al (2007) found no differences in overall reported time spent in physical activity between the South Asian and white ethnic groups, or in time spent watching television and playing computer games. Their data are consistent with previously discussed findings of gender differences, with British Pakistani girls reporting less time spent in physical activity during school time. Physical activity levels amongst immigrant families are likely to alter to some degree and generational changes in physical activity, and some studies show that second generation British South Asian women are more physically active than the first generation (Lean et al 2001; Pollard et al 2008a). The studies discussed here on physical activity levels in British Pakistanis and British South Asians were assessed by semi-quantitative methods; but very few studies, if at all, have assessed physical activity in these populations by objective quantitative measures, a methodological issue discussed in Section 2.2.2.

1.3.3 Children's knowledge and practices

Public health efforts have attempted to improve children's health education by conducting research into children's knowledge of diet, nutrition and physical activity. Lifestyle interventions in schools may successfully help to reduce the levels of childhood obesity (Brown and Summerbell 2009). Children are increasingly allowed to make their own food choices but do not necessarily have the motivation or knowledge to make healthy choices (Hart, Bishop, and Truby 2002). Potential motivators for children to choose healthy foods include feeling good physically and mentally, and motivators for engaging in physical activity include social interaction (O'Dea 2003). Sex differences have been identified whereby girls can be motivated to stay healthy more for aesthetic reasons and boys more for sport activities (McKinley et al 2005).

1.3.4 Parental knowledge and practices

Children who are raised by healthy parents tend to be healthier, an effect believed to be largely a result of learned behaviours from parent to child (Perry et al 1988; Lobstein, Baur, and Uauy 2004; Tabacchi et al 2007). Children as young as 3 years old who have diets consisting of unhealthy levels of fats and sugars also have a significantly high risk for being obese by the age of 7 years (Reilly et al 2005), and is shown that 83% of British children do not meet their dietary recommendations of five portions of fruits and vegetables per day (Department of Health 2005). British children have been found to prefer obesogenic foods, such as those high in fat and sugar, which has been attributed to a lack of early exposures by their parents to healthy foods, such as fruit and vegetables (Hill 2002). Because only an approximated 25% of adults achieve the Department of Health's (2004a) recommendation for time spent engaged in physical activity (Sport England 2008), it is therefore no surprise that British children do not meet their own physical activity recommendations of 60 minutes a day of physical activity (Department of Health 2007; 2008).

Young children's lifestyles are largely influenced by parental guidance. For example, Skinner et al (2004) found children's intake of protein and fat during 2-8 years of age were positively associated with BMI at 8 years old, indicating parental dietary choices strongly affect child adiposity. Decreased sleep duration has been correlated with an increased risk of obesity in children, which may be a result of parental influences such as later bedtimes, irregular meal times, and excessive TV viewing (Kaur et al 2003; Agras et al 2004; Reilly et al 2005; Penev 2007; Snell et al 2007). Parents tend to underestimate overweight and obesity in their children, especially if the parents are overweight or obese, which is likely to influence parental healthy choices for their children (Hart, Bishop, and Truby 2002; Lobstein, Baur, and Uauy 2004; Department of Health 2008).

Exposure to the developmental risks for adiposity and to a poor lifestyle could together contribute to the particularly high risk of adiposity in British Pakistani migrants: they are susceptible to the same obesogenic environment as are all Britons, and as migrants they are particularly vulnerable to excess storage of adiposity.

1.4 Background of the study population

This section provides a brief background of the participants and location involved in the current study in order to contextualize the study population. It includes the demographics of the city studied, as well as relevant history, in particular the migration history of British Pakistanis to the area.

The north east of England has some of the highest prevalence rates of child obesity in the country, and the city of Middlesbrough has rates well above the region. The 2007/2008 National Child Measurement Programme report estimated a prevalence of obesity in 10-11 year old children in the north east of 19.9%, compared to 18.3% estimated for the UK. In Middlesbrough, 22.7% of 10-11 years olds were estimated to be obese. Middlesbrough has a small yet under-studied population of British Pakistanis. The national 2001 census reported British Pakistanis as the largest minority group in Middlesbrough, with 4,839 out of a total of 134,855 people (Office of National Statics 2001). Nationally, the largest concentrations of British Pakistanis are in Leeds/Bradford, Birmingham, and London (Office of National Statistics 2004).

The first major migration of Pakistanis to Britain occurred after Pakistan's Partition from India in 1947. Pakistan remained a subject of the British Commonwealth, and the 1948 British Nationality Act allowed people from the Commonwealth to enter Britain without restriction (Walvin 1984). The populations of people from Pakistan who migrated to the UK have a history of economic migration within Pakistan, which may explain their particular ability to migrate to Britain in search of prosperity (Shaw 2000). Currently 95% British Pakistani migrants come from rural areas, with 60-70% identified as having origins from the Mirpur district of Azad Jammu and Kashmir and approximately one third from the Panjab (Department for Communities and Local Government 2009). Shaw (2000) describes two main regions of Pakistan where British Pakistanis originate, the northern rainfall districts, including Mirpur, and the canal colonies in the Panjab plains. The northern rainfall districts are long-settled rainfall dependent rural areas with a tradition of labour migration in nineteenth century, whereby men would spend long periods in military service or abroad during dry seasons. The canal colonies in the Panjab plains were worked by agriculturalists, who were relocated to the canal colonies a result of the British scheme of irrigation and settlement.

Pakistanis began migrating to Britain in the early 1950s to take advantage of the high demand for labour and the high price wages relative to those in Pakistan. Most of these early immigrants were male labourers and first settled in West Yorkshire, Lancashire or the West Midlands (Shaw 1988). Pakistanis migrated to Britain via 'chain migration', meaning here that once migrant men found work and settled, they would send for members of his family, community or village to join him (Shaw 1988). Men and women continue to come from Pakistan as marriage partners for second generation British Pakistanis.

British Pakistanis arriving to these areas by means of chain migration often needed to search for work throughout Britain, including Middlesbrough in the early 1950s when the first settlers came. Migrants mainly were manual labourers in the shipping industry, which primarily involved coal industries, and also steel, iron, and chemical industries (Panikos 1999; Renton 2006). Many white British labourers in Middlesbrough around this time were looking for better working conditions throughout Britain, opening up a niche in the labour market for British Pakistanis (Renton 2006). The 1962 British Commonwealth Immigrants Act, which came in response to the influx of migrants, restricted the number of immigrants, and ironically resulted in a massive migration in anticipation of the future restrictions (Walvin 1984).

Beginning in the 1970s there was a sharp decline in heavy industry throughout Britain which left the local economy in decline and the community debilitated. Middlesbrough is now a part of the post-industrialised north east region of England. It has recently been undergoing urban regeneration with grants from Middlesbrough Council and Tees Valley Regeneration and the European Union aimed at generating business that lends a sense of identity, culture, and community (Association of North East Councils 2009). Despite efforts at urban regeneration, Middlesbrough still continues to experience the damaging effects of the industrial collapse in 1970s and thereafter. In 2007 Middlesbrough showed levels of income deprivation and child poverty rates above average for England with almost 39% of children living in households dependent upon benefits (Association of Public Health Observatories and Department of Health 2007). In 2006, low birth weight rates in Middlesbrough were 2.3% higher than the national average of 7.6%, and the rate of early death from heart disease and stroke was significantly higher than the averages for England (Office of National Statistics 2006; Association of Public Health Observatories and Department of Health 2007). Based on a national poll conducted by the property televisions how Location, Location, Location (2007), Middlesbrough was named the 'Worst Place to Live in Britain' in 2007 due to high crime rates, smoking, and binge drinking.

1.5 Hypotheses of the Present Study

This thesis reports mainly two different comparisons: British Pakistani and white British children; and second generation and third generation British Pakistani children. The generation of British Pakistani children are defined by place of birth through the maternal line. My hypotheses are as follows:

1) British Pakistani children will store more fat, both generally and centrally, than white British children.

The predictive adaptive response model, based on the foetal origins hypothesis, expects a thrifty phenotype to develop in the foetus if it anticipates a nutrient-scarce environment. This adaptation is based on either cues from the external environment or information from the foetal environment experienced by the mother. In the case of British Pakistanis, an increased efficiency of fat storage would be beneficial if responding to the relatively nutrient-scarce environment of Pakistan; however the phenotype is mismatched with the obesogenic environment in Britain, which results in elevated levels of adiposity.

2) Second generation British Pakistani children will be fatter than third generation British Pakistani children, both centrally and generally.

The intergenerational phenotypic inertia hypothesis predicts a slow ‘washing out’ of the thrifty phenotype over generations if the environment significantly changes. In the case of British Pakistanis, migration to a nutrient-abundant environment from a nutrient-scarce one will signal to the foetus that the thrifty phenotype of energy storage efficiency is no longer necessary in the UK.

3) British Pakistanis will show more foetal growth restriction compared to white British children.

The predictive adaptive response model, based on the foetal origins hypothesis, expects a thrifty phenotype to develop in the foetus if it anticipates a nutrient-scarce environment. This adaptation is based on either cues from the external environment or information from the foetal environment experienced by the mother. In the case of British Pakistanis, a restriction of growth *in utero* would be beneficial if responding to the relatively nutrient-scarce environment of Pakistan.

4) Foetal growth will be more diminished in second generation British Pakistani children compared to the third generation

The intergenerational phenotypic inertia hypothesis predicts a slow 'washing out' of the thrifty phenotype over generations if the environment significantly changes. In the case of British Pakistanis, migration to a nutrient-abundant environment from a nutrient-scarce one will signal to the foetus that the thrifty phenotype of decreased foetal size is no longer necessary in the UK.

5) Diminished foetal growth will predict elevated adiposity during middle childhood, regardless of ethnicity or generation status of British Pakistani children from immigrant families.

While early origins of disease predicts that exposure to a nutrient-scarce environment results in diminished foetal growth, and while diminished foetal growth and elevated adiposity in middle childhood is hypothesised to be observed in British Pakistanis, particularly in the second generation, this association is a result of diminished foetal growth and not ethnicity per se.

It is expected that lifestyle should be a major factor explaining adiposity in all British children. However, based on hypotheses 1 and 2, differences in adiposity between British Pakistani and white British children will already exist. If British Pakistani children do consume unhealthy foods more frequently and have lower physical activity levels than white British children, the effect from such postnatal factors would enhance any observed differences in adiposity due to a thrifty phenotype for a higher propensity store fat. The findings will nonetheless inform public health interventions. I will test for differences in diet and physical activity between British Pakistani and white British children, and between second generation and third generation British Pakistani children.

I also conduct a sub-study exploring various factors which might motivate children to participate in the overall study, and if any differences in motivation exist between British Pakistani and white British children. I questioned whether the interest in and turn out for my study may have been motivated by ethnic and cultural differences between participants.

The two chapters to follow are methodological. In Chapter 2 I review the literature of methods available for studies of adiposity and lifestyle, and in Chapter 3 I detail the methods of data collection and preparation that I employed.

CHAPTER 2: METHODOLOGICAL LITERATURE REVIEW

This chapter discusses the types of methods used to collect data on adiposity, diet, and physical activity. I summarise the methods currently available, consider their strengths and weaknesses, and finally justify the methods I used in this research. Given that I have studied children within school settings, anthropometrics were chosen, rather than clinically based methods. However, in the first section covering anthropometry I summarise all methods that are available to assess body composition in order to explain how anthropometrics are validated by them.

2.1 Anthropometry

Anthropometry is the study of the human body, involving measurements such as weight, dimensions, circumferences, and skinfold thicknesses. Anthropometrics can be used to assess body composition by using the raw measurements, ratios, or prediction equations. Anthropometrics are only indirect measurements of body composition because they do not assess the chemical composition of the body as do direct methods (Deurenberg and Reubenoff 2008). Therefore, anthropometrics rely on validation studies whereby they are compared to 'gold standards', which measure atomic, molecular, and cellular levels of body composition (Deurenberg and Reubenoff 2002). Anthropometrics have been standardised by Lohman et al (1988) and published in the widely used *Anthropometric Standardization Reference Manual.*

2.1.1 Summary of body composition methods

Body composition can be assessed on five levels: atomic, molecular, cellular, tissue and whole body (Malina et al 2004; Deurenberg and Roubenoff 2008). The atomic level deals with the basic chemical elements in the body, including oxygen, carbon, hydrogen and nitrogen. The molecular level of body composition includes water, lipids, proteins and minerals. The cellular level of assessment measures the mass of cells, extracellular fluids and solids, and fat. Body composition refers to muscle, adipose, and bone tissues. The whole body level deals with size, shape and physique of the body (Malina et al 2004). Models used for assessing body composition are based on these five levels. A two-component model limits the focus of body composition to fat mass and fat-free mass. A three-component model includes fat mass and fat-free mass, dividing fat-free mass into total body water and dry mass. The four-component model includes fat mass, total body water, dry mass and bone mineral from the fat-free dry mass. It is considered most ideal to use a four component model that directly measures the chemical composition of the body (Malina et al 2004; Deurenberg and Roubenoff 2008). It is possible to achieve a four component model by combining methods. For example, in addition to fat mass and fat-free mass, hydrodensitometry measures total body water and DEXA measures bone mineral, which would combine to give four components (Graves et al 2006; Scott 2008).

Three and four level models are considered the most precise methods of assessing body composition (Graves et al 2006; Malina et al 2004). Isotopic dilution techniques, or doubly labelled water, allow an isotope of water (3H20, D20 or 18O) to circulate the body. Because body water is predominantly associated with fat-free mass, total body water can be measured and used to estimate fat-free mass (Malina et al 2004). With the dual photon absorptiometry, photons are transmitted through tissues at two energy levels. Dual energy x-ray absorptiometry (DEXA) is a three-component body composition model that uses radiology to assess regional and whole body composition. DEXA differentiates body weight into mineral-free lean soft tissue, fat soft tissue, and bone (Graves et al 2006). Magnetic Resonance Imaging (MRI) and computed tomography (CT) are direct methods that use magnetic field and x-ray, respectively, to examine fat patterning and to differentiate subcutaneous and intra-abdominal fat (Deurenberg and Reubenoff 2002).

The three and four component models are highly accurate but they are very expensive. There are various 2-component methods available that are relatively less expensive. Hydrostatic densitometry and air displacement plethysmography are two of the most common methods used to assess body composition (Graves et al 2006). Hydrostatic densitometry, also referred to as hydrostatic weighing, provides an estimate of body fat from body density using Archimedes principle of displacement (Malina et al 2004). It has been considered the gold standard for developing prediction equations for body composition field methods, although the three component DEXA method is gaining popularity as it becomes more available (Graves et al 2006). Air displacement plethysmography, commonly referred to as the 'BODPOD', also provides an estimate of body fat from body density as does hydrostatic weighing, but instead uses Poisson's law of pressure and volume equilibrium (Graves et al 2006). Ultrasound is becoming an increasingly popular method for assessing body composition. It works by directing high frequency sound waves into the body. Muscle tissue, fat tissue and bone all have differing densities, so the sound waves reflect off the tissue with the highest density with highest velocity, which in this case is bone (Graves et al 2006).

Anthropometry and bioimpedance assay (BIA) are also 2-component models and they are the most commonly used methods in field research because they are relatively inexpensive and highly portable. Bioimpedance assays use a small electrical current to run through the body. The resistance met by the electrical current is inversely related to the amount of the fat-free mass contained within the body (Graves et al 2006). Anthropometric measurements are the least expensive methods overall, and can provide regional information on body composition whereas bioimpedance assays cannot (Graves et al 2006). Though less precise than other methods, measurements such as bioimpedance assays and anthropometrics are considered acceptable methods of assessing body composition if the study is more to do with generalised risk assessment rather than clinical assessment or health policy (Scott 2008).

The anthropometric methods used to measure and analyse body composition in children are generally different than those used for adults, given children's ever-changing proportions and pubertal changes (Freedman and Perry 2000). Relatively high measures of waist circumference, body fatness, and body mass index (BMI) are associated with increased health risks, such as diabetes and heart disease (Reaven 1988; Oken and Gillman 2003; Janssen et al 2004). Such health conditions are typically not found in children, although rates have increased in recent years, especially amongst adolescents, as childhood adiposity has become more prevalent (Williams and Horlick 2008; McCarthy et al 2005 b; Freedman et al 1999). Furthermore, indicators of risk have been identified, such as insulin resistance and hyperinsulinemia (Whincup et al 2002; Yajnik et al 2002; Yajnik et al 2003; Misra et al 2004; Vikram et al 2006; Ghosh 2007). Adult cut-offs are made based on clinical outcomes of poor health associated with anthropometric measurements (Freedman and Perry 2000). To determine cut-off points for children, current methods utilise data from longitudinal studies which find that children generally remain within the same centile throughout their lifespan (Cole et al 2000). This process is known as tracking and is discussed in more detail later in Section 3.7.2.2. Measurements of body composition can be very useful in assessing potential future health risks in children, provided they are applied appropriately (Scott 2008).

2.1.2 Height, weight, and indexes

Standing height in children can be measured after 2 years of age, and is used as an indicator of physical activity levels or nutritional status, as well as used as a predictor of height to be attained in adulthood (Malina et al 2004; Williams and Horlick 2008). The metric system is the most widely used method of measurement, with a meter defined by using the distance of the speed of light over time (Organisation intergouvernementale de la Convention du Mètre 2006). Stature is commonly measured by stadiometers, and can be validated against this measure (Lohman 1988).

Body weight measures the mass of all composites of the body: fat, muscle, bone, minerals, water; and can be used as an indicator of inadequate nutrition (either under or over nutrition) and underlying disease (Williams and Horlick 2008). Weight is a measure of the mass of an object plus the factor of acceleration of an object exerted by gravity, expressed in units of newtons or pounds; however, the term weight is commonly used synonymously with mass, measured in kilograms. The most widespread method of measuring body weight is by using balance scales, which compares the weight of a known object to that of known object (Lohman et al 1998). Some commonly used scales include a mechanism which can take into account gravitational force and calculates mass.

The Quetelet index, more commonly known as the body mass index (BMI), is defined by the equation body mass/height^2 (kg/m^2). BMI is widely used to identify overweight or underweight individuals; however BMI cannot be considered an exact measure of fatness (Norgan et al 2005). BMI reflects frame size, leg length, and the amount of combined fat and fat-free mass, and therefore is used to predict body composition rather than directly assessing it (Norgan et al 2005). BMI does not correlate as strongly with body fatness as do other anthropometric methods, such as skinfold thicknesses (discussed in Section 2.1.4); however measurements of weight and height are ubiquitous among records and are the easiest measurements that can be obtained.

The Rohrer index, sometimes referred to as the ponderal index, is defined as body mass/height^3 (kg/m^3) and is also used to predict body fatness, although less frequently than BMI (Sopher, Shen, and Pietrobelli 2005). Using the square of height minimises the correlation of BMI with height, while the cube of height allows weight to be analysed completely independent of scale (Burton 2007).

Justification of methods selected

Standing height (cm) and weight (kg) were collected from all participants in the present study, and BMI was calculated from these two measurements. While the benefit of using the ponderal index is that it allows for comparison of individuals of greatly varying heights, such as children of different age groups, the BMI has been found to be a better predictor of body fatness in children (Mei et al 2002). Furthermore, BMI is currently the most common assessment of fatness and the use of it in this study will allow for comparisons. BMI is not used in the present study to predict any of the hypotheses in the present study; rather it is used as a measure of body size and as a covariate in analyses of other anthropometrics, such as waist circumference and skinfold thicknesses.

2.1.3 Waist circumference and ratios

Waist circumference is a measurement that is easy to obtain and reflects central body fat distribution. Waist circumference is thought to accurately estimate intra-abdominal fat in pre-pubertal children, which is the component of abdominal fat most closely associated with obesity-related illnesses (Goran et al 1998). The method can also be used in populations of varying ethnic backgrounds, although its use for predicting co-morbidities of obesity has been challenged with respect to populations at particularly high risks of abdominal adiposity, such as South Asians (Scott 2008; Misra, Wasir, and Vikram 2005). Studies have found co-morbidities in people of South Asian ethnicity present at lower measures of waist circumference, an issue discussed in Section 1.1 (Whincup et al 2002; Lear et al 2003; Misra et al 2004; WHO 2004; Ehtisham et al 2005; Misra et al 2007). Waist circumference has been validated against hydrostatic densitometry to predict body fat percent within 2.5-4% in adults and is considered to be a very reliable method (Scott 2008).

Waist circumference-to-height ratio (WHtR) has been proposed as a useful and simple calculation for clinicians to assess abdominal adiposity whilst considering effects of stature on the dimensions of the waist (McCarthy 2006). A ratio ≥0.5 has been used as the cut-off for excess of abdominal fat, meaning that one’s waist circumference should be no larger than half of one’s height (Ashwell et al 1996).

Abdominal obesity can also be assessed using the waist-to-hip ratio (WHR); however studies have found that this method is not useful in prepubescent children (Deurenberg 1990). In an assessment of skinfold measurements, waist-to-hip ratio was correlated with central-to-peripheral skinfold ratio in older children and adolescents, but not in younger children (Deurenberg 1990). It is suggested that because abdominal fat is increasingly deposited throughout childhood development, skinfold measurements are more sensitive in detecting variations in fat distribution in younger age groups than waist-to-hip ratio (Law et al 1992). Analyses of waist-to-hip ratio using regression may be limited due to findings that ratios in general produce spurious results (Tanner 1949; Kronmal 1993; Ashwell et al 1996; Packard and Boardman 1999).

Justification of methods selected

Waist circumference was collected in this study and used to calculate waist-to-height ratio. Waist-to-hip ratio was not used because the method is not appropriate in the age range for participants in this study.

2.1.4 Skinfold thicknesses, ratios, and prediction equations

Skinfold thicknesses (SFTs) are measured using calipers to determine the thickness of subcutaneous fat from one specific fold of skin on the body, and there are several skinfold points that can be measured. Skinfold thickness is a measurement of two layers of subcutaneous skin due to folding of the skin. The method is based upon the assumption that subcutaneous fat is a good predictor of total body fat (Scott 2008). The relationship between subcutaneous fat and total body fat is influenced by age, sex, fatness, and ethnicity of the individual (Scott 2008). Potential sources of measurement error associated with skinfold measurements are caliper selection, tester reliability, and variance within the measurer's selection of the skinfold site. Skinfold thickness measurement of obese individuals can be difficult because the skinfold may be larger than the breadth of the caliper, caliper tips may slide on the skinfold, and the oedema that results from compression of subcutaneous fat causes the thickness of the skinfold to decrease (Bray and Gray 1988).

The subscapular-to-triceps skinfold ratio (SFR) is calculated and used as a mean of assessing central fat patterning (Pollock and Jackson 1984; Malina et al 1988). Subscapular-to-triceps skinfold ratio takes into account fat patterning in the periphery as well as the centre of the body, and therefore describes relative fat distribution, which waist circumference alone is unable to do. The use of subscapular-to-triceps skinfold ratio has been criticised for a number of reasons. For one, it is limited to two skinfolds and so does not describe the entire fat patterning of the body, such as the abdomen or thighs (Malina et al 1988). Analyses of subscapular-to-triceps skinfold ratio using regression may be limited due to findings that ratios in general can produce spurious results (Tanner 1949; Kronmal 1993; Ashwell et al 1996; Packard and Boardman 1999). Use of dual x-ray absorptiometry (DEXA) has been cited as a more robust method for assessing relative fat distribution, although it is less practical than using skinfold calipers (Malina et al 2004).

Prediction equations using skinfold thicknesses can be used to calculate fat mass and fat-free mass. There are many factors that can affect the reliability of prediction equations, including obesity status, age and ethnicity. As a result, there is debate in the literature as to whether there is systematic bias when comparing body composition between ethnic groups with anthropometric prediction equations. Ideally, prediction equations will derive from studies that divide the population by sex, age, and ethnicity (Norgan 2005). Most validation studies of prediction equations include only white participants, so do not account for analyses of differing ethnic groups (Schafer et al 1993; Boye et al 2002; Deurenberg et al 2002). Furthermore, there are some observed differences among ethnicities in body shape, for example limb length, which may affect results from body composition assessment (Tanner 1976; Norgan 2005; Lohman and Going 2006). Given the arbitrary definitions of ethnicity, some researchers warn that while intergroup variation is observed between ethnic groups, there is likely to be equally significant intragroup variation within ethnic groups (Gatrad, Birch, and Hughes 1994; Norgan 2005).

In children the issue of assessing body composition by skinfold thicknesses is complicated further by the observation that body composition tracks differently, that is to say there are differing trends in the growth and development, depending upon ethnicity and age (Graves et al 2006; Tabacchi et al 2007). For example, linear and adipose tissue growth over the course of childhood alternates, a process sometimes referred to as ‘stretching’ (i.e. linear) and ‘filling’ (i.e. adipose tissue) (Tanner 1981). Tricep and subscapular SFT measurements can be used to chart this process (Brook 1978), which is particularly useful in studies examining the effects of rapid childhood growth of adiposity (Duran-Tauleria, Rona, and Chinn 1995; Malina, Katamarzyk, and Beunen 1996; Bavdekar et al 1999; Okusun et al 2000; Ong 2000; Labayen et al 2006). For the case of South Asians, there are some validation studies of prediction equations provided by Durnin and Womersley (1974) in Indian adult populations, but there are not yet any validation studies of prediction equations for Indian children (Kuriyan et al 1998; Vasudev et al 2004).

Justification of methods selected

Skinfold thicknesses were selected for use in this study because they were the most practical measurement of regional body fatness to use for data collection in schools and least invasive for measuring children. The triceps, subscapular, suprailiac, and abdominal skinfold points were initially collected in the pilot study and used to assess fat stored in the periphery and centre of the body (Section 3.4). These points are recommended and considered to be the most appropriate for children because they most reliably detect adiposity in the unique dimensions and tissue development in children, and they are considered to be clinically significant for children (Seefeldt and Harrison 1988).

2.1.5 Blood pressure and resting heart rate

Blood pressure is a commonly used method of assessing cardiovascular health in adults. Growing evidence suggests it is appropriate to monitor cardiovascular health risks in children as young as three years old because early indicators of the disease are already apparent (American Heart Association 2002; Hopkins Tanne 2002). Furthermore, British South Asian children are shown to have higher blood pressure than white British children (Whincup 2002), although the Department of Health (2005) only found this relationship in boys. Blood pressure is therefore an important and revealing method for assessing cardiovascular health in South Asians, even in children. Resting heart rate is often used as a proxy for physical fitness. A lowered resting heart rate indicates cardiovascular fitness due to a physiological response to physical activity involving blood volume and circulation (Wilmore, Costill, and Kenney 2008). Whincup et al (2002) found in children ages 10-11 years that British South Asians had significantly higher resting rates compared to white British children by 4 beats per minute.

Blood pressure machines are commonly used instead of manometers because they require less expertise, in particular automated ones, and they are portable for fieldwork. British Hyper tension Society protocol recommended that these devices be validated by their set of protocol (O'Brien et al 2002). In general, a mercury sphygmomanometer is used to provide control values to compare to device readings. This protocol was created as a way of simplifying in response to the more rigorous protocol set by the British Hypertension Society protocol, for example by requiring fewer test observers (O'Brien et al 1993). However, Stergiou et al (2010) critiques the latter is a simplified version and that more rigorous protocol is required, such as the 1993 protocol. The devices can also be calibrated by connecting it to a mercury column, although some are self-calibrating.

Justification

Data collection of blood pressure and resting heart rate in children may reveal obesity-related risk. Blood pressure machines, which also provide data on resting pulse, are relatively inexpensive, easily portable for field work, and require minimal training to operate.

2.1.6 Birth weight

Birth weight data in the United Kingdom are measured and stored in medical records, and are frequently used in epidemiological research. Data on birth weight can also be obtained by self-report, usually from the children's mothers; however these data are not as reliable as hospital records. Hospital records increase reliability of data and can include more data, for example gestational age and mother's BMI.

Catch-up growth is assessed by observing a significant increase in adipose growth between two periods in time, a phenomenon known as centile crossing, and discussed in more detail in Section 3.7.2 (Prader, Tanner and Von Harnack 1963; Boersma and Wit1997). This method is often employed in studies of childhood development of adiposity from birth to middle childhood (reviewed here in Section 1.2.2). Standard deviation scores (SDSs) are used in analysing catch-up growth because they standardise measurements for age and sex when comparing children of different ages and sexes (Section 3.7.2). Centile crossing is a difference between two growth measurements greater than 0.67 SDS (Boersmat and Wit 2008). This difference is equivalent to a jump between one percentile band on a standard growth chart, e.g. 25^{th} to 50^{th} percentile (Ong et al 2000). Catch-up growth is indicated when a centile crossing in early life results in elevated adiposity in later life (e.g. in primary school).

Justification

Data on birth weight were collected from hospital records. Data were initially collected via the Pilot Study parent questionnaire, but many parents could not recall or did not know their children's birth weight (Section 3.4).

2.2 Lifestyle

2.2.1 Diet

This section reviews the methods available for assessing diet, which can be done semi-quantitatively by food intake and also quantitatively by nutrient intake. Wrieden et al (2003) provide a procedure for measuring food and nutrient intake. It involves obtaining a report of food consumed, coding foods to standard food tables, quantifying the portion sizes, determining the frequency of food eaten, and calculating the nutrient intake (portion size*frequency* nutrient content per gram). Because questions range, many studies would not include all five procedures.

Interviews can be conducted which ask individuals to recall their diet from a specified time period. The 24-hour recall is one of the most commonly used methods of food intake recall because a 24-hour period is considered the most reliable in terms of a respondent's ability to remember foods eaten (Rutishauser and Black 2002). The multiple pass recall (MPR) method was devised by the United States Department of Agriculture as a tool to thoroughly learn individual's dietary intake (Lee and Nieman 2003). The respondent is asked to recall their diet from the previous day in three passes, asking first for a quick list, then a detailed description of each food, and finally a summary of the day's food (Appendix F). This method is thought to help trigger the memory and recall more foods with each pass (Lee and Neiman 2003).

Validation studies have shown that individual's estimation of portion size correlates with the known portion size (Foster et al 2008). A Food Atlas can be used with multiple pass recall as a visual cue to assess portion size. This is a book containing pictures of commonly consumed British foods (Nelson et al 1997). On each page a particular type of food is shown in six frames on a plate or bowl of food. Each picture has a different portion of the food and is given a special code. The documents provided by the Food Atlas include some foods found in South Asian diets, such as curries, chapattis and naan bread.

There are two types of food record methods, diary and weight records, and both measure food intake on specific days. Food diaries are a relatively simple way of gathering food intake from a respondent because the respondent is asked only to record all food and drink consumed over a relatively short period of time (e.g. one week), but not necessarily the portion size (Rutishauser and Black 2002). With the weight record, the respondent or researcher must weigh all food before being eaten, then whatever was not eaten is measured and subtracted from the weight of the meal before it was eaten. While a more precise method, weight records require a high degree of training in order for it to be done properly (Rutishauser and Black 2002).

Another way of assessing food intake over a relatively short period is first-hand observation of the participant's food consumption. This method is most often used with adults in controlled studies or alongside participant observer methods, and is very useful with younger children when a parent or carer acts as the observing researcher (McPherson Day et al 2008). The observation can also be used to validate other methods of food intake that assess specific days, such as food recall or food records.

The food frequency questionnaire (FFQ) assesses the habitual intake of food over an extended period of time rather than on specific days, as do the previously discussed methods (McPherson Day et al 2008). The questionnaires ask respondents to indicate how frequently specific types of food are eaten over the course of a month or within a year. Food frequency questionnaires are primarily used to associate food intake with disease, therefore the types of food included in the questionnaire are determined based on the nutrients that are being assessed and the nutritional content of the food (Rutishauser and Black 2003). There are many standardised questionnaires available for adults and children. For example, the calcium food frequency questionnaire has been designed to estimate calcium intake and only uses 11 categories of food, while the EPIC food frequency questionnaire is used for estimating overall nutrient intake in adolescent children as part of the European Prospective Investigation of Cancer uses 130 categories (Nelson et al 1988; Bingham and Nelson 2001).

A diet history is another method of assessing habitual food intake in the individual. This method can allow for seasonal variation in food intake by assessing food over the course of a year (McPherson Day et al 2008). The respondent is asked to review a typical day of food intake as a starting point, and then variations are explored thereafter (Rutishauser and Black 2002). Food photographs such as those found in the Food Atlas can also be used to estimate portion size (Nelson et al 1997). The results from the interview are then checked against a standardised list of commonly consumed foods (Rutishauser and Black 2002).

Sources of error

All of the dietary methods described here involve some degree of measurement error, and there is no gold standard in measuring food intake (Rutishauser and Black 2002). Methods that involve estimation of portion size, such as multiple pass recall interview, food frequency questionnaire, and diet history are subject to error because individuals are known to vary in their ability to accurately estimate portion size (Bingham and Nelson 1991). However, the use of photographic images of food portions are shown to reduce error in estimating portions size with these methods (Nelson et al 1997; Rutishauser and Black 2002). Differences amongst respondents are shown to affect accuracy of recall and contribute to recall error, for example age and weight status, as discussed below (McPherson Day et al 2008). Day-to-day variation of food intake introduces a degree of error in methods that assess specific days of food intake in order to estimate habitual food intake. Therefore, records over more days increases the precision of such measures.

Justification of methods selected

Multiple pass recall interviews were selected because they involve interview cues and reasonably short sessions, both of which are appropriate for children. The nutritional content of foods was not assessed because the study question explored differences in diet (Section 1.5), so analysis of nutritional intake would not lend any further necessary information than would food intake alone. The diet histories were considered to be too lengthy, and records and questionnaires would have been too dependent upon literacy and compliance. Observation methods would not have been practical for this study design in schools as a whole since this method would have only been used on lunches eaten at school.

Validation of MPR in children

Multiple pass recall has been validated by both American and British studies in adults (Conway et al 2003; 2004) and in children (Montgomery et al 2005; Moreno et al 2005), albeit with some degree of error (Jonnalagadda et al 2000). Twenty-four hour recall has been demonstrated to be useful in children aged 10 years and older, and younger children showed difficulty recalling food intake without a parent or carer present (Biró et al 2002). Indeed, in studies employing isotopic dilution, recall in children aged 3-7 years was not an accurate measurement of dietary energy intake (Reilly et al 2001; Montgomery et al 2005). Children normally are less accurate in reporting than adults; however studies have shown MPR is still a very useful method with children (McPherson Day et al 2008). A potential source of recall bias in administering food intake methods is the tendency of healthy weight individuals to over-report and for overweight and obese people underreport, leading to a need for validation studies for each BMI category (Fisher et al 2000; Rutishauser and Black 2002; Baxter et al 2006). Robertson et al (2005) recommend quality control to minimise error, which would include intensive training of methods and strict adherence to the protocol.

2.2.2 Physical activity

Physical activity can be defined by the expenditure of energy as a result of skeletal muscle movement (Bouchard et al 1990). Energy expenditure refers to bodily metabolism and includes energy expenditure during rest, physical activity, and food consumption (Malina et al 2004). The measurement of physical activity is multi-faceted and ideally measures intensity, duration, type, and frequency of activity (Malina et al 2004). However, it is a methodological challenge to accurately measure these multiple factors simultaneously (Malina et al 2004). As a result, there are numerous methods of assessing physical activity used in research. Semi-quantitative measurements of physical activity are in general reliable in identifying the frequency, duration, and type of activity (Malina et al 2004). Objective measures are able to provide estimates of energy expenditure, intensity, duration, and frequency; however they do not measure the type of physical activity.

2.2.2.1 Objective methods of physical activity

Objective measures of physical activity are most often employed by sport and exercise scientists, and include gold standards with which to validate other methods of assessing physical activity. The accepted gold standard for measuring energy expenditure in free living populations (i.e. individuals not within a study facility) is isotopic dilution, or doubly labelled water, and does so by estimating exhalation of carbon dioxide (Ainslie et al 2003). Indirect calorimetry assesses energy expenditure by measuring oxygen and carbon dioxide levels, although it can not be used in free living populations. Both isotopic dilution and indirect calorimetry assess energy expenditure very accurately, but these methods are time consuming, expensive, and require expertise. They also do not measure any of the four facets of physical activity, intensity, duration, type, and frequency.

Heart rate monitoring has also become a popular method of physical activity assessment for both children and adults. It measures the number of heart beats per minute, measuring the duration of intensity, calories burned and breathing rate (Karvomen and Vuorimaa 1988). Direct observation of physical activity measures the intensity, duration, mode and frequency of activity; however it is an extremely labour intensive method and subject to participant reactivity (Sirard and Pate 2001).

Motion detectors have become more widely used in epidemiological studies as the technology becomes cheaper and thus more realistic for large scale research (Rowlands, Ingledew, and Eston 2000). Pedometers are simple motion detectors worn on the hip that measure the amount of steps taken by an individual. Accelerometers are a more sophisticated type of motion sensor as they are able to accurately measure intensity of activity. They average and record acceleration of vertical movement over a defined epoch of time, and they can also record step counts. Like the pedometers, they are small and light and can be worn on the hip, secured by a durable elastic waist belt (Ekelund et al 2001; Metcalf et al 2002). Activity can be identified as either light, moderate, or vigorous, and therefore gives a more detailed assessment of physical activity than other methods, such as the step counter (Riddoch et al 2004). Accelerometers do not measure the type of activity undertaken and they are not able to detect upper body movement, cycling, swimming or movement on a gradient.

Sources of error

Accelerometers may tend to underestimate physical activity during everyday activities, such as walking. For example, Welk, Almeida, and Morss (2003) showed a coefficient of variation of around ten percent for most accelerometers and a coefficient of variation of around twenty percent for participants. This is of particular concern with respect to children because they are more likely to show fluctuations in activity throughout the day (Welk, Almeida, and Morss 2003).

Justification of methods

This study used accelerometry to assess duration and intensity of physical activity. Accelerometry has a stronger association between physical activity levels and measured adiposity in children compared to questionnaires (Rowland et al 2000). Accelerometers have been modelled successfully in the UK with children and shown to be tamperproof (Metcalf et al 2002). Diaries were used for children to keep record of when they wore and took off the accelerometers, mainly as a way to increase children's compliance to wear the monitors, and they were also used as a way of double checking when the monitor had or had not been worn.

2.2.2.2 Semi-quantitative methods of physical activity

Twenty-four hour recall of physical activity can be used method in primary school children and provide detailed information on activity. Twenty-four hour recall measures can either be time-based, such as the Previous Day Physical Activity Recall questionnaire (PDPAR) (Weston 1997), or activity-based, like the Self-Administered Physical Activity Checklist (SAPAC) (Sallis 1991). A study by McMurray (1998) showed that the SAPAC overestimated physical activity by four to five times when compared to an activity monitor; however, there was no apparent systematic bias in the error, indicating that a correction factor may be applicable. Self-reported physical activity questionnaires in general provide a quick assessment of physical activity but require multiple days of recall data to reflect typical activity patterns. Semi-quantitative methods can illustrate the types of physical activities in which participants are engaged.

Sources of error

Assessment of physical activity has somewhat moved away from semi-quantitative methods as a result of objective measures having become more practical to use (Janz 2006). Although semi-quantitative measures have the benefit of being cost-effective, they are based on self-report, which can be influenced by recall bias. For example, Hendelman et al (2000) showed that youths tend to over-report vigorous activity, yet they underreport moderate intensity physical activity. Physical activity questionnaires are susceptible to measurement error, however the self-error is somewhat counteracted by the large sample sizes that questionnaires are designed to assess (Wareham and Rennie 1998). For this reason, questionnaires are most appropriate in large-scale epidemiological studies (Wareham and Rennie 1998).

Justification of methods

The multiple pass recall interview was used to identify the type and duration of activity in which the children engaged. The method was originally designed for assessing nutritional intake, and it has been adapted by the present study for assessment of physical activity. While the multiple pass recall method has not yet been validated specifically for physical activity, it is likely to be reliable given its demonstrated effectiveness to increase children's memory recall. It is used in the present study to improve comparability of semi-quantitative diet and physical activity data.

2.3 Participation and Qualitative Methods

Qualitative methods are available to researchers aiming to study people's motivations. They are exploratory in nature, and seek to induce information and identify patterns within a cultural context (Strauss and Corbin 1999). Data obtained from such methods aim to be sensitive and flexible to a social context, and can be distinguished from the more rigid quantitative methods (Mason 2002).Despite this distinction, qualitative methods must nonetheless be systematic and rigorous in their approach. The interpretation of qualitative data relies upon the subjective interpretation of the researcher, rather than the strict objective nature of quantitative study. The qualitative researcher must therefore be reflexive in her or his role as a researcher, understanding and taking into consideration how their presence will invariably influence data collected from social interactions (Mason 2002).

2.3.1 Participant observation

Participant observation is the original method used in anthropology, whereby the researcher is immersed in a cultural context of study in order to empathetically understand the culture (Malinowski 1922; Mead 1928). One might use this method when seeking to study a population from an ontological perspective by investigating the components of that culture, or from an epistemological perspective by attempting to reveal meanings. The participant observer's role as a researcher may be made explicit to the study population, or they may enter the culture covertly in an effort to observe behaviours that may not occur within a research study. In either case, the researcher's position will invariably be subjective. The act of maintaining awareness of this position can aid in filtering out biases and practising impartiality when undertaking participant observation methods.

2.3.2 Individual interviews

Interview conversations offer in-depth data from an informant, collected in various manners such as taking life histories or conducting survey. They can range in structure, from being entirely structured, semi-structured, or guided with minimal direction. Structured interviews usually involve a list of specific questions for the interviewee to answer, and while semi-structured interviews also aim to answer particular questions, the questions asked should be open ended to allow the interviewee to expand upon their answers. In guided interviews, the interviewer uses a few key words to explore a topic without specific research questions (Finch and Paget 1999). Even semi-quantitative methods, which may aim to answer similar questions to those of qualitative methods, do not allow the interviewee to elaborate due to their relatively set structure.

2.3.3 Focus groups and group interviews

Focus groups are a very useful way of elucidating people's perspectives which may not have been formalised until participating in the discussion (Kitzinger 1999). The benefits of working in groups are that they can lower inhibitions to participate and help people to remember details they might have otherwise missed out by other methods. Focus groups tend to explore a specific topic which emphasises interaction with a group more so than group interviews, but can be formalised with the interviewer being directive with discussion, or informal with the interviewer being more passive, allowing discussion to take its own course, and they can be spontaneous, for example during field work (Merton 1999; Mason 2002). Group interviews can also be executed using preset questions that do not necessarily depend on group interaction.

Justification of methods

Motivations for and experiences of participation in the study were assessed qualitatively through participant observation and focus groups. Participant observation allows for behaviour that might not be observable under an explicit study environment. A semi-structured format was selected for the focus groups so as to provide a structure with which to encourage reflection and expression of participants' thoughts.

2.4 Predictions of the Present Study

I make study predictions based on the methods selected from the review in this chapter. I present my predictions based on the hypotheses of this study, which are presented in Section 1.5 and restated here for reference.

1) I hypothesise that British Pakistani children store more fat, both generally and centrally, than white British children.

I predict that British Pakistani children will have larger anthropometric measurements of adiposity. General adiposity will be assessed using waist circumference and triceps and subscapular skinfold thicknesses, and central adiposity will be determined using waist circumference and subscapular skinfold thickness.

2) I hypothesise that second generation British Pakistani children will be fatter than third generation British Pakistani children, both centrally and generally.

I predict that second generation British Pakistani children will show larger anthropometric measurements than third generation children of general adiposity, as measured by waist circumference and triceps and subscapular skinfold thickness; and central adiposity, as measured by waist circumference and subscapular skinfold thickness.

3) I hypothesise that British Pakistanis will show more foetal growth restriction compared to white British children.

Using birth weight as a proxy for foetal growth, I predict that birth weight will be lower in British Pakistani children compared to white British children, and that the prevalence of having been born small-for-gestational age and with a low birth weight (2.5kg) will be lower in British Pakistani children compared to white British children.

4) I hypothesise that foetal growth will be more diminished in second generation British Pakistani children compared to the third generation.

Using birth weight as a proxy for foetal growth, I predict that birth weight will be lower in second generation British Pakistani children compared to the third generation, and that the prevalence of having been born small-for-gestational age and with a low birth weight (2.5kg) will be lower in second generation British Pakistani children compared to the third generation children.

5) I hypothesise that diminished foetal growth will predict elevated adiposity during middle childhood, regardless of ethnicity or generation status of British Pakistani children from immigrant families.

I predict an inverse association between birth weight and birth weight adjusted for gestational age and sex with waist circumference and triceps and subscapular skinfold thicknesses in all children.

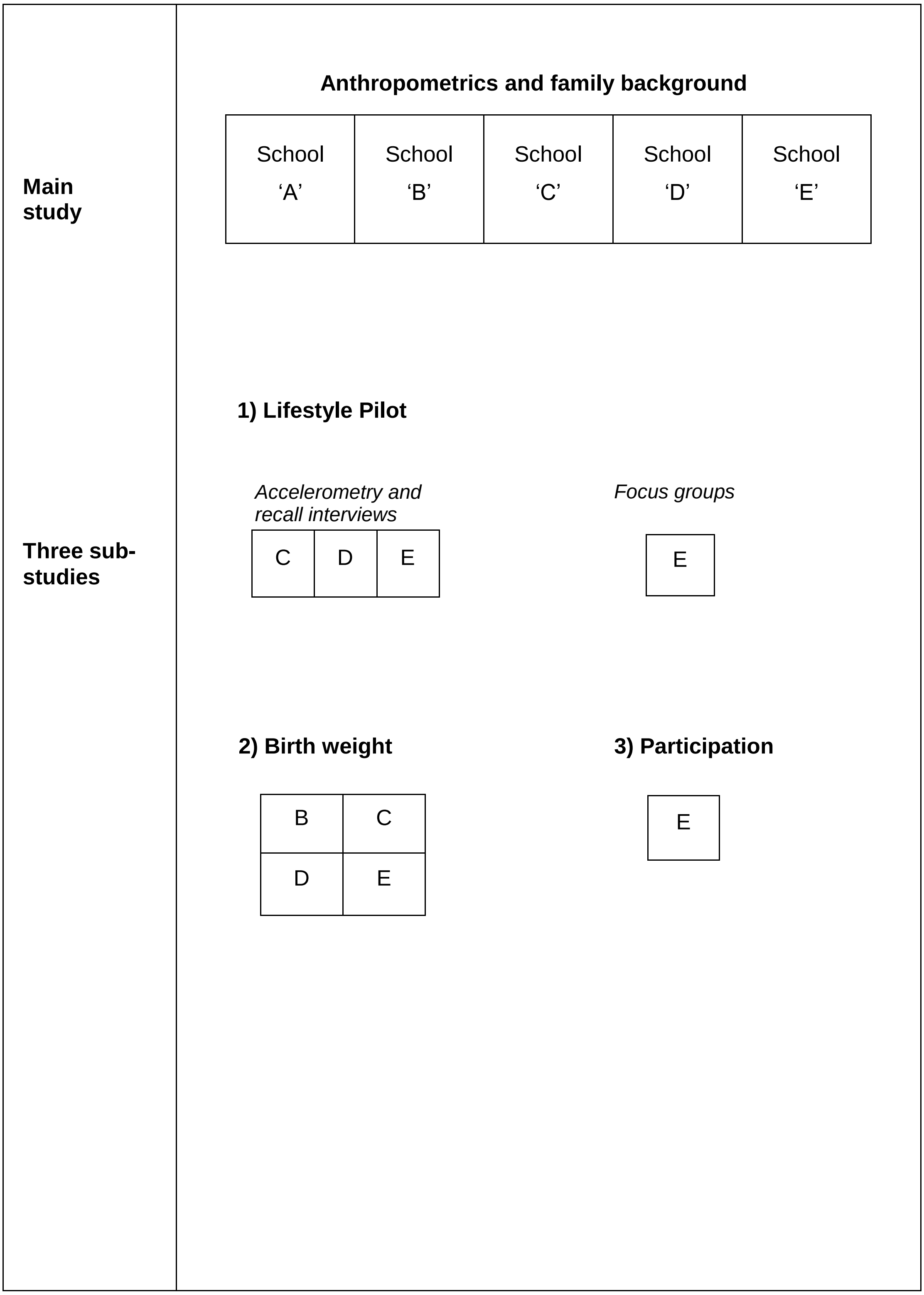
I do not make predictions for the lifestyle and participation sub-studies in Chapters 7 and 8, respectively.

CHAPTER 3: METHODS OF DATA COLLECTION AND ANALYSIS

3.1 Overview of Study Components

This thesis is a cross-sectional observation study that gathers data from children, parents, and hospital records. Its main analysis is of anthropometric data collected from children and of background data collected from parents. There are also three sub-studies conducted on the topics of birth weight, lifestyle, and children's experiences of participation in study. Figure 3.1 summarises the components of the study, including the sub-studies and the five schools where the data were collected. School 'A' was used as a pilot study to test anthropometric methods and feasibility, so only family background and anthropometric data were collected from participants at this school. Birth weight data were obtained from hospital records on children of all schools, except school 'A' where the pilot was conducted. Lifestyle data were not collected from school 'B' due to limitations in time. The participation sub-study investigated children's perceptions of the study and was conducted at the last school visited, school 'E'.

Figure 3.1 Relationship of study components



3.2 Data Collection of Study Sample

3.2.1 Identification of participants

Children selected for this study were in school years 3-6, which included ages 7-11 years. This year group range was ideal for the study's purposes because capping the highest age at 11 years old minimised the pre-pubertal influence on growth and development. Accordingly, the issue of sexual maturity was not addressed or controlled for in the study. The lowest age cut-off was established based on child development, with ages 8-10 being a period of increased growth of adiposity relative to linear growth (Wabtisch 2002).

Six primary schools in the city of Middlesbrough were identified as having a high proportion of children of South Asian ethnicity: 'A', 'B', 'C', 'D', 'E' and 'F' primary schools, in chronological order of invitation to join the study. The schools were identified based on information given by two postgraduate students at Durham University who were both local to Middlesbrough. There were many children in the schools who were not of either British Pakistani or white British ethnicities; however, children of any ethnicity were invited to participate so as not to exclude or single out any group of children.

Secondary routes of recruiting British Pakistani children were considered in addition to recruiting primarily in schools in order to widen recruitment efforts. The Community Centre Representative of Middlesbrough based at the International Community Centre helped to identify three community centres as places where British Pakistani families attended. Through discussions with the community centre organisers it became apparent that these community centres were strategically located in neighbourhoods where British Pakistanis already lived and attended schools. It was reasoned to be the same case for the two mosques in Middlesbrough. These secondary routes were not pursued any further because it was apparent that children from the five schools visited would likely be recruited a second time.

3.2.2 Head teacher, parent, and child consent

Initial contact was made by sending letters to the head teachers of the six schools that provided information about the study and invited their schools to participate. Five of the schools that were contacted agreed to involvement with the study, while the head teacher at school 'F' declined. Meetings with the head teachers were held to further discuss the study and to answer any questions the head teachers had. A letter of approval signed by the Local

Education Authority was obtained and presented to the head teachers at meetings. After agreeing how the study was to proceed, the head teachers signed a consent form (Appendix A). Head teachers then helped to coordinate meetings with children and parents.

Each school had their own suggestions as to how to approach the children and parents. They all had a strong sense of the personalities and minds of the students and parents, and helped to predict which approach would yield the highest number of participants. Most schools thought it best to speak with the children first, and then send the recruitment forms with the invitations to the parent meeting (Appendix B). The rationale was that the children would be able to explain to the parents what the study was about and hopefully encourage the parents to come to the meetings and sign the forms. The head teachers at the three schools in the centre of Middlesbrough (‘A’, ‘B’, and ‘E’) reported a low level of participation in all aspects of school activity among the parents. It was therefore expected be a challenge to get parents to respond. Forms for the study were printed on school letterhead to further communicate the schools’ support of the study in hopes to improve recruitment.

Meetings with children were organised by the school and held during class time. Children were either met in individual classrooms or in larger groups in an assembly hall. The discussion depended on the year group and the ability of the children to answer questions and make discussion. A general script of a typical conversation is summarised in Appendix C. Children were told that the measurements would be conducted in private, either with just me or me and another person (either a research assistant or teaching assistant, depending on the school situation), and that only the children’s parents and I would know the results. Children were also explained how each measurement would be taken and were given a demonstration of the skinfold calipers. I always tried to get a teacher to have the demonstration done on them because children enjoyed seeing their teacher as a ‘victim’ and to show the children that the calipers were not painful or they were not injections. Children were told where and when the parent meetings were to be held, and given invitations and recruitment forms to take home to their parents. It was emphasised to the children that they did not have to participate even if their parents consented.

Parent meetings were offered at all schools to allow everyone the chance to meet me and to ask questions, and for those with difficulty filling out the forms to receive assistance. Parents were given similar information as given at children meetings, which was essentially a summary of what was included on the information sheet (Appendix B). The parent meetings were held for parents to ask any questions. Parents were given the option to fill out the consent forms and questionnaires after the meeting or to take the information home to think further about it.

3.2.3 Parent questionnaire

The recruitment forms given to parents included an information sheet, consent form, and questionnaire (Appendix B). The Parent Questionnaire was used to gain background information of the children and their families, including children's age and ethnicity, and parents' migration history, occupation, education, and health background. Categories for ethnicity were taken from the England and Wales Census of 2001 (Office of National Statistics 2001) in order to standardise the definition of ethnicity and make results comparable to other national statistics (Bhopal 2007).The variable Occupational Status was created based on each parents' reported occupation. Occupational Status included a set of categories taken from the National Statistics Socio-Economic Classification system (Office of National Statistics 2005). The questionnaire was not translated into Urdu, the national language of Pakistan, since it seemed reasonable to assume that most British Pakistanis who cannot read and write in English would be illiterate in Urdu as well.

3.3 Data Collection of Anthropometry

The study plan before the Anthropometry and Recruitment Pilot Study was that each child would be measured for the following anthropometrics: weight, height, waist circumference, and triceps, subscapular, suprailiac, and abdominal skinfold thicknesses (SFTs), and blood pressure. Three measurements of each were taken in order to decrease intraobserver error (error made by one measurer), and the mean of the three used for statistical analysis. For weight and blood pressure two measurements were taken because variation still exists with digital machines. Data were recorded on a pre-formatted data collection sheet (Appendix D). No measurements were discarded, except in the case of SFTs, as discussed below.

3.3.1 Training received

I received training in anthropometry from another postgraduate student in the department who was experienced in the methodology, Mwenza Blell. I produced a standard protocol and practiced the anthropometric techniques on adults and children from a range of body sizes and ethnicities. I later met with Ms. Blell and tested our degree of interobserver error by measuring the same people and comparing our results (Ulijaszek and Kerr 1999). This was done to assess whether my results were within an acceptable limit and whether there was any one technique I might have needed to improve. Once our measurements were consistent, we were satisfied that I could continue practicing and test my skills in the Anthropometric and Recruitment Pilot Study.

3.3.2 Weight and height

The digital and self-calibrating Seca bathroom scale was used to measure weight in kilograms. It was calibrated daily by weighing a known weight several times to ensure consistency between measures. Children were measured between the hours of 9:00am and 3:00pm throughout the British school year. Weight has diurnal variation and is lowest in the morning and increases throughout the day. The effect of this variation was slightly minimised because measurements were all taken during a set period of time in the morning and early afternoon (Williams and Horlick 2008). In this study sample of British primary school children, all children wore uniforms. Most children wore trousers and a t-shirt, and some children wore dresses. Participants were asked to remove outer clothing such as coats and jumpers. Participants were instructed to stand up straight, hold still, and keep their heads looking forward while their weight and height measurements were taken. Units were recorded to the 0.1 kg.

Height was measured using a Karrimetre stadiometer. The head bar of the stadiometer was used to define the head positioning within the Frankfurt plane (Gordon, Chumlea, and Roche 1988). Children wearing long trousers were checked to make sure they were not standing on the hems. Children were told to stand on the platform with their rear and heels touching the post if possible where the measuring tape was fastened. Children were encouraged to stand as straight and tall as possible. The profiles of children’s faces were examined to ensure that the corner of the eye was aligned in the horizontal plane with the tragus of the ear (the triangular section) (Gordon, Chumlea, and Roche 1988). Children were instructed to exhale, take a full inhale, and momentarily hold the breath, at which point the measurement was taken. Measurements were recorded to the nearest 0.1 cm.

Weight and height were used to calculate body mass index (BMI), defined as mass/height^2 (kg/m^2). The applications of BMI in this study are discussed below in Section 3.7.2.

3.3.3 Waist circumference

Waist circumference was measured using standard non-tearing measuring tape at the narrowest part of the waist, typically between the lowest rib and the iliac crest bones (Callow et al 1988). The protocol required that the tape must not be too slack or too tight, and that it be completely horizontal all the way around the waist. Participants were asked to lift their shirts just below the breast level. If girls were wearing dresses and a vest under the dress, they were asked to take the top of their dresses down to their hips and to lift their vests just above their waistline. For the few girls who were wearing dresses and did not have a vest underneath, a jumper was draped over their front. They were then asked to take the top of their dresses down to their hips and the jumper was lifted just high enough to measure around the waist. Waist circumference values were recorded to the 0.1 cm.

3.3.4 Skinfold thicknesses (SFTs)

Protocol taken from Harrison et al (1988) was used to identify triceps, subscapular, suprailiac, and abdominal skinfolds in children (Appendix E). SFTs were measured using Holtain calipers and were taken from the right side of the body for consistency. The skinfold was held in place while each of the three readings for one skinfold point was measured. Readings were recorded after 1 second but no more than 2 seconds after the calipers had been released. Calipers were calibrated to zero after each participant and stored safely in their case when not in use. To measure the subscapular skinfolds, children were asked to pull their right arm inside their shirt so the shirt could be lifted exposing only the back of the upper arm and upper back. To measure the abdominal and iliac skinfolds, children were asked to lift their clothing as described above for waist circumference measurements (Section 3.3.3). Measurements were estimated to the nearest 0.1 mm.

The allowable range of intrameasurer error is the greatest distance between the three measurements collected from one skinfold, and are given by Harrison et al (1988). These values were used to compare with the data collected so that if measurements fell outside the accepted range of intrameasurer error, three new measurements could be taken. I included the allowable range of intrameasurer error values on the data collection sheet for quick and easy reference (Appendix D).

3.3.5 Blood pressure and resting heart rate

Blood pressure and resting heart rate were measured and recorded twice using an automated A&D UA-767 monitor with a child-sized cuff. This device has been validated by the British Hypertension Society protocol, as discussed in Section 2.1.5 (O'Brien et al 1993; Rogoza, Pavlova and Sergeeva 2000). The machine is self-calibrating, and was tested at the beginning each day for reliability by taking several measurements, as recommended by O'Brien et al (2000). Procedures were followed according to the guidebook included with the model. Participants were encouraged to sit quietly and remain still during the measurement. If children were measured after a break or physical education, children were asked to sit and wait until they had rested. The left arm of each participant was always used, as recommended by the guidebook. The cuff was applied securely around the upper arm. Diastolic, systolic, and resting heart rate values were recorded to the whole number.

3.3.6 Birth weight

Data on birth weight were extracted from participants' hospital records at James Cook University Hospital in Middlesbrough. The variables extracted on children's details included last name, date of birth, birth weight, and gestational age (number of weeks at birth based on last menstrual period). The variables collected on mothers' information were last name, histories of type 2 diabetes and gestational diabetes, and BMI at date of registration with the maternity department (usually within the first weeks of pregnancy). Data on the parity of the children was collected via parent questionnaire. Data were collected from all participants' records except those from the Anthropometric and Recruitment Pilot Study in school 'A'.

Extraction of hospital record data was conducted by the Women and Children's Information Manager, Barbara Woodward, in the Department of Gynaecology. Ms. Woodward extracted the required variables from the Maternity Unit database from all children born between years 1994 and 2000. The Maternity Information System used was provided by Euroking Miracle Ltd., an NHS Net approved supplier. These data were saved in an Excel spreadsheet and password protected. Once the birth record data were linked with children's names and birth dates, the children’s names were replaced with their participant number. The parent questionnaire collected data on the children’s hospital of birth to cross-check records (Appendix B).

3.4 Input from the Recruitment and Anthropometry Pilot Study

3.4.1 Summary of the Pilot Study

The aim of the Anthropometric and Recruitment Pilot Study was to test anthropometric and recruitment methods, and the overall feasibility of the main study. After meetings with children in the schools, parents were sent invitations to information meetings recruitment forms similar to those presented in Appendix B. Only children whose parents had provided written informed consent and who themselves provided verbal consent were measured. The participants were 33 children ages 8-9 from primary school ‘A’. Measurements took place in the last few weeks of term before summer holidays. Twenty-five children were British Pakistani, 3 were white British and 5 were from other ethnicities. One child was first generation British Pakistani, leaving a total of 14 second generation and 10 third generation British Pakistani children. Data gathered included family history; weight, height and waist circumference; triceps, subscapular, suprailiac, and abdominal skinfold thicknesses (SFTs); and blood pressure and resting heart rate.

3.4.2 Lessons learned

Study sample

There was a response rate of 25% from all children in years 3 and 4. Factors that may have limited recruitment include too short a period of time spent at the school, visiting during a time in the school year when children were out of the classrooms in activities, and low literacy levels amongst some of the parents. I concluded that the recruitment method of sending home recruitment forms to this population would invariably limit the proportion of respondents, and that I should focus on building stronger relationships with schools and parents to improve recruitment efforts.

I observed that teacher participation in recruitment efforts influenced child participation. The teachers seemed reluctant to be a part of key recruitment processes, such as distributing consent forms and reminding children to return their forms on a daily basis. Taking children out of class for measurements caused some upset for some teachers. There were fewer year 3 students who participated compared to year 4 children, and a limited involvement in the Anthropometric and Recruitment Pilot Study by year 3 teachers may explain why their students participated less.

Parent questionnaire

Some answers on the parent questionnaire were left blank or misunderstood and answered inappropriately. There was a high proportion of mothers who reported the highest level of education attained below 16 years of age and who did not speak English as a first language. Few parents were able to recall their children's birth weights but the majority did indicate the hospital where their children were born. I surmised that, because of the low turn out at the parent meetings, some parents did not ask for the clarification they needed.

The questions on mothers' and fathers' history of diabetes and heart disease were most likely to be left blank. I concluded that the low response was due to the way the questions were phrased. The questions stated, 'Please tick the box if you have a history of the following: diabetes or heart disease'. If someone declined the answer, their response would have been interpreted as 'no'; thus 'no history' of the disease or a non-response were not being captured.

Anthropometry

Four skinfold thickness (SFT) measurements were taken: subscapular, triceps, abdominal, and suprailiac. Data from these four points were selected for this study because they assess central, abdominal, and peripheral subcutaneous fat. I found that taking several measurements on the children's torsos was stressful for some children, in particular the abdominal and suprailiac measurement. The suprailiac SFT point was cumbersome to access without being able to lower or remove the trousers. Two skinfold measurements, the subscapular and triceps, are considered to be a minimum number of skinfold points to assess peripheral and central adiposity patterning (Seefelt and Harrison 1988).

Use of the skinfold calipers was occasionally difficult with overweight and obese participants. This is expected when using calipers due to the larger size of the skinfolds in proportion to the calipers, and the nature of the fat tissue towards edema (Bray and Gray 1988). If measurements had to be redone due to intraobserver error (Section 3.3.5), I often found that obese children found it uncomfortable either due to overuse of the calipers or embarrassment.

3.4.3 Methods that changed as a result of the Pilot Study

Study sample

It was important to improve the effectiveness of recruitment in this population of British Pakistanis due to the low proportion relative to white British children and the decreased likelihood of their participation. A focused recruitment strategy at subsequent schools was devised to increase the numbers of British Pakistani participants. I acquired the schools' term diaries well in advance so as to measure certain children when they were available, and attempted to persuade schools to hold teacher meetings to procure teacher consent and participation. If there were gaps in my schedule where I could not do measurements, I focused my attention on recruitment efforts. This involved going to classes to either distribute more consent forms (as they often were lost), remind students to bring their forms to schools the next day, or send home forms that needed to be corrected.

Participants were notified that the study focused on obesity amongst British Pakistanis in order to obtain fully informed consent. To address this issue in the main study, the information sheet included a statement that the participation of all children was of great value so as not to single out one group or exclude others (Appendix B). The information sheet and parent meetings also highlighted the high risks of all children living in the north east of England in developing obesity, not just British Pakistanis. Even for groups whose data I did not intend to use in the study, I emphasised the fact that children and their families could benefit from the study by getting their measurements done as a way of maintaining an equal inclusion policy.

Parent questionnaire

Questions asking for mothers' and fathers' history of diabetes and heart disease were rephrased. The revised questionnaires instead asked, 'Do you have a history of diabetes?

Please circle yes/no' to ensure record of a negative response. Filling out the forms with the parents at the parent meetings would have helped to clarify any misunderstandings that might have arisen from the questionnaires, and so extra efforts were made to encourage attendance at the parent meetings. Parents were no longer asked to recall their children's birth weights, and data on hospital records were obtained from the city hospital. Parents were still asked to indicate the hospital where their children were born as a means of cross-checking hospital records.

Anthropometry

I decided that collecting four SFTs measurements in the school setting was not appropriate in this population of children based on my findings from abdominal and iliac SFTs measurements. In the school setting children could not be expected to remove more than their outer clothing, so the suprailiac skinfold point proved too awkward to access both from the researcher's and the participant's perspective. The recruitment effort was ongoing during measurements, and children often would feedback to each other their experiences being measured. I noticed the SFT measurements became a somewhat unpopular aspect of the study amongst the children at school 'A'. Using two skinfold points instead of four to assess central and peripheral SFT would be sufficient as a minimum and were measured at subsequent schools (Malina et al 2004).

3.4.4 Calculation of sample size

Power calculations were conducted to determine an appropriate sample size using data from the Anthropometric and Recruitment Pilot Study. Waist circumference was used because abdominal adiposity is the most critical measure of adiposity I used, in terms of health risk. As a first step in conducting power calculations I considered what would be a meaningful difference in waist circumference. A nationally representative sample by McCarthy et al (2001) found that the 50th centile for waist circumference for 9 year old boys was 56.4 cm (age 9 was used because it was the predicted study mean). The 75th centile, which has been identified as a threshold to predict metabolic syndrome in children, was 59.7 cm (Hirschler et al 2007). The figures for girls are 55.3 cm and 58.5, respectively. It thus seems reasonable to suggest that difference in waist circumference of 3.3 cm in this age group is meaningful for health.

I calculated the standard deviation of waist circumference from the waist circumference measurements of all 33 8-9 year old British Pakistani and white British children measured in the Anthropometric and Recruitment Pilot Study. The standard deviation was 7.6 cm, producing an effect size of 0.44. This effect size, a significance level of 0.05, and power of 0.8 were entered into the Gpower 3.0 software programme, which gives a required sample size of 83 children in each group for waist circumference. Hence, the total desired minimum population sample size was 249 children, one-third white British and two-thirds British Pakistani (in order to divide equally and analyse by generation). Since 0.8 is a minimum level of power, I also ran calculations for a power of 0.9, which gives a required sample size of 110 children in each group.

It was decided that using the data set from McCarthy et al (2001) data was more reliable because it was much larger and more representative of the population than the pilot sample. With a significance level of 0.05, power of 80% and an effect size of 0.59, the final proposed sample size was 47 per group.

3.5 Data Collection of the Lifestyle Pilot Sub-Study

A sub-sample of children 9-11 years old was selected to pilot a study lifestyle factors from schools ‘C’, ‘D’ and ‘E’ (see Figure 3.1 Relationship of study components). The aim was to recruit fifteen second generation British Pakistani, fifteen third generation British Pakistani, and thirty white British children in order to perform analyses between ethnic and generation groups. All children participated in the 24-hour dietary recall interviews for physical activity and wore accelerometers. These same children also participated in the 24-hour dietary recall interviews for diet. Parent questionnaires investigated parents’ knowledge of obesity and related health issues, as well as their own healthy lifestyle practices. The focus groups explored children’s knowledge about obesity and related health issues as well as healthy lifestyle practices. The 9-11 year age range was selected because the older groups were expected to be more mature than 7-8 year olds, and therefore more reliable respondents for the recall interviews (Biró et al 2002).

3.5.1 Training received

I received training for multiple pass recall and accelerometry from members of Prof Carolyn Summerbell's team the Centre for Food, Physical Activity and Obesity within the School for Health and Social Care at Teesside University. The lifestyle sub-study was conducted with a third year thesis student Yvonne Hornby, who I trained on procedures.

3.5.2 Multiple pass recall interviews

Twenty-four hour multiple pass recall interviews took place over the course of 3 days, a time frame considered a sufficient minimum to validate group estimates of food intake in children (Johnson et al 2001). We met on a consecutive Monday, Tuesday and Wednesday so children could recall food intake from a Sunday, Monday and Tuesday, respectively. Weekends and weekdays were included to minimise error from weekend and weekday variation (Acheson et al 1980). Each interview was calculated to take approximately 30 minutes per child based on training practice. Interviews were conducted strictly on school grounds and during school hours. The typical time schedule at the primary schools visited allowed a maximum of 5 hours per day to work with the children, which was enough time to conduct approximately seven interviews per day.

Protocol for the multiple pass recall interviews are presented in Appendix F. The interviewers started by asking the participants to quickly list all the foods they ate in a day in chronological order. For the second pass, more detailed information was asked, including the time of day food was eaten, components of the meal (e.g. types of vegetables), what kind of food was eaten (e.g. brown or bread) and how much of the food was eaten. The third pass involved reading back the detailed list of foods given by the participant and asking if there was anything else eaten that day, mentioning commonly forgotten foods such as snacks, pieces of fruit and drinks. This method increases the likelihood that respondents will remember a greater amount of detail by being asked to repeatedly recollect foods (Rutishauser and Black 2002). Responses were recorded on a 24-hour recall data sheet, which was developed based on a standardized form available from the United States Department of Agriculture, and modified for the present study population of British children from (Appendix G). The fourth and final pass uses a Food Atlas as a visual cue to assess portion size (Nelson et al 1997). Particular types of foods were shown in plates or bowls in frames of increasing portion sizes and a corresponding portion code. I used plates, bowls, glasses and spoons as props and asked children to indicate which frame best represented the portion of food on the plate or bowl. They were also asked to estimate how much of the portion was actually eaten, selecting either all, half, part or none of the food.

Multiple pass recall interviews were also conducted to obtain more descriptive data of physical activity. Physical activity interviews were done during the same interview session for diet because it was expected that subsequent recall of the day's activities would improve children's memories. Data were recorded on 24-hour recall data sheets adapted from forms provided by the United States Department of Agriculture (Appendix H). Recall interviews were performed on the same Monday, Tuesday, and Wednesday following the Friday when the accelerometers were distributed in order to compare data, which is discussed below. Participants were asked to briefly list all the physical activities they engaged in the day before. They were then asked more detailed information about the activities, having them recall them in chronological order. They were asked where, when, and for how long the activity occurred, and whether they got either tired, out of breath, or sweaty. The third and final pass involved restating the activities given by the participant and asking if they left out any activities, such as walking or physical education.

3.5.3 Accelerometry

Actigraph GM accelerometers were used. The devices were fitted on the children after lunch on a Friday afternoon and collected the following Wednesday. Children were given Friday and Saturday to adjust to wearing the monitors properly, so data from those days were not used. This provided one weekend and two weekdays days of data, meeting the recommended 3-day minimum (Reilly et al 1999; Penpraze et al 2006). I instructed children how to properly fit the belts and to take them off at bedtime and when bathing or swimming (Ekelund et al 2001). Parents were sent an Instruction Sheet, a Parent Questionnaire on Lifestyle, and an Activity Monitor Diary for the children to fill out (Appendix I). The Parent Questionnaire on Lifestyle is discussed below in Section 3.5.5.

3.5.4 Focus groups on lifestyle

Semi-structured focus group interviews were conducted with British Pakistani and white British children ages 9-11 years old as an exploratory pilot study into whether there were any differences in their knowledge of obesity, obesity related illnesses and healthy lifestyle practices (Table 3.1). The focus groups on the topic of lifestyle were conducted during the same time and with the same participants as a focus group on the topic of children's experience as participants in the study, discussed in more detail below in Section 3.6.2. This section also discusses selection bias, which I consider in my interpretation of the results from the lifestyle pilot sub-study (Chapter 7).

Table 3.1 Schedule of focus group on lifestyle sub-study

1. What do you know about diabetes and heart disease? What do you know about healthy eating and exercise? Why is it important to know about these things?
2. Have you heard of 'five-a-day'? Do you like fruit and vegetables? Why/why not?
3. Do you choose to eat fruit or vegetables at dinner time or any other time? Are they served to you? Do you buy snacks for yourself after school? Are you allowed to help yourself to food out of the refrigerator and cupboards? Do your parents serve you what you eat?
4. Are you involved in or any organised activity, like after-school sport or dance? If no, would you like to be? What other things might you do in a day instead of physical activity?
5. Do you think you might try to be healthier in the future as a result of having your measurements taken?

3.5.5 Parent questionnaire on lifestyle

All children who participated in the Lifestyle Pilot were sent home with a Parent Questionnaire on Lifestyle for their parents to fill out (Appendix I). This questionnaire was developed for the purposes of the pilot and used an open-ended line of questioning (Gillham 2007).The questionnaire assessed parents' knowledge of obesity and related illnesses and their obesity related lifestyle practices. The main food preparer of the household was presented with a list of signs and symptoms and were instructed to select the ones they thought were associated with diabetes and heart disease. Parents were also asked to tick the box that best described their lifestyle practices, and to indicate reasons that would prevent them from being healthier. The final component of the questionnaire inquired about parents' perceptions of their own obesity status and that of their child's.

3.6 Data Collection of the Participation Sub-study

3.6.1 Participant observation

I employed participant observation methods over the entire course of my fieldwork at schools, and this included interactions with children, parents, and teachers during my recruitment and data collection phases. By the end of the fieldwork, I had considered the following themes:

- Issue of inclusion
  - Inclusion of overweight and obese children
  - Inclusion of British Pakistani children
  - Teacher consent
- Issue of study design and ethics
  - Parent and child consent
  - Space used to conduct measurements
  - Dissemination of measurements to families

I considered all of these themes before the outset of the field research, except one which emerged as a result. For example, it seemed reasonable to observe in particular whether the study sample included or excluded overweight and obese children, as well as British Pakistani children. By contrast, I did not realise before entering the schools the extent to which the role teachers would play in recruitment efforts. All themes dealing with issues of study design and ethics were considered at the outset of the fieldwork.

Observations relevant to these *a priori* themes, or that surfaced over the course of the fieldwork, were recorded in a field notebook and reread to identify themes (Bogden 1972). These themes helped to inform the theories that were further developed in the focus groups.

3.6.2 Focus groups on participation

A small sub-sample of children at school 'E' participated in focus groups that discussed the children's experiences in the measurement study. I decided to conduct a sub-study on motivations for participation in the study after data were collected at the previous four schools, given that the overall sample size had fallen below the desired amount (data presented in Table 8.1). The sub-study was designed to be retrospective in order to aid the doctoral learning process. The participant focus groups were conducted directly after those on the topic of lifestyle and with the same participants (Section 3.5.4).

The selection of participants was done with consideration, as the selection of respondents introduces potential bias. I selected children who seemed most willing and best able to participate in discussions in spite of the potential to introduce a bias in children who might have an affinity to participate in activities. The focus groups discussions were not central to the doctoral investigation, so in the interest of time I chose participants who seemed to me most likely to provide useful data. If I had selected children at random, conversation may have been stilted as a result of too few children contributing to discussion. I could have taken volunteers, but faced poor turnout and perhaps inclusion of children who would not focus on discussion and distract the group. These children were given the opportunity to decline participation. In light of this selection technique, my interpretation of the results takes into account potential bias in selection of the children most likely to participate in the overall study (Chapter 8). Four stratified samples were created to select the four focus groups: white British boys, white British girls, British Pakistani boys, and British Pakistani girls.

The aims of the focus groups were to understand overall what helped or hindered child participation in the study and whether there were any ethnic or gender differences in experience of the study. The focus groups involved semi-structured interview questions that were developed based on Krueger's methods (1998), specifically by asking open-ended questions to allow the respondent to elaborate. Children were asked to recollect their first impressions of the study, things they liked or did not like and things that may have improved the study (Table 3.2). Exit interviews were conducted prior to the focus groups in order to help inform the focus group questions (Appendix J).

Focus groups took place in a classroom and each group lasted approximately 30 minutes, depending on level of child engagement. I sat children in a circle at a large table with Ms.

Hornby, the Teaching Assistant, and me. I began the discussions by reminding children that they were part of a study. I explained to about terms of mutual respect and confidentiality in group discussions, and everyone expressed they understood and agreed to them. Ms. Hornby and the Teaching Assistant took notes while I moderated. Notes were taken by others to ensure that I could focus my attention on the discussion, and were used to cross-validate notes between the two note takers. Discussions were audio taped to confirm findings from the notes and to provide direct quotes (Mason 2002).

Table 3.2 Schedule of focus group sub-study on children's experiences as participants

1. You've been a part of a study by being measured. What did you think of the study? (i.e. Did you enjoy participating in the study? Why or why not?)
2. What did your family and friends think about you participating in the study?
3. Why did you decide to participate in this study? What motivated you?
4. When or how did you first learn about this study? What were your first thoughts of the study when you first learned of it?
5. What would have made it sound more interesting at the start?
6. What things could have been done differently for you to have enjoyed participating?
7. Any other comments or questions?

3.7 Data Preparation

All data from all five schools were entered into SPSS and double-checked for accuracy. A child participant number was assigned to each individual and recorded on the data collection sheet (Appendix D) and into SPSS. Continuous variables were analysed either by t-test, analysis of variance, or analysis of co-variance. All categorical variables were analysed by chi-squared test. Based on the two-by-two table used in the Pearson's chi-squared test, the statistical significance of all results ($p<0.05$) is reported even where the expected count is less than five, and is noted as such. The majority of tests compared British Pakistani with white

British children, and second generation British Pakistanis with the third generation. Linear regression analyses, focus groups, and participant observation are also discussed.

3.7.1 Preparation of study population data

Data on the study population were taken from the Recruitment Parent Questionnaires and entered into the SPSS spreadsheet. Age was calculated by subtracting the date of measurement from the birth date. The entire study population was first grouped by ethnicity including either ‘white British’ or ‘British Pakistani’. Children of ‘other’ ethnicities, e.g. ‘mixed’, ‘Black African’, etc., were not included in the study analysis. Other variables gathered, such as first language, religion and parent and grandparent country of origin, were used to verify ethnicity.

Using National Statistics Socio-economic Classification (NS-SEC) system (2005), each occupation was given a code and a corresponding analytical class. This is a hierarchy of occupations based on economic prospects of advancement, and the level authority and autonomy of the occupation. Category eight includes those who have never worked or are long-term unemployed, and are involuntarily excluded from the labour market (see Table 3.3). For this study sample, ‘homemaker’ was added to category eight to reflect a non-employed status. Categories were condensed into the two forms of employment given by NS-SEC, including people who are salaried with full or partial benefits and employees who are on a contract earning wages. The final Occupational Status groupings are expressed as 1 = salaried with partial or full benefits, 2 = contract earning wages; and group 3 = non-employed.

It is ideal to use the highest earner in the household as the reference person; however the Parent Questionnaire (Appendix B) did not require details such as earned annual income, so I did not use this method. The parent questionnaires used in the Anthropometry and Recruitment Pilot Study were often returned incomplete; usually with details on education and occupation left blank (Section 3.4). Based on these findings from the Anthropometry and Recruitment Pilot Study, it was expected that asking for financial details on the Parent Questionnaire would prove unsuccessful in this population, due to the sensitive nature and level of detail of the questions. Fathers’ occupation data were not used in further analyses because it was unclear from the Parent Questionnaire from the many men who were taxi drivers whether they were owners or employees of a taxi firm. This distinction is important because the conceptual basis of the National Statistics Socio-economic Classification (NS-

SEC) system assesses not only economic prospects of advancement of the position, but also the level of authority and autonomy in the working environment (Office of National Statistics 2005). As a result, only mothers' occupation data were used in analyses; however, Occupational Status is limited in its interpretation because the category of non-employed does not indicate the level of socio-economic status.

For children who were reported with a 'Pakistani' ethnicity, the generation of the child was determined using reported mothers' country of birth and maternal grandmothers' country of birth. Figure 3.2 describes the migration time frame of Pakistanis to the UK as it relates to generation category. If a child's mother was born in Pakistan and her mother was born in Pakistan (or India before Partition), the child was classified as second generation. If a child's mother was born in the UK and the maternal grandmother was born in Pakistan (or India before Partition), the child was classified as third generation. If a child's mother and maternal grandmother were born in the UK, the child was assumed to be fourth generation unless it could be ascertained otherwise through the child or parent as a reporting error. This population of British Pakistanis migrated to the UK mainly from the 1960's. It is therefore likely there are fourth generation British Pakistani children, although it seems more likely to have been a reporting error (Figure 3.2). For analyses comparing generations of British Pakistanis, the 'second generation' or 'third generation' were included. First generation British Pakistanis were not included as a comparison group because this group was too small. Fourth generation British Pakistanis were grouped with the third generation to increase group size. Thus, the term 'third generation' includes the fourth.

Figure 3.2 Approximated timeline of British Pakistani participant's family migration to the UK and corresponding generations

First migration of Pakistani men to UK	Pakistani men bringing families to UK			Study children born 1994-2000	Data collected 2005-2007
1950s	**1960s**	**1970s**	**1980s**	**1990s**	**2000**
	First generation mothers bearing second generation children		Second generation mothers bearing third generation children	Third generation mothers' bearing fourth generation children	Fourth generation children participating in study
		First generation mothers bearing second generation children		Second generation mothers bearing third generation children	Third generation children participating in study
				First generation mothers bearing second generation children	Second generation children participating in study

Table 3.3 National Statistics Socio-economic Classification (NS-SEC) system

NS-SEC Coding System		**Recoded Variables**	
1	Higher managerial and professional occupations 1.1 Large employers and higher managerial occupations 1.2 Higher professional occupations	1	Salaried with full or partial benefits
2	Lower managerial and professional occupations		
3	Intermediate occupations		
4	Small employers and own account workers		
5	Lower supervisory and technical occupations	2	Labour contract earning wages
6	Semi-routine occupations		
7	Routine occupations		
8	Never worked and long-term unemployed – involuntary exclusion from the labour market	3	Non-Employed, e.g. homemakers, retirees

3.7.2 Preparation of anthropometric data

3.7.2.1 Technical error of measurement

The technical error of measurement was calculated for all anthropometric measurements taken in schools in order to assess both intraobserver and interobserver error (Ulijaszek and Kerr 1999). Calculations showed that all anthropometric measurements from both observers had a minimum of 97% reliability (Appendix K). Measurements at school ‘B’ were conducted by Master’s student Caroline Jones because I took an unexpected suspension of studies due to illness during the planned time for data collection at that school. Ms. Jones had planned to use data from the project for her Master’s thesis and decided to collect them on her own. Her thesis studied the relationship between sleep and obesity in the same population, and she gathered additional information about sleep behaviour in the children through parent questionnaire and short interviews with the children. Measurements at the four other schools, ‘A’, ‘C’, ‘D’ and ‘E’, were conducted solely by me.

Ms. Jones was given the appropriate training on anthropometrics in an attempt to minimise intraobserver as well as interobserver error. This was done so that data collected by Ms. Jones and me could be analysed as one cohort. I trained Ms. Jones on several occasions until her measurements of the same subject were within a reasonable range of error (Section 3.3.1). A protocol for all measurements was created so that we were practicing the same procedures (Appendix E). I also was able to visit Ms. Jones once at school ‘B’ to confirm that our measurements were being conducted similarly (Ulijaszek and Kerr 1999).

3.7.2.2 Reference populations

The LMS software programme used in this study provided reference populations from the 1990 UK census data and International Obesity Task Force (IOTF) international standards for children. Table 3.4 compares the two methods. The UK 1990 reference data uses centiles to define overweight and obese (Cole, Freeman, and Preece 1998). Centile points are expressed as a percentage of a reference population, and it is assumed that a sample population will reflect the proportions of the reference population. The UK 1990 data can be used population monitoring or for clinical purposes. It is recommended that population studies use the 85^{th} and 95^{th} centiles, and clinical measurements should use the 91^{st} and 98^{th} to define overweight and obese, respectively. In the case of population monitoring, for example, 15% of the reference population is predicted to be ‘overweight’ and 5% is considered ‘obese’. The other, more increasingly used reference population, is from the IOTF. It uses the cut-offs used for adult for overweight and obese, which are 25 kg/m^2 and 30 kg/m^2, respectively (Cole et al 2000). The method involves tracking, whereby the cut-off points are based on what BMIs children are projected to have in adulthood. Cut-offs for adult BMIs are established based on associations with obesity-related illnesses, but young children typically do not exhibit any clinical effects from overweight and overfat (Section 1.1.2; Cole et al 2000). People tend to remain in the cut-off they were classified as children: healthy weight children usually become healthy adults; overweight children usually become overweight adults (Cole et al 2000).

There is a trade-off between specificity and sensitivity using cut-offs within reference populations. The IOTF cut-offs are shown to have high specificity and lower rate of false-positive, but lower sensitivity (Zimmerman et al 2004). Higher specificity means that, when defining a child as overweight by the IOTF cut-offs, there is a greater certainty that the child is in fact overweight; hence a lower false-positive rate. Lower sensitivity means that because the IOTF cut-offs are very extreme, they will not detect as many overweight/obese children. It has been argued that using the 91^{st} and 98^{th} centiles may underestimate obesity because the cut-off values are higher than the 85th and 95th, and so include less numbers of potentially overweight/obese people (Zimmerman et al 2004). The counter-argument is that such extreme cut-offs include those who are more likely to suffer as adults from co-morbidities associated with obesity (Cole et al 2005).

The UK 1990 reference population from the National Study for Human Growth was used in the present study to define overweight, and obesity (Cole 1998). The IOTF reference population is ethnically diverse and would be the preferred method for these analyses comparing British Pakistani and white British children; however, the IOTF method currently only have cut-offs for BMI. The present study used BMI, waist circumference, and skinfold thicknesses (SFTs) to define overfat and obesity. Because the aim of the study was not for population monitoring, and because the sample size was projected to be relatively small, the UK 1990 cut-offs used for clinical measurements were used. Even thought the IOTF method does not use centles, its definition for overweight and obesity correspond approximately to the 90th and 99th centiles, respectively, of the UK 1990 data (Cole and Green 1991). These values are roughly similar to the UK 1990 centile clinical measurements of 91st and 98th, respectively. Out of methodological interest, results from the two methods for BMI were used to compare BMI with the primarily white British UK 1990 population (Cole, Freeman, and Preece 1998; Cole et al 2000). Skinfold thickness data taken from Tanner-Whitehouse (1975) were provided by Tim Cole to include as an ‘add-in’ to the LMS software (Davies et al 1993). Standard deviation scores (SDS) were calculated for height, weight (for birth and primary school ages), BMI, waist circumference, skinfold thicknesses and birth weight using the LMS software (Cole and Green 1991).

The UK 1990 reference population was also used to calculate standard deviation scores for birth weight and size-for-gestational-age in order to compare with the body composition results in middle childhood. The variable size-for-gestational age allows for the comparison of birth weights regardless of gestational age or sex, and can identify diminished growth *in utero* (WHO 1995). Babies born early (<39 weeks) tend to be lighter and babies born late (>39 weeks) heavier than babies born at full term (Roberts and Thompson 1976). Small-for-gestational-age (SGA) is generally defined as a birth weight less than or equal to the 10th percentile of reference population (WHO 1995). Large-for-gestational-age (LGA) is defined as a birth weight greater than or equal to the 90th percentile of a reference population.

Table 3.4 Summary of the UK 1990 and IOTF definitions of childhood body mass index

	UK 1990	**IOTF**
Geography of reference population	UK population only, mainly of white British ethnicity	International population: UK, Brazil, Hong Kong, Netherlands, Singapore and the USA.
Methodology	Distribution based approach whereby overweight and obesity are defined by exceeding the 85th and 95th centiles for population monitoring and 91st and 98th centiles for clinical measurement	Age and sex specific cut points that are extrapolated from the adult BMI cut points of 25kg/m^2 and 30kg/m^2 for overweight and obesity respectively
Ethnic variation in the sample	No	Yes
Advantages and disadvantages	The population monitoring and clinical cut points approach is quite old now. The continuity between this approach and adult BMI cut points at age 18 is poor	The IOTF definition for overweight and obesity correspond approximately to the 90th and 99th centiles of the UK 1990 data This methodology may underestimate obesity prevalence

Source: NEPHO (2008) Obesity microsite: BMI and children. Online. http://www.nepho.org.uk/np2/obesity/child_and_maternal/bmi_children

3.7.2.3 Comparison groups

The present study compared anthropometric variables for two comparison groups: British Pakistani and white British children; and second generation and third generation British Pakistani children. Analysis of variance (ANOVA) and analysis of covariance (ANCOVA) were conducted using anthropometrics, blood pressure, and resting heart rate. Assumptions for parametric data were tested and corrected for where necessary, including normality, homogeneity of variance, interval data, and independence (Field 2008). Two different methods were used to control for age and sex, and were run in separate analyses to observe any different effects. Raw anthropometrics were analysed using age and sex as covariates. Standard deviation scores (SDSs) were calculated using LMS software to produce z-scores, which allowed for comparison between all children of any sex or age. BMI was used as covariate in analyses of both methods for controlling for age and sex in order to control for potential variances in waist circumference, SFTs, blood pressure, and resting heart rate due to body size. The results from ANOVA or ANCOVA, including the F-statistics and p-values, are reported separately from each other to observe how the covariates affected the results of the group comparisons. Occupational Status was also used as an additional covariate, but was conducted in separate but similar models because there was a low response to the question of occupation on the Parent Questionnaire on Recruitment (Section 4.1.1 and 5.1.1).

Chi-squared tests were conducted to test the hypothesis that British Pakistani children would be smaller-for-gestational age than white British children. Standard deviation scores (SDSs) were calculated using LMS software to produce z-scores, which allowed for comparison between all children of any sex or gestational age This study does not report results for large-for-gestational age because the size of the sample did not allow for reliable chi-squared tests using three comparison groups. Results were dichotomised as either 'SGA' ($\leq 10^{th}$ percentile) or 'not SGA' ($>10^{th}$ percentile).

3.7.2.4 Regression models

Linear regression analyses were used to examine the association between birth weight and body composition in middle childhood. The outcome variables were SDSs for waist circumference, tricep, and subscapular SFTs, and raw systolic and diastolic blood pressures. The predictor variables considered for the analyses were: birth weight, gestational age, parity, current BMI, and maternal factors of BMI, history of type 2 diabetes, history of gestational diabetes, and Occupational Status.

Two separate sets of models were run, one using raw birth weight and the other using SDSs for birth weight, to assess whether gestational age confounded the association between birth weight and later adiposity and blood pressure. The maternal factors, including BMI, parity, history of diabetes, and Occupational Status, were entered into the model because these factors have been found to be associated with birth weight or later adiposity (Barker 1994; Fall et al 1998; Ong et al 2000; Yajnik 2000; Margetts et al 2002; Snethen et al 2007). Representativeness of the sub-sample to the main studies in Chapters 4 and 5 was assessed by ANOVA of raw anthropometrics and blood pressure between the ethnic and generation comparison groups.

Each model was tested for the assumptions of linear regression before results were analysed.

Ordinary least squares linear regressions were run with established predictor variables using hierarchical regression analysis. Models were checked for multicollinearity between predictors. In each case, homoscedasticity was tested by plotting residuals of the predictors to ensure they had the same variance. Durbin-Watson tests were run to test that residual terms were uncorrelated by determining that the D-W statistics was a value between one and three. Normal distribution of the residuals was checked by the Q-Q plot.

3.7.3 Preparation of the lifestyle pilot sub-study data

Data from the lifestyle sub-sample were analysed using objective, semi-quantitative, qualitative methods. Table 3.5 summarises all the methods employed, and their respective variables and sample sizes. Non-parametric independent t-tests were conducted using Mann-Whitney, Kruskal-Wallis, and Kolmogorov-Smirnov Z tests. Medians, interquartiles and p-values for exact significance are presented.

Table 3.5 Summary of lifestyle pilot sub-study methods, variables, and sample sizes

	Data collection method	N	Unit of analysis
Objective	Accelerometry	27	- Intensity (counts/hour) - Frequency (occurrence over the week)
Semi-quantitative	Dietary 24-hour multiple pass recall interview	30	- Frequency (number of times per day) - Types of foods eaten(e.g. fruits, whole grains)
	Physical activity 24-hour multiple pass recall interview	30	- Duration (minutes) - Intensity (reported) - Types of activities engaged in (e.g. physical activity, TV viewing)
	Parent questionnaire on lifestyle	24	- Demonstrated knowledge - Reported lifestyle
Qualitative	Focus groups	31	Identification of recurrent themes

3.7.3.1 Twenty-four hour multiple pass recall on diet and physical activity

Food categories were created from the multiple pass recall data by identifying themes in the diets and by modelling categories from studies into British children's diets (Food Standards

Agency 2000; Buttriss 2002). Food Standards Agency (2000) identified that the most commonly consumed foods by British children ages 4-18 were white bread, savoury snacks, chips/fries, biscuits and chocolate, and British children have been reported to only eat half their recommended daily intake of fruits and vegetables (Buttriss 2002). The final categories for the current study included 1) ‘unhealthy’ foods: sweets, savoury snacks (e.g. crisps), added-sugar drinks, fried foods, and pizza and 2) ‘healthy’ foods: fruit (including pure fruit juice), vegetables and whole grains. Any other foods, such as milk, white bread or meats, were not defined as either ‘healthy’ or ‘unhealthy’, and were not included in the analysis. Curry meals were included as a food type to explore consumption trends of traditional Pakistani foods. Frequencies were analysed by week days, weekends, and weekends and weekdays combined to identify any temporal patterns of food consumption.

The semi-quantitative data on physical were used to identify similarities and differences in behaviour between groups. Data were coded into categories, including ‘physical activity’, ‘tv/computer use’ and ‘other leisure’ activities, which were reported in units of estimated duration in minutes. There were not enough data to describe in more detail the types of physical activity in which children engaged. Physical activity time includes activities such as sport, walking, or dancing. TV and computer use, and leisure activities were considered to be less physically demanding activities. The sedentary nature of TV and computer usage has associated with obesity in British children (Manios et al 2003; Baur and O’Connor 2003; Reilly et al 2005). Children were also asked to report how they felt during physical activities as a way of assessing moderate-to-vigorous physical activity (MVPA). Children were asked to select from three options: ‘easy’, ‘out of breath’ and ‘very tired and sweaty’, and data were recorded on the 24-hour recall record sheet for physical activity (Appendix H). The variables ‘out of breath’ and ‘very tired and sweaty’ were both coded as the self-reported MVPA variable discussed further in Section 3.7.3.2.

3.7.3.2 Accelerometry

Data from the accelerometers were uploaded using the Actigraph software and then saved in SPSS files (Riddoch et al 2004). Each participant’s file included the raw activity counts per minute and a summary of total counts/hour. The raw data indicated whether a child did not wear a monitor for a day if all epoch of recordings showed zero counts. The Activity Monitor Diary (Appendix I) was used to confirm when the accelerometers were worn. Data were not included in the analyses if there were less than 3 hours of data per day (Reilly et al 1999;

Penpraze et al 2006). As a result, the sample size for each analysis varied depending on how many children wore their monitors each day. Individual participant's data were consolidated into one Excel document in order to tabulate the hours of valid data for each participant per day and create the variable 'total counts per day'. Total counts per hour were calculated by dividing total counts per day by the number of hours the devices successfully captured data each day.

Counts were summarised into one hour segments on the hour, starting at 6 o'clock in the morning and ending at midnight, based on the range of children's waking activity. Differences in counts per hour by day of the week, comparison group, and sex were assessed via t-tests and expressed graphically. Differences in physical activity counts between sexes were analysed because of research indicating that girls are less active (Section 1.4.2). It was expected that children would have different activity levels when at home on the weekend and at school during the week.

The Department of Health recommends that children engage in 60 minutes moderate-to-vigorous physical activity (MVPA) per day, based research of children's self reported level of activity (Association of Public Health Observatories 2007). This study used children's self-reported amount of time spent in physical activity, as discussed in Section 3.7.3.1 to assess differences between British Pakistani and white British children.

3.7.3.3 Focus groups on lifestyle

The lifestyle focus groups were conducted in conjunction with the focus groups exploring participation in the main study. The preparation for these data is similar, and is discussed below in Section 3.7.4.

3.7.3.4 Parent questionnaire on lifestyle

Data from the parent questionnaire on lifestyle (Appendix I) compared frequencies of responses between differences between British Pakistani and white British parents. The sample size for second and third generations of British Pakistani children was too small for comparisons. The responses from parents regarding their perception of their child having a problem with obesity were compared to their children's anthropometrics.

3.7.4 Preparation of the participation sub-study data

3.7.4.1 Participant observation

Fieldwork notes were read and reread for consistency and clarification. Analysis of the results used grounded theory as a method to develop theory from the data rather than approach the data with a strict set of objectives (Glaser and Strauss 1967; Strauss and Corbin 1999). The field notes, therefore, were examined for frequently recurring themes and topics to understand the themes that I had initially raised regarding the success of recruitment and participation (Miles and Huberman 1994).

Taking the themes that I considered during participant observation, I developed the areas of enquiry for the focus groups. This was done by an 'iterative process', in which I used my observations to inform my thinking and theory building for the focus group questions, as described by grounded theory (Glaser and Strauss 1967). For example, at school 'E', where there was a particularly high participation rate from British Pakistanis, I observed that British Pakistani children and parents were very receptive to the British Pakistani Teaching Assistant who aided in recruitment. I was thus interested in investigating my developing theory that it was important in this population to have members of their community involved in the research. Following on from this exploration, my focus group questions inquired about motivations for participation and family and friend involvement to see whether similar themes would emerge from the British Pakistani groups.

3.7.4.2 Focus groups on participation

The notes taken by the two research assistants were cross-checked after each focus group for inconsistencies or contradictions from individuals and within groups (Ryan and Bernard 2003). I read through the notes several times in order to gain an understanding of the content of the responses given by the participants. This method was employed given the small number of participants and limited number of themes, instead of formal coding. The interpretation of the interviews conducted in this study was based on the frequency of the recurring themes that were taken from field notes. Audio recordings were used to cross-check themes considered from participant observation methods and to confirm findings and to provide direct quotes (Mason 2002). Recordings were not transcribed because a narrative analysis was not conducted with this small sample.

3.7.5 Feedback to parents and schools

Letters to parents were sent home for all children containing BMI and blood pressure measurements, and whether the results were within a healthy range or whether it was advisable the parents should consult their physician (see Appendix L). Cut-offs for BMI were taken from Cole et al (2000) and cut-offs for blood pressure were taken from standard cut-offs for adults (Department of Health 2005).

After all data had been collected from a school, the results for a school feedback report were immediately produced. Schools expressed an interest in using the reports to inform decisions around improving health in their schools. Information in the summary reports included the proportion of students who were overweight and obese, a summary of the types and frequencies of food eaten, and activities in which the children engaged.

3.8 Ethics

This study obtained ethical clearance from the head of the department of anthropology, the university ethics committee, and Research and Development of South Tees Hospitals at James Cook University Hospital in Middlesbrough. It was necessary to seek approval outside of the university because the study proposed to collect data from birth records at the hospital. The Central Office for Research Ethnics Committee (COREC) North Officer, who presides over the North East, the North West and Cumbria, decided that the study did not need COREC approval, only Research and Development approval. This was justified because the study already had ethics approval from the university, and because the birth weight records were included only in a sub-sample.

3.8.1 Legal considerations

The Anthropometry and Recruitment Pilot Study ethics application went through only the university because there was no research being conducted through James Cook University Hospital at that time. The approval process was delayed when the Research and Ethics Committee flagged up concerns about potential university and researcher liability involved with the study. The university's solicitors reviewed the project and provided a report of potential risks and advice on specific 'safeguards'—actions to put into place as a way of minimising risk of legal action—the project should employ.

There were two main issues the solicitors identified as needing safeguarding: the need to obtain informed consent from both children and parents, and to have a third party from the school present during all body measurements. The Information Sheet that was originally submitted to university ethics committee did not include that the primary schools were selected for their high British South Asian population. To ensure informed consent, this detail was added to the form (Appendix B). Meetings with children continued to adequately inform the children about the study, and that they could still decline even if their parents consented. Informed consent was obtained from all the children who participated in the present study. I spent the first five minutes speaking with each child to ensure that they remembered who I was, what the measurements involved, and that they wanted to participate. Children were measured by me at their school in a private room with the presence of the third party, when possible.

I also acquired informed written consent from the head teacher and the local education authority, and kept the local social services telephone numbers on hand in case abuses toward the children were presented during data collection. Some of the recommended safeguards I had already had in place, including the required criminal records bureau clearance for working with children, and establishing a plan to be in compliance with the Data Protection Act 1998 and Freedom of Information Act 2000. To ensure the Data Protection Act 1998 was in place, participants' data were stored in a locked drawer or in a password-protected computer. To uphold the Freedom of Information Act 2000, the Information Sheet stated that participants or their parents could access their children's data at any time during the study (Appendix B).

3.8.2 Children as participants

The involvement of children in research opens up additional ethical concerns. It is unclear how participation in a study dealing with the issues of obesity can affect children's perception of themselves and their peers (Boulton and Parker 2007). Studies on this topic have only begun to emerge in the UK, in wake of the National Child Measurement Programme (Ridler, Townsend, Dinsdale, et al 2009), a national measurement scheme of reception and year 6 children. Shucksmith et al (2007) identified various issues to consider, including the responsibility of the researchers to acquire informed consent; sensitive handling of the issue;

provision of counselling and public health outreach; agency in children; objectification of children. Their assessment is in line with the issues considered in the present study.

CHAPTER 4: ANTHROPOMETRIC DIFFERENCES BETWEEN BRITISH PAKISTANI AND WHITE BRITISH CHILDREN

Excess storage of adiposity is exceptionally high in South Asian adults, including British Pakistanis, especially centrally distributed fat, and it puts them at a high risk for co-morbidities such as diabetes and heart (Department of Health 2005; Yoon et al 2006). Overweight (determined by BMI) and overfat (determined by indirect or direct measurements of body fat) are influenced by a myriad of factors, including socio-economic status, migration and early development. Low socio-economic status is highly correlated with a higher prevalence of obesity and co-morbidities than the general population (Sobal and Stunkard 1989; Tabacchi et al 2007; Wang and Beydoun 2007). British Pakistanis are amongst the poorest and most at risk for obesity and related illnesses of all ethnic groups in Britain (Office of National Statistics 2002b; Department of Health 2001; 2005). Although data on Pakistanis are limited, there is evidence that the migration of South Asians to more urban environments, such as Britain, results in a significant elevation in adiposity (Bhatnager et al 1995; Fall et al 2001; Misra and Vikram 2004). Obesity and related illness amongst British Pakistanis may originate in early development (Barker 1994; Bateson et al 2004). Extreme shifts in the developmental environments, as a result of migration for example, could cause the foetus of the migrant mother to be physiologically maladapted to a drastically different environment (Barker 1994; Hales and Barker 1992; 2001; Gluckman et al 2007).

This chapter reports the results from testing the hypothesis that British Pakistani children would store more fat, both generally and centrally, than white British children. I predict that British Pakistani would have higher anthropometric measurements of general adiposity, as measured by BMI, waist circumference, and triceps and subscapular skinfold thickness; and of central adiposity, as measured by waist circumference and subscapular skinfold thickness; and higher blood pressure and resting heart rate.

4.1 Results

4.1.1 Description of the study sample

The participants were 137 British Pakistani and 211 white British children aged 7-11 years. Incomplete data exist for some children because a number of questionnaires were returned incomplete or with questions having been misunderstood, or children declined particular measurements (mainly waist circumference, skinfolds, and blood pressure, see Section 2.1.3). Where appropriate, it was possible to re-contact some of these parents for clarification with regards to information on the Parent Questionnaire for Recruitment.

Background information taken from the Parent Questionnaire for Recruitment is summarised in Table 4.1. All children were born in the UK, mainly in the Middlesbrough area. There was a higher proportion of girls to boys in the sample, but the difference was not significant ($p=0.735$ by chi-squared test). White British children were significantly older than British Pakistani children by approximately 3.7 months ($p=0.014$ by t-test).

The majority of occupations reported by white British mothers were forms of employment that were salaried with benefits. The majority of British Pakistani mothers were classified as being non-employed ($p<0.001$ by chi-squared), most of whom reported themselves as being ‘homemakers’ or ‘housewives’. White British mothers acquired just over 2 years more education than British Pakistani mothers ($p<0.001$ by t-test). A higher proportion of British Pakistani fathers were classified with occupations being salaried with benefits than white British fathers ($p=0.021$). White British fathers reported approximately 1.5 years more education than British Pakistani fathers ($p=0.003$ by t-test).

Many parents declined to state their religion or first language. The vast majority of British Pakistani parents reported speaking English as a second language, with Punjabi and/or Urdu as their first language ($p<0.000$ and $p<0.000$ for mothers and fathers, respectively, by chi-squared). For religion, most British Pakistani parents reported Muslim and most white British parents reported some form of Christianity, although there was some crossover ($p<0.000$ and $p<0.000$ for mothers and fathers, respectively, by chi-squared). Chi-squared test showed no

Table 4.1 Summary of the sample comparing British Pakistani and white British children

		British Pakistanis	White British
Sex	**Male**	59 (43.1%)	87 (41.2%)
	Female	78 (56.9%)	124 (58.8%)
Age (mean in years)†		9.11±1.2 (137)	9.42±1.9 (211)
Mothers' Occupational Status**	**I. Salaried and/or Benefits**	22 (22.7%)	103 (58.2%)
	II. Labour Contract	23 (23.7%)	62 (35.0%)
	III. Non-employed	52 (53.6%)	12 (6.8%)
Mothers' mean education (years)††		9.96±4.5 (78)	12.2±2.5 (133)
Mothers' religion**	**CoE, Catholic, Christian**	1	27
	Muslim	52	4
Mothers' first language**	**English**	7	44
	Punjabi and/or Urdu	49	0
Mothers' history of diabetes	**Yes**	10	6
	No	112	157
Mothers' history of gestational diabetes	**Yes**	0	0
	No	56	27
Mothers' history of heart disease*	**Yes**	5	1
	No	117	160
Fathers' Place of Birth**	**UK**	23	132
	Pakistan	49	0
Fathers' Occupational Status*	**I. Salaried and/or Benefits**	68 (68.7%)	90 (57.0%)
	II. Labour Contract	24 (24.2%)	63 (39.9%)
	III. Non-employed	7 (7.1%)	5 (3.1%)
Fathers' mean education (years) †		10.6±4.4 (60)	12.3±2.4 (103)
Fathers' religion**	**CoE, Catholic, Christian**	0	17
	Muslim	51	5
Fathers' first language**	**English**	13	39
	Punjabi and/or Urdu	37	0
Fathers' history of diabetes	**Yes**	11	5
	No	106	145
Fathers' history of heart disease*	**Yes**	8	1
	No	109	147

* $p < 0.05$ by Chi-Squared test
** $p < 0.001$ by Chi-Squared test
† $p < 0.05$ by T-test
†† $p < 0.001$ by T-test

statistically significant difference between reported cases of diabetes or gestational diabetes in mothers. British Pakistani mothers' and fathers' history of heart disease were statistically significant (p=0.044 and p=0.006, respectively) compared to white British mothers and fathers, but the expected count from the chi-squared tests were less than five (Section 3.7).

4.1.2 Anthropometry

Results comparing raw anthropometrics and blood pressure by study group using ANOVA and ANCOVA are summarised in Table 4.2. The differences between group means for height, BMI, and waist circumference-to-height ratio were not statistically significant, even after controls. Waist circumference just neared statistical significance with British Pakistanis having a smaller mean waist circumference than white British children, but the relationship did not appear after controls for age and sex or BMI. British Pakistani children had significantly larger triceps SFTs, subscapular SFTs and triceps-to-subscapular ratios than white British children, and the strength of the relationship increased after all controls. Differences between groups for mean triceps STFs was statistically significant only after controlling for BMI. The difference between group means for systolic and diastolic blood pressure was not statistically significantly, even after controls. The differences between groups for mean resting heart rate was statistically significant and neared significance after controls, with British Pakistani children on average having 3 beats per minute more than white British children.

Results comparing standard deviation scores (SDSs) for anthropometric variables using ANOVA and ANCOVA are presented in Table 4.3, and are similar to results using raw anthropometrics. British Pakistani children had smaller waist circumferences compared to white British children, but after controlling for BMI the relationship did not remain. The narrow range between adjusted means for British Pakistani (0.842±0.044) and white British (0.906±0.035) children confirm this finding. Confidence intervals for mean SDSs for waist circumference in British Pakistani (95% 0.765, 0.928) and white British confidence intervals (95% 0.838, 0.975) show that means for both ethnicities fall well within range which contains the value of no effect.

The difference between mean SDS for triceps SFT was statistically significant only after controlling for BMI. The adjusted means confirmed that British Pakistani children still had higher means for triceps SFT (0.673±SE0.051) than white British children (0.482±0.04). Confidence intervals capture mean SDSs for triceps SFT for white British children (95% 0.574, 0.773) and British Pakistani children (95% 0.403, 0.561).

British Pakistani children were significantly fatter than white British children by mean SDS for subscapular SFT, and the relationship strengthened after controlling for BMI. Adjusted means for subscapluar SFTs confirm the direction of the relationship was still such that British Pakistani children's mean SDS (0.572±SE0.039) was larger than those of the white British children (0.166±SE0.031). Mean SDSs for subscapular SFT are not captured by confidence intervals for British Pakistani (95% 0.495, 0.650) and white British children (95% 0.104, 0.227).

It was of interest to explore for any effects from interactions between the variables sex and age within the grouping variable for ethnicity, given the range in the sample. Functional two-way ANOVA tests were conducted, and the independent variables were ethnicity and sex, the dependent variables were SDS for BMI, waist circumference, and triceps and subscapular SFTs, and the covariate was age. Main effects were calculated for ethnicity, sex, and age, and interactions were calculated for interaction terms sex*age, sex*ethnicity, and ethnicity*age. For SDSs for triceps SFT, the main effect from ethnicity, and the interaction term ethnicity*age neared significance (Levene's Test of Homogeneity p>0.05). Adjusted means show that the SDSs for triceps SFTs remained higher in British Pakistanis (0.615 SE 0.089 95%CI 0.444, 0.787) than in white British children (0.558 SE 0.069 95%CI 0.421, 0.694). There were no statistically significant main effects or interactions with SDSs for BMI, waist circumference, or subscapular SFT.

Categories for overweight and overfat using the 91st centile identified the proportion of children defined as being healthy and at risk for developing obesity and related illnesses in adulthood (Section 3.7.2.2). Values equal to or above the 91st centile were used define overweight by BMI, and overfat by waist circumference and SFTs. The 98th centile, which is often used to define obese, was not used in this analysis in order to maintain the larger sample size. The proportions of healthy and overweight and overfat British Pakistani and white British boys and girls analysed by chi-squared test are summarised in Table 4.5. Using the IOTF reference population, there were no statistically significant differences between the proportion of healthy and overweight BMIs between British Pakistani and white British boys (p=0.488) and girls (p=0.781). The UK 1990 reference population showed that the proportion of healthy and overweight BMIs between British Pakistani and white British children were not significantly different for boys (p=0.253) or girls (p=0.630).

There were twice as many overfat British Pakistani girls than white British girls by subscapular skinfold thicknesses, a relationship found to be highly significant (p=0.001 by chi-squared test) The proportion of British Pakistani boys with a waist circumference defined as healthy was similar to that of white British boys (p=0.887 by chi-squared test). Likewise, the proportion of girls with a 'healthy' waist circumference was similar for both British Pakistani and white British girls (p=0.653). The difference in triceps SFT between British Pakistani and white British was not statistically significant for boys (p=0.126) or girls (p=0.562). There were no statistically significant differences for subscapular SFTs between groups amongst boys (p=0.451 by chi-squared test).

Occupational Status was not used as a covariate in the main analyses due to the low response rate from the parent questionnaires (Section 3.7.2). It was still of interest to assess whether Occupational Status had any effect on the mean anthropometric differences observed between British Pakistani and white British children, given the vast literature associating ethnicity and socio-economic status (Bhopal et al 2002; Wardle et al 2006; Tabacchi et al 2007; Wang and Beydoun 2007). A sub-analysis using SDSs for anthropometrics was conducted, which included only participants whose mothers reported their occupation. Analyses were run as was done with the main analyses using SDSs, using Occupational Status and BMI as covariates.

Results for the sub-analysis of Occupational Status are summarised in Table 4.6. The difference between SDS for subscapular skinfold thickness was statistically significant, with British Pakistanis having thicker skinfolds than white British children. The relationship was weakened after controlling for Occupational Status, but after controlling for BMI the relationship reappeared and was highly significant. The difference between mean SDS for height and BMI were not statistically significant, and they were also not statistically significant after controlling Occupational Status. The difference between mean SDS for waist circumference, triceps SFT was not statistically significant, and there was no statistical significance after controlling for Occupational Status or BMI.

Table 4.2 Comparison of raw anthropometrics and blood pressure between British Pakistani and white British children using ANOVA and ANCOVA

	Ethnicity (n)	Mean±SD (95%CI)	F-statistic		Control for age and sex		Control for age, sex and BMI*	
			F	p	F	p	F	p
Height (cm)	Pakistani (137)	134.9±9.11 (-3.36-0.48)	2.174	0.141	0.282	0.596		
	White (211)	136.3±8.78 (-1.03-0.36)						
BMI (kg/m2)	Pakistani (137)	17.6±3.4	0.965	0.327	0.152	0.697		
	White (211)	18.0±2.8						
Waist circumference (cm)	Pakistani (132)	61.1±8.6	3.831	0.051	1.581	0.21	2.128	0.146
	White (207)	62.8±8.3						
Waist circumference to height ratio	Pakistani (132)	0.452±0.051	2.061	0.152	2.588	0.109		
	White (207)	0.461±0.052						
Triceps SFT (mm)	Pakistani (132)	13.1±4.7	0.051	0.822	0.68	0.41	4.676	**0.031**
	White (207)	13.0±4.6						
Subscapular SFT (mm)	Pakistani (132)	9.26±5.0	5.562	**0.018**	8.324	**0.004**	44.639	**0.000**
	White (207)	8.12±3.8						
Tricep to subscapular ratio	Pakistani (132)	0.696±0.20	12.2	**0.001**	12.364	**0.000**	14.109	**0.000**
	White (207)	0.629±0.16						
Blood pressure (Systolic, mmHg)	Pakistani (133)	103±15	0.477	0.49	1.547	0.214	2.024	0.156
	White (207)	102±11						
Blood pressure (Diastolic, mmHg)	Pakistani (133)	61±12	0.056	0.814	0.509	0.476	0.676	0.412
	White (207)	61±8						
Resting heart rate (beats / minute)	Pakistani (133)	86±16	4.068	**0.044**	2.986	**0.085**	2.966	**0.086**
	White (207)	83±13						

*Control using age, sex, and BMI as covariates where appropriate

Table 4.3 Comparison of anthropometric standard deviation scores (SDSs) between British Pakistani and white British children using ANOVA and ANCOVA

	Ethnicity (N)	Mean±SD	F-statistic		control for BMI	
			F	p	F	p
Height	Pakistani (137)	0.234±1.0	0.277	0.599		
	White (211)	0.176±0.98				
BMI	Pakistani (137)	0.297±1.4	2.287	0.131		
	White (211)	0.505±1.1				
WC	Pakistani (132)	0.714±1.3	4.265	**0.040**	1.312	0.253
	White (207)	0.988±1.1				
Tricep SFT	Pakistani (132)	0.586±1.0	0.255	0.614	8.751	**0.003**
	White (209)	0.537±0.96				
Sub-scapular SFT	Pakistani (132)	0.479±0.97	5.865	**0.016**	65.44	**0.000**
	White (207)	0.225±0.92				

Units used before standardised were in meters for height, kilograms/meters^2 for BMI, centimetres for waist circumference, and millimetres for skinfold thicknesses.

Table 4.4 Proportions of overweight, overfat, and obese between British Pakistani and white British boys and girls anthropometrics using the 91st centile

	Boys		Girls	
	British Pakistani % (n)	**White British % (n)**	**British Pakistani % (n)**	**White British % (n)**
IOTF				
BMI (kg/m²)				
<91st	69.5 (41)	71.7 (65)	74.4 (58)	72.6 (90)
≥ 91st	30.5 (18)	25.3 (22)	25.6 (20)	27.4 (34)
UK 1990				
BMI (kg/m²)				
<91st	61.0 (36)	70.1 (61)	75.6 (59)	63.8 (60)
≥ 91st	39.0 (23)	29.9 (26)	24.4 (19)	36.2 (34)
Waist circumference (cm)				
<91st	59.3 (35)	58.1 (50)	64.4 (47)	61.2 (74)
≥ 91st	40.7 (24)	41.9 (36)	35.6 (26)	38.8 (47)
Tricep SFT(mm)				
<91st	58.6 (34)	70.9 (61)	77.0 (57)	80.5 (99)
≥ 91st	41.4 (24)	29.1 (25)	23.0 (17)	19.5 (24)
Subscapular SFT (mm)				
<91st	72.4 (42)	77.9 (67)	75.7 (56)	92.6 (112)
≥ 91st	27.6 (16)	22.1 (19)	**24.3 (18)****	7.4 (9)

* $p < 0.05$
** $p < 0.001$

Table 4.5 Occupational Status sub-analysis comparing anthropometric standard deviation scores (SDSs) for British Pakistani and white British children using ANOVA and ANCOVA

	Ethnicity (N)	Mean±SD	F-test		Control for occupation		Control for occupation and BMI	
			F	p	F	p	F	p
Height	Pakistani (97)	0.300±1.0						
	White (177)	0.134±1.0	1.671	0.197	1.49	0.223		
BMI	Pakistani (97)	0.292±1.5						
	White (177)	0.434±1.1	0.843	0.359	0.567	0.452		
Waist circumference	Pakistani (95)	0.730±1.4						
	White (173)	0.914±1.1	1.426	0.233	1.532	0.217	1.74	0.188
Tricep SFT	Pakistani (93)	0.551±1.0						
	White (176)	0.485±0.98	0.27	0.604	0.039	0.845	0.583	0.446
Subscapular SFT	Pakistani (93)	0.464±0.99						
	White (174)	0.198±0.91	4.914	**0.027**	3.583	**0.059**	23.63	**0.000**

Units used before standardised were in meters for height, kilograms/meters^2 for BMI, centimetres for waist circumference, and millimetres for skinfold thicknesses.

4.2 Discussion of the Results

The previous section presented results comparing the background of the sample and anthropometric and blood pressure data between British Pakistani and white British children. This section considers the main hypothesis of this chapter, which is that British Pakistani children would show higher levels of adiposity compared to white British children, in light of previous research.

4.2.1 Study sample findings

The target sample size of 47 for each group for 80% power was determined by conducting power calculations using data from a national reference population and the Pilot Study for waist circumference and the software programme Gpower (Secion 2.1.3). The sample sizes for British Pakistani (n=137) and white British (n=211) children did reach this target, so it can be assumed that there was significant power for the tests conducted.

Analysis of the study population showed that the sample was evenly distributed in terms of sex, but not by age. An age bias in the sample is likely explained by a relatively high response rate from younger British Pakistanis (Section 2.2.3). The use of age as a covariate and of standard deviation scores controlled for this potential bias. Given that participation in the present study was optional, there is also a potential bias in willingness of overweight or obese individuals or families to participate. This issue is discussed in detail in Sections 8.2.1 and 8.4.

White British mothers were more likely to be employed, and most were employed in a higher form of employment with salaries and benefits. The majority of British Pakistani mothers were classified as non-employed. White British mothers on average reported college as their highest level of education attained, while British Pakistani mothers on average reported completing secondary school. More British Pakistani fathers reported and occupation with salaries and benefits, but they also reported a lower level of education attained compared to white British fathers. There was a high prevalence of taxi drivers among the British Pakistani fathers which may explain how their educational and occupational statuses do not agree. The National Statistics Socio-economic Status system categorises taxi drivers as independent contractors with a relatively high degree of autonomy, and therefore higher social status (Section 3.7.1). This system seems to bias fathers' Occupational Status toward salaries with benefits over labour and contract forms of employment because the Parent Questionnaires on Recruitment did not ask for further details.

4.2.2 Findings for anthropometrics and blood pressure

The results from the present study support the study prediction that British Pakistani children would be fatter than white British children by triceps and subscapular SFTs, but not by waist circumference. The results are consistent with prior research comparing groups of South

Asian and European ethnicities. Yajnik et al (2002) found that newborn Indian babies in Pune were fatter by triceps and subscapular SFTs, and had a higher prevalence of hyperinsulinemia compared to English newborns in London. A study comparing children aged 9-10 years found that South Asian children had lower measures for BMI and waist circumference than their white counterparts, but they also demonstrated higher body fat by bioimpedance and higher combined SFTs (Nightingale et al 2009). Ehtisham et al (2005) found 14-17 year olds British South Asian boys and girls were fatter than their white British counterparts as measured by triceps and subscapular SFTs.

There were no significant differences found between the groups for waist circumference in the present study. Other studies that have observed higher levels of abdominal adiposity by waist circumference in people of South Asian ethnicities compared to European ethnicities in children (Misra et al 2004; Ehtisham et al 2005; Vikram et al 2006; Ghosh 2007) and adults (Misra et al 2007; WHO 2004; Department of Health 2005), but there are still some studies that find no differences between groups for waist circumference in very young children (Whincup et al 2002; Yajnik et al 2002). It is possible that the phenotype of the high intra-abdominal fat storage typical in South Asian groups is apparent only after puberty, as one recent study suggests (Cameron et al 2009). However, even at comparable waist circumferences, pre-pubertal South Asian children still show early indications risk of associated morbidities that become apparent in adolescent and adult South Asians (Yajnik et al 2002; Ehtisham et al 2005; Vikram et al 2006). Yajnik et al (2002) found that newborn Indian babies in Pune had smaller waist circumferences and higher prevalence of hyperinsulinemia compared to English newborns in London. In British South Asian and white British children ages 10-11 years, Whincup et al (2002) found no significant differences between measures of waist circumference, but South Asian children had higher risk of cardiovascular disease based on their higher blood levels of triglyceride and fibrinogen, and insulin concentration after fasting and glucose load. Indeed, in a cohort of 14-17 year olds, South Asians had larger waist circumferences and were more insulin resistant than their white European counterparts (Ehtisham et al 2005).

BMI cut-offs that are used to define overweight and overfat have been established based on their association with risk of co-morbidities, such as insulin resistance, glucose intolerance, and elevated blood lipids (Cole et al 2000). It is therefore not surprising that the results of the present study are consistent with data on central adiposity in South Asian adults. The Health

Survey for England found that British Pakistani men and women aged 16 years and older were amongst the most centrally obese ethnic group in the country, having a prevalence of raised waist-to-hip ratios above the general population (Department of Health 2001; 2005). Kalhan et al (2001) found American South Asian adults ages 18-30 years, including Pakistani Americans, were fatter centrally than European Americans by the sum of suprailiac and abdominal SFTs, but not for BMI or peripheral SFTs. Similarly, McKeigue et al (1991) found in Londoners mean waist-hip ratios and central skinfolds were higher in the South Asian group than in the European group. However, waist circumference and SFTs are shown to be stronger indicators of co-morbidities in post-pubertal Asian Indian children than BMI (Misra, Wasir, and Vikram 2004). Therefore, current methods may not assess abdominal overfat—and therefore predict associated health risks—in pre-pubertal South Asian children. The utilisation of a population-specific reference population for South Asian children and adults has been suggested (WHO IOTF 2000; Deurenburg et al 2002; Lear et al 2003; Snehalatha, Viswanathan, and Ramachandran 2003; Misra et al 2005; Kelishadi et al 2007).

Overall, British Pakistanis were from a lower socio-economic background than the white British families in this sample, based on differences in Occupational Status and level of education attained. Using mothers' Occupational Status as an additional covariate in a smaller sub-sample yielded results for nearly all anthropometrics and blood pressure variables that were similar to analyses that did not use Occupational Status as a covariate. Many studies have found socio-economic status does not influence ethnic differences in adiposity, reflecting the challenge to methodology that socio-economic status poses in health research (Wang 2001; Zhang and Wang 2004; Saxena et al 2005: Whitaker and Orzol 2006). The results from the present sample suggest socio-economic status may not have as strong an influence on measures of adiposity in this population in middle childhood.

However, the use of Occupational Status in analyses in the present study is limited in its interpretation. For one, the data on parent education and occupation are not likely to be representative of the sample, given that many parents declined to provide this information. Also, the variable Occupational Status is not as detailed a variable as socio-economic status because it does not include information such as income or property owned (Office of National Statistics 2005). The NS-SEC manual, used in the present study to classify Occupational Status, recommends establishing a household reference person, for which the highest income holder is designated (Office of National Statistics 2005). Mothers' occupation data were used instead of fathers' because it was not clear from the Parent Questionnaire for Recruitment (Appendix B) of the many men who were taxi drivers whether they were owners or employees of a taxi firm, which made defining Occupational Status not possible. However, the category non-employed, which included mostly 'homemakers', was used as a nominal variable of occupation, not socio-economic status. There are also many factors associated with health, ethnicity and socio-economic status not addressed in this study that could be explored in future, such as poor access to healthy food and physical activity options, as well as issues of racial discrimination and racism (Chinn et al 1999; Karlsen and Nazroo 2002).

There was some indication that the weak interaction term between age and ethnicity had an effect on the results for SDSs triceps SFT. There is some evidence that people of different ethnicities grow and develop at different stages throughout childhood (Greaves et al 1989; Tabacchi et al 2007). Adiposity has consistently been shown to increase with age, and obesity in childhood is considered to be most difficult to reverse after puberty (Parsons et al 1999; Wang and Beydoun 2007; Tabacchi et al 2007). Differences in adiposity between ethnic groups might not be apparent in middle childhood, but would rather be more marked after sexual maturity. As a result, any small differences in adiposity between groups before puberty may not be as easily detectable as after puberty. The methods used in this study may not be able to detect such subtle differences. For one, the sample size calculated for this study had enough power to detect medium sized differences between groups (Section 3.4.3). Second, anthropometric methods can be considered limited compared to direct methods of assessing body fatness, such as dual-energy x-ray absorptiometry, because they indirectly assess body fat and cannot detect levels as precisely (Deurenberg and Reubenoff 2002; Scott 2008).

The results presented here show that the vast majority of children had blood pressure readings within a healthy range (<120/70 mmHg). Indeed, only 10 children in the entire sample had raised blood pressure (data not shown). Blood pressure is used to identify risk of cardiovascular illness in adults, and some studies have identified elevated blood pressure in pre-pubertal children (Department of Health 2005). Mean resting heart rate was higher in British Pakistani children than white British children, and neared significance after controlling for age, sex, and BMI. Whincup et al (2002) found similar difference in resting heart rate between British South Asian and white British children ages 10-11 years by 4 beats per min. An elevated resting heart rate indicates poorer cardiovascular fitness and a more sedentary lifestyle due to a physiological response to physical activity involving blood volume and circulation (Wilmore, Costill, and Kenney 2008). These results are considered later on in light of results from the lifestyle sub-study reported in Chapter 7.

The national health survey in the UK, the National Child Measurement Programme, currently assesses obesity in children solely by use of BMI (Department of Health 2006). BMI is widely used to establish overweight because it is shown to be a good predictor of excess adiposity and health risks associated with obesity (Williams and Horlick 2008). However, BMI does not correlate as strongly with body fat as do waist circumference and SFTs, so may not help to define overfat as precisely (Goran et al 1998; Norgan et al 2005; Scott 2008). Indeed, some studies comparing methods conclude that BMI is not sensitive enough in detecting body fat than other methods such as skinfold thicknesses (Flegal 1993; Shaw et al 2007; Burkhauser, Cawle, and Schmeiser 2009). In a comparison by and waist circumference have been shown to be stronger indicators of co-morbidities in post-pubertal Asian Indian children than BMI (Misra, Wasir, and Vikram 2004). The results showing that British Pakistani children can still be overfat by SFTs even if they are not considered overweight by BMI suggest that British Pakistanis could be overlooked for associated health risks if only current methods for assessing obesity are used.

4.3 Summary

This chapter reports results that tested the study prediction that British Pakistani would have higher anthropometric measurements of central and general adiposity compared to white British children. The results support the prediction by demonstrating that British Pakistani children had higher levels of adiposity than white British children as measured by tricep and subscapular SFTs, but not waist circumference.

CHAPTER 5: ANTHROPOMETRIC DIFFERENCES BETWEEN SECOND AND THIRD GENERATION BRITISH PAKISTANI CHILDREN

South Asian people who migrate to more urbanized environments, such as Britain, tend to have significantly elevated levels of adiposity (McKeigue et al 1991; Bhatnager et al 1995; Kalhan et al 2001; Misra and Vikram 2004). There is some evidence that levels of adiposity in British South Asian women, including British Pakistanis, decline slightly over generations, demonstrated by waist-hip ratio (Lean et al 2001; Pollard et al 2008a). It would be expected that levels of adiposity amongst migrant communities would come to reflect levels of the general population; however, Lean et al (2001) report the levels of adiposity in successive generations of South Asians are still significantly higher than those of the general population. Developmental origins of disease research theorizes that, if a migrant mother moves from an environment with higher rates of under-nutrition to an environment with higher rates of over-nutrition, the foetus of the migrant mother may be physiologically maladapted (Hales and Barker 1992; 2001). Slow retention of elevated adiposity levels in migratory groups over generations could occur due to a lag in a biological response to a sudden change in the environment. Intergenerational phenotypic inertia predicts that a mother could pass to her foetus information about the intrauterine environmental conditions that the mother experienced as a foetus (Kuzawa 2005). This would ensure that the traits that have been best adapted for several prior generations would be passed onto the developing foetus and increase its evolutionary fitness.

This chapter reports the results from testing the hypothesis that second generation British Pakistani children would be more centrally and generally fat than the third generation. I predict that second generation British Pakistani children will show larger measurements for waist circumference, triceps and subscapular skinfold thicknesses (SFTs), blood pressure, and resting heart rate compared to third generation British Pakistani children.

5.1 Results

5.1.1 Description of the study sample

Participants were 82 second generation and 51 third generation British Pakistani children. Background information from the parent questionnaire is summarised in Table 5.1. All children were born in the UK, mainly in the Middlesbrough area. In general there were more girls than boys, but there were no significant differences between generations for sex ($p=0.581$ by chi-squared test) or age ($p=0.280$ by t-test). The highest proportion of mothers of third generation children were classified in category 1 for Occupational Status, the employment form of having a salary and benefits, and the majority of second generation mothers were in category 3, non-employed ($p<0.001$ by chi-squared test). Mean educational level attained by mothers showed the mothers of third generation children attained nearly 2 years more education than the second, a difference shown to be statistically significant by t-test ($p=0.034$). There were no significant differences between groups found for father's Occupational Status ($p=0.332$ by chi-squared test) or level of education ($p=0.471$ by t-test).

Many parents declined to state religion or first language for both parents. The only statistically significant result in analyses of these variables was that second generation mothers reported Punjabi and/or Urdu as their first language than did third generation ($p=0.022$), but the chi-squared tests showed the expected count were less than five (Section 3.7). To generalise, the majority of Pakistani parents reported speaking English as a second language, with Punjabi and/or Urdu as their first, including many of whom were British born. For religion, most parents reported Muslim, with a very small minority stating either Christian or 'none'. None of the results for mothers' and fathers' history of diabetes or heart disease were statistically significant.

Table 5.1 Summary of the sample comparing second generation and third generation British Pakistani children

		Second generation	Third generation
Sex	**Male**	34 (41.8%)	22 (43.1%)
	Female	47 (58.2%)	29 (56.9%)
Age (years)		9.2±1.2 (N=82)	8.8±1.0 (N=51)
Mothers' Occupational Status **	**1. Salaried and/or Benefits**	7	15
	2. Labour Contract	9	13
	3. Non-employed	40	11
Mothers' mean education (years) †		9.2±4.4 (N=50)	11.4±4.1 (N=27)
Mothers' religion	**CoE, Catholic, Christian**	0	2
	Muslim	25	24
Mothers' first language*	**English**	0	8
	Punjabi and/or Urdu	25	17
Mothers' history of diabetes	**Yes**	6	5
	No	70	37
Mothers' history of gestational diabetes	**Yes**	1	2
	No	35	19
Mothers' history of heart disease	**Yes**	3	2
	No	73	40
Fathers' Place of Birth	**UK**	16	7
	Pakistan	26	21
Fathers' Occupational Status **	**1. Salaried and/or Benefits**	40	27
	2. Labour Contract	11	11
	3. Non-employed	6	1
Fathers' mean education (years)		11.1±4.2 (N=42)	10.1±4.5 (N=15)
Fathers' first language	**English**	8	5
	Punjabi and/or Urdu	15	19
Fathers' religion	**Muslim**	24	24
Fathers' history of heart disease	**Yes**	5	3
	No	67	37
Fathers' history of diabetes	**Yes**	8 (11.1%)	3 (7.5%)
	No	64 (88.9%)	37 (92.5%)

* $p < 0.05$ by chi-squared test
** $p < 0.001$ by t-test

5.1.2 Anthropometry

The raw means, standard deviations, F-statistics, and p-values for anthropometrics and blood pressure using ANOVA and ANCOVA are summarised in Table 5.2. The differences between group means for height, BMI, waist circumference, triceps SFT were not statistically significant, even after controls. Differences between subscapular SFTs and triceps-to-subscapular skinfold ratio neared significance, with second generation British Pakistani children having larger measurements than the third generation. The differences between subscapular SFTs did not appear after controls. SFT ratio remained as approaching significance after controlling for age and sex, but not after controlling for age, sex and BMI. The difference between group means for systolic and diastolic blood pressure was not statistically significant, even after controls. Resting heart rate neared significance after control for sex and age, and neared slightly closer towards significance after controlling for sex, age and BMI. Second generation British Pakistani children on average had approximately 3 beats/minute more than the third generation.

Results for ANOVA and ANCOVA using SDSs for anthropometric variables are reported in Table 5.3. The results were similar to these results found for analysis using raw anthropometrics presented in Table 5.2. The differences between mean SDS for height, BMI, waist circumference, triceps SFT and subscapular SFT were not statistically significant, even after appropriate controls.

It was of interest to analyse whether there were any effects from interactions between the variables sex and age within the grouping variable for generation, given the interaction found in Section 4.1.2. Functional two-way ANOVA tests were conducted, and the independent variables were ethnicity and sex, the dependent variables were SDS for BMI, waist circumference, and triceps and subscapular SFTs, and the covariate was age. Main effects were calculated for ethnicity, sex, and age, and interactions were calculated for interaction terms sex*age, sex*ethnicity, and ethnicity*age. There were no statistically significant effects or interactions seen for any of the terms.

The proportion of healthy and overweight/overfat girls and boys for second and third generation British Pakistani children are summarised in Table 5.5. Values equal to or above the 91st centile define overweight for BMI and overfat for waist circumference and SFTs (Section 3.7.2.1). Using the IOTF reference population for BMI, there was a higher proportion of overweight among second generation boys than the third generation boys (p=0.011) but not girls (girls p=0.219, by chi-squared test). Using the UK 1990 reference population for BMI, more second generation British Pakistani boys were overweight than third generation, a difference which neared significance for boys (boys p=0.091), but this relationship was not found in girls (p=0.617, by chi-squared test).

The proportion of second generation British Pakistani boys with a 'healthy' waist circumference was similar to third generation boys (p=0.425) and amongst girls (p=0.596 by chi-squared test). The differences in triceps SFT between second and third generation British Pakistani was not statistically significant for boys (p=0.220) or girls (p=0.442 by chi-squared test). There were four times more overfat second generation British Pakistani boys than third generation boys by subscapular SFT (p=0.045 by chi-squared test). The difference in subscapular SFT between groups for girls was not statistically significant (p=0.235).

Occupational Status was not used as a covariate in the main analyses of variance and covariance due to the low response rate from the parent questionnaires (Section 5.1.1). It was still of interest to assess whether Occupational Status had any effect on the mean anthropometric differences observed between second and third generation British Pakistani children. Table 5.6 presents results from a sub-analysis using SDSs for anthropometrics, including only participants whose mother's reported occupation. Analyses were run exactly as those presented in Table 5.3, and Occupational Status was included as an additional covariate. The differences between mean SDS for all anthropometric means were not statistically significant before or after controlling for Occupational Status and BMI. These results are similar to the results found in the main analysis of anthropometric SDSs. As discussed there, the data on parent education and occupation are not likely to be representative of the sample, given that many parents declined to provide this information and results are interpreted with caution.

Table 5.2 Comparison of raw anthropometrics and blood pressure between second and third generation British Pakistani children using ANOVA and ANCOVA

	Generation (N)	Mean±SD	F-statistic		Control for age and sex		Control for age, sex and BMI*	
			F	p	F	p	F	p
Height (cm)	2nd (82)	134.9 ± 9.7	0.047	0.829	0.820	0.367		
	3rd (51)	134.6 ± 8.5						
BMI (kg/m^2)	2nd (82)	17.9 ± 3.6	1.37	0.244	0.745	0.390		
	3rd (51)	17.2 ± 3.2						
WC (cm)	2nd (79)	61.9 ± 9.5	1.78	0.185	1.18	0.280	0.235	0.629
	3rd (49)	59.7 ± 7.2						
Waist:height	2nd (79)	0.46 ±0.05	2.213	0.139	2.42	0.122		
	3rd (49)	0.44 ± 0.05						
Tricep SFT (mm)	2nd (79)	13.4 ± 5.0	1.24	0.268	0.559	0.456	0.699	0.405
	3rd (49)	12.4 ± 4.1						
Subscapular SFT (mm)	2nd (79)	9.8 ± 5 2	3.101	**0.081**	2.28	0.133	0.471	0.494
	3rd (49)	8.3 ± 4.5						
Triceps: subscapular SFT	2nd (79)	0.72±0.19	3.13	**0.079**	3.175	**0.077**	1.68	0.198
	3rd (49)	0.66±0.21						
Blood pressure Systolic (mmHg)	2nd (78)	104.3±17.8	3.92	0.050	2.679	0.104	1.44	0.233
	3rd (50)	101.1±11.4						
Blood pressure Diastolic (mmHg)	2nd(78)	63.2±10.9	1.85	0.176	1.34	0.249	0.488	0.486
	3rd (50)	60.7±8.76						
Resting heart rate (beats/ min)	2nd (79)	87.2±16.0	1.64	0.202	2.86	**0.093**	3.00	**0.086**
	3rd (50)	83.7±17.8						

*Control for BMI where appropriate

Table 5.3 Comparison of anthropometric standard deviation scores (SDSs) between second and third generation British Pakistani children using ANOVA and ANCOVA

	Generation (n)	Mean±SD	F-test		Control for BMI	
			F	p	F	p
Height	**2nd (82)**	0.18 ±1.0	0.627	0.430		
	3rd (51)	0.33±0.98				
BMI	**2nd (82)**	0.39±1.4	0.801	0.372		
	3rd (51)	0.16±1.4				
WC	**2nd (79)**	0.78±1.4	0.555	0.458	0.452	0.502
	3rd (49)	0.60±1.2				
Triceps SFT	**2nd (79)**	0.60±1.0	0.106	0.745	1.92	0.17
	3rd (49)	0.53±0.95				
Subscapular SFT	**2nd (79)**	0.55±1.00	1.70	0.195	0.159	0.691
	3rd (49)	0.32±0.93				

Units used before standardised were in meters for height, kilograms/meters^2 for BMI, centimetres for waist circumference, and millimetres for skinfold thicknesses.

Table 5.4 Proportions of healthy, overweight, and overfat between second and third generation British Pakistani boys and girls using the 91st centile

	Boys		Girls	
	Second generation % (n)	**Third generation % (n)**	**Second generation % (n)**	**Third generation % (n)**
IOTF				
BMI (kg/m²)				
<91st	54.5 (18)	87.0 (20)	69.4 (34)	82.1 (23)
≥91st	**45.5 (15)***	13.0 (3)	30.6 (15)	17.9 (5)
UK 1990				
BMI (kg/m²)				
<91st	51.5 (17)	73.9 (17)	73.5 (36)	78.6 (22)
≥91st	48.5 (16)	26.1 (6)	26.5 (13)	21.4 (6)
Waist circumference (cm)				
<91st	54.5 (18)	65.2 (15)	63.0 (29)	69.2 (18)
≥91st	45.5 (15)	34.8 (8)	37.0 (17)	30.8 (8)
Tricep SFT (mm)				
<91st	51.5 (17)	48.5 (16)	66.7 (38)	33.3 (19)
≥91st	68.2 (15)	31.8 (7)	56.3 (9)	43.8 (7)
Subscapular SFT (mm)				
<91st	50.0 (20)	50.0 (20)	60.7 (34)	39.3 (22)
≥91st	**80.0 (12)***	20.0 (3)	76.5 (13)	23.5 (4)

* $p < 0.05$
** $p < 0.001$

Table 5.5 Occupational Status sub-analysis comparing anthropometric standard deviation scores (SDS) between second and third generation British Pakistani children

	Generation (n)	Mean±SD	F-statistic		Control for occupation		Control for occupation and BMI	
			F	p	F	p	F	p
Height	2nd (58)	0.268±1.0	0.209	0.649	0.00	0.998		
	3rd (38)	0.367±1.1						
BMI	2nd (58)	0.481±1.4	0.844	0.360	1.25	0.267		
	3rd (58)	0.140±1.5						
WC	2nd (58)	0.838±1.4	0.738	0.392	2.66	0.106	0.504	0.479
	3rd (36)	0.590±1.2						
Tricep SFT	2nd (56)	0.597±1.1	0.244	0.622	1.53	0.220	0.228	0.634
	3rd (36)	0.488±0.95						
Sub-scapular SFT	2nd (56)	0.556±1.0	1.00	0.319	1.83	0.180	0.056	0.814
	3rd (56)	0.345±0.91						

Units used before standardised were in meters for height, kilograms/meters^2 for BMI, centimetres for waist circumference, and millimetres for skinfold thicknesses.

5.2 Discussion of the Results

The previous section presents background data on the sample and anthropometrics and blood pressure from second generation and third generation British Pakistani children. The following section considers the relevant literature in light of the main prediction of this chapter, which is that second generation British Pakistani children would show higher levels of adiposity and blood pressure than the third generation.

5.2.1 Findings for the study sample

Analyses show that the sample was evenly distributed in terms of sex and age. Section 4.2.1 refers to the potential bias in anthropometrics in terms of participation of overweight or obese individuals or families because participation in the present study based on an 'opt-in' method. This issue is also discussed in detail in Chapter 8. The target sample size of 47 for each group for 80% power was determined by power calculations using data from a national reference population for waist circumference and the software programme Gpower (Section 3.4.3). The sample sizes for the second generation (n=82) and third generation children (n=51) did reach this target, so it can be assumed that there was significant power for both groups. However, this sample size only had enough power to detect medium sized differences between groups, so small differences that may be occurring cumulatively over generations would not be detected with this study's sample size.

5.2.2 Findings for anthropometry and blood pressure

The current study examined potential generational trends in adiposity within the migrant population of British Pakistanis. There is some evidence from previous research that levels of adiposity in British South Asians, including British Pakistanis, decline slightly over generations, demonstrated by waist-to-hip ratio in women (Lean et al 2001; Pollard et al 2008a). What is more, the levels of adiposity in successive generations were still found to be significantly higher than those of the general population (Lean et al 2001). The present study demonstrates that second generation British Pakistani boys were overfat by subscapular SFTs by four times compared to third generation boys. Results from Chapter 4 do not find that British Pakistani boys were overfat in higher proportions by subscapular SFTs than white British boys; however it has been shown here that British Pakistani children were fatter by raw and SDSs for SFTs. Taken together, these results may support previous findings by showing in British Pakistani boys that there is a decrease in the prevalence of adiposity from the second generation to the third generation.

The method of using cut-offs highlights the children at highest risk of obesity because they identify children at the extreme tail of the population, whereas the analysis of the mean considers the sample overall. In general, by using cut-offs at the 91st centile, results show that the majority of overweight and overfat children were second generation British Pakistani children in comparison with the third generation. Second generation British Pakistani children also showed higher mean SDSs for waist circumference, and triceps, and subscapular SFT than the third generation. The effects from these results were not statistically significant after controls, but there does appear to be a general trend. It is possible that the method of using cut-offs is better able in identifying slight differences between generations in the most adipose children, rather than differences between adiposity in the groups overall. The Health Survey for England 1999 and 2004 do not show any dissimilarity for mean BMI between 2-15 year old British Pakistani girls and boys and the general population. However, in 2004, there was a lower prevalence of overweight in British Pakistani girls by 5% compared to the general population of girls, and a higher prevalence of obesity in British Pakistani boys by 9% in boys of the general population (Department of Health 2005).

Using the IOTF reference population for BMI, there were three times the proportion of second generation boys who were overweight compared to third generation boys. Results using the UK 1990 reference population, although approaching significance, show that nearly double the amount of second generation British Pakistani boys were overweight by BMI than the third generation. These results are consistent with the individual capabilities of specificity and sensitivity of the two methods, with the IOTF method identifying overweight more frequently than the UK 1990 method (Section 3.7.2.2). The UK 1990 reference population does not reflect the ethnic diversity currently found in Britain today (Cole 1995; Cole et al 2000).

Some studies have observed differences among ethnicities in body dimensions, which may bias analyses of anthropometrics (Tanner 1976; Norgan 2005; Lohman and Going 2006); however some researcher have warned that such delineations of ethnic groups can be misleading in light of data that indicates nutrition and socio-economic status may be the underlying causes of such variations (Shams and Williams 1997; Kelly et al 1997). Shams and Williams (1997) found that stature in South Asians increased after migration to the UK from the first generation to the second, and that the second generation children's statures were comparable with those of the general population comparison group. Kelly et al (1997) found a similar trend in British Pakistani children. The authors of both papers attribute this increase to improved nutrition and living conditions in the second generation. An 'improvement' in nutrition (i.e. relative to under-nutrition) would explain increases in height, but the over-nutrition prevalent today in Britain also predicts a correlating increase in weight. Kelly et al (1997) and Shams and Williams (1997) unfortunately did not adequately explore differences in BMI between generations. The finding in the present study that mothers of third generation children reported 2 years more education, a factor of socio-economic status, than mothers of second generation children support this logic, given studies correlating obesity with lower socio-economic status (Sobal and Stunkard 1989; Tabacchi et al 2007; Wang and Beydoun 2007). However, the sample size for these results is small, and may not be representative of the main sample due to a high degree of non-response of education and occupation data on the parent questionnaires

The second generation British Pakistani children's mean resting heart rate was higher than third generation children, a value which neared significance after controlling for age, sex, and BMI. Second generation British Pakistani children on average had approximately 3 beats per minute more than the third generation. Whincup et al (2002) found similar difference in resting heart rate between British South Asian and white British children ages 10-11 years by 4 beats per minute. A lowered resting heart rate indicates cardiovascular fitness because due to a physiological response to physical activity involving blood volume and circulation (Wilmore, Costill, and Kenney 2008). These results are considered in light of results from the lifestyle sub-study reported in Chapter 7.

If adiposity is decreasing among British Pakistani over generations, the change is quite small. It is possible that differences in adiposity between generations might not be apparent in middle childhood but would be more marked after sexual maturity. Adiposity has consistently been shown to increase with age and the development of obesity in childhood is considered to be most difficult to reverse after puberty (Parsons et al 1999; Wang and Beydoun 2007; Tabacchi et al 2007). The power calculated for this study was limited to detect a medium-size effect (effect size = 0.44), but given the sample comparing generations the effect size was only able to detect a large effect (0.59). If the change in adiposity is smaller than this, the present study may not have sufficient power to detect it. Direct methods of assessing body fatness, such as dual-energy x-ray absorptiometry, are considered ideal, and anthropometry can be considered limited because they indirectly assess body fat (Deurenberg and Reubenoff 2002; Scott 2008). The present study is also limited in this respect being cross-sectional in design, where as a longitudinal study would best be able to observe the life cycle.

5.3 Summary

The prediction made in this chapter was that second generation British Pakistani children would be more adipose than the third generation as measured by anthropometrics. The results from using the UK 1990 cut-offs for overfat by subscapular SFTs show adiposity is lower decrease adiposity from the second generation to the third generation in British Pakistani boys. These results may support previous findings by showing a decrease in adiposity over generations.

CHAPTER 6: PRENATAL GROWTH AND POSTNATAL ADIPOSITY IN BRITISH PAKISTANI AND WHITE BRITISH CHILDREN, AND SECOND AND THIRD GENERATION BRITISH PAKISTANI CHILDREN

South Asians have some of the highest rates of low birth weight globally (WHO 2008), and British South Asians are found to have birth weights lower than the general British population (Margetts et al 2002; Harding, Rosato, and Cruickshank 2004). Intrauterine growth retardation (IUGR) is diminished growth of the foetus *in utero* and is often determined by a low birth weight (LBW) (2.5kg) or a birth weight small-for-gestational-age (SGA) (United Nations Children's Fund and World Health 2008). Diminished foetal growth is associated with small size at birth, including weight, length, decreased fat-free mass, and organ size (Lampl, Kuzawa, and Jeanty 2002; Singhal et al 2003; Padoan et al 2004). Many studies have found an association between lowered birth weight and elevated adiposity in infancy, childhood, and adulthood, which have been reviewed elsewhere (Parsons et al 2001; Rogers and the EURO-BLCS Study Group 2003; Oken and Gillman 2003; Nobili et al 2009). It is thought that the body compensates for small size at birth by accelerating linear and adipose growth, especially during middle childhood, a process know as catch-up growth (Tanner 1978; Hales and Barker 2001). Children in this age range, around 5-11 years, who had lowered birth weights or were SGA tend to show higher levels of adiposity than their peers (Fisch, Bilek, and Ulstrom 1975; Maffeis, et al 1994; Guillaume et al 1995; Duran-Tauleria, Rona, and Chinn 1995; Malina, Katamarzyk, and Beunen 1996; Bavdekar et al 1999; Williams and Poultan 1999; Blake et al 2000; Forsen et al 2000; Okusun et al 2000; Ong et al 2000; Parsons, Power, and Manor 2001; Kuh et al 2002; Yajnik 2002; von Kries et al 2002; Kensara et al 2005; Labayen et al 2006; Rugholm et al 2005; Rogers et al 2006; Massiera, Guesnet, and Aihaud 2006; Karaolis-Dancker, et al 2006; Elia et al 2007; Adair 2008; Mardones, et al 2008; Kain et al 2009).

This chapter reports results from a sub-analysis of foetal growth and adiposity that compares the two main study groupings. The first hypothesis tested is whether foetal growth would be diminished in British Pakistani children compared to white British children. It was predicted that birth weight, a proxy for foetal growth, would be lower in British Pakistani children compared to white British children, and that British Pakistani children would be more likely to have been born LBW and SGA than white British children. The second hypothesis of this chapter is that second generation British Pakistani children would have more diminished foetal growth compared to the third generation. It was predicted that second generation British Pakistani children would have lower mean birth weight than third generation British Pakistani children and that second generation British Pakistani children would be born LBW and SGA more frequently compared to the third generation. The third hypothesis was that diminished foetal growth would be correlated with elevated adiposity and blood pressure in middle childhood, regardless of ethnicity or generation. An inverse relationship was predicted, such that children who had lower birth weights would have larger values for body composition and blood pressure in middle childhood.

6.1 Results

6.1.1 Description of body composition and blood pressure in the sub-sample

The final participants included children for whom birth variables were available. These were 47 second generation British Pakistani, 33 third generation British Pakistani and 104 white British children aged 7-11 years. The exclusion process is described in Table 6.1. Children not included in the sub-sample were those who 1) were not born at James Cook University Hospital, 2) were from school ‘A’, where the Pilot Study was conducted, 3) did not provide individual consent for the birth weight substudy from school ‘B’ (Section 3.1), 4) reported having been born at the hospital of study but no records were found or 5) were twins.

Table 6.1 Exclusion process for the sub-sample of British Pakistani and white British children aged 7-11 years

	n								
	2nd generation British Pakistani			3rd generation British Pakistani			White British		
	Total	M	F	Total	M	F	Total	M	F
Included in main study	81	34	47	51	22	29	211	87	124
Not born at JCUH	4	2	2	2	2	0	7	3	4
Children from school 'A' (no consent requested)	5	3	2	4	3	1	2	1	1
Non response from school 'B'	23	9	14	11	4	7	89	44	45
Born at JCUH records not found	2	0	2	1	0	1	5	2	3
Twins	0	0	0	0	0	0	4	2	2
Final analytic sample	47	20	27	33	13	20	104	32	72

6.1.2 Intrauterine growth retardation (IUGR) findings

Grouping by ethnicity

Mean gestational age for each group was around 39 weeks (Table 6.4), and the two did not differ significantly by t-test (p=0.533). Mean birth weight for British Pakistanis was significantly lower than mean birth weight for white British children by approximately 300g (p<0.001, by t-test). Mothers' BMI did not differ significantly between British Pakistani and white British groups. In general, there were more first born children in the white British group than in the British Pakistani group, a difference which neared significance by chi-squared test (p=0.087).

Results from chi-squared tests comparing the variables of LBW and SGA between British Pakistani and white British girls and boys are summarised in Table 6.4. There were nearly three times as many British Pakistani boys and girls born with weights lower than 2.5kg compared to white British children (p=0.009). Five times as many British Pakistani boys were LBW compared to white British boys (p=0.042), but the expected count was less than five (Section 3.7). Twice as many British Pakistani girls had low birth weights compared to white British girls, but this relationship only neared significance (p=0.081). The majority of children were categorised as 'not SGA'. The proportion of British Pakistanis boys and girls having been born SGA was over two times more than white British children (p=0.001). The prevalence of British Pakistani boys born SGA was 30% while there were no white British boys born SGA (p<0.001); however, the expected count was less than five (Section 3.7). There were no significant differences in proportion of SGA between British Pakistani and white British girls (p=0.152).

Table 6.2 Birth weight data from hospital records on children and mothers including comparison of prevalence of low birth weight (LBW) and small-for-gestational-age (SGA) amongst Pakistani and white British boys and girls

			British Pakistani (n)	White British (n)
Children				
Gestational age (weeks)			39.2±2.6 (80)	39.5±2.4 (104)
Birth weight (kg)**			2.98±0.60 (80)	3.28±0.58 (104)
First born		Yes	21	41
		No	34	36
Low birth weight (LBW)	Boys*	Yes (<2.5 kg)	15.6% (5)	2.4% (1)
		No (2.5-4.5 kg)	84.4% (27)	97.6% (40)
	Girls	Yes (<2.5 kg)	17.0% (8)	6.5% (4)
		No (2.5-4.5 kg)	83.0% (39)	93.5% (58)
	Total*	Yes (<2.5 kg)	16.5% (13)	4.9% (5)
		No (2.5-4.5 kg)	83.5% (66)	95.1% (98)
Small-for-gestational-age (SGA)	Boys**	Yes (≤ 10th percentile)	29.2% (10)	0.0% (0)
		No (>10th percentile)	70.8% (23)	100% (42)
	Girls	Yes (≤ 10th percentile)	24.2% (11)	22.6% (8)
		No (>10th percentile)	71.7% (36)	77.4% (54)
	Total**	Yes (≤ 10th percentile)	31.6% (21)	14.4% (8)
		No (>10th percentile)	68.4% (59)	85.6% (96)
Mothers				
BMI (kg/m^2)			22.2±3.7 (18)	23.6±3.0 (25)
Diabetes		Yes	0	1
		No	78	103
Gestational diabetes		Yes	1	0
		No	79	104

* $p < 0.05$
** $p < 0.001$

Grouping by generation

The differences between groups were not statistically significant for mean raw birth weight (p=0.703) or for mean gestational age (p=0.557 by t-test). Mothers' BMI did not differ significantly between second generation and third generation British Pakistani groups. There were no records of diabetes among mothers and only one record of gestational diabetes. There were more first born children in the third generation group than the second generation British Pakistani group (p=0.032 by chi-squared test).

Chi-squared analysis of LBW and SGA for girls and boys by generation group is summarised in Table 6.3. The majority of birth weights for all children fell into the categories 'average birth weight' and 'not SGA'. There were no significant differences between second generation and third generation British Pakistani boys or girls for low birth weight, nor for boys and girls together (p=0.650; p=0.900; p=0.640, respectively). There were no significant differences between second generation and third generation British Pakistani boys or girls for SGA, nor for boys and girls together (p=0.963; p=0.635; p=0.732, respectively).

Table 6.3 Birth weight data from hospital records on children and mothers including comparison of prevalence of low birth weight (LBW) small-for-gestational-age (SGA) amongst second and third generation British Pakistani children

			Second generation British Pakistani (n)	**Third generation British Pakistani (n)**
Children				
Gestational age (weeks)			39.4±2.5 (47)	39.0±2.4 (33)
Birth weight (kg)			2.96±0.59 (47)	3.01±0.61 (33)
First born *		Yes	8	13
		No	23	11
Low birth weight (LBW)	Boys	Yes (<2.5 kg)	15.0% (3)	16.7% (2)
		No (2.5-4.5 kg)	85.0% (17)	83.3% (10)
	Girls	Yes (<2.5 kg)	14.8% (4)	20.0% (4)
		No (2.5-4.5 kg)	85.2% (23)	80.0% (16)
	Total	Yes (<2.5 kg)	14.9% (7)	18.8% (6)
		No (2.5-4.5 kg)	85.1% (40)	81.3% (26)
Small-for-gestational age (SGA)	Boys	Yes (≤ 10th percentile)	30.0% (6)	30.8% (4)
		No (>10th percentile)	70.0% (14)	69.2% (9)
	Girls	Yes (≤ 10th percentile)	25.9% (7)	20.0% (4)
		No (>10th percentile)	74.1% (20)	80.0% (16)
	Total	Yes (≤ 10th percentile)	27.7% (13)	24.2% (8)
		No (>10th percentile)	72.3% (34)	75.8% (25)
Mothers				
BMI (kg/m^2)			22.0±3.7 (11)	22.5±4.0 (7)
Diabetes		Yes	0	0
		No	46	32
Gestational diabetes		Yes	0	1
		No	47	31

* $p < 0.05$
** $p < 0.001$

6.1.3 Prediction of body composition and blood pressure including birth weight as a prenatal factor

Birth weight was used as a predictor of body composition and blood pressure in middle childhood. Multiple linear regression models were run using SDSs for the following outcome variables: waist circumference, triceps and subscapular skinfold thicknesses (SFTs), and systolic and diastolic blood pressure. Predictor variables that were available from hospital records and that have been shown in previous research to confound, modify or associate with birth weight, later body composition, and blood pressure were considered for analyses (Barker 1994; Fall et al 1998; Ong et al 2000; Yajnik 2000; Margetts et al 2002; Snethen et al 2007). The predictor variables were: birth weight, gestational age, parity, BMI in middle childhood, and maternal factors of BMI, history of type 2 diabetes, history of gestational diabetes, and Occupational Status. Mothers' BMI was not used because data on this variable were not widely collected before 1999, when it became standard for the hospital to gather mothers' BMI at her first hospital visit during her pregnancy. There was only one case of each for maternal diabetes and gestational diabetes, so these variables were not included in analyses. Hierarchical regression analysis showed that the addition of Occupational Status did not improve the model, but birth order did, so birth order was kept in the model and Occupational Status removed. Hence the final predictor variables used in analyses were birth weight, parity, and SDS for BMI in middle childhood (N=132).

Hierarchical regression models were run again using the three established predictor variables. The model was tested for various assumptions as discussed in Section 3.7.2.3 with reference to guidelines outlined by Field (2005). No predictor variables correlated with a Pearson correlation coefficient greater than 0.9 ($r < 0.90$), so it was assumed there was no co-linearity in the model. Residuals of the predictors were plotted and shown to have the same variance, which confirms homoscedasticity. D-W statistics were values between one and three and reveal that the residual terms were uncorrelated. Normal distribution of the residuals was confirmed by the Q-Q plot. There were a few outliers, but they were included because all were less than ±4 standard deviations from the mean.

Results for the univariate model including raw birth weight as a predictor of SDSs for anthropometrics and blood pressure in middle childhood are presented in Table 6.4. There was a weak and positive association between raw birth weight and waist circumference, which neared significance.

Results for the multivariate model including raw birth weight as a predictor of anthropometric variables controlling for covariates are presented in Table 6.5. SDSs for BMI in middle childhood was strongly, positively, and significantly associated with all the outcome variables. Birth weight did not significantly predict any of the outcome variables. The relationship between waist circumference and raw birth weight was positive and weak, and approached significance. Parity significantly predicted SDSs for waist circumference.

Results for the univariate model including SDSs for birth weight as a predictor of anthropometric variables in middle childhood are presented in Table 6.6. The weak and positive association that was found between raw birth weight and waist circumference in Table 6.4 still neared significance after adjustments, slightly strengthened.

Results for the multivariate model including SDSs for birth weight and other established predictor variables are presented in Table 6.7. The relationship between waist circumference and raw birth weight nearing significance was weakened. The statistically significant relationship found between waist circumference and parity was weakened slightly. SDSs for BMI in middle childhood was still strongly, positively and significantly associated with all the outcome variables. When ethnicity was added to the model, birth weight did not significantly predict waist circumference (data not shown).

Table 6.4 Raw birth weight (kg) as a predictor of standard deviation scores (SDSs) for measures of body composition and blood pressure in middle childhood

Dependent Variable	N	β-coefficient	95% CI	p-value
SDS Waist circumference	179	0.137	-0.022, 0.621	0.067
SDS triceps SFT	180	0.103	-0.078, 0.441	0.170
SDS subscap SFT	178	0.084	-0.109, 0.393	0.266
Systolic BP (mmHg)	180	-0.003	-2.892, 2.767	0.965
Diastolic BP (mmHg)	180	0.012	-2.070, 2.453	0.868

Units used before standardised were in meters for height, kilograms/meters^2 for BMI, centimetres for waist circumference, and millimetres for skinfold thicknesses.

Table 6.5 Predictors of raw birth weight (kg) in a multivariable model

Dependent variable	Independent variable	N	β-coefficient	95% CI	p-value
SDS WC	Raw birth weight (kg)	128	0.066	-0.018, 0.331	0.079
	Birth order	128	-0.098	-0.440, -0.062	0.010
	SDS BMI child	128	0.902	0.802, 0.946	0.000
SDS triceps SFT	Raw birth weight (kg)	130	-0.018	-0.198, 0.133	0.696
	Birth order	130	-0.026	-0.251, 0.140	0.576
	SDS BMI child	130	0.857	0.612, 0.767	0.000
SDS subscap SFT	Raw birth weight (kg)	128	-0.030	-0.205, 0.725	0.500
	Birth order	128	0.011	-0.156, 0.200	0.808
	SDS BMI child	128	0.877	0.608, 0.742	0.000
Systolic BP (mmHg)	Raw birth weight (kg)	131	-0.106	-4.994, 0.974	0.185
	Birth order	131	0.015	-3.193,3.848	0.854
	SDS BMI child	131	0.460	2.566, 5.242	0.000
Diastolic BP (mmHg)	Raw birth weight (kg)	131	-0.079	-3.892, 1.370	0.345
	Birth order	131	0.043	-2.285, 3.923	0.603
	SDS BMI child	131	0.375	1.514, 3.923	0.000

Model p<0.000; Birth order is dichotomised as either first born or not first born.

Units used before standardised were in meters for height, kilograms/meters^2 for BMI, centimetres for waist circumference, and millimetres for skinfold thicknesses.

Table 6.6 Standard deviation scores (SDSs) for birth weight as a predictor of measures of body composition and blood pressure in middle childhood

Dependent Variable	N	β-coefficient	95% CI	p-value
SDS WC	179	0.143	-.0005, 0.374	0.056
SDS triceps SFT	180	0.079	-0.75, 0.248	0.291
SDS subscap SFT	178	0.014	-0.143, 0.172	0.853
Systolic BP (mmHg)	180	0.056	-1.078, 2.386	0.457
Diastolic BP (mmHg)	180	0.059	-0.831, 1.938	0.431

Units used before standardised were in meters for height, kilograms/meters^2 for BMI, centimetres for waist circumference, and millimetres for skinfold thicknesses.

Table 6.7 Predictors of standard deviation scores (SDSs) for birth weight in a multivariable model

Dependent variable	Independent variable	N	β-coefficient	95% CI	p-value
SDS WC	SDS birth weight	128	0.063	-0.012, 0.142	0.097
	Birth order	128	-0.099	-0.442, -0.063	0.009
	SDS BMI child	128	.903	0.802, 0.947	0.000
SDS triceps SFT	SDS birth weight	130	-0.031	-0.095, 0.047	0.509
	Birth order	130	-0.026	-0.250, 0.141	0.582
	SDS BMI child	130	0.859	0.614, 0.762	0.000
SDS subscapular SFT	SDS birth weight	128	-0.044	-0.099, 0.033	0.322
	Birth order	128	0.011	-0.154, 0.201	0.794
	SDS BMI child	128	0.879	0.609, 0.744	0.000
Systolic BP (mmHg)	SDS birth weight	131	-0.100	-2.105, 0.472	0.212
	Birth order	131	0.015	-3.180, 3.867	0.847
	SDS BMI child	131	0.460	2.561, 5.241	0.000
Diastolic BP (mmHg)	SDS birth weight	131	-0.070	-1.617, 0.655	0.404
	Birth order	131	0.043	-2.280, 3.933	0.600
	SDS BMI child	131	0.374	1.507, 3.870	0.000

Model p<0.000; Birth order is dichotomised as either first born or not first born.

Units used before standardised were in meters for height, kilograms/meters^2 for BMI, centimetres for waist circumference, and millimetres for skinfold thicknesses.

6.2 Discussion of the Results

The following discussion section considers the results and the three predictions of this chapter: 1) British Pakistani children would have lower mean birth weight, and be more likely to be low birth weight (LBW) and small-for-gestational age (SGA) compared to white British children; 2) second generation British Pakistani children would have lower measurements for birth weight, and be born with LBWs and SGA compared to third generation British Pakistani children; and 3) diminished foetal growth would be associated with elevated adiposity and blood pressure in middle childhood, regardless of ethnicity or generation.

Section 4.2.1 refers to the potential bias in anthropometrics in terms of participation of overweight or obese individuals or families because participation in the present study based on an 'opt-in' method. This issue is discussed in detail in Chapter 8. This bias may apply to the use variable BMI used in the present chapter. The target sample size of twelve for each group for 80% power was determined by conducting power calculations using data from a national reference population for birth weight and the software programme Gpower (Section 3.4.4) The sample size for British Pakistani (n=80) and white British (n=104), and for second generation (n=47) and third generation (n=33) British Pakistani children did reach this target, so it can be assumed that there was significant power in the analyses.

6.2.1 Intrauterine growth retardation (IUGR) findings

Grouping by ethnicity

British Pakistani babies were 300g smaller than white British babies on average. There were more first born children in the white British group than in the British Pakistani group. The Margetts et al (2002) study demonstrates that that British South Asian babies, regardless of their generation, had birth weights lower than the national UK average, despite controlling for variables known to be associated with birth weight, such as age, height and weight of the mother. Harding, Rosato, and Cruickshank (2004) found a similar trend in British Pakistanis compared to white Britons.

In the present study there were twice as many British Pakistani children born SGA as white British children. This observation was independent of gestational duration, so it is probable that retarded foetal growth was present in the British Pakistani babies. Hediger et al (1998) found that infants born SGA were more likely to be fatter than those who were born average-for-gestational age. There were 15 times more British Pakistani boys than white British boys born SGA. Linear and adipose tissue growth alternates over the course of childhood, a process sometimes referred to as 'stretching' (i.e. linear) and 'filling' (i.e. adiposity) (Tanner 1981). Referring to studies on catch-up growth, Lampl, Thompson, and Frongillo (2005) found evidence that weight gain acts as a signal for linear growth, during which time the mode of storing adipose is switched to utilising adipose as energy for growth. In their study of healthy infants, Lampl, Thompson, and Frongillo (2005) observed that abdominal-to-suprailiac SFTs best predicted a growth spurt in linear growth. Considering observations that male infants have higher growth rates, and a subsequent heightened demand from fat stores (Malina, Koziel, and Bielcki 1999; Guihard-Costa et al 2002), it is possible that in males who experienced intrauterine growth retardation may be at a higher risk for adiposity later in life than females.

Grouping by generation

There were no significant differences between second generation and third generation British Pakistani children for raw birth weight or proportion of SGA. The Margetts et al (2002) study of British South Asians demonstrates that babies born to first generation and second generation mothers showed no significant differences in birth weights. The current study did not have sufficient maternal variables to use as covariates to assess whether the findings were confounded by them.

6.2.2 Findings for prediction of body composition and blood pressure including birth weight as a prenatal factor

The current model found that birth weight did not predict any anthropometric variables for adiposity and blood pressure while controlling for parity and SDSs for BMI in middle childhood. The association with systolic blood pressure neared significance using raw birth weight, but not after using SDSs for birth weight, which adjusted for gestational age and sex. This suggests that the effect of BMI in middle childhood may explain the potential effect of birth weight on systolic blood pressure. The positive association between SDSs for birth weight and SDSs for waist circumference is very weak and neared significance so is interpreted with caution. This would suggest that low birth weight predicts small waist circumferences; however models that can include maternal factors, such as BMI and age, will be better able to explore this potential relationship.

The present model tested for an association between prenatal growth, i.e. birth weight, with adiposity in middle childhood. The model did not include a variable for rapid weight gain between birth and middle childhood, which would have allowed an assessment for catch-up growth, because data for weight in infancy were not available in this sample (Barker 1994; Ong et al 2000; Parsons et al 2001). Post-natal growth of adiposity is thought to be as influential a predictor of later adiposity as pre-natal growth (Lucas et al 1991). The current models did not include any maternal predictor variables, such as BMI in middle childhood, age at pregnancy, and history of smoking, which would improve the model, because these factors are shown to influence birth weight and confound effects of birth weight on later adiposity (Barker 1994; Ong et al 2000; Snethen et al 2007). Chapter 5 reports that British Pakistani mothers attained 2 years less education than white British mothers, and poorer health, as demonstrated by a higher prevalence of heart disease, which may indicate here a need for health education in British Pakistani mothers.

6.3 Summary

This chapter tested three predictions on the topic of birth weight. The results support the first prediction that birth weight, as a proxy for foetal growth, would be lower in British Pakistani children compared to white British children, and that British Pakistani children would be more likely to be LBW and SGA than white British children. There was no support found for the second prediction, which expected that the same three birth weight values would be smaller in second generation British Pakistanis compared to the third generation. The model predicting adiposity from birth weight found waist circumference was very weakly predicted by birth weight.

CHAPTER 7: LIFESTYLE IN BRITISH PAKISTANI AND WHITE BRITISH CHILDREN, AND SECOND AND THIRD GENERATION BRITISH PAKISTANI CHILDREN

British children are found to eat high amounts of obesogenic foods, such as added-sugar drinks and high fat savoury snacks, and also demonstrate inadequate levels of physical activity (Harnack et al 1999; Hill 2002; Department of Health 2005; Sport England 2008). Some aspects of British South Asian diets may be cardioprotective (i.e. protect against CVD), including high amounts of polyunsaturated fats; however they can also be in part atherogenic (i.e. contribute to CVD), including high amounts of saturated fats (Anderson et al 2005). Lean et al (2001) found that self-reported levels of physical activity in British born South Asian women were reportedly higher than those of migrant South Asian women. A systematic literature review of twelve studies on children and adults found British South Asians, including British Pakistani adults, engaged in lower amounts of physical activity compared to white Britons (Fischbacher et al 2004). The review reports that such studies used semi-quantitative methods that were not validated for assessing physical activity (Section 2.2). Generational changes in diet and physical activity have been found in women migrating from South Asia to the UK (Anderson and Lean 1995; Anderson et al 2005) and to Norway (Mellin-Olsen and Wandel 2005) suggesting further research into generational patterning in migrant groups.

This chapter reports results from the lifestyle pilot sub-study that assessed food intake, physical activity and perceptions of healthy lifestyle in British Pakistani and white British children. There are no predictions made in this chapter. Based on the first and second hypotheses of this study, a mismatch between a thrifty phenotype and Western lifestyle, including over-nutrition and relatively low physical activity, should result in an increase in adiposity above the general population (Section 1.5). This chapter explores lifestyle practices of British Pakistani families, how they compared to those of white British families, and possible generational changes. Dietary data were coded as types and frequency of food consumed. Quantitative data for physical activity were expressed as activity counts per unit of time. Semi-quantitative data for physical activity were expressed as minutes of time spent in each category of physical and non-physical activities, and moderate-to-vigorous physical activity (MVPA). Four focus groups explored children's knowledge of obesity, related health issues, and healthy lifestyle practices. A parent questionnaire was developed for the present study to investigate parent's knowledge of obesity and related health issues, as well as their own healthy lifestyle practices.

A total of 31 children aged 9-11 years participated in the diet and physical activity sub-study. In total, there were 18 white British and 13 British Pakistani children, of whom eight were second generation and five were third generation. The desired minimum sample size was 30 children per group. The nonparametric independent t-tests Mann-Whitney, Kruskal-Wallis, and Kolmogorov-Smirnov Z tests were conducted. Medians, interquartiles and p-values for exact significance are presented. Results from these smaller sample sizes are treated cautiously. As well, a limited number of comparisons were conducted between second generation and third generation British Pakistani children for accelerometry and recall interview data.

7.1 Results

7.1.2 Food intake

Grouping by ethnicity

Results for comparison of food frequency (portion per day) by nonparametric t-tests between British Pakistani and white British children are summarised in Tables 7.1. One white British boy declined to participate in the recall interviews, leaving the food intake sample size with 13 British Pakistani and 17 white British children. Table 7.1a compares the medians and interquartiles of portions consumed per day between groups on weekdays and weekends combined, which is an average of Sunday and the mean of Monday and Tuesday data (Section 3.7.3). Portions of food were reported as either whole or half sizes.

British Pakistani children ate more portions of curry meals than white British children. Results from the Kolmogorov-Smirnov Z tests, which have more power with sample sizes under 25, show the difference between frequencies of curry meals nearing significance, where $p=0.051$. No other results were statistically significant in comparisons using weekday and weekend data combined.

Table 7.1b compares food frequency during the weekday, which is an average of Monday and Tuesday data. It indicates that British Pakistani children drank more portions of sugary drinks per day than white British children, with results nearing significance; however, Kolmogorov-Smirnov Z tests of 2-tailed exact significance show no significant relationship (p=0.154). Similarly, British Pakistani children were shown to eat fewer portions per day than white British children, with results nearing significance; but, Kolmogorov-Smirnov Z tests of 2-tailed exact significance show no significant relationship (p=0.239). Results for the frequency of curries eaten also neared statistical significance in comparisons (p=0.056, Kolmogorov-Smirnov Z tests) using weekday data, indicating British Pakistani children ate more.

Table 7.1c shows the British Pakistani and white British children as having the same median for the frequency of whole grains eaten on a weekend. Results just neared significance by Mann-Whitney test of significance, and significant by Kolmogorov-Smirnov Z (p=0.033). Results neared significance showing that white British children ate twice as many portions of vegetables than British Pakistani children on weekends, but not by Kolmogorov-Smirnov Z (p=0.135).

Grouping by generation

Results for comparison of food frequency between second and third generation British Pakistani children are summarised in Tables 7.2. There were no statistically significant differences between generations on weekdays and weekends (Table 7.2a), weekdays (Table 7.4b) or weekends (Table 7.2c).

Table 7.1a Comparison of food frequency (portion/day) between British Pakistani and white British children on weekdays and weekends combined

Portion/day	British Pakistani (n=13)		White British (n=17)		Exact sig (2-tailed)
	Median	Interquartile	Median	Interquartile	
Fruit	1.25	1.00-2.50	1.75	1.25-2.25	0.411
Vegetables	1.00	0.63-1.50	1.25	0.88-1.63	0.175
Whole grains	0.75	0.50-1.88	0.75	0.00-1.13	0.143
Sweets	1.75	0.88-2.38	2.00	1.00-3.00	0.702
Savoury snacks	0.25	0.00-0.50	0.25	0.00-0.50	0.555
Sugary drinks	0.50	0.00-1.00	0.00	0.00-0.63	0.182
Fried foods	0.50	0.00-0.75	0.50	0.13-0.50	0.692
Pizza	0.25	0.00-0.25	0.25	0.00-0.38	1.000
Curry	0.50	0.13-0.75	0.00	0.00-0.50	**0.029**

Table 7.1b Comparison of food frequency (portion/day) between British Pakistani and white British children on weekdays

Portion/day	British Pakistani (n=13)		White British (n=17)		Exact Sig (2-tailed)
	median	interquartile	median	interquartile	
Fruit	1.00	0.75,2.00	2.00	1.25, 3.00	**0.089**
Vegetables	2.00	0.50,2.00	1.50	1.00, 2.00	0.779
Whole grains	1.00	0.50, 1.25	0.50	0.00, 1.50	0.269
Sweets	1.50	1.50, 2.75	2.00	1.75, 3.25	0.350
Savoury snacks	0.50	0.00, 0.50	0.50	0.00, 1.00	0.620
Sugary drinks	0.50	0.00, 1.00	0.00	0.00, 0.50	**0.079**
Fried foods	0.00	0.00, 1.25	0.50	0.00, 1.00	0.859
Pizza	0.50	0.00, 0.50	0.50	0.00, 0.50	0.821
Curry	0.50	0.00, 0.50	0.00	0.00, 0.00	**0.056**

Table 7.1c Comparison of food frequency (portion/day) between British Pakistani and white British children on weekends

Portion/day	British Pakistani (n=13)		White British (n=17)		Exact Sig (2-tailed)
	median	interquartile	median	interquartile	
Fruit	2.00	1.00,2.50	1.00	0.50, 2.00	0.382
Vegetables	0.00	0.00,1.00	1.00	0.00,2.50	**0.061**
Whole grains	1.00	0.00, 2.00	1.00	0.00, 1.00	**0.074**
Sweets	2.00	1.00,2.00	1.00	1.00, 2.50	0.826
Savoury snacks	0.00	0.00, 0.50	0.00	0.00,0.50	1.00
Sugary drinks	0.00	0.00, 1.00	0.00	0.00, 1.00	0.448
Fried foods	0.00	0.00, 1.00	0.00	0.00, 0.50	0.608
Pizza	0.00	0.00, 0.00	0.00	0.00, 0.00	0.806
Curry	0.00	0.00,1.00	0.00	0.00, 0.50	0.132

Table 7.2a Comparison of food frequency (portion/day) between second and third generation British Pakistani children on weekdays and weekends combined

Portion/day	Second generation British Pakistani (n=8)		Third generation British Pakistani (n=5)		Exact Sig (2-tailed)
	median	interquartile	median	interquartile	
Fruit	1.25	0.625, 3.16	1.25	1.00, 2.50	0.961
Vegetables	0.875	0.75, 1.44	1.00	0.13, 1.75	0.977
Whole grains	0.875	0.31, 1.69	0.75	0.50, 2.88	0.544
Sweets	2.00	1.06, 3.25	1.50	0.75, 2.00	0.266
Savoury snacks	0.125	0.00, 0.63	0.25	0.00, 1.00	0.814
Sugary drinks	0.250	0.00, 0.75	0.75	0.38, 1.50	0.146
Fried foods	0.50	0.13, 0.69	0.50	0.00, 0.88	0.999
Pizza	0.25	0.06, 0.63	0.00	0.00, 0.25	0.246
Curry	0.375	0.63, 0.69	0.50	0.13, 0.75	0.783

Table 7.2b Comparison of food frequency (portion/day) between second and third generation British Pakistani children on weekdays

Portion/day	Second generation British Pakistani (n=8)		Third generation British Pakistani (n=5)		Exact Sig (2-tailed)
	median	Inter-quart	median	Inter-quart	
Fruit	1.25	0.63, 3.50	1.00	0.75, 2.00	0.872
Vegetables	1.75	0.63, 2.38	2.00	0.25, 2.00	0.618
Whole grains	0.75	0.13, 1.38	1.00	0.75, 1.75	0.381
Sweets	1.75	1.50, 3.75	1.50	1.00, 2.25	0.506
Savoury snacks	0.25	0.00, 0.50	0.50	0.00, 0.50	1.00
Sugary drinks	0.25	0.00, 0.88	0.50	0.50, 1.25	0.224
Fried foods	0.50	0.00, 1.38	0.00	0.00, 1.25	0.902
Pizza	0.50	0.00, 0.50	0.00	0.00, 0.50	0.592
Curry	0.25	0.00, 0.50	0.50	0.00, 0.50	0.587

Table 7.2c Comparison of food frequency (portion/day) between second and third generation British Pakistani children on weekends

Portion/day	Second generation British Pakistani (n=8)		Third generation British Pakistani (n=5)		Exact Sig (2-tailed)
	Median	Interquartile	Median	interquartile	
Fruit	1.50	1.00, 2.75	2.00	1.00, 3.00	0.720
Vegetables	0.00	0.00, 1.00	0.00	0.00, 1.50	0.739
Whole grains	1.00	0.25, 2.00	1.00	0.00, 4.00	0.800
Sweets	2.00	1.00, 2.75	1.00	0.50, 2.00	0.389
Savoury snacks	0.00	0.00, 0.75	0.00	0.00, 1.50	1.00
Sugary drinks	0.00	0.00, 1.00	1.00	0.00, 2.00	0.429
Fried foods	0.00	0.00, 1.00	0.00	0.00, 1.00	1.00
Pizza	0.00	0.00, 0.75	0.00	0.00, 0.00	0.487
Curry	0.50	0.00, 1.00	1.00	0.00, 1.00	1.00

7.1.3 Physical activity

7.1.3.1 Accelerometry

There was total of 30 children who wore the accelerometers, including 13 British Pakistani and 17 white British children. One child declined to wear the accelerometer but participated in the recall interviews. Another child's data from the monitor were corrupted and would not upload into the software programme. This is an unfortunate although occasional outcome from using accelerometers, and the Actigraph has a higher reported frequency of doing so

(Trost et al 2005). For two of the children, data were not successfully captured for more than 3 hours of data for all three days, so these participants' data were not included in any of the analyses (Section 3.7.3). The final sample was 27 children, with 13 British Pakistani and 14 white British children. A few children had sufficient data for some days but on other days there was less than 3 hours of data. These data were not included in the combined weekday and weekend analyses but were kept for the individual weekday and weekend analyses, as appropriate.

Grouping by ethnicity

Table 7.3 summarises differences by nonparametric t-test between British Pakistani and white British children in counts per hour (cph) for weekday and weekend data combined, for weekdays, and for weekends. The median hours of valid data show the accelerometers captured a reasonably high number of hours in each day for all children (Reilly et al 1999; Penpraze et al 2006). Comparing boys and girls in total and boys separately, there were no statistically significant differences between British Pakistani and white British children in physical activity levels for any analysis. British Pakistani girls showed significantly lower levels of physical activity than white British girls throughout the week. Kolmogorov-Smirnov p-values were significant for weekends (p=0.038) and neared significance on weekdays (0.091) and weekdays combined (0.091).

Figure 7.1 represents physical activity levels by accelerometry (counts per hour) for all British Pakistani and white British children during weekdays and weekends over the course of the day. There appeared very little difference in physical activity patterning between ethnicities on weekdays, with white British Pakistani children slightly more active during lunch time and after school. At the weekend, white British children showed a dramatic peak in physical activity mid-day compared to the more consistent levels demonstrated by British Pakistani children. White British children took up the majority of their exercise midday and then gradually became less active in the evening. British Pakistani children showed the highest levels of physical activity overall in the evening hours compared to the other children.

Table 7.4 illustrates differences in parent reported bed times between 9-11 year old British Pakistani and white British children collected from schools 'D' and 'E'. Sleep data were not collected at school 'B', so the sample size for children with sleep data and accelerometry data from schools 'D' and 'E' is 14. Thus, the results presented in Table 7.4 suggest probable median bedtimes amongst the diet and physical activity sub-sample. British Pakistani children were reported to be awake significantly later in the evenings than white British children, during weekdays and weekends combined, weekdays, and weekends. British Pakistani boys had later bed times than white British boys, and British Pakistani girls had later reported bed times than white British girls on all days of the week studied. Kolmogorov-Smirnov Z test of significance do not show a change in the level of significance in the relationships of all models. These results support the trend observed in Figure 7.1, with British Pakistani children more active in the later hours.

Grouping by generation

Table 7.5 shows there were no significant differences between second and third generation British Pakistani children in accelerometry counts.

Table 7.3 Comparison of physical activity by accelerometry (counts/hour) between British Pakistani and white British children on weekdays and weekends

		British Pakistani			White British			Exact Sig (2-tailed)
		Valid data (hrs/day) (n)	Counts/hr		Valid data (hrs/day) (n)	Counts/hr		
			Median	Inter-quart		Median	Inter-quart	
Weekdays and weekends	Total	11.1 (11)	26,719	20,005; 30,000	11.9 (12)	34,167	25,557; 41,400	0.118
	Boys	10.7 (5)	27,436	26,158; 52,265	11.0 (5)	35,634	23,915; 42,686	0.841
	Girls	11.4 (6)	20,734	18,239; 27,557	12.8 (7)	29,008	24,483; 41,936	**0.035**
Weekday	Total	13.5 (11)	25,080	19,868; 30,637	11.1 (11)	33,708	22,629, 43,676	0.134
	Boys	13.4 (5)	25,540	23,352, 67,338	9.85 (5)	33,281	17,004; 43197	1.00
	Girls	13.6 (6)	19,802	17,615; 29,254	12.4 (7)	34,135	27,656; 45,102	**0.035**
Weekend day	Total	8.6 (11)	25,140	21,667; 32,749	12.8 (11)	31,361	23,173; 37,504	0.376
	Boys	8.05 (5)	32,619	24,847; 41,506	12.2 (5)	28,860	21,009; 35,531	0.639
	Girls	9.16 (6)	23,109	18,506; 25,859	13.3 (7)	34,480	21,310; 40,672	0.138

Figure 7.1 Temporal patterning (hours/day) by accelerometry (counts/hour) comparing British Pakistani and white British children for weekdays and weekends

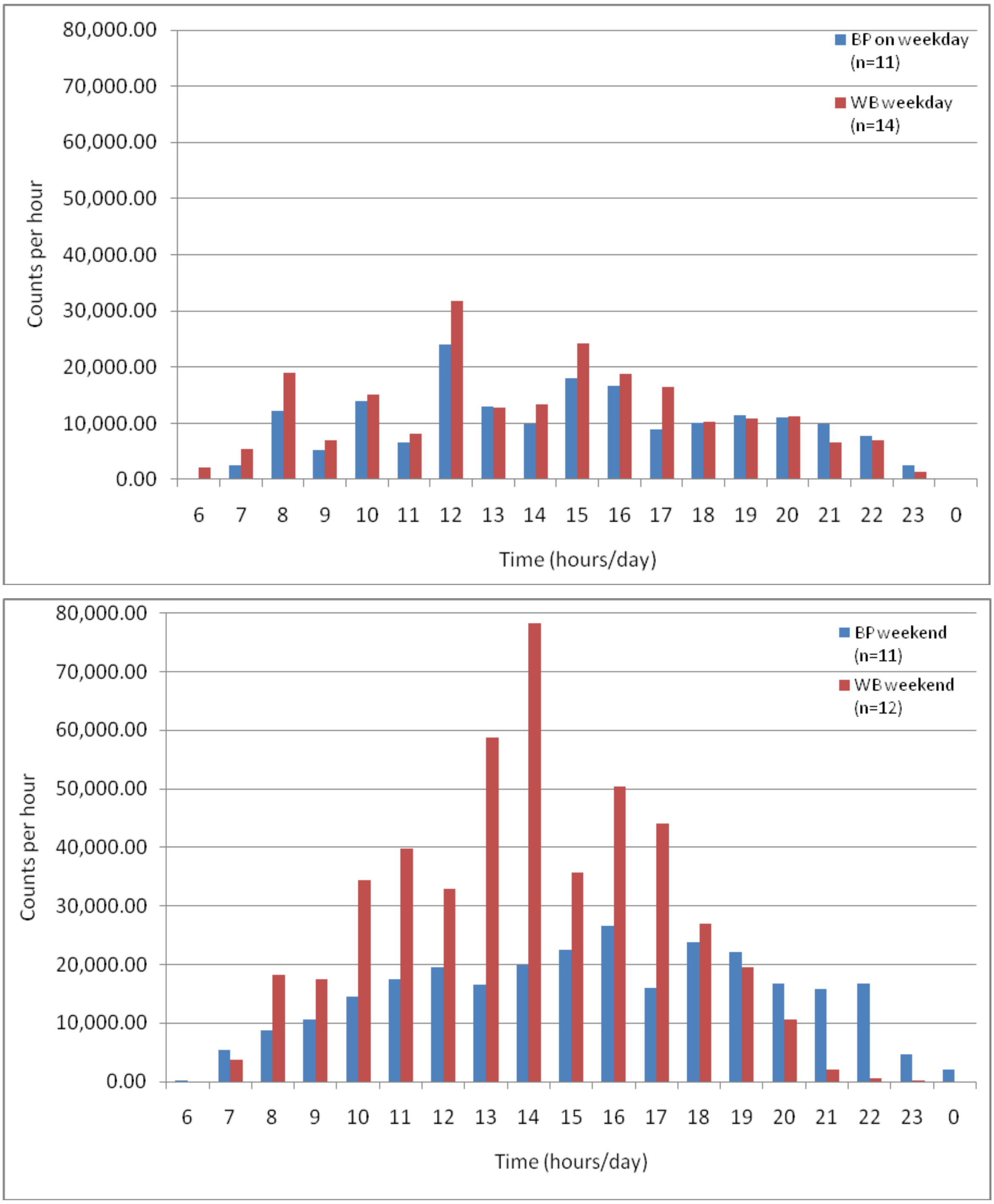


Table 7.4 Parent-reported bed times for 9-11 year old British Pakistani and white British boys and girls at schools 'D' and 'E'

	British Pakistani (n)			White British (n)			Exact Sig (2-tailed)
	Median (hour)	Inter-quart	n	Median (hour)	Inter-quart	n	
Weekday and weekend days combined bed time							
Boys and girls	22:00	21:18, 22:15	28	20:52	20:30, 21:28	36	**<0.000**
Boys	22:00	21:15, 22:18	14	20:37	20:18, 21:30	16	**0.001**
Girls	21:52	21:22, 22:18	14	20:52	20:30, 21:16	20	**0.004**
Weekday bed time							
Boys and girls	21:30	21:00, 22:00	28	20:30	20:00, 21:00	36	**<0.000**
Boys	21:30	20:52, 22:00	14	20:22	20:00, 21:00	16	**0.001**
Girls	21:30	20:52, 22:00	14	20:30	20:00, 21:00	20	**0.005**
Weekend bed time							
Boys and girls	22:00	21:45, 22:52	28	21:00	21:00, 21:45	36	**<0.000**
Boys	22:00	21:45, 23:00	14	21:00	20:45, 22:00	16	**0.003**
Girls	22:15	21:41, 22:37	14	21:00	21:00, 21:30	20	**0.003**

Table 7.5 Comparison of physical activity by accelerometry (counts/hour) between second and third generation British Pakistani children on weekdays and weekends

	Second generation British Pakistani				Third generation British Pakistani				Exact Sig (2-tailed)
	Valid data (hrs)	Median (counts /hour)	Inter-quart	n	Valid data (hrs)	Median (counts /hour)	Inter-quart	n	
Weekdays and weekend	10.7	27077	18239, 39667	8	11.6	25194	20734, 31597	5	0.93
Weekday	13.0	26688	17615, 50103	6	12.2	21626	19802, 28089	5	0.792
Weekend day	9.2	26578	17885, 32107	8	11.0	24847	21667, 37063	5	1.00

7.1.3.2 Child-reported physical activity

There were a total of 30 children who participated in the both the diet and physical activity recall interviews, which comprised of 13 British Pakistani and 17 white British children. One white British girl who wore an accelerometer did not attend school during the time of recall interviews and her data was not collected.

A comparison of child-reported estimates of time spent in activity types between British Pakistani and white British children is summarised in Table 7.6. There were no differences in this analysis that were statistically significant. White British children, especially boys, reported after school activities such as walking, football, and chase games, while British Pakistani children often attended mosque after school (data not shown). During and after school, boys reported playing a lot of cricket and football, while girls frequently engaged in games like chase and skipping rope (data not shown). British Pakistani girls seemed to report a lot of socialising, often stopping intermittently to talk during physical activities, visiting friends and relatives and doing chores at home (data not shown).

Differences between groups for self-reported minutes spent in moderate-to-vigorous physical activity (MVPA) were analysed. Table 7.7 shows that there were no statistically significant differences in minutes reported as spent in MVPA between British Pakistani and white British children.

Grouping by generation

A comparison of child-reported time spent in activity between second and third generation British Pakistani children is given in Table 7.8. There were no relationships in this analysis that were statistically significant.

Table 7.9 shows that there were no significant differences between second and third generation British Pakistani children for minutes spent in MVPA.

Table 7.6 Comparison of child-reported type of activity (minutes/average day) between British Pakistani and white British boys and girls

Activity (min/day)	British Pakistani			White British			Exact Sig (2-tailed)
	median	Inter-quart	n	median	Inter-quart	n	
Physical activity							
Boys and girls	26.563	18.878, 45.208	13	38.685	26.484, 62.104	17	0.213
Boys	36.688	26.042, 48.550	7	46.271	31.820, 70.527	8	0.189
Girls	18.878	10.859, 38.438	6	27.500	14.375, 47.446	9	0.456
TV / computer use							
Boys and girls	20.00	9.38, 29.21	13	21.46	8.75, 50.00	17	0.718
Boys	26.25	-0.56, 30.00	7	35.10	20.94, 64.38	8	0.281
Girls	16.88	6.56, 28.81	6	12.50	1.88, 21.98	9	0.665
Leisure							
Boys and girls	27.50	27.50, 45.00	13	0.00	0.00, 41.25	17	0.309
Boys	4.38	0.00, 27.50	7	0.00	0.00, 0.00	8	0.232
Girls	45.00	22.50, 63.75	6	3.75	0.00, 67.50	9	0.535

Table 7.7 Comparison of child-reported moderate-to-vigorous-physical activity (MVPA) minutes between British Pakistani and white British children on weekdays and weekends

	British Pakistani			White British			Exact Sig (2-tailed)
	Median (mins)	Inter-quart	n	Median (mins)	Inter-quart	n	
Weekday and weekend							
Boys and girls	31.8	5.6, 47.5	13	34.3	12.2, 52.4	17	0.733
Boys	46.9	31.8, 53.1	7	38.1	8.0, 101.3	8	0.955
Girls	6.9	4.8, 25.3	6	18.8	12.2, 45.2	9	0.191
Weekday	12.5	7.50, 46.67	13	24.2	10.6, 42.4	17	0.541
Weekend	20.0	0.00, 50.00	13	35.0	0.00, 50.0	17	0.608

Table 7.8 Comparison of child-reported type of activity (minutes/average day) between second and third generation British Pakistani children

Activity (min/day)	Second generation British Pakistanis			Third generation British Pakistanis			Exact Sig (2-tailed)
	Median	Inter-quart	n	Median	Inter-quart	n	
Physical activity	26.302	21.296, 42.813	8	36.688,	14.427, 49.567	5	0.622
TV / computer use	23.58	9.06, 30.00	8	20.00	7.50, 26.79	5	0.544
Leisure and religious	2.19	0.00, 52.50	8	30.00	21.25, 45.00	5	0.280

Table 7.9 Comparison of child-reported moderate-to-vigorous physical activity (MVPA) minutes between second and third generation British Pakistani children on weekdays and weekends

	Second generation			Third generation			Exact Sig (2-tailed)
	Median	Inter-quart	n	Median	Inter-quart	n	
Weekday and weekend	28.333	4.813, 47.344	8	31.750	6.250, 60.938	5	0.724
Weekday	13.13	13.13, 34.38	8	10.00	3.75, 60.63	5	0.915
Weekend	25.00	0.00, 55.00	8	7.50	3.00, 90.00	5	1.000

7.1.4 Focus groups

Four focus groups comprised of year five and six children at school ‘E’, the last school visited. The four focus groups included: two white British girls; seven British Pakistani girls; three white British boys; and eight British Pakistani boys. The interview questions were developed based on exit interviews (n=5) (Appendix J). Data from the interviews were analysed for emergent themes based on children’s responses to the questions (Section 3.7.4.2). Results are presented according to the underlying questions of the study.

Did participants enjoy wearing the monitors and the recall interviews?

Many of the children in all focus groups said they felt ‘weird’ or ‘silly’ wearing the activity monitors. Two British Pakistani girls reported that they wore their monitors under their clothing at mosque because they were not sure if it would be allowed. These same children also claimed the monitors were uncomfortable at first, until they returned with them to school and were reminded how to properly wear them. A white British girl reported that recalling diet was ‘weird’, and she also found it difficult to remember what foods she ate.

Did participants’ friends and family support the study?

In general it seemed British Pakistani families were more interested and willing to provide support than white British families. For example, many British Pakistani children reported their parents would remind children to wear or remove their monitors while at home. White

British children in general reported that parents expressed interest in the study, but were relatively less involved. One white British boy reported that his family did not mention the monitor he wore, which was over the course of six days.

All of the participants' friends took a strong interest in the monitors the children wore; however their opinions about the study were polarised. The participants' friends either thought the monitors were 'stupid' and 'weird', or they were 'interested' and 'jealous' of the participating child. It is possible that some of the participants' friends felt jealous, and as a result, criticised the study. This finding might coincide with the participants' sentiments that it felt 'weird' to wear the monitors; perhaps participants felt more self-conscious than a physical discomfort.

What are participants' healthy eating practices?

All of the children had heard of and understood the Department of Health's 'Five-a-day' programme recommending at least five portions of fruit and vegetables per day (Department of Health 2007). When asked whether children liked fruits and vegetables, most children said they did not. Three children reported they liked to eat fruits but not vegetables and only two children reported that they liked vegetables. One child said she did not eat fruit because she did not have 'enough time' and did not like having to prepare fruit. Not all children were clear about what constitutes five portions in a day. For example, one British Pakistani boy claimed he satisfied eating his 'five-a-day' by consuming only fruit juice; however, only one portion of fruit juice can count towards one portion of fruit because of its high sugar and low fibre content (Department of Health 2007).

Most children reported that their food intake was monitored by their parents, including buying snacks or accessing food in the house. Only one child, a British Pakistani boy, reported buying snacks with pocket money, saying, 'everyday I buy chocolate after school'.

Are participants involved in organised physical activity outside of school? If no, would they like to be? What other activities might they do that were not physical?

All children reported some form of physical activity outside of school time. White British boys reported a high involvement in after-school activities such as sport or unstructured active play outside. British Pakistani boys enjoyed playing cricket or football, but reported a lower level of involvement than desired in such activities because attendance at mosque took up a lot of their extra time after school.

Both white British and British Pakistani girls reported some participation in outside activities with some desire to be more a part of an organised physical activity. One white British girl reported she had to quit her dance lessons due to the high cost. Both white British girls expressed a wish that there were more opportunities to engage in physical activities outside of school, namely in the summertime and for such activities to be more affordable.

British Pakistani girls unanimously reported that they tended to avoid physical activity in groups for fear of being ‘picked on’. A positive example they gave of overcoming this challenge was group participation in dance, football, and field events at the Middlesbrough Mela. This event gave the girls the opportunity to practice together daily for the event in a group with which they felt comfortable.

What do participants know about obesity and related illnesses?

The British Pakistani children clearly showed a better understanding of diabetes and heart disease than the white British children. Many of the British Pakistani children reported having family members who had diabetes or heart disease and demonstrated knowledge of the symptoms of diseases superior to that of the white British children. For example, British Pakistani children immediately recognised the association of sugar with diabetes. In fact, British Pakistanis sometimes use the term ‘sugar’ synonymously with ‘diabetes’. The groups of British Pakistani children could associate obesity-related illnesses with a list of factors, including dietary fat, exercise and smoking. One British Pakistani boy even knew a consequence of diabetes was getting ‘cuts to the hands’, which after clarification, meant amputation. One white British boy had a father with heart disease and he drew upon his knowledge from that. Comparatively, the white British children took a longer time to answer the questions and responded with less information.

Has the study itself influenced knowledge and food practices of participants?

Most of the children volunteered some sort of behavioural change since participating in the study. Two British Pakistani girls and one British Pakistani boy said they wanted to eat more vegetables, one of whom said she wanted to engage in more exercise. One white British boy said he would ‘think about it [diet and physical activity] more’.

7.1.5 Parent questionnaire on lifestyle

The parent lifestyle questionnaire was filled out by the meal preparer of the family at schools ‘C’, ‘D’, and ‘E’. Seven parents did not return a questionnaire, and the final sample was 24 mothers and two fathers. Parents were presented with thirteen questions and asked to identify factors which they thought were associated with obesity and related illnesses, and to report their healthy lifestyle behaviours. Parents were given a selection of correct answers to each question that they could choose to ‘tick’ (Appendix I). The frequencies are considered, and presented according to the underlying questions of the study. No statistical analyses were conducted.

Parents’ perceptions of risk of obesity and related illnesses within their families

The anthropometric cut-offs reported in Chapter 4 were compared with parents’ perceptions of overweight and obesity in their children and in themselves. Only one child did not have all anthropometric measurements and was not used in analyses.

Table 7.10 compares parents’ perceived risk of co-morbidities for their children with their children’s measured adiposity status. As was reported in Chapter 4, most children were classified as being healthy by all anthropometrics, and there were equal proportions of British Pakistani and white British children who were classified as either as healthy, overweight, and overfat. Most parents reported that they did not think their child had a problem with obesity or health-related risks. Out of the ten children classified as overweight / overfat, nine parents were not able to correctly identify that their child had a problem with obesity.

Five parents thought they themselves had a problem with obesity. Their five children were all classified as overweight or overfat by all anthropometric methods. One of these parents, who was white British, did not think that her child had a problem with obesity but her child was classified as overweight and overfat. Two other parents, one British Pakistani and the other white British, thought their children had problems with obesity, but their children were not classified as such. The remaining parent who thought they themselves had a problem with obesity themselves was white British and did not think their healthy child was overweight.

Studies have found that parents tend to underestimate overweight and obesity in their children, especially if the parents are overweight or obese (Hart, Bishop, and Truby 2003; Lobstein, Baur, and Uauy 2004). The results found in Table 7.10 are consistent with previous findings that overweight parents tend to underestimate their children's risk of obesity. Only one of the five self-reported overweight parents was able to accurately estimate their child's adiposity status. The results are also consistent with previous findings that while parents with healthy adiposity levels were able to judge healthy levels of adiposity in children, they could not when children's adiposity status was overweight or overfat (Department of Health 2008).

Table 7.10 Comparison of parents' perceptions of obesity risks for their children, and children's adiposity status for at least one anthropometric method

	British Pakistani children (n=10)		White British children (n=13)	
Parents' perceived risk for child	**Healthy**	**Overweight / Overfat**	**Healthy**	**Overweight / Overfat**
Yes (n=2)	1	0	1	0
No (n=21)	4	5	7	5

Parents' knowledge of causes, symptoms, and consequences of obesity related illnesses

Averages and percentages of correct answers are presented in Table 7.11. White British parents indicated a higher percentage of correct answers about diabetes and coronary heart disease than British Pakistani parents. White British parents indicated better knowledge of coronary heart disease than diabetes. On average British Pakistani parents could not identify more than half of the correct answers listed on the questionnaires for either co-morbidity (Appendix I). These results appear to contradict findings from the present chapter that British Pakistani children in the focus group interviews demonstrated having more knowledge of obesity and co-morbidities than the white British children. Results from Chapter 4 indicate that there was a higher proportion of British Pakistani fathers and mothers who had a reported history of diabetes or heart disease compared to white British fathers and mothers. Although speculative, it is possible British Pakistani children learned of these co-morbidities first-hand through their tight-nit family and community groups, while white British children may rely more on a more formalised mode of health education, which they will not have gotten by this age. A larger study with enough statistical power is needed to further explore this relationship and use of this questionnaire method.

Table 7.11 Number of correct answers given by British Pakistani and white British parents on the topic of diabetes and coronary heart disease (CHD)

	Total questions given	British Pakistani parents (n=11)		White British parents (n=13)	
		mean±sd	Percent correct	mean±sd	Percent correct
Diabetes knowledge	15	5.6±3.2	0.37	7.9±2.2	0.52
Causes	4	1.5±0.9	0.38	1.6±0.7	0.53
Symptoms	7	2.8±1.7	0.36	4.2±1.1	0.40
Consequences	4	1.4±0.9	0.34	2.2±1.2	0.54
CHD knowledge	24	10.5±7.0	0.44	18.2±3.0	0.76
Causes	11	5.4±3.2	0.49	8.2±1.3	0.74
Symptoms	7	2.5±1.6	0.35	4.9±1.0	0.70
Consequences	6	2.7±2.5	0.45	5.1±1.5	0.85

Parents' food preparation and physical activity practices

The majority of parents identified most of the healthy foods from a given list as healthy foods they prepare at home (Table 7.12). Many parents reported they found it difficult to prepare healthy foods for their children because of limits in time. If parents were unable to provide healthy foods, the main reason given for it was that healthy foods were not always to their child's liking. Five British Pakistani parents said they found it difficult because they could not always find healthy foods that were Halaal.

The results for reported amount and frequency of reported physical activity were in equal proportion between British Pakistani and white British parents. Most parents did not achieve the Department of Health's recommended minimum daily amount of physical activity, reportedly taking only 1-4 days per week of 30 minutes of exercise (Department of Health 2004a). This weekly value is similar to the national average of people who are estimated to take approximately 25% of the recommended amount of time spent in physical activity (Sport

England 2008). Nine parents reported values that achieved or nearly achieved the suggested minimum.

British Pakistani parents reported that they did not achieve enough exercise because they either did not know how to start or maintain a routine, they did not like exercise, or they were limited by finances. The main reason given why white British parents found it difficult to take enough exercise was attributed to a lack of time in their lives, results which were similarly reported by some British Pakistani parents. Socio-economic factors, such as cost, were not reported as primary reasons. Around half of the parents expressed interest in learning more about obesity, health risks and preventions, and thought such knowledge would be valuable in prevention or treatment of related illnesses, and these proportions were equal between ethnic groups.

Table 7.12 Summary of parents' reported food preparation and physical activity practices

	British Pakistani parents n=11	White British parents n=13
Healthy foods prepared on a regular basis		
Whole grains	11	8
Fruit	11	11
Vegetables	11	12
Low-fat meats	8	13
Pulses	7	6
Milk products	8	10
Main reason healthy foods were not prepared on a regular basis		
Availability	0	0
High expense	0	0
Not enough time	3	2
Not to child's liking	5	9
Not to parent's liking	1	0
Limited Halaal foods	5	0
Unsure what a balanced meal is	1	0
Frequency of spending a minimum of 30 minutes each day in physical activity		
1-2 days / week	4	4
3-4 days / week	2	4
5-7 days / week	4	5
Less than 30 min/week	1	0
Reasons why physical activity was less than 30 minutes each day		
Lack of time	4	6
Lack of money/resources	2	1
Feel awkward exercising	0	1
Do not know how to start / maintain a routine	3	0
Not a common thing to do amongst my friends / family / community	0	1
Feel unsafe	0	0
Do not like physical activity	2	0
Parents who wanted to learn more about diet and exercise, and how they relate to diabetes and heart disease	7	7
Parents who thought learning more would help manage diabetes and heart disease, either for prevention or treatment	7	7

7.2 Discussion of the Results

The previous section presents data on differences in food intake, physical activity, and perceptions of healthy lifestyle between 1) British Pakistani children and white British children, and 2) second and third generation British Pakistani children. The following section discusses together these results and those from the focus groups and parent questionnaires in light of the wider literature. It considers how results from the pilot sub-study might inform study design of future studies on the topic.

7.2.1 Findings for food intake

British Pakistani children seemed to have eaten more whole grains, which may have been sourced from eating chapatti bread at home (data not shown). White British children ate more vegetables on the weekends than British Pakistani children. Other studies on European South Asian diets find a mixture of cardioprotective and atherogenic foods (Anderson et al 2005; Mellin-Olsen and Wandel 2005; Edwards et al 2006). The results from the present study may indicate similar findings, with some components of the British Pakistani children's diets healthier than white British children and some unhealthier. However, results from Mann-Whitney test of significance indicating that British Pakistani children drank more sugary drinks and ate less fruit and vegetables were not statistically significant when using the more robust Kolmogorov -Smirnov test. It may be of interest to note that during recall interviews in the present study British Pakistani children seemed to report having eaten fewer traditional English carvery meals, which include side portions of vegetables such as peas, carrots, and cabbage (data not shown). Future studies using large sample sizes with sufficient power will be able to explore these relationships further.

This study did not aim to assess whether curry meals could be defined as healthy or unhealthy, but rather to initially gauge whether this food type was consumed differently between the two ethnic groups and between the two generations of British Pakistanis. British Pakistani children tended to eat more curries than white British children. Based on field work observations, British Pakistani children seemed to eat more home-prepared curries and white British children tended to eat take-out curries (data not shown). Some of the curry dishes that were reported included vegetables and pulses (data not shown), which was one the few sources of vegetables for British Pakistani children. The Mellin-Olsen and Wandel (2005) study of self-reported changes in Norwegian Pakistani women's diets shows a decrease in vegetable (including pulses) intake after migration. Through focus group interviews, Mellin-Olsen and Wandel observed that women presumed the Norwegian diet was healthy, and that to adopt any aspect of it would be beneficial, such as eating less vegetable and lentil curries. It may be worthwhile to consider that the British Pakistani families in the present pilot sub-sample may have done the same, by not conversely assuming a beneficial aspect of the British diet relatively higher in vegetables—possibly the traditional carvery meal. However, this is speculative and data on curry recipes would first be needed to explore this possibility.

It is apparent from the results in the present pilot sub-study that British Pakistani families continued to prepare and consume curries, a traditional Pakistani food. At the same time, many British foods have been adopted into their diets at home and at school at frequencies as high as white British children, including chips, crisps, and pizza. This observation is supported by other studies (Anderson et al 2005; Anderson and Lean 1995; Mellin-Olsen and Wandel 2005; Edwards et al 2006). There were no significant differences in frequency of consumption for any food between second and third generation British Pakistani children's families, and it may be of interest to note most parents in the overall sample were first or second generation (data not reported here). This observation may suggest that while first generation parents have readily adopted a British diet, at the same time first and second generation parents have not ceased to prepare traditional foods.

7.2.2 Findings for physical activity

White British boys and girls are the most physically active of the children during lunch time on school days, but this burst of physical activity does not significantly increase their daily average over British Pakistani boys. It is likely British Pakistani boys make up for their relatively consistent and moderate levels of physical activity throughout the day by staying up later in the evenings, as indicated by reported bedtimes by parents and a temporal daily trend. However, no direct correlation between physical activity levels and sleep data can be made because sleep data were not collected from school 'B', and the diet and physical activity sub-study included schools 'B', 'D', 'E'.

British Pakistani girls demonstrated lower physical activity levels by accelerometry throughout the week. Other studies have observed lower physical activity levels in South Asian girls and women. The Department of Health's (2005) questionnaire-based study on adults, found that British South Asian women, including British Pakistanis, were less physically active compared to their male counter parts and the general population. Khunti et al (2007) found in a study using questionnaires with 11-14 year old South Asian (Indian, Pakistani, and Bangladeshi) and white British children that South Asian girls tended to report less time spent in physical activity during school break periods and after school.

British Pakistani children usually spent around 2 hours after school at mosque, as reported by children in recall interviews and focus groups, which may explain in part why they were engaged in less physical activities overall. A lower resting heart rate demonstrated in British Pakistani children in Chapter 4 support these results that British Pakistani children are less physically active, and as a result less physically fit, than white British children (Wilmore, Costill, and Kenney 2008). In the focus groups, British Pakistani girls reported a reluctance to participate in organised physical activities, and it could be that it this form of physical activity where the other children are benefiting. British Pakistani girls reported similar amounts of time spent in physical activity throughout the school day as the other children, but this time was intermixed with breaks taken to socialise. It is possible that the recall interview method may overestimate physical activity in British Pakistani girls.

British Pakistani girls were also reported to have later bed times compared to white British girls. Evidence exists for a correlation between shorter sleeping hours with an increased risk of obesity in children (Kaur et al 2003; Agras et al 2004; Reilly et al 2005; Snell et al 2007). Preliminary results from data used in the current study indicate that this relationship exists amongst the participants in this study population (Jones et al 2008, conference abstract). The mechanism is unclear, however it can be hypothesised that more physically active children acquire more restful sleep and as a result require less sleep. The correlation between sleep and obesity may be linked with behaviours associated with late nights, such as late night snacking. The elevated levels of adiposity found in Chapter 4 in British Pakistani girls by subscapular SFTs may result from lowered physical activity and later bed times. These results could be helpful in future studies on a much larger scale which make direct comparisons between sleep and physical activity.

The Department of Health recommends that children engage in a minimum of 60 minutes of moderate-to-vigorous physical activity (MVPA) per day because it is shown to provide the best prevention against or treatment for overweight and obesity (Association of Public Health Observatories 2007). There were no differences in the amount of time reported as spent in

MVPA between British Pakistani and white British children, or second and third generation British Pakistanis. On average, none of the children achieved a sufficient amount of time engaged in MVPA, with all of them achieving at most two-thirds the recommendation.

There appeared to be no ethnic differences in parent's or children's reported time spent in physical activity. Children's lifestyle practices and obesity statuses are usually found to reflect those of their parents' (Perry et al 1988; Lobstein, Baur, and Uauy 2004; Tabacchi et al 2007). All parents and children in this sample on average demonstrate an insufficient amount of physical activity. Generational differences between British Pakistanis were not assessed in this small sub-analysis piloting parent questionnaires, although a potential generational trend may have been observed in the present study sub-sample in unhealthy lifestyle practices amongst both white British and British Pakistani families. These issues should be explored in future research with validated questionnaires and larger sample sizes.

7.3 Summary

This chapter explored lifestyle practices of British Pakistani families, how they compared to those of white British families, and potential generational changes. British Pakistani girls spent less time engaged in physical activity than the other boys and girls, a finding which might be explained by a combined effect of the findings that British Pakistani girls were less rested and thus less active, spent more time after school in mosque rather than in physical activity, and spent less time in organised physical activity. British Pakistani children reported less time spent in after-school and organised activities, and girls of both ethnicities expressed a desire to be more a part of such activities.

Parents of both ethnicities might affect the obesity status of their children by not being aware of their children's health risk, by modelling an obesogenic lifestyle, and by being at risk for obesity and related illnesses themselves. British Pakistani parents demonstrated less knowledge of obesity related illnesses than white British parents, and indicated difficulty in maintaining a physical activity regimen. The results presented in Chapter 4 that British Pakistani parents may have higher proportions of diabetes and cardiovascular diseases than white British parents support these findings.

Further research is warranted in this population to assess whether there are lifestyle differences between ethnicities and generations. Further studies will require sample sizes large enough to generate sufficient power to detect any effects, and will also do well to use qualitative and semi-quantitative methods, such as focus groups and questionnaires, to guide study design.

CHAPTER 8: PARTICIPATION IN THE PRESENT STUDY AMONGST BRITISH PAKISTANI AND WHITE BRITISH CHILDREN

This chapter reports results on the topic of participation in the measurement study from participant observation and focus group methods. The observations I discuss were made while working daily for year in total in the schools, except ‘B’ where data were collected by another researcher (Section 3.3.2). Reviewing my field notes, I consider how the issues of inclusion, study design and ethics may have influenced recruitment efforts and children’s experiences of the study. Four semi-structured focus group interviews were conducted with a sub-sample at school ‘E’ at the end of the study (The focus groups also investigated children’s knowledge of obesity and healthy practices, data for which are presented in Section 7.2.4). The focus groups were: 1) British Pakistani boys (n=7), 2) British Pakistani girls (n=6), 3) white British boys (n=3) and 4) white British girls (n=2). The discussions were recorded by two scribes and audio tape, and analysed for themes (Section 3.7.4.2). The aim of the focus groups was to understand children’s motivations for and experiences of participating in the study, and whether there were any ethnic or gender differences.

8.1 Results of Overall Recruitment

Table 8.1 summarises the response rates of recruitment from British Pakistani and white British children from each of the five schools. There were no real differences in the total response rates between ethnic groups on average; however, there was great variation within each individual school. For example, at school ‘E’ the majority of British Pakistani children invited did participate and a majority of white British children did not, whereas at school ‘D’ only one-fifth of British Pakistani and one-half of white British children responded.

Table 8.1 Summary of the number of British Pakistani and white British children per school who were invited to participate and those who did participate in the main study

School	British Pakistani		White British		Total	
	Total Invited*	Final Participants	Total Invited*	Final Participants	Total Invited*	Final Participants
A	93	25 (27%)	25	4 (16%)	118	29 (25%)
B	70	35 (50%)	224	102 (46%)	294	137 (47%)
C	90	18 (20%)	81	16 (20%)	171	34 (20%)
D	86	11 (13%)	145	67 (46%)	231	78 (36%)
E	73	48 (66%)	189	22 (12%)	262	70 (27%)
Total	412	137 (33%)	664	211(32%)	1076	348 (32%)

*Figures are either estimates given by head teachers or taken from school's annual reports, and only include year groups 3-6

8.2 Participant Observation

I anticipated a variety of issues that would influence the success of recruitment and participation. In the following section I explore how issues of inclusion may have positively or negatively influenced recruitment efforts. I assessed bias based on willingness to participate from children who were overweight, healthy weight, British Pakistani or white British, and also whether the inclusion of teachers in the recruitment process would benefit participation rates. I also consider here how the issues of study design and ethics might have influenced families' decisions to participate in the study. These issues included parent and child consent, quality of space used to conduct measurements, and dissemination of results home to the families.

8.2.1 Issues of inclusion

Inclusion of overweight and obese children

I suspected children and parents may have feared that by participating in my study they would be associated with a particular stigma. I was explicit about the study's focus on childhood obesity in the study literature and at the parent and child meetings in order to ensure the consent obtained was informed. Overweight or obese children may have felt they were drawing unwanted attention to themselves by participating. To counteract this effect, I aimed to include all children by emphasizing the importance of healthy eating and physical fitness for everyone. My observations of parents and children on this point led to mixed results.

Some parents of overweight and obese children strongly ‘encouraged’ their children to participate (i.e. they insisted); some of the children of these parents absolutely refused no matter the encouragement. Children who were compelled to participate by their parents but nonetheless consented to the study usually dragged their heels as they came for their measurements, speaking very little and averting eye contact with me. A father of a white British boy approached me after school because his son was unwilling to participate. The father said he thought ‘it would be good for [his son]’ to participate and told me I could measure him even if his son ‘put up a fight’; the child reluctantly participated in the end. One year 5 British Pakistani girl would often offer to help teachers and me by carrying equipment or to find children on the playground for us. This girl was shy, very tall, and likely overweight. The Teaching Assistant approached this girl several times in the hopes of convincing her to participate, suggesting that the girl would be considered a leader to the rest of her classmates by taking the brave move to participate, or that her parents would be very proud of her if she participated. Despite this girl’s strong affection for the Teaching Assistant, she absolutely, albeit politely, refused.

Some obese and overweight children showed positive attitudes towards getting measured. An obese British Pakistani girl in year 6 brought her younger overweight male cousin to be measured because the boy had expressed to his cousin in confidence that he was nervous about the measurements. I measured her first while he waited in the hallway, and then she explained to him what had happened and what to expect. Both of them ended up laughing during our time together, and the boy said he felt silly for being scared in the first place. Other British Pakistani children who said they were afraid of being measured believed this issue could be resolved by coming to see me in pairs, an issue further discussed in the following section.

Some parents, including those of overweight children, refused to have their children participate for reasons unknown. One white British girl from school ‘E’ who was clearly overweight wanted desperately to participate in the study, but I never received consent from her parents so I could not measure her. She would continually return a consent form with her name on it but without a signature, and every time she saw me she would ask when it was her turn to be measured. Some studies have shown that parents of overweight children can tend to underestimate their children's weight (Hart, Bishop, and Truby 2003; Lobstein, Baur, and Uauy 2004). It is possible that some parents did not want their children to participate in the study because they did not want to admit their children had a weight problem.

Inclusion of British Pakistani children

I expected to face some difficulty recruiting enough British Pakistanis based on demonstrations by previous research that this community tends to decline participation in research and to include 'outsiders' (Thomas et al 2000). The results from Table 8.1 summarise a modest turnout from both British Pakistani and white British families. There were 39% more white British children invited to participate than British Pakistani children, which meant that an even stronger effort was needed to recruit British Pakistani families.

At school 'E' I was helped with recruitment by a British Pakistani Teaching Assistant who was appointed by the head teacher to the study. She acted as a gatekeeper who introduced me to British Pakistani families whom she thought most likely to participate, and also a research assistant who actively and persuasively recruited parents (Agar 1980; Bogdan 1972). Her position in the study was practically ideal, as she was an 'insider' of the community, given her prominence in the community, status at the school, close relationships with parents and children, and fluency in Urdu and Punjabi. Unlike me, the Teaching Assistant was in an appropriate position to uncover reasons for hesitation from parents and attempt to change their minds. She was very persistent in a way that would have been perceived as off-putting were it to come from me. Most of the time she was able to assuage fears or clarify misunderstandings people had, and sometimes she would convince parents to participate even if they had not been particularly motivated at the start.

The exceptionally high recruitment rate of British Pakistanis at school 'E' described in Table 8.1 indicates the major impact from the Teaching Assistant. At no other school studied was there someone recruiting who was also a member of school staff or the Middlesbrough British Pakistani community. In most senses I was an outsider at the schools, being a white American researcher living in Durham. That I was in my twenties, unmarried with no children, and not a school teacher or a PhD lowered my status and authority. Thomas et al (2000) discuss how insiders within a research team can help to establish trustworthiness and credibility in the eyes of the potential participants. The pairing between me and the Teaching

Assistant unique to school ‘E’ likely helped to shift identities between me and parents, children and schools staff.

Some negative sentiments about the study nonetheless erupted at school ‘E’ that I had not witnessed at any of the other schools I visited. All the children knew me from the child meetings so it was not unusual for children to shout my name or start talking to me; however once, while alone at the start of a parent meeting, a boy, whom I did not see, ran past the door saying that Americans think they can ‘boss everybody about’. In another instance a group of British Somali and British Pakistani boys who were not participating in the study would sometimes mimic my American accent in the halls. A final occasion led me to suspect that political views from parents may have affected interest in the study. In the middle of a class, the Teaching Assistant and I asked a British Pakistani boy if he had brought his consent form. The child brought out his form which had been torn up, and said that he had asked his uncle to sign the form, but his uncle tore up the paper and said ‘Here is my signature’. The Teaching Assistant berated the uncle’s actions and advocated the worth of my study; however she could not elucidate from the boy the reasons for the uncle’s behaviour. Given my other negative experiences, I could not help but suspect there were some anti-American sentiments within the community.

In spite of some negativity surrounding the study, some British Pakistani children participants demonstrated a very positive solution to their fears of being measured by suggesting they be measured in pairs. My first example has already been described in the above section involving two cousins. Another example involved a British Pakistani year 3 girl who brought a friend (whose parents had already given consent) along her to be measured. Both had healthy measurements, but the girls were particularly young, having just turned 7 years old. The fact they got to participate together seemed to reassure them because they were giggling and asking questions about the measurements throughout our session. I also discuss below British Pakistani girls suggestion to do measurements in pairs as a way of assuaging their fears.

Teacher consent

I had a stronger rapport with the families and children at the schools where the head teachers took a more proactive position, evident by positive feedback and interest from parents and children on a daily basis. Head teachers from schools ‘A’ and ‘E’ in particular made extra efforts to help the success of the study by personally contacting parents and children or spending significant amounts time with me planning our approach of dealing with the challenges of recruitment. Compared to other head teachers, these two were particularly motivated individuals and seemed to take a special pride in representing a multi-cultural school. I found that the way the project and I were first introduced influenced teachers', parents' and children's attitudes. For example, the head teacher at school 'E' was the only one after the Recruitment and Anthropometry Pilot Study to take my suggestion to hold a teachers' meeting. He gave me very gracious introductions at the meetings for children, teachers and parents. Very simple gestures by powerful gate keepers such as head teachers gave me the 'seal of approval' some families needed (Bogdan 1972; Agar 1980). In the other schools where head teachers approved the study but primarily just let me get on with the work, I felt a sense of disconnect between me and the families. Parents, and to a lesser extent the children, did not engage with me with the same familiarity I received at the schools where teachers were more involved.

The teaching staff also showed varying degrees of commitment to the study, irrespective of head teacher involvement, which played an integral role in my recruitment efforts. At school 'A' the head teacher was very enthusiastic, while it became evident that the teaching staff was not interested. I asked one teacher with whom I had a good rapport about my sense that the teaching staff was agitated by my study. She said they felt the study was forced upon them rather than something to which they had consented. Teachers felt pressured within their own jobs to keep to their curriculum, and each time I took children for measurements the teacher would have to ensure that child received the lesson at a later time. This observation gave me the idea to hold teachers' meetings to include teachers in the initial stage of recruitment and gain their support for the study (see Section 3.4). Other researchers have found this approach can help to minimise conflicts of interest and power imbalances (Hall 2001; Heron and Reason 2001; Hampshire et al 2005). Teachers at subsequent schools were generally positive but there were some teachers expressing similar sentiments as seen at school 'A'. One teacher at school 'C' made her opinion clear to me and her students once when I interrupted one of her lessons to request a child for measurements, which was standard practice at all schools. She sighed loudly and said, 'Oh, I don't like you Emily. You always come and interrupt my class.' Out of context this comment could have been interpreted as light hearted banter, but instead there was an uncomfortable silence in the classroom. Many teachers unfortunately perceived the power dynamic between them and my study as a contractual form of participation, whereas my aim was to be more collaborative by involving teachers for the benefit of the children's health (Biggs 1989).

It was clear to me some teachers thought my study had merits and could contribute to the success of their students. School 'E' displayed the highest level of involvement amongst teachers in terms of being interested, enthusiastic, and helpful compared to the other schools. This school was the biggest of all the schools and perhaps had more resources at their disposal to support the teachers. For example, after the teachers' meeting one teacher suggested I recruit British Pakistani parents at a cookery course she had started at the community centre near the school. One of the most influential teachers in terms of recruitment at school 'E' incorporated the health science of obesity into her year 6 curriculum. She did not tell me she was doing this, I only chanced to interrupt her class in the middle of a lesson where she was teaching malfunctions of the heart, like having too much fat in the blood. Not surprisingly, the vast majority of her class participated in the study, which is impressive considering the general tendency for year 6 children to resist participation.

8.2.2 Issues of study design and ethics

Parent and child consent

Parents were sent home study forms and invited to an informational parent meeting. Considering the final sample size for the study was 348, the overall turn out for the parents meetings was low, with schools 'A' (3), 'B' (3), 'C' (8), 'D' (18), and 'E' (11). Parents typically wanted me to give a small talk about the study and then to hold a question-and-answer session. Many parents asked questions or voiced concerns, and after some time the discussions would lead to the wider health issues of child obesity. Most parents decided to fill out the consent forms and questionnaires and return them at the meeting, and some took the information home to think further about it. It seemed most parents at the meetings were in support of the study but needed to meet me and to feel I was a trustworthy person. Children were told at the child meetings that they did not have to participate, even if their parents had already given consent. Three children in total declined the measurements. One child had his mother tell me he did not want to participate. Two children declined after I had taken them out of class and on our way to do the measurements. One child burst into tears at the prospect of being measured, while the other one calmly shook his head 'no' and went back to class.

The combination of collecting data in schools and needing 'affirmative consent', or to opt-in, restricted the fluency of recruitment and kept me in the role as an outsider at the schools. The National Child Measurement Programme (NCMP 2006), which was being carried out by school nurses around the same time that I was visiting schools, employed an 'opt-out' method, meaning all reception and year 6 children would be measured unless a child or parent objected. While undoubtedly I believe informed affirmative consent was appropriate for my study, the contrast in 'validity' of the two separate studies would have been apparent to parents and children and parents. For example, families and teachers are familiar with school nurses and they hold the professional authority I did not as a researcher outside the school and the community. Most of the five schools visited did not maintain a staff nurse or have a member of staff to act as a gatekeeper and provide me with some symbolic capital through association. I had the approval of all the head teachers, but their standard line of communication with families was through letters home more than personal contact, and it was common knowledge amongst teachers that a large portion of parents rarely responded to written communication. Recruiting through schools rather than community groups or as a member of the community posed limitations on the study's response rate. Working within schools I could not use qualitative methods to develop my role as an insider, by first establishing relationships and building trust from within as a community member. For example, I could not enter covertly and volunteer as a teaching assistant to gain a direct association with the school. Schools are the best approach to recruiting children because they are the most direct way of identifying families with children, but they also impose a degree of restriction.

Space used to conduct measurements

Children's experiences of being measured would often feed back to other children and families, and I expected the space to used to conduct measurements would likely affect the reputation of the study. This issue is further considered below in the discussion of focus groups. The main priority when selecting a room from a school with limited space and resources was the privacy and comfort of all children. At two schools I was given an entire classroom to use, but I had to request the windows be butcher-papered over for the children's privacy. At two other schools I was offered the back corners of classrooms, but because children could be seen by others, I had to instead accept the cleaners' and janitors' break rooms. These rooms were essentially cupboards or large closets, often smelling of cigarettes. The most ideal room to use was the nurses', which I fortunately was able to use at school 'C'.

I had to share every room with some member of staff, and often was interrupted or asked to leave the room for a time. Interruptions sometimes caused delays in obtaining measurements, and I believe made the children uncertain of the study and my role at the school. This sentiment could have had a knock on effect to other children and their families.

Dissemination of measurements to families

The short-term and long-term impact of obtaining measurements with respect to obesity on children is not yet known. Criticism has arisen around the National Child Measurement Programme and a lack of sufficient attention given to the psychological well-being of participants (Shucksmith et al 2007). In the present study, I disseminated the results to children's families as sensitively and professionally as I could within the limitations of the university ethics committee. It was decided because I was not a medic and the study was not linked with any NHS service, the mode of dissemination was to be by letters sent home to parents. From the five schools participating, I only knew of one instance where a child became distressed over the results of measurements. The parents of the child received in the post results that their daughter was classified as overweight based on her BMI, and they showed the letter to their child. A learning mentor from the school informed me that the parents of the child requested a letter of apology from me. I was in a difficult situation because I had been aware such an issue could arise and yet I was unable to prevent it in this case. I wrote a letter to the family apologising for the upset and explained that sending the BMI results was intended to help inform parents of their children's health. I heard nothing further of the issue. In the case of disseminating results to participants who were categorised as overweight or obese by BMI, a more sensitive option would have been for me to be able to hold meetings with parents.

8.3 Focus Groups on the Feasibility of the Study

The focus group discussions were conducted to understand what aspects may have either motivated or discouraged children to participate. The focus group questions explored children's opinions about the study, parents' and friend's opinions about the study, reasons for participation, first impressions of the study, suggestions for improving recruitment, and overall experience (Section 3.6.2).

Children's opinions about the study

There was a clear difference in opinion of the study between the sexes. Girls from both ethnicities showed a very positive and proactive attitude toward the study. When asked what they thought of the study, British Pakistani girls all chimed in various enthusiastic responses, such as 'I feel proud' and 'I feel happy'. One girl expressed how the study had affected her behaviours:

'[The study] made me eat different foods'
--British Pakistani girl, year 5

White British girls were positive, though perhaps less exuberant than the British Pakistani girls. The size of the group was very small (n=2), and unlike the group of British Pakistani girls, the white British girls were not well acquainted with each other. The white British girls in the focus group did not fully realise that they were a part of a study. They thought the activities were educational rather than for research, and admitted that they thought of the study more as a good opportunity to get out of class. Overall their opinions about the study were positive and constructive, focusing on the health benefits:

'I thought it was a good idea because you can know if something is wrong and correct it'
--white British girl, year 5

British Pakistani boys on the other hand showed a de-motivated and sometimes apathetic take on the study. They said the study was 'daft', and did not think it was worthwhile at first because 'nobody else was doing it'. Some British Pakistani boys had initial misunderstandings about the study. They thought the calipers and blood pressure machines were injections, even though at the assemblies I emphasised that there would be no injections.

By the same token, white British boys seemed indifferent about the study. As with the girls, they were not well acquainted with each other as were the British Pakistani boys. They said very little, if only that the study was 'ok' and beneficial because they could get out of class. However, one boy did acknowledge the intended benefits of the study:

'So we don't grow fat.'
--white British boy, year 6

Perceptions of parents' and friends' opinions about the study

All four groups reported that parents and other family members expressed a positive interest in the study. British Pakistani girls said their parents thought the study was 'really good' and 'fantastic' and were interested in what was happening with the study:

'My parents said, "We hope you learn something from this"'.
-- British Pakistani girl, year 5

White British children indicated less enthusiastic responses from their parents towards the study:

'My parents just asked "how did it go?".'
--white British boy, year 5

'[My family] thought it was a good idea because it would, like, benefit the children'
--white British girl, year 5

The groups reported different attitudes and reactions from their friends towards the study. British Pakistanis seemed to have received more interest and support from their friends. White British boys stated their friends 'don't care' about the study, that they did not ask and they did not want to know about it, while white British girls just said their friends did not think much of the study either way. In contrast, British Pakistani boys' and girls' friends were curious what happened, asking questions such as 'What did you do?' and 'Did it hurt?' Some children claimed they ultimately decided to participate because a friend who had already received the measurements said the study was worthwhile.

Motivations for participation

The girls tended to be more motivated to participate for health reasons:

'I wanted to know how healthy I was'
--British Pakistani girl, year 6

‘I wanted to know about my health’
--British Pakistani girl, year 5

There were only two children in the white British girls group; one was a competitive swimmer and another I had classified as overweight based on her measurements. Not surprisingly, the swimmer wanted to participate, and the overweight girl said she did not want to participate but said ‘Mum said I had to’. One of the girls reported an interest in the health aspects of the study, and the other agreed:

‘[I was motivated] to find out if I was healthy’
--Two white British girls, years 5 and 6

The boys in general did not focus on the health benefits but rather seemed to go along with the study at the behest of their parents. White British boys were particularly *laissez-faire*, saying they thought the study was good and would ‘see what happens’. British Pakistani boys reported that their family encouraged them to participate, even though they were not particularly motivated themselves. The British Pakistani boys explained how their parents filled out the consent form for them regardless of how the children felt about participating.

‘I was made to do it if friends are doing it.’
--British Pakistani boy, year 6

However, British Pakistani boys indicated that they were aware of the threat of obesity related illnesses and therefore accepted their parents’ insistence of the importance of participating (data reported in Chapter 7).

Both the British Pakistani groups reported that the Teaching Assistant who helped me with recruitment was a motivating factor to participate. A few of the girls said they participated because there was a ‘familiar face’, which confirms my observations above that the Teaching Assistant acted as an invaluable gatekeeper to the participating children.

Three of the four groups reported a major benefit to participating in the study was that children could get out of class, the exception being British Pakistani girls. Some British Pakistani girls even said they were motivated to participate ‘for fun’.

First impressions

It was difficult to get a clear response from the boys regarding their impressions of the study when they first learned of it. I was not able to elucidate any answer from the British Pakistani boys; their attention seemed to flag during the part of the interview when this question was asked. White British boys did not answer the question directly.

> 'My mum asked first if I wanted to do it [the study]. I said that I wasn't bothered.'

British Pakistani girls were able to give a much more detailed recollection of their first impressions of the study. They recalled that at the child meetings they were initially 'scared' and 'frightened' of the 'pinchers' (skinfold calipers) and the blood pressure machine. They reported that they were no longer scared if friends who had already participated told them that there was nothing to be scared about. One of the white British girls said she first learned of the study when she saw an activity monitor on her friend, and another white British girl learned about it at the assembly for the child meetings. The white British girl who was a competitive swimmer said she immediately wanted to participate, while the white British girl who was overweight initially felt she did not.

Suggestions for improving recruitment and overall experience

The boys in the focus groups suggested rewards and incentives as a way of making the study more attractive and enjoyable. British Pakistani boys recommended certificates of completion or 'rewards', like a trophy or a prize. White British boys responded immediately and imaginatively to the question, also proposing rewards for participation, such as a bag of sweets and food tasting sessions, like healthy cooking demonstrations as done by celebrity chef Jamie Oliver. The white British boys all agreed that if the study had brought in a professional footballer, this would have made the study more interesting.

British Pakistani girls suggested I give a step-by-step demonstration in class and how I was going to perform each measurement. This is likely because their initial impressions of the study were fearful. They also suggested more interactive activities, such as games, physical education, or football. All the British Pakistani girls reported emphatically that they would have liked to have been measured in pairs, as discussed in participant observations. The white British girls suggested more vaguely that an activity is interesting if it is different and something ‘to keep you occupied’. The overweight white British girl maintained her overall dislike of the study:

‘I wouldn’t want to do it even for £100’
--white British girl, year 5

8.4 Summary

The recruitment efforts of the present study focused on British Pakistanis because the sample size required two times more British Pakistani than white British children, and there were nearly twice as many white British than British Pakistani children in the schools visited. Overall, there were no differences in response rates between ethnic groups, but observed variances between schools illuminate factors that were successful in recruitment efforts.

A high level of engagement from head teachers and the inclusion of teaching staff in the recruitment process seemed to positively affect parents’ and children’s willingness to participate. British Pakistani families responded favourably to an additional gatekeeper, a Teaching Assistant whom both children and parents knew personally. Issues of my identity, in particular associations with me and United States foreign policies, may have affected families’ decisions to participate. I felt I could not alter my role as an outsider in other ways given the clear role in which the university ethics committee and schools required I remain in.

Girls of both ethnicities displayed more positive attitudes toward the study than boys, as marked by opinions, motivations and first impressions. British Pakistani girls seemed the most enthusiastic of all, which may have resulted from support for the study from close ties they reported within their community. British Pakistani children and parents showed a more concerted interest in participating for health reasons than white British children which likely resulted from their positive discussions with the Teaching Assistant. Overall, the children expressed excitement about the study, but felt that it would have been more engaging for them if there had been more interactive ways in which children could be involved.

It is possible that the children who felt they did not fully relate to or connect with the study also did not feel capable or willing to fully engage in the focus groups. I observed that the

British Pakistani children overall were more talkative and engaged than the white British children, and this may have come as a result of the British Pakistani children's close relationships amongst themselves. The sub-sample was not fully representative of the main study sample primarily because it included only children 9-11 years of age. The sample may also have been biased with children who were more motivated to participate overall, because a few children did decline the invitation to take part. The results from this sub-study have been illuminating by showing that some of the constraint on my recruitment efforts can be explained by teachers' and families' preconceptions of the study and me. This substudy will be best put to use to inform future studies of a similar nature at the outset of the recruitment stage.

CHAPTER 9: DISCUSSION AND CONCLUSION

This thesis has presented findings from analyses of various factors that were predicted to influence adiposity in British Pakistani children by using diverse methodologies. The main analyses of the study focused on differences between the ethnic and generation comparison groups: 1) British Pakistani and white British children; and 2) second and third generation British Pakistani children. This final chapter reviews how the findings presented in Chapters 4-7 may have either supported or refuted the study hypotheses by discussing the relevant research and existing theoretical frameworks. In the first section I discuss my overall findings from analyses of differences between British Pakistani and white British children by drawing upon anthropometric, birth weight, and lifestyle results from Chapters 4, 6, and 7. Similarly, in the second section I discuss all the results from analyses of differences between second generation and third generation British Pakistani children. In the last two sections, I consider the methodological contributions of the present study for future research, and finally how adiposity in the British Pakistani community can be better understood and addressed.

9.1 Ethnicity and Adiposity: Early Origins and Current Lifestyle Effects

The results from Chapter 4 support my prediction that British Pakistanis would have higher levels of adiposity than white Britons as measured by triceps ($p=0.003$) and subscapular SFTs (<0.000), but not by waist circumference ($p=0.253$). Results from Chapter 6, which used birth weight as a proxy for foetal growth, support my prediction that British Pakistani children would have lower birth weights ($p<0.001$), be more frequently classified as low birth weight ($p<0.01$) and small-for-gestational age ($p<0.001$) compared to white British children. These figures were particularly marked in British Pakistani boys. Chapter 7 suggested that British Pakistani girls spent less time engaged in physical activity than the other boys and girls. British Pakistani girls also reported more time after school in mosque rather than engaged in physical activity like their peers, and a resistance to participate in organised physical activity. One possible explanation for this could be a combined effect between sleep and physical activity. British Pakistani girls spent less time sleeping, and as a result may have been less well rested and less likely to be very physically active. British Pakistani boys spent time after school in mosque and had later bed times, it seems their time spent in organised physical activities compensated for these factors thought to contribute to lowered physical activity. There were no major differences between groups in terms of obesogenic foods, but it is likely that a combination in diet of health and unhealthy foods. A more in depth study will be better able to determine whether or not a balance is struck between the two.

The results from the current study may have implications for the predictive adaptive response model by demonstrating that, while on average British-born British Pakistani children had similar body sizes (i.e. BMIs) as white British children, they were still fatter centrally and generally. The present study also found that British Pakistani children were born smaller than white British children by all measures assessed, including birth weight, low birth weight and small-for-gestational age. It has been theorised in developmental origins of disease research that if a migrant mother moves from an environment with higher rates of under-nutrition and infection to an environment with higher rates of over-nutrition and lower rates of infection, the foetus of the migrant mother may be physiologically maladapted (Hales and Barker 1992; 2001). The predictive adaptive response model expects that the foetus prepares for a nutrient-scarce environment by decreasing body size and increasing energy stores (i.e. fat mass) and access to abdominally stored adiposity (Gluckman and Hanson 2004). Although data on Pakistanis are limited, there is evidence that migration of South Asians to westernised environments, such as Britain, results in a significant elevation in adiposity (McKeigue et al 1991; Bhatnager et al 1995; Kalhan et al 2001; Misra and Vikram 2004). The foetus' diminished ability to cope with new environments could be the result of a mismatch between the environment that the foetus physiologically prepares for and what the environment actually is (Eaton, Konner, and Shostak 1988). The findings in the present study that British Pakistani children were born smaller and were fatter in middle childhood compared to white British children suggests a foetal origin of adiposity in this population.

The regression model used in the present study to predict adiposity from birth weight did not find any significant associations, so it is not clear whether there may be foetal origins of adiposity in the study population. Adiposity in adults who were born with lower birth weights can also occur as a result of maternal insulin resistance (Fall et al 1998). Post-natal growth of adiposity is thought to be as influential a predictor of later adiposity as pre-natal factors (Lucas, Fewtrell, and Cole 1999), if not greater (Ong et al 2000; Parsons et al 2001; Adair and Cole 2003; Eriksson et al 2003; Ong et al 2006). The elevated levels of adiposity found in British Pakistani children could be more to do with post-natal development rather than pre-natal development. The present model tested for an association between prenatal growth, i.e. birth weight, with adiposity in middle childhood, however, it did not test for any growth in adiposity between birth and middle childhood (Lucas 1991). An intermediate anthropometric variable was unfortunately not available to the present study to run such analyses that might have identified catch-up growth that would link the findings for lowered birth weight and elevated adiposity.

A mismatch between a thrifty phenotype and a Western lifestyle, including over-nutrition and relatively low physical activity, should result in an increase in adiposity. In the pilot sub-study presented in Chapter 7, British Pakistani girls were the least physically active of all groups of children. The differences in birth weight, small-for-gestational-age and low birth weight were marked in British Pakistani boys in particular, which may or may not be related to their elevated levels of adiposity in middle childhood. Therefore, a possible line of enquiry is that in this population of British Pakistani children adiposity may be sex and gender based, with the factor of current lifestyle a greater influence in girls and the stronger factor being intrauterine growth restriction in boys.

Research into obesity commonly considers socio-economic status as an influential factor (Sobal and Stunkard 1989; Power et al 2003; Lobstein et al 2004; Zhang and Wang 2004; Tabacchi et al 2007; Wang and Beydoun 2007). The sub-sample analysed in Chapters 4 and 5 may not be representative of the main sample due to a high degree of non-response of education and occupation data on the parent questionnaires. While British Pakistanis had lower Occupational Status (mothers, $p<0.001$; fathers, $p<0.001$) and education levels (mothers, $p<0.001$; fathers, $p<0.01$) than white British families, Occupational Status as a covariate did not affect results which found that British Pakistani children were more adipose than white British children. A more detailed investigation into this relationship is warranted because use of mothers' Occupational Status does not indicate socio-economic status in the household, due to the high likelihood of women being classified as 'homemakers'. There are also many factors associated with ethnicity and socio-economic status not explored in this study, such as poor access to healthy food and physical activity options, as well as issues of racial discrimination and racism (Chinn et al 1999; Karlsen and Nazroo 2002).

9.2 Generational Differences in Adiposity

I formulated the hypotheses that levels of adiposity would decrease and birth weight would increase over generations in British Pakistani children in light of studies that found such a trend between first generation and second generation British South Asians (Lean et al 2001; Margetts et al 2002). I also considered the thrifty phenotype and intergenerational phenotypic inertia hypotheses. The results in the present study show a higher proportion of second generation British Pakistani boys were overfat by subscapular skinfold thickesses compared to the third generation ($p<0.001$). Second generation British Pakistani children had higher mean SDSs for waist circumference, and tricep and subscapular SFTs than the third generation, but the differences were not significant. It is possible that the method of using cut-offs is better able in identifying slight differences between generations in the most adipose children, rather than differences between adiposity in the groups overall. There was no support for the prediction that second generation British Pakistani children would have lower birth weights, or be born defined as low birth weight or small-for-gestational age more frequently than third generation British Pakistani children. No evidence emerged from the exploratory pilot sub-study on lifestyle that indicated statistical differences between generations, but sample sizes were too small to detect any real effect.

The results in the present study indicate that if adiposity is decreasing among British Pakistani over generations, the change is quite small. Kuzawa (2005) predicted that change in phenotype under the intergenerational phenotypic inertia hypothesis would occur over several generations, and in fact might only be noticeable on such a large time scale. The migration of Pakistanis to Britain currently spans four generations, so this phenomenon may not be observable as yet. Power in this sample comparing generations was limited to detect a large-size effect, so if the change in adiposity is smaller than this, there may not have been sufficient power to detect it. It is also possible that differences in adiposity between generations might not be apparent in middle childhood, but would be more marked after sexual maturity. Adiposity has consistently been shown to increase with age, and the development of obesity in childhood is considered to be most difficult to reverse after puberty (Parsons et al 1999; Tabacchi et al 2007; Wang and Beydoun 2007). Study into intergenerational effects that include adolescents and adults in this population is thus warranted, particularly in the light of work by Pollard et al (2008a), which found differences in adiposity between first and second generation British Pakistani women in Newcastle. In future examination of adiposity in multiple generations, findings from the present study suggest a longitudinal study to observe the life cycle, and power sufficient to detect small effects.

There is some evidence from this body of work suggesting that there is a generational trend at play in British Pakistani health. However, due to the limitations in the study design, by no means does this research refute the intergenerational phenotypic inertia hypothesis.

9.3 Methodological Assessment and Contributions

Results from the present study showing that British Pakistani children can still be overfat by skinfold thicknesses (SFTs) even if they are not considered overweight by body mass index (BMI) suggest that British Pakistanis could be overlooked for associated health risks if only current methods for assessing obesity are used. National health surveys in the United Kingdom currently assess obesity in children solely by use of BMI (Department of Health 2006). BMI is widely used to establish overweight because it is shown to be a good predictor of excess adiposity and health risks associated with obesity (Williams and Horlick 2008). However, BMI does not correlate as strongly with body fat as do waist circumference and SFTs (Goran et al 1998; Norgan et al 2005), and studies comparison studies conclude that BMI is not sensitive enough in detecting body fat than other methods such as skinfold thicknesses (Flegal 1993; Shaw et al 2007; Burkhauser, Cawle, and Schmeiser 2009). SFTs and waist circumference are also found to be stronger indicators of co-morbidities in post-pubertal Asian Indian children than BMI, which further underscores this point (Misra et al 2004). Variation in anthropometrics among different ethnicities also poses a methodological challenge. The cut-off points used to define overfat, overweight, and obese cannot necessarily be universally applied to all ethnic groups and populations, even if the reference population is ethnically diverse (WHO IOTF 2000; Deurenberg et al 2002; Misra et al 2005).

Given the high risk of British Pakistanis to develop obesity related illnesses, such as type 2 diabetes and cardiovascular diseases discussed in Section 1.1.2, there is an overwhelming need in the British Pakistani community for prevention. Despite this, the Middlesbrough Primary Care Trust does not currently have services specifically aimed at obesity prevention for this minority group, for example in the form of educational out-reach programmes or weight loss groups. British Pakistanis in Middlesbrough have been found to be satisfied with the care they receive, including general care, interpreter services, and availability of Halaal foods (Madhok, Hameed, and Bhopal 1998). Lawton et al (2006), however, found Pakistanis and Indians in Edinburgh held a sense of indebtedness for socialised medical care in Britain, which may deter them from asking for more or improved care. Lawton et al (2006) also found that their sample of diabetic patients only sought services for symptoms and not for advice or information on managing their care. Another study in Edinburgh successfully trialled a project which provided health checks at a community mosque, demonstrating how local needs can be met with innovative efforts (Ghouri 2005). The numerous studies that have assessed foetal origins of disease in South Asians, and that have been reviewed here (Section 1.2.2), call for prevention efforts. In light of their review of prenatal and postnatal factors that influence obesity risk in children, Snethen et al (2007) in particular recommend a more high-profile position of midwives in such prevention efforts, who are positioned to promote health screening and healthy lifestyles early in pregnancy. The results from the present study support arguments for the case of providing health services for children and women of child-bearing ages, in particular relatively inactive girls, that are also sensitive and accommodating to British Pakistani culture and customs.

Findings from my exploratory sub-study on participation, presented in Chapter 8, provide a good background for future research in Middlesbrough schools, especially of British Pakistani children. Particularly useful information for recruitment is that a more hands-on and group orientated approach with the children would more strongly engage the children with the study and encourage participation from their parents. Teachers can act as valuable gatekeepers so long as they are informed and willing to participate in the study. British Pakistani families seemed motivated for health-related benefits, and it advised that a member of teaching staff or other well-known members of the community convey the health benefits as an approach to gaining approval of the research. There has been little previous work on the topic of children as participants in obesity research, and it is yet unclear how participation in a study dealing with the issues of obesity can affect children's perception of themselves and their peers (Boulton and Parker 2007). This sub-study explored how the study might have affected children's perception of themselves, their peers, and the intended meaning of the study. Exploratory studies on the topic of participation are very useful methods in informing study design, and should be used in studies where recruitment may be particularly challenging.

9.4 Childhood Adiposity in British Pakistanis: A Multi-Factorial Health Issue

This study set out to investigate adiposity as a multi-factorial health issue from a life course perspective by assessing differences in adiposity and related factors between British Pakistanis and white Britons in middle childhood. The research aimed to understand the factors associated with adiposity in British Pakistani children in the under-studied population of Middlesbrough, and to test hypotheses based on the developmental origins of health and disease.

Communities such as British Pakistanis could be more vulnerable to obesity than other Britons because in addition to being exposed to risk factors as members of the British population, they are also particularly susceptible as migrants or descendants of migrants. British Pakistani children are at additional risk for developing adiposity and related illnesses because incidence rates of obesity in Britain are higher in children (Department of Health 2004b). Indeed, recent public health measures taken to address obesity by lowering the prevalence of childhood obesity in 2020 to what the prevalence was in 2000 (Department of Health 2004b). This sample of children from Middlesbrough showed prevalence rates for overweight and adiposity defined by BMI that are similar to the overall very high national averages from 2004 (Department of Health 2001; 2005). Based on this sample of children, important and distinct health risks in British Pakistani children have come to light.

The factors associated with adiposity were used to examined here that were prenatal development, postnatal growth, and migration. diet, and physical activity. Factors that could have provided a more comprehensive assessment were diet and physical activity, which in this study were explored only as a pilot. Other factors include a more detailed variable for socio-economic status, child weight in infancy, and maternal factors. Obesity in different groups and populations will be influenced more strongly by certain factors than others, and there is no prescribed set of explanatory factors for adiposity for all populations (Wang and Beydoun 2007; Zhang and Wang 2004). Any observed differences found between either of the two comparison groups in this study—British Pakistani and white British, and second and third generation

British Pakistani children—are likely to be correlated with a myriad of issues faced by British Pakistanis rather than a select few.

This study serves as a first step in determining exactly which factors contribute to the observed differences in body composition between British Pakistani and white British children. Overall, the results encourage future research into developmental origins of adiposity in the British Pakistani community. The three recommendations based on the findings of this study are: 1) Qualitative methodologies should be used to inform study design as a way of illuminating complex and interrelated issues such as obesity and ethnicity; 2) health care provision specific to British Pakistanis, including obesity prevention, healthy lifestyle promotion, and health education and prenatal care to women of reproductive ages; and 3) the need for well-validated methodology, such as skinfold thicknesses, to assess body composition in British Pakistanis specifically, and possibly extended to South Asians and other minority ethnic groups.

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APPENDIX A
CONSENT FORM FOR HEAD TEACHERS

Dear Members of the Ethics Committee,

I have met with Durham University's research student, Ms. Emily Henderson, in regards to her request to gather data on the children at Green Lane Primary School for her project. She has given me copy of the university ethics application, which includes details of the proposed study. I have read through this, and believe what she proposes to do is acceptable. I have agreed to allow her to begin recruiting participants by firstly meeting with the parents.

I also understand you, the Ethics Committee, have sought solicitor's advice regarding the sensitive nature of the researcher's proposed body measurements and her focus on British Pakistani children. I am aware a document of advised safeguards was provided, and that the investigator (Ms. Henderson) and her supervisor have put these safeguards in to place. Therefore, I am confident the project should commence.

Yours Faithfully,

Mr. Head Teacher

Example Primary School

APPENDIX B
FORMS USED IN THE RECRUITMENT OF PARTICIPANTS

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please carefully read the following information and discuss it with others if you wish. If there is anything that is not clear or if you would like more information, please feel free to contact any of the researchers using the contact informtion provided below.

What is the study about? Obesity and storing fat around the waist area in children is known to increase risk for diabetes and heart disease in adulthood. We wish to test how levels of obesity and fat patterning around the waist in British children are increasing. It is possible ethnicity and low birth weight may influence such poor health conditions. We also wish to test whether children who sleep less each night may have increased risk for obesity, as some researchers have suggested.

Who are we? Ms. Henderson is a Ph.D. student at Durham University. She is supervised by Dr. Tessa Pollard in the Department of Anthropology. Ms Henderson has enhanced clearance from the Criminal Records Bureau.

Who shall take part? We are asking children ages 7-11 to participate because we believe the children may be at a high risk for fat patterning around the waist and future disease such as diabetes and heart disease. We seek background information about the children's birth history and sleeping habits, as well as background information about the childrens' parents.

What will it involve? Parents who agree to take a part in this study are asked to fill out the consent form provided. Children as well will be informed about the project and asked for their verbal consent once their parents have consented in writing.

There are three areas to the study. First, we will measure for weight, height, blood pressure, body fat and fat storage around the waist. Body fat is measured using skinfold calipers on the upper arm and upper back, and fat storage around the waist is measured by measuring around the waist. These measurements will be conducted on school grounds during term time. We will ask the children simple questions about their sleep, including what time they go to bed and what time they wake up. For the second area, we will ask a small number of children before lunchtime to recall their food and physical activity over a 4 day period. Additionally, we will ask them to wear physical activity monitors for 2 school days and 1 weekend, on 4 consecutive days. This will require some parental supervision to ensure devices are taken off at bedtime and worn again the following morning. For the third area of the study, we will gather data from records of children born at James Cook University Hospital, including birth weight, number of weeks at birth, maternal height, smoking status, and maternal diabetes.

You will be sent your child's confidential results for blood pressure and weight (normal, overweight, obese), and informed whether they should be checked by your GP. You are welcome to observe any of the research sessions with your child. Please let us know so we can arrange the date and time for you.

Confidentiality We will not release any information about you or your child collected for this study to anyone without your permission. Questionnaires and data collected will be stored securely according to the Data Protection Act 1998. The project has been approved by Durham University Ethics Committee and by James Cook University Hospital Research and Development Committe.

If you or your child change your mind Participation in this research study is entirely voluntary, and even if you have signed the consent form, you or your child can change your minds and withdraw at any time. You do not have to give a reason.

Project Investigator: Ms. Emily Henderson, Department of Anthropology, 0191 334 6189
Project Supervisor: Dr. Tessa Pollard, Department of Anthropology, 0191 334 6186
Address: Department of Anthropology, Durham University, 43 Old Elvet, Durham DH1 3HN

Body composition, Diet and Exercise in Middlesbrough Children
PARENT/GUARDIAN CONSENT FORM

Please answer all questions, and make sure to circle either a 'yes' or a 'no'.
Please return pages 4-6 to researchers and retain pages 1-3 for your personal records.

Have you read the Information Sheet for Participants? YES / NO

Do you consent that your child may participate in the study? YES / NO

Do you understand that your child may decline even if you have given consent? YES / NO

Do you understand that your child is free to withdraw from the study:

* at any time and
* without having to give a reason for withdrawing YES / NO

Child's Name..

Signed .... **Date** ....
Parent/Guardian I

(NAME IN BLOCK LETTERS) ....

Signed .... **Date** ....
Parent/Guardian II (if applicable)

(NAME IN BLOCK LETTERS) ....

Body Composition, Diet and Exercise in Middlesbrough Children
PARENT/GUARDIAN QUESTIONNAIRE

Thank you for completing this questionnaire.
Please make sure you answer ALL questions on BOTH pages.
Please return pages 3-6 and keep pages 1-3 for your records.

Information about the child

What is your child's full name? ____

When was your child born? Day__________ / Month__________ / Year_______

If your child was born in hospital which hospital was it? ___________________________

In what city was your child born? (e.g. Middlesbrough)___________________________________

In what country was your child born? (e.g. UK)____

Was your child born a twin, triplet etc? Yes ☐ No ☐

Is this child your first born, second born, etc.? 1st ☐ 2nd ☐ 3rd ☐ 4th ☐ 5th+ ☐

What is your child's ethnicity?

Bangladeshi ☐ Indian ☐ Pakistani ☐ White British ☐ White Irish ☐

White & Asian ☐ White & Black African ☐ White and Black Carribean ☐

Black African ☐ Black Caribbean ☐ Chinese ☐

Any other background ☐

Information about the child's mother

In what city and country were you born? ____

In what country was your mother born? ____

Highest level of education you have achieved? ____

Current occupation (or occupation before child): ____

First language: ______________________ Religion: ____

Have you been diagnosed with: **diabetes?** Yes ☐ No ☐ At what age were you diagnosed?_______

Did you develop diabetes when you were pregnant with the child participating in this study? Yes ☐ No ☐

Have you been diagnosed with: **heart disease?** Yes ☐ No ☐

Current height: ___________________________

<u>Information about the father</u>

In what city and country were you born? ______________________________

Highest level of education you have achieved? ______________________________

Current occupation: ______________________________

First language: ________________ Religion: ______________________________

Have you been diagnosed with: **diabetes?** Yes ☐ No ☐ At what age were you diagnosed?_______

Have you been diagnosed with: **heart disease?** Yes ☐ No ☐

<u>Information on Sleep</u> (we are interested in possible links between how much a child sleeps and weight gain in children)

On average, how many hours of sleep does your child get:

on a night before a school day? ______________________________

on a night before a weekend day? ______________________________

What time on average does your child get into **bed**

on a night before a school day? ______________________________

on a night before a weekend day? ______________________________

What time on average does your child go to **sleep**

on a night before a school day? ______________________________

on a night before a weekend day? ______________________________

On average, what time does your child **wake up**

on school mornings? ______________________________

on weekend mornings? ______________________________

How often does your child wake during the night?

Never ☐ Very rarely ☐ Rarely ☐ Sometimes ☐ Often ☐ Very often ☐

Other ______________________________

Finally, it would be useful if we had your postal address. This way, we can be in contact with any further issues regarding the study. We will also be able to mail home your child's health measurements. We will not give your address to anybody else. If you are willing, please provide your address below:

____

APPENDIX C
SCRIPT OF INFORMATIONAL MEETINGS WITH CHILDREN

'Hello, my name is Ms Henderson. I come from Durham University. Do you know where Durham is? Do you know what people do at a university?'
'I live up at Durham, but you can probably tell I don't come from Britain. Where do you think I'm from? Do you know where America is? What things do you know about America?
'I have come to England to study the health of children because it is a very important subject. Does anyone know what diabetes is? (show of hands). What is diabetes? Does anyone know what heart disease is?' (show of hands). What is heart disease?'
'I'm concerned about diabetes and heart disease because so many people in America and Britain get these illnesses. Has anyone heard the word obesity? Why do children get overweight or obese? What things can be done to help your heath?'
'I'm here to see about the health of children in Middlesbrough. I want to measure you so I can tell your school and your parents how healthy you are. At the university I can tell doctors and people who work for the prime minister just how healthy you are. So if you participate, you will also be helping the entire country understand about children's health.'

APPENDIX D
SHEET USED TO RECORD DATA ON ANTHROPOMETRICS

Please ensure all data (except blood pressure) is recorded to the nearest tenth decimal place (i.e. 0.1).

Participant Information:

Name____Sex M F

Date_____/_____/_06_ Time_____:_____ (24-hour) Participant #:_____________

School ______________________ Teacher_________________ Year________

Blood Pressure: (1)_______/_______mmHg (2)________/________ mmHg

Pulse: (1)_____________beat/min (2)_______________ beat/min

Dimensions:

Height (1)___________cm (2)___________cm (3)____________cm

Weight (1)____________kg (2)____________kg

Waist circumference (1)__________cm (2) ___________cm (3) ___________cm

Skinfolds:

MUAC (1)______________cm (2)______________cm (3)______________cm

Intrameasurer Error (mm)	
0.4-0.8	Tricep (1)__________mm (2)__________mm (3)__________mm
0.88-1.53	Subscap (1)__________mm (2)_________mm (3)_________mm

APPENDIX E
PROTOCOL FOR IDENTIFYING AND MEASURING SKINFOLD THICKNESSES

Tricep
1. Measure the right side of the body. Measure mid-upper arm circumference. Find and mark midpoint from the elbow to the clavicle with a measuring tape. Ensure the tape is flush with the skin and neither too tight or too lose .
2. Using the midpoint mark, grab the tricep skinfold just superior (1 cm) with the non-dominant hand. Skinfold should be parallel to the humerus bone. Make sure to distinguish the skin and subcutaneous fat from the muscle by feeling the tissue.
3. Grab the fold with the calipers parallel to the humerus bone and just centred with the midpoint mark.
Subscapular
1. Measure the right side of the body. Ask participant to lift shirt so the entire back can be accessed. Typically they will need to pull their right arm out of their shirt.
2. Find the scapula, and mark where it makes an approximate 90° angle in the medial upper back. Placing the arm at a 90° angle behind the back and resting it just on the waist usually helps to bring the bone into view.
3. The skinfold should be grabbed just inferior to the horizontal line of the scapula by 1 cm, and just medial to the mark by 1 cm. Therefore, the hold is at an angle, and the caliper should align along this diagonal and lie centred with the midpoint mark.
Suprailiac
1. Find the iliac crest by palpating the side of the hips. View the medial line of the participant as you stand facing their profile. Mark just superior to the iliac crest where it intercepts this medial line.
2. Grab the fold parallel to the top of the iliac crest (on the transverse plane). Align the calipers just centred with the midpoint mark.
Abdominal
1. Measure 3 cm from the absolute centre of the umbilicus distally from the medial plane. The mark is measure 1 cm inferior from that point.
2. Grab a skinfold in the transverse plane (horizontal) and align the calipers just centred with the midpoint mark.

Reproduced from: Harrison et al. (1988)

APPENDIX F
PROTOCOL FOR 24-HOUR MULTIPLE PASS RECALL INTERVIEWS

Pass	Protocol
1. Quick List	The participant is asked to quickly recall all the foods eaten and activities participated in from the previous day, from midnight to midnight
2.Detailed Description	The participant is asked to think more carefully about the previous day, what they did, when the foods were eaten, what activities they did to help trigger memory. Details of food and activities are recorded.
3. Review	The participant is read a review of the foods and activities given and asked again to describe anything not previously mentioned.
4. Portion size estimation	For recall of diet, the participant is shown pictures of each item of food recalled from the Food Atlas and asked to estimate their portion size.

APPENDIX G
SHEET TO RECORD DATA FROM RECALL INTERVIEWS ON DIET

DAY: SA SU M T DATE RECALLED: ____/____/___ DAY OF WEEK RECALLED: M T W
START TIME: _ ____:_____ (24-hour clock)

	Quick list	Time	Place	Description of Food or Drink	Brand	Amount (P/H/W)	Left overs (P/H/W)

APPENDIX H
SHEET TO RECORD DATA FROM RECALL INTERVIEWS ON PHYSICAL ACTIVITY

DAY: SA SU M T DATE RECALLED: ____/____/___ DAY OF WEEK RECALLED: M T W
START TIME: _ ____:_____ (24-hour clock)

	Quick list	Time	Place	Description of Activity	Duration (mins)	Intensity (tick)			Activity monitor on? Yes/no

APPENDIX I
FORMS USED IN ACCELEROMETRY SUB-STUDY

Today your child has been given an activity monitor to wear over the weekend until Wednesday morning. This device will measure your child's movement and tell us how much activity he or she has done over the course of the 5-day period.

The activity monitor has a small computer chip and measures a lot more than a step-counter! It should remain affixed to the belt it comes with to prevent it from being lost. Please find below a list of instructions to help you and your child best wear the activity monitor.

1. **Proper Use.** The activity monitor should be worn with the belt around the hips. In particular, the small device itself should ride just on the child's hip bone in front. This is important as the device measures activity best when it sits on the hip bone. The belt should fit snugly so it doesn't bounce or jiggle with your child's movement.

2. **Sleeping.** At night, the monitor should be taken off and stored somewhere safe, but also some where your child will remember to wear it again in the morning. This will prevent any movement being recorded, as it will record 24 hours a day.

3. **Bathing/Swimming.** The activity monitor should not be worn whilst swimming or bathing. Simply take it off during swimming and bathing and put it back on immediately after.

We have given your child a logbook to complete. Each time your child is meant to either put on or take off the monitor, he or she may ask you for a sticker (attached). He or she may then put that sticker in the logbook to show us that the monitor has been worn correctly. Once the monitor has been brought back, we will give your child a reward for the great effort made!

Finally, your child will be called out of class Monday, Tuesday and Wednesday before school dinner for about 20 minutes each time. They will be asked some questions about the activity they did over the 5 days, and about what foods they have eaten as well. We will collect the monitors at the last meeting on Wednesday.

Project Investigator: Ms. Emily Henderson, Department of Anthropology, Durham University 0777 43 2878
Project Supervisor: Dr. Tessa Pollard, Department of Anthropology, Durham University 0191 334 6186
Address: Department of Anthropology, Durham University, 43 Old Elvet, Durham DH1 3HN

Body Composition, Diet and Exercise in Middlesbrough Children

DIET AND PHYSICAL ACTIVITY QUESTIONNAIRE FOR FOOD PREPARER OF HOUSEHOLD

Thank you for completing this questionnaire.
Please make sure you answer ALL questions on BOTH of the following pages.

What is your child's full name? ____

When was your child born? Day__________ / Month__________ / Year________

What is your relationship to your child (please circle one)? Mother Father Guardian Other___________

Are you the main preparer of food for your child? Yes ☐ No ☐ If no, who is?___________________

1) Do you think your child may have a problem with obesity and risks for diabetes and/or heart disease?

Yes ☐ No ☐

2) Do you think you may have a problem with obesity and risks for diabetes and/or heart disease?

Yes ☐ No ☐

3) Please tick **ANY** of the following you think influence whether someone develops diabetes.

☐ Genetic inheritance (passed from parents to children)

☐ From eating too much sugar

☐ Child birth

☐ Not enough physical activity

4) Please tick **ANY** of the following you believe to be symptoms associated with diabetes.

☐ Frequent urination

☐ Thirst

☐ Tiredness

☐ Malaise

☐ Headaches

☐ Elevated blood sugars (from tests)

☐ Central obesity (fat around the stomach)

☐ Don't know

5) Please tick **ANY** of the following you believe to be a health consequence of diabetes.

☐ Blindness

☐ Loss of sensation in hands and feet

☐ Amputation (surgical removal of hands or feet)

☐ Decreased immune function

☐ Don't know

6) Please tick **ANY** of the following you think influence whether someone develops coronary heart disease.

- ☐ Smoking
- ☐ No exercise
- ☐ Dietary fat
- ☐ Dietary salt
  Stress
- ☐ High blood pressure
- ☐ Cholesterol
- ☐ Diabetes
- ☐ Family history
- ☐ Age
- ☐ Male gender
- ☐ Obesity / over weight
- ☐ Do not know

7.) Please tick **ANY** of the following you believe to be symptoms associated with coronary heart disease.

- ☐ Chest pain
- ☐ "Attack"
- ☐ Sweatiness
- ☐ Palpitations
- ☐ Anxiety
- ☐ Headache
- ☐ Trouble Breathing
- ☐ Do not know

8) Please tick **ANY** of the following you believe to be a health consequence of coronary heart disease.

- ☐ Arterial blockage
- ☐ Chest pain
- ☐ "Malfunction" of the heart
- ☐ Valve problem
- ☐ Surgery
- ☐ Death
- ☐ Do not know

9) As the food preparer in your home, please tick the following you would include in a balanced meal for your family on a **REGULAR** basis (daily).

- ☐ Whole grains (e.g. brown bread, roti, porridge)
- ☐ Fruit (e.g. apples, bananas)
- ☐ Vegetables (e.g. salads, peas & carrots)
- ☐ Low-fat meat (e.g. fish, chicken)
- ☐ Pulses (e.g. lentils, beans)
- ☐ Milk products (e.g. skimmed milk, low-fat yoghurt

10) If you do not always manage to include what foods you consider to be balanced above, please tick the **ONE MAIN** reason not:

- ☐ Availability (e.g. seasonal, unable to find in Middlesbrough)
- ☐ Too expensive to purchase
- ☐ Not enough time to prepare
- ☐ Not to my child's liking
- ☐ Not to my own liking
- ☐ Can't always get desired Halaal foods (when on holiday, away from home)
- ☐ Not sure what a balanced meal is

11) The Department of Health recommends a minimum of 30 minutes per day of physical activity in order to maintain a healthy lifestyle. How often do you exercise a minimum of 30 minutes a day in an average week?

- ☐ 30 minutes per day, 1-2 days per week
- ☐ 30 minutes per day, 3-4 days per week
- ☐ 30 minutes per day, 5-7 days per week
- ☐ Less than 30 minutes per week

12) If you don't engage in at least 30 minutes of physical activity per day, what might prevent that from happening (please select **ANY**)?

- ☐ Lack of time
- ☐ Lack of money/resources
- ☐ Feel awkward exercising
- ☐ Don't know how to start/maintain a routine
- ☐ Not a common thing to do amongst my friends / family / community
- ☐ Feel unsafe
- ☐ Don't like physical activity

13a) Would you like the opportunity to learn more about diet and exercise, and how they relate to diabetes and heart disease?

☐ Yes ☐ No

13b) If you answered *yes* above, do you think the opportunity to learn more would help the way you manage diabetes and heart disease, either for prevention or treatment?

☐ Yes ☐ No

14) Does your child have any medical condition you would like to share with us? Yes ☐ No ☐

If yes, please state:____

Thank you for completing this questionnaire—please have your child return it in the envelope provided to us along with your child's logbook on Wednesday.

Activity Monitor Diary

Name:________________

Year:_________________

Teacher_______________

TUESDAY

Morning:	Good Morning! Don't forget to put your monitor on first thing!	☺
Bath: (optional)	Take the monitor off beforehand	☺
	Put the monitor back on afterward	☺
Swim: (optional)	Take the monitor off beforehand	☺
	Put the monitor back on afterward	☺
Bedtime:	Take the monitor off beforehand. Last night before you return your monitor!	☺

APPENDIX J
QUESTIONNAIRE USED IN EXIT INTERVIEWS ON LIFESTYLE SUB-STUDY

1.	Did you enjoy wearing the monitor and participating in the recalls? Explain reasons why or why not
2.	What did your family and friends think about you wearing the monitor and participating in the recalls?
3.	Have you heard of 'five-a-day'? Do you like fruit and vegetables? Why/why not? Do you choose to eat fruit or vegetables at dinner time or any other time? Do you buy snacks for yourself after school? Do you get to help yourself to food out of the fridge, cupboards etc., or do your parents control what you eat?
4.	Are you involved in or any organised activity, like after-school sport or dance? If no, would you like to be?
5.	What other things might you do in a day instead of physical activity?
6.	What do you know about diabetes and heart disease? What do you know about healthy eating and exercise? Why is it important?
7.	Have there been any changes for you after having worn the monitor and been asked about your diet [Do you think you might try to be healthier in the future?]

APENDIX K

TECHNICAL ERROR OF MEASUREMENT EQUATIONS

Technical error of measurement (TEM) can be calculated in order to assess both intraobserver and interobserver error. The equation taken from (Ulijaszek and Kerr 1999) is

$$\text{TEM} = \sqrt{(\sum D^2 / 2N)}, \quad \textbf{(1)}$$

where D is the difference between measurements and N is the number of individuals measured. There are reference values for the maximum acceptable TEM for various measurements, but not for height and weight (Ulijaszek and Kerr 1999). Furthermore, they do not take into account the age dependence of TEM (Lourie and Ulijaszek, 1997). For this cohort of children of various age ranges, it was necessary to use analytical tools that would produce results independent of age. To compare TEM between various types of measurements, Ulijaszek and Kerr (1999) recommend calculating the coefficient of reliability, R

$$= 1 - ((\text{Total TEM}^2) / SD^2). \quad \textbf{(2)}$$

Total TEM

$$= \sqrt{((\text{TEM}_{(intra1)}^2 + \text{TEM}_{(intra2)}^2 / 2) + \text{TEM}_{(inter)}^2)}, \quad \textbf{(3)}$$

where $\text{TEM}_{(intra1)}$ is the intraobserver error for the first observer, $\text{TEM}_{(intra2)}$ is the intraobserver error for the second observer and $\text{TEM}_{(inter)}$ is the interobserver error between the two observers.

APPENDIX L
LETTER GIVEN TO PARENTS WITH RESULTS OF CHILDREN'S ANTHROPOMETRICS

Dear Parent / Guardian of

____

I write to inform of the health-related measurements we took for your child.

Blood pressure is usually low in children of this age. BMI (body mass index) provides a measure of whether your child's weight is appropriate for his or her height.

Please review your child's measurements:

Blood Pressure

__________ / __________mmHg, which is Normal / Above normal

Body Mass Index (BMI)

__________kg/m^2, which is Healthy / Overweight / Obese

A normal measurement for blood pressure for your child is below 120/80. A healthy BMI (body mass index) depends on your child's age and gender.

Your child's measurements indicate that you **SHOULD / SHOULD NOT** seek a GP's advice.

If you have any further questions, please do not hesitate to contact me.

Yours Sincerely,

Emily Henderson