Childhood Obesity in Bangladeshi Immigrants: A biocultural investigation

MCCLURE, ERIKA,IOLANTHE

MATERIAL ABSTRACT

Childhood obesity is a problem of increasing concern worldwide. The causes of obesity are complex and varied, but it is clear that there are biological, genetic and social determinants. The Childhood Obesity in Bangladeshi Immigrants project aims to further understand how cultural and biological factors interact in a population at increased risk for obesity-related metabolic diseases.

Research was based in neighbourhood primary schools and was centred on pre-adolescent girls, aged 10-12, in a Bangladeshi migrant community in the city of Sunderland in the northeast England, and white British girls of the same age, socioeconomic status and geographical location. Diet and eating behaviours were assessed using 1) a series of school lunchtime observations 2) a single 24-hour photographic food diary, and 3) researcher-administered questionnaires. Physical health has been assessed through height, weight and waist circumference measurements, health histories (as given by parents) and saliva samples for evaluation of bodily inflammation via CRP assay. In concert with these collected data, interviews with school staff, and further questionnaires and focus groups with children and parents were administered on the topics of eating and health beliefs and behaviour.

A much greater number of study participants in both cohorts were identified as at risk for metabolic disease by waist circumference measurement than identified as overweight or obese by BMI (18/20 vs 6/20 for the Bangladeshi-British cohort, and 17/20 vs 11/20 for the white British cohort). A significant positive correlation was found between CRP levels and waist-to-height ratio in white British participants ($p=0.006$). Fruit and vegetable intake was markedly lower in the Bangladesh-British cohort during school hours: 15 servings in 40 lunches vs 40 servings in 52 lunches in the white British cohort. However, food diaries reveal that over the whole day intake is similar in both groups (median intake of 1 serving of vegetables and 2 of fruit per day for Bangladeshi British participants, and a median of 0.5 servings of each for white British participants). Cohorts engaged in very different types of physical activity outside of school hours, with Bangladeshi-British subjects engaging primarily in casual play and white British subjects primarily engaged in formal lessons or team sports. It was also found that the school lunchroom environment has significant impact on the amount and types of food consumed during the lunch period, and it appears that certain types of room arrangements are more conducive to healthy eating than others.

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Erika Iolanthe Brockfeld McClure

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Durham University

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DECLARATION

I declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person, except where due acknowledgement has been made in the text. A previous version of the systematic review included in this thesis was submitted by me as my dissertation for MSc in Medical Anthropology at Durham University, in preparation for the commencement of work on this PhD. The systematic review has been fully updated prior to its inclusion in this thesis.

STATEMENT OF COPYRIGHT

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CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

Childhood obesity is a problem of increasing concern worldwide. Long a problem of wealthy, developed nations, it appears to be a by-product of globalisation, and obesity now coexists with undernutrition in developing countries (Bell and Popkin 2001; Shafique et al. 2007; Jehn and Brewis 2009). The causes of obesity are complex and varied, but it is clear that obesity has genetic, developmental and social determinants. For South Asian immigrants in the United Kingdom, the move to the obesogenic western environment (Swinburn et al. 1999) appears to have exceptionally deleterious health consequences: there is a higher incidence of both diabetes mellitus II (DMII) and cardiovascular disease in obese South Asian populations than obese European populations in the UK (Kopelman 2000). It has been found that for any given value of BMI, people of South Asian ethnicity have a higher degree of abdominal obesity and adiposity and lower muscle mass than white Europeans (Bhardwaj et al. 2008).

This project is a biocultural, cross-sectional investigation into how diet, food habits and health beliefs relate to obesity and overall health in Bangladeshi immigrant girls, aged 10-12, and their white British counterparts. The project focuses solely on girls for a number of theoretical, practical and methodological reasons. South Asian women face an increased risk of diseases associated with obesity and metabolic syndrome compared to other women. Additionally, South Asian Muslims tend to have a high degree of social sex segregation from adolescence onwards (Mohammad 2013). As a female researcher with female research assistants, I was better able to engage with girls, and they felt more comfortable being measured and questioned in a single gender environment. Further, Bangladeshi girls are more likely to be involved with cooking and the domestic sphere than their male peers. Therefore,

their preferences and opinions about food and nutrition will not only shape their own lives, but the lives of generations yet to come. This project has been designed to take into account the influences of the sending (Bangladeshi) culture as well as the process of immigration and enculturation into the receiving culture, where children are often more exposed to new sociocultural ideas than other members of their families (Gold 2007).

The first section of this introductory chapter will outline the various theoretical approaches employed to approach this project from biological anthropology and sociocultural anthropology. Following this outline, there will be a section discussing childhood obesity and its health implications which will also give a background to the nutritional assessment methods used in this thesis, including anthropometric measurements and dietary assessment methods. The third section of this chapter will discuss UK school food policy and its aims, and the final section will discuss the history of the study population and its setting.

A. The biocultural approach: an amalgamation of theories

The biocultural approach understands human beings as shaped by biological, environmental and sociocultural factors (McElroy 1990). This integrated thinking, as McElroy goes on to discuss, requires more than supplementing a quantitative study with ethnographic inquiry, but instead demands rethinking basic assumptions at the point of study design. Goodman and Leatherman (1992) advocated a new biocultural synthesis based on the political-economic perspective of anthropology, where local environments are examined, and ethnographic research is then interpreted through the lens of those existing political and economic factors. Dressler (2003) argued that socioeconomic disparities had to be recognized as culturally meaningful in order to have a biological impact.

The use of the biocultural approach has been particularly fruitful in medical anthropology. Previous approaches in this subfield were found to be too simplistic, focusing on the pathogen as the only cause of disease. Redefining research variables to include the socioeconomic context, and studying a population more holistically, rather than just individual aspects, allowed researchers to consider the non-biologic insults that are important to the disease process. These include physical trauma and the factors that lead to it, chemical pollutants, and psychological factors, as well as the realization that cultural systems can either protect or expose a population to certain diseases and insults. Furthermore, coping and adaptive behaviours occur at both macro and micro levels. Indeed, Leatherman and Jernigan (2014) suggest that medical anthropology was, in part, founded on the premise that "human health and health disparities are shaped by interwoven biocultural processes operating at multiple levels, and best understood through a combination of humanistic and scientific perspectives…" (Leatherman and Jernigan 2014: p171). Using biocultural theory as a guide to bring together both the biological and the cultural, and societal, familial and individual levels of inquiry, a number of theoretical approaches formed the basis of the design of this project.

1. Biocultural perspectives on nutrition and fatness

Aside from innate preferences for sweet and fatty foods, the human diet appears to be primarily shaped through the ability to learn what is good to eat from both the natural and social environments (Birch 1999; Pollard 2008; Turner et al. 2008). Therefore, to understand how obesity is becoming such a global problem, we must turn to biocultural perspectives on diet and obesity. The biocultural approach acknowledges that social aspects are instrumental

in shaping behaviour; but practices must also fulfil biological needs (Armelagos 1987) and cultural, social and biological aspects of the human experience cannot be viewed separately (McElroy 1990; Armelagos et al. 1992).

Much has been made in recent years of how the modern western diet is poorly matched to our 'Palaeolithic' bodies. Researchers have been attracted to both exploring and critiquing the idea that a return to a diet from some point of in our evolutionary history is the answer to the problems of obesity and other diseases of westernization (Eaton and Konner 1985; Bogin 1998; Milton 2001; Turner et al. 2008). The balance of the available literature does not appear to support the idea that there is a single optimal human diet, per se. Rather, the best diet for humans, and one that is protective against western diseases, is one that is highly varied in composition, coupled with a highly active lifestyle (Eaton et al. 1996).

Turner and Thompson (2013) provide an interesting critique of Eaton and Konner's idea of our current diet being mismatched with our Palaeolithic bodies. They believe that the concept of mismatch relies on a few assumptions: 1) human diet in our evolutionary past was essentially universal, 2) that humans are genetically unchanged since the Paleolithic era, and 3) human dietary behaviour is primarily shaped by genetic mechanisms. The authors suggest that these assumptions obscure the inherent flexibility of the human diet throughout its evolution. They also critique the idea that the advent of the agriculturally-based diet is directly linked with diseases of civilization, pointing to modern hunter-gatherer groups that subsist on a diet high in cultivated cereal grains who still remain relatively free of obesity and metabolic diseases. However, while modern hunter-gatherer groups may not suffer from diseases of civilization, the archaeological record suggests that the transition from hunter-gathering to agriculture caused a decreased average lifespan, and modern hunter-gatherer and

pre-industrial groups tend to have lower blood pressure and persistent insulin sensitivity as compared to western populations (Carrera-Bastos et al. 2011).

It appears that it is not simply the gross energetic abundance in modern westernized countries that is to blame for the dramatic rise in obesity and related diseases, nor is it the lack of specific foods or incorrect proportion of food types consumed. Instead, it appears to be an interaction of markedly reduced activity levels (Winterhalder 1987) and a diet that is, evolutionarily speaking, incredibly narrow (Larsen 2001; Mysterud et al. 2008; Turner and Thompson 2013) with highly-processed cereal grains instead of fruits and vegetables comprising the bulk of carbohydrate intake (Eaton et al 1996). Additionally, both hunter-gatherer and traditional agriculturist diets were distinctly higher in fibre than most modern diets. Improved milling and processing in post-industrial societies, however, has allowed a more comprehensive absorption of nutrients from foods consumed, thus compounding risk of obesity in an age of extreme energetic excess (Eaton et al 1996; Strassmann and Dunbar 1999; Wrangham 2009).

Fat storage has been advantageous for almost all of our evolutionary history, allowing survival through lean times and increased fecundity (Power and Schulkin 2009). It is only very recently that energetic environments have become so plentiful. In western environments and also in parts of the developing world, foods that are high in fat and sugar and low in fibre are readily accessible, and are coupled with increasingly sedentary lifestyles that are not only possible but encouraged (Brewis 2003; Ulijaszek and Lofink 2006; Mungreiphy and Kapoor 2010).

It is this obesogenic environment which faces not only people in developed but also developing nations. Obesity risk is a complex interaction of the biological, the environmental, and the cultural. Therefore, a biocultural approach, investigating all of these aspects of risk, is necessary in order to fully investigate it. In anthropology, the biocultural approach can be used to understand those factors "that have made fatness-related traits to be advantageous across evolutionary time and in relation to cultural change" (Ulijaszek 2008 p37S). Political economics and culture are interacting to create environments that are obesogenic, and biocultural studies investigate how humans respond to that environment. There is an indication that the ability to become obese is universal (Ulijaszek and Lofink 2006), so in obesogenic environments the question could be why certain individuals do *not* become obese, rather than why those who are obese have become so.

2. Life History Theory

Life history theory (LHT) comes from biology, and was developed to help explain variation in the timing of growth, development, fertility and mortality of organisms. Variations in life events are studied in order to understand how specific behaviours have evolved through natural selection and other evolutionary forces. Each species has developed its own life history traits that mark out the life course from conception to death.

What combination of traits will optimize survival and reproductive success in an organism? Classical LHT makes a simplifying claim: that only two things must be understood in order to understand the evolution of life histories. The first is how the external environment affects survival and reproduction, and the second is how traits are interconnected, and how internal constraints on an individual organism can vary.

In a given organism, there is a finite amount of resources to be used over the course of the lifespan, and energy used for one purpose cannot be used for another. Somatic resources can be used for maintenance and repair, growth, storage or reproduction. Resources allocated to aid in reproduction, for example, cannot be used for maintenance and repair and can therefore detract from an organism's longevity, while resources devoted to a current reproductive event cannot be devoted to any future reproductive effort. Therefore, trade-offs must be made between traits, as maximum effort can never be placed in any one area (Stearns 1992; 2000). These 'decisions' regarding energy investment are made variously at molecular, physiological and behavioural levels (Hill 1993).

Like all other living organisms, humans are not 'designed' to maximise their lifespan. Rather, reduced longevity is taken in exchange, to some degree, for increased reproductive ability. LHT can be used to understand why the human life course is different from our primate relatives, and can also help to explain why trade-offs occur that have long term consequences for a seemingly smaller short-term gain (Kaplan et al. 2000). Bogin et al (2007) have identified a number of biocultural domains that exert influence on human life history: phylogeny, ecology, social/economic/political, and family. The neuroendocrine system is the link between these systems and the soma, affecting the timing of stages of growth and reproduction, and the tradeoffs that occur.

i. The Effects of Birth Weight and Early Life Growth Trajectory

Life history theory tells us that any organism has only a finite amount of energy available for growth, maintenance and reproduction over its lifespan. Due to this limited resource availability, energy allocation adjusts itself in response to environmental and ecological

factors, and phenotypic adjustments in response to these factors vary over a lifetime (Hill 1993). Occasionally, adjustments will be made that are antagonistically pleiotropic, or rather, beneficial for the juvenile with costs experienced later in life. The developmental programming hypothesis states that insults during various stages of development can manifest later in life as adult disease. Numerous animal models suggest that obesity has its roots in early development (Vickers et al 2005; Vickers 2007; Taylor and Poston 2007).

It has been recognized for some time that babies are often born small for gestational age, are frequently also "thin-fat," with a higher proportion of subscapular/visceral fat on their bodies than other babies of the same size (Yajnik et al 2003), and South Asian babies have been found to be of low birthweight with higher frequency than white babies (Seaton et al. 2011; Leon and Moser 2012). This thin-fatness has often been attributed to a poor or uncertain gestational environment, but more recent studies have also found increased visceral adiposity in babies of well-nourished mothers (Monteiro and Victora 2005). It has also been found that overnutrition during critical phases of development can result in deleterious metabolic effects (Misra et al. 2007). It is of concern because this increased central adiposity appears to persist throughout the lifespan.

Additionally, in well-resourced environments, babies that are born small for gestational age tend to follow what is called a catch up growth trajectory, where they rapidly gain weight through infancy and toddlerhood, not in line with standard growth curves. This period of catch up growth seems to be strongly associated with both childhood and adult obesity (Fall 2004; Monteiro and Victora 2005). South Asian immigrants have displayed a tendency toward small for gestational age babies and catch up growth trajectories extending into second- and third- generation mother-baby pairs (Fall 2004).

3. The Anthropology of Food

Given biocultural understandings of how people choose their foods, it is appropriate to turn to the sociocultural literature on food to better frame an investigation into how food is conceptualized, and how these conceptualizations are transmitted among and between groups.

Krondl and Coleman (1986) discuss various social and biocultural aspects of food selection, especially as they are related to trade and market availability. In resource-rich environments, biocultural factors of food selection include perceived healthfulness, real or perceived adverse reactions, and the sensory-related aspects of foods. Interest in the health attributes of food tends to increase as an individual ages, and associations made between food and health are influenced by social, cultural and historical factors. The authors note that food diversity varies widely between nations, and this variability is largely influenced by wealth. In developing nations, once food sufficiency is attained, increased income will then come with a commensurate increase in food variety. In low income countries, a rising household income will first increase consumption of staple foods, and then eventually lead to an increase in other, 'luxury' foods from fruit to convenience items. Conversely, in higher income countries, an increased household income will cause a reduction in consumption of staple goods as consumption of luxury foods increases. Krondl and Coleman make a distinction between what they call internal poverty, or a psychological inability to provide for the future, and external poverty, or poverty that is typically caused by a temporary constraint in finances. Those living with internal poverty tend to utilize convenience foods, which, while being less nutritious, generally provide pleasure through their flavours and perceived variety. When income increases, those suffering from internal poverty will not necessarily undergo a change in philosophy and these individuals will generally retain their learned habits. In contrast,

individuals suffering from external poverty live outside this 'culture of poverty, and when their income increases, their diet diversifies and improves its healthfulness. The authors also note that for immigrants moving from developing to developed nations, the new food environment in which they find themselves often allows access to cheap, energy dense foods that are high in fat, sugar and salt. Further, second generation immigrants often have markedly decreased vegetable consumption compared to their parents.

Carole Counihan's (1999) primary focus of research is what she terms "foodways", which she defines as all the beliefs and behaviours that are involved with the production, preparation, service and consumption of foods. In the case of migrants, food and food preparation of the community and its inhabitants must adapt for a number of reasons: availability of traditional ingredients, access to convenience foods and restaurants, the pace of life in the new country, differing ideas about the role of women in the home, and how changed ideas affect who controls the domestic sphere. All of these have influenced the way people eat and how they view food, and together point to an intersection of economics, gender, power and tradition.

In *Around the Tuscan Table* (2004), Counihan details her experiences in Florence, Italy, where she spent two years gathering what she called 'food-centered life histories' of 23 Florentines. She views food as the voice of modernity, or the processes through which the western world was changed in the twentieth century (Counihan 2004). Foodways are also considered a voice of family and gender, exposing relations through gendered roles in production and reproduction. The term production is used to describe the work necessary to ensure survival (the earning/acquiring of money, producing goods in and outside of the home, etc) while the term reproduction is used to describe the physical, mental and emotional work

of rearing offspring (Counihan 2004). In addition, Counihan identifies the ways in which food can be used to define and maintain cultural identity, keeping people linked in small and large ways, noting how this cultural identity varies between social classes and geographic distribution.

The evolution of food production and consumption in refugee and migrant populations living in western countries has been the focus of much research. Abby Lynn Gold's (2007) doctoral dissertation explored changes in food consumption patterns over time in several refugee populations in the northern United States, noting that food patterns can mimic a family's overall interaction dynamics. Gold found that, while younger adolescents expressed a strong preference for American food, especially fast food and packaged convenience food, older adolescents and young adults indicated preference for foods traditional to their country of origin and began integrating traditional foods and dishes with American fare. In addition, acculturation seems to involve the adoption of more typically American consumption habits: three meals a day, with the largest in the evening (Gold 2007).

Harbottle (1997) investigated how continuity and change in the food habits of Iranian immigrants to Britain is influenced by embodied beliefs about taste and culture. Harbottle identified certain "flavour principles" that dominate the Iranian palate both in Iran and in Britain, while also determining in which ways immigrants' tastes are changed through exposure to both British food and the necessary variations on traditional Iranian food due to ingredient availability.

In "Eating American" (2002), Sidney Mintz explores the question of whether the United States has a 'cuisine' and seeks to "typify American eating habits." He discusses the

implications of regional specialty foods being nationally available, and seeks to define the typical American food profile, summarizing it as "high in animal protein, salt, fats, and processed sugars while low in fresh fruits and vegetables" He also brings to the fore the notion of 'time' and how the perception of a lack of available time, rather than its actuality, affects how Americans consume, and how and when they do (or, more specifically, do not) prepare their own foods (Mintz 2002). Mintz suggests that, because: a) Americans are made to feel by wider society that their time is constantly at a premium, and b) consumption of processed convenience food has become so common, that is has become normal and necessary to default to pre-prepared convenience foods, which are typically high in fat, salt and sugar. While Mintz was speaking specifically about the US, his assessment is applicable to westernized diets as a whole as the American model exports itself around the globe, including the UK. It is this type of food environment which immigrants to the UK face.

In *In the Active Voice* (1982), Mary Douglas notes that one of the assumptions of cultural anthropology is that human behaviour is a patterned activity, and these patterns are strongly affected by political economy. She claims that behavioural patterns that are clear and stable enough to be identified by researchers have a commensurately stable distribution of social power, and as the distribution of power changes, so will the cultural patterns affected by it. Each family; (or here, each school) will develop a regular pattern of food and mealtimes, and what constitutes ordinary food and celebratory food. Douglas views food as "the medium through which a system of relationships within the family is expressed," and in the context of this research, the same view can be applied to a school. The family food system is impacted by many outside influences and overlapping food systems: here, it is the school food system that is impacted by a multitude of overlapping food systems, primarily those of the families

who send their children to the school in question. The relationship between schools and the wider social environment is also discussed in the school food policy section of this chapter.

Goode et al.'s 1984 study provides a useful framework for the study of food and migration. Following Douglas (1982), as above, the authors sought to investigate and explain the nature of a food behavioural system. Their primary concerns were the determination of any internal logic inherent in the food system, how it relates to other cultural subsystems (e.g. religion and health beliefs) and how external factors enact change within the system. There was an initial supposition that food systems were socially transmitted, and that these social rules were common within a community. This supposition is made in large part because food is often utilized in the underscoring of social relationships. The structure, approach and implementation of this study are valuable in developing an investigation into how ideas about food (and health) are culturally transmitted.

i. Relationship between nutrition beliefs and food consumption

The relationship between beliefs about nutrition and consumption patterns does not appear to be direct or universal. Leanne Birch's (1999) work on the development of food preferences is very useful in understanding this complicated relationship. Food neophobia, or fear/avoidance of new foods, is a common trait amongst all omnivores, including humans. This trait is protective, as consumption of unknown foodstuffs can be life threatening. Given that most omnivores require a varied diet, this tendency toward neophobia must work in concert with social learning and association mechanisms to develop both food preferences and avoidances (Birch 1999). Under the age of four, familiarity is the primary motivating factor in food choice, whereas children over age four, while retaining the tendency to reject

the unfamiliar, identify sweetness as their primary choice motivator, while mother's food choice, media and peer influence also play roles in the way children decide what foods to eat (Birch 1980; Birch and Fisher 1997; Birch 1999; Peters et al. 2012). Food aversions often form quite quickly, especially to novel foods, and/or when seemingly tied to a negative consequence such as illness, and learned aversions are not easily extinguished. Learned preferences develop more slowly, through repeat exposure, are more precarious than aversions, and can be extinguished by a single bad experience with a particular food. Ultimately, attempts to exert control over a child's diet often have the reverse effect, and can negatively affect the child's diet in the long term (Birch and Fisher 1997; Birch 1999; Peters et al. 2012). However, parent-child preferences become more similar as the child approaches adulthood (Birch 1999).

Glanz et al. (1998) found that for adults, taste was the biggest predictor for food choice, over nutrition, cost, convenience and weight control. This predictor did not vary significantly with age or income level, but it appeared to be more important to women than men and less important to whites than other ethnic groups. Demographic factors remained a fairly significant predictor of how individuals weighed these five factors. Overall, while taste was the most important predictor in the selection of foods, all five factors (taste, nutrition, cost, convenience and weight control) contributed to an individual's decision making process.

4. Transnational Migration

At one time, the focus of migration studies was primarily on the appeal of the new location and how and why immigrants became acculturated and assimilated into that new location's

culture (Gardner 2005; Zimmerman 1996). Lately there has developed a more globalized view, however, one that takes the entire process of migration more thoroughly into account.

Gardner (1995) suggests that rather than diasporas being caught in between their sending and receiving cultures, instead migrants are part of wider, interconnected network that spans from their original country to the new one in which they are now building their lives. The individual identities and lives of migrant groups are constantly changing, and likewise their sending communities are also very dynamic. Gardner characterizes migration as a process that involves remaking oneself and one's community—not once, but continually over time.

Aihwa Ong (1999, 2003) has led investigation into the area of transnationality, wherein the dynamics between both countries sending and receiving migrants are studied in equal part. She characterises transnationality in terms of Foucault's governmentality, the technologies through which people come to govern themselves (Ong 1999). Ong (2003) explores not only how the lives and identities of Cambodian refugees in California have changed since coming to the United States, but also how their presence has modified the political and economic policies that are forcing change upon them. This new paradigm allows one to consider groups who do not fall into the purview of traditional immigration studies. Instead of viewing all migration in terms of pull factors and assimilation, migrant groups can now be considered in regard to what pushed them away and how they are able to maintain their cultural identity in the face of a new and dominant culture (Buff 2005). In *From Another Place,* Gillian Bottomley (1992) notes that migrants often must come to grips with new and pre-existing power relationships and ways of understanding and relating in their new environment. Additionally, after migration, women and other marginalised groups frequently

come to question long-established orthodoxies in their sending culture when they live in societies formed by migrants and/or people from a variety of backgrounds.

This paradigm shift also allows new questions with respect to food identity and ideas of health and body. Foodways are not simply to be considered as vestigial to the sending culture, something that will slowly fade away as the population becomes increasingly assimilated into the new dominant culture. Instead, one can now view food as a dynamic force in a community that provides not only insight to its past through traditions, but also clues to the present state of the community and the larger society as a whole. For example, the infusion of "Indian" cuisine into the mainstream British consciousness is largely the result of the Bangladeshi restaurant industry (Panayi 2008).

Himmelgreen and colleagues (2014) take a very biocultural approach to looking at the relationship between migration, globalization, diet and energy balance, using an ecological model of food and nutrition. They posit that the micro- and macro- level forces that inform diet are connected to global capitalism, neoliberal economic policies, migration, and culture. All of these forces are strongly linked to the nutrition transition, where a more traditional diet heavy in native cereal grains shifts towards a more western-style diet heavy in sugars and fat.

Ideas about food are often closely tied to culturally held beliefs about health and the body, both of which can be reshaped when migration occurs. Renzaho (2003) discussed how sub-Saharan African refugees coming to Australia faced these changing ideas, noting that larger body size in sub-Saharan Africa often denotes social status and wealth, instead of being viewed as indicative of a health problem. This perception of excess body weight is common in developing countries, including Bangladesh, where undernutrition is still an issue,

particularly the idea that a fat child is a healthy child, and that children should be fed in excess (Bhardwaj et al. 2008).

However, as a population moves through the 'nutrition transition' to increased energetic availability and decreased energetic demands, larger body size often comes to be viewed as a health problem and/or a symbol of lower socioeconomic status (Brown and Sweeney 2009). Understanding how and why these culturally held ideas are shaped and reshaped through migration are vital to any effective investigation into the sociocultural (as well as biological) influences on obesity.

5. Governmentality and Children

The concept of governmentality has its roots in historian, philosopher and sociologist Michel Foucault's work on the technologies of power. Foucault found the idea of governance to be inextricably linked to modes of thought; therefore, technologies of power and domination must be understood in concert with the political philosophies underpinning them. Broadly, governmentality is understood to be the techniques and procedures through which human behaviour is directed (Foucault 1991). This concept applies at all levels, from states to households, and in fact governmentality does not just mean the external governance of others from a top-down position of power, but also internal governance of self. A key feature of Foucault's idea of the technologies of power is that power exists at all levels of society, and these technologies influence individuals to self-regulate with what are called the 'technologies of the self.' Lemke (2001) characterizes this notion of self-regulation thus: a state or other governing body will make individuals (and smaller collective groups such as families and schools) responsible for such social risks as illness or poverty by reframing the

problem as one of 'self-care,' and therefore in the domain of the individual or group. In this way, societal responsibility for such problems is attenuated and instead falls under the moral/ethical responsibility of the individual as a member of that society.

Zivkovic and colleagues (2010) highlight this form of governmentality in their paper analysing print media representations of childhood obesity as it relates to parental neglect, subsequent to a widely reported article in an Australian medical journal suggesting that severe childhood obesity should be considered a child protection issue, as it may be the result of or compounded by poor parenting. Despite the original journal article's framing of childhood obesity as a multi-factorial issue caused by the confluence of a number of genetic, environmental and behavioural causes, the popular print media, when reporting on this matter, framed it almost entirely as an issue of failed parenting, and more specifically as a failure of mothers to properly feed and care for their children. Newspaper reports highlighted a gendered division of household labour, where women, as keepers of the domestic sphere, were singled out as being responsible for failing to provide healthy food and appropriate opportunities for exercise. Children were framed as 'docile bodies,' without agency or responsibility over their own actions, who are either protected or put at risk by the actions of their parents. In this discourse we can see the concept of technologies of the self in action. A complicated societal issue with many root causes is reframed as one of personal maternal responsibility. While ignoring the other potential root causes of obesity aside from poor parenting, this discourse also obscures a number of other issues: the fact that children are not passive receptacles to be 'managed,' and that there are any number of structural constraints upon mothers (such as lack of education, poverty, and poor support networks) that limit their ability to manage their children effectively. Children were seen as irresponsible and helpless vessels for their mothers' behaviour, and an obese child is seen as a visible and irrefutable

failure of parenting on the part of the mother, and one for which they may be legally responsible. These mothers' failure to govern their children's bodies successfully therefore puts them at risk of losing that authority to the state.

B. Obesity and health: definitions and measurement

1. Childhood Obesity and Health

Obesity and overweight during childhood and adolescence are most strongly associated with an increased risk for obesity in adulthood, which is closely connected to numerous health problems. Adult obesity, especially central or abdominal obesity, has multiple co-morbidities including coronary heart disease, osteoarthritis, sleep apnoea, fatty liver, diabetes mellitus II (DMII), increased risk of certain types of cancers and metabolic syndrome (MetS) (Kopelman 2000; Lawrence and Kopelman 2004). MetS is a term used to describe a cluster of symptoms including insulin resistance, hyperinsulinaemia (high levels of insulin), dyslipidaemia (high levels of triglycerides and low-density lipoprotein (LDL) cholesterol) and hypertension (Alberti et al. 2005; Carr et al. 2004; Pollard 2008). Obesity is also linked to increased levels of bodily inflammation, which increases a person's risk for a host of health problems (discussion to follow). This is not an exhaustive list of obesity-related pathologies. Given that it is difficult for obese adults to lose weight effectively or to maintain weight loss (Ebbeling et al. 2002), it becomes apparent how childhood obesity can contribute to major health problems later in life.

The relationship between childhood and adult obesity is not necessarily direct; many obese children do not grow into overweight or obese adults (Whitaker et al. 1997; Zemel and

Bardon 2001). However, as children enter into adolescence, becoming or remaining obese is a significant predictor of adult obesity (Whitaker et al. 1997; Deckelbaum and Williams 2001). An additional predictor of adult obesity has been observed in children: the age of what is known as 'adiposity rebound.' Body fat tends to increase from birth until around one year, and then decreases again until between six and eight years of age when it begins to again increase as the child heads into adolescence. It has been found that the earlier this rebound in adiposity level occurs, the more likely the individual is to have a high BMI later in life (Cameron and Demerath 2001; Malina 2001).

Craigie and colleagues (2011) conducted a systematic review of obesity related behaviours from childhood into adulthood. Two categories of behaviours were examined: physical activity and food consumption. Engaging in moderate to vigorous activity in adolescence (11-18 years) was found to be a significant predictor of a continuing active lifestyle 5 and 10 years later, and, for girls, being sedentary at age 18 was a significant predictor of remaining inactive into adulthood. Tracking food intake accurately into adulthood was difficult, largely due to the fact that questionnaires used for children had to be modified substantially to be appropriate for adults, but it was found that over-consumption of carbohydrates and fat in childhood was a significant predictor of continuing to over-consume these foods as adults.

In addition to the future health risks outlined above, childhood obesity has also been shown to have more immediate consequences. MetS has been found in children as young as five, although current definitions from the International Diabetes Foundation do not diagnose MetS until the age of ten. Children from ages five to ten can only be considered 'at risk' for MetS under these definitions (International Diabetes Federation 2007). DMII is becoming increasingly common in adolescents and children, along with associated problems such as

sleep apnoea and asthma (Ebbeling et al. 2002). Additionally, elevated LDL cholesterol levels and hypertension are now being found in overweight/obese children and adolescents (Deckelbaum and Williams 2001). The most common morbidities related to childhood obesity, however, are what have been termed psychosocial problems, which can include low or negative self-esteem, depression, anxiety, and withdrawal from social situations (Hill and Lissau 2002). These psychosocial problems often compound the problem of obesity, with the obese child avoiding engaging in physical activity where they fear ridicule from peers, and perhaps also turning to food for comfort (Dietz 1998).

2. Obesity and Ethnicity

Variation in obesity prevalence between ethnicities is a well-documented phenomenon. In the United States, incidence of childhood obesity is much greater in African Americans, Mexican Americans and Native Americans than whites, while incidence in 'Asian Americans' (a term usually used in the US to describe people of East and Southeast Asian origins, not South Asians) is much lower; South Asians as a group were not well explored in this study (Caprio et al. 2008). Further, Johnson et al. (2009) found ethnic disparities in the onset of the symptoms of MetS in at-risk adolescents, with African American youth having a relatively lower prevalence of MetS despite the presence of numerous risk factors, including high incidence of central adiposity. Similarly, Carroll et al. (2008) found substantial variation in visceral fat between ethnicities in men and women, despite similar BMI and waist circumference measurements.

Despite the obvious effects of environment, there also appears to be a marked genetic influence on susceptibility to obesity. Wardle et al. (2008) point out that, while the obesity

epidemic is due to drastic changes in the environment, individual variation in susceptibility appears to be due to variation across a large number of genes, each potentially exerting a small effect, and many of these small genetic effects may be related to appetite and satiety cues, in addition to genetic variation of the biology of fat storage. There is also some evidence that there are genetic influences that increase the risk of pre-diabetes and DMII, although at this time no genetic 'signature' for DMII has been identified. Regardless, it appears that there is a significant subset of obese and diabetic individuals that are biologically inclined toward these diseases (O'Rahilly 2009).

It has been found for that, for any given value of BMI, people of South Asian ethnicity have lower muscle mass, and a greater degree of abdominal obesity and adiposity than white Europeans (Bhardwaj et al. 2008). South Asians also appear to have a higher susceptibility to cardiovascular problems and MetS, suffer from *acanthosis nigricans* (a skin condition associated with insulin resistance), acne, and, in South Asian women, polycystic ovarian syndrome and hirsutism (androgenic body hair) to a higher degree than whites (de Silva et al. 2006; Grandhe et al. 2005; Misra et al. 2007). South Asian ethnicity has also been identified as a risk factor for DMII in overweight children (Ehtisham et al. 2000), and adolescent obesity has been shown to increase dramatically in second and third generation immigrants in western countries (Popkin and Udry 1998). These and similar findings have caused researchers to suggest that BMI cut-offs for South Asians should be lowered to reflect this increased risk (Weisell 2002) or, at the very least, interpreted with caution (Pařízková and Hills 2001).

A number of factors have been attributed to the sudden and swift increase in obesity-related health risks in South Asians, including urbanization, increased affluence of the middle class,

sedentary lifestyles, changes in the way food is produced and also changes in the amount of calorie-dense foods that are regularly consumed (Misra and Vikram 2008). As discussed below, there are also phenotypic and genotypic risks for obesity for South Asian populations.

3. Metabolic Syndrome in children

MetS has existed in the consciousness of medical practitioners for a number of years, although a single, global definition for MetS in adults was not developed until fairly recently (Alberti et al. 2005). Criteria for the diagnosis of MetS currently involve specific cut-off points in the following measurements: waist circumference, triglycerides, lowered high-density lipoprotein (HDL) cholesterol, blood pressure, and fasting glucose.

While this diagnostic definition was fixed in 2005, a similar set of criteria was not developed for children until more recently despite clinicians having noted the apparent presence of MetS in children as young as five (Ebbeling et al. 2002; Weiss et al. 2004). International Diabetes Federation (IDF) definitions, established in 2007, recommend that existing adult definitions are used for adolescents aged 16 and over, while setting new cutoff points in above-mentioned diagnostic areas for children aged 10 to 16. For children under 10, the IDF asserts that MetS cannot be diagnosed, but rather children who present symptoms should be followed closely.

Misra and colleagues (2007; 2008a; 2008b; 2009) have done considerable work investigating MetS in South Asians, including a comprehensive review of the topic in children and adolescents. They note that high adiposity and insulin resistance have been consistently recorded in Indians regardless of their geographic location, and that heightened

cardiovascular risk is frequently found in those with even a normal BMI and waist circumference. Furthermore, South Asian children were found to have a greater central adiposity than other ethnic groups, as well as a high incidence of insulin resistance. Misra and Ganda (2007) have also identified migration as an independent risk for the development of DMII and the MetS.

i. Inflammation

The impact of obesity on the body is augmented by the accompanying chronic low-grade bodily inflammation, which is key to the development of many obesity- related health conditions including cardiovascular diseases, DMII, and certain types of cancer (Visser et al. 2001).

The precise mechanisms through which these pro-inflammatory pathways are triggered and maintained are not yet fully understood; however, it is known that white adipose tissue is a key production site of inflammation-related proteins. It has been demonstrated that adipose tissue is infiltrated by macrophages, and this infiltration increases dramatically when an individual becomes obese (Wellen and Hotamisligil 2003). These macrophages are responsible for the overproduction of pro-inflammatory cytokines, such as IL-6 (interleukin-6) and TNF-$\propto$ (tumour necrosis factor alpha), both of which are also implicated in insulin resistance (Antuna-Puente et al. 2008).

Levels of bodily inflammation can be assessed using salivary C-reactive protein (CRP), which is produced in the liver in response to pro-inflammatory cytokines. While CRP is a nonspecific indicator of bodily inflammation (levels rise in the short term during infection), it

has also been found to be useful in identifying chronic inflammation (Brasil et al. 2007; McDade et al. 2010). Misra et al. (2007) has found evidence of a relationship between both generalized and abdominal obesity and elevated CRP levels in adolescent South Asian populations.

Serum CRP assay has a higher degree of sensitivity than salivary CRP, and is typically used in clinical contexts and some research contexts, when the taking of blood spots is possible and practical (Kao et al. 2006). Salivary assay of CRP is not as widely used clinically as serum assays, and it appears that the correlation between the two measures is uncertain (Dillon et al. 2010). However, salivary CRP has been shown to be closely related to BMI and DMII risk (Qvarnstrom et al 2010) and remains a useful and non-invasive tool to distinguish differences between groups.

4. Nutritional Assessment

i. Measures of obesity

Obesity has conflicting definitions, but generally both obesity and overweight are defined by the adiposity level of an individual being in excess of a pre-determined cut-off. The most common measurement used is the body mass index (BMI), which is calculated by dividing body weight by body height squared (kg/m^2). Measures are compared to a chosen reference standard. For children, these references standards are generally presented in the form of a sex and age specific growth chart upon which the BMI can be plotted and also tracked longitudinally. Overweight and obesity are then determined by plotting those measures and identifying where those measures exceed a set point on the selected reference (Cole and

Rolland-Cachera 2002). The use of BMI to identify obesity is not without its critics (see Rothman 2008 and Freedman and Sherry 2009 for further discussion of this issue), with the most compelling criticism being that BMI does not actually measure levels of adiposity in the body. Regardless, it remains the most widely used measure, at least in part because it is simple to assess (Brewis 2011). For children specifically, BMI has been found to be more accurate in those with higher adiposity, while it is less precise in relatively thinner children (Freedman and Sherry 2009).

Given the growing body of evidence that central adiposity is more related to obesity-related disease than is overall adiposity, it has increasingly been suggested that waist circumference (WC) is a preferable measure to BMI for the identification of health risk (Ferreira-Hermosillo 2014; Griffiths et al. 2011; Hirshler et al. 2005; Ness et al. 2006). WC requires no calculation; the WC measurement itself is compared to a reference standard to determine risk. In addition to being gender specific, and, for children, age-specific, it is important that these reference standards also be ethnic-specific as it has been shown that differing cutoff points are required to accurately reflect increased risk for various ethnic groups (Misra et al. 2005).

It has been suggested that use of the Waist to Height Ratio (WHtR) is preferable to BMI for screening for central obesity and those individuals at greater risk for related health issues (Ashwell and Hsieh 2005; Ferreira-Hermosillo et al. 2014; Li et al. 2013; Mokha et al. 2010). The value of WHtR is that it is easy to measure and calculate, more sensitive than BMI for capturing health risk, and provides a simple boundary value that can be used for men, women and children of all ethnicities. Overall, WHtR of 0.5 or greater is considered to be of increased risk for comorbidities with central obesity, meaning a waist circumference greater

than or equal to half of the individual's height (Ashwell and Hsieh 2005; Li et al. 2013), although Peng et al. (2015) also found a cutoff of 0.57 for severe central obesity.

ii. Assessment of food intake

Assessment of food intake in children has long been a challenge to researchers. Methods which are well-validated for use with adults are not always useful when working with children. McPherson et al. (2000) conducted a review of the validity and reliability of dietary assessment methods for children, reviewing dietary recalls, dietary records, food frequency questionnaires, diet histories and observation. The use of food frequency questionnaires is the most validated technique; however, dietary recalls and records are difficult to employ with younger children and estimation of portion size remained generally problematic even with older children and adolescents. McPherson and colleagues did note that all existing methods are problematic when it comes to differences in age, gender and ethnicity. Their primary recommendations were for new and modified approaches to the assessment of diet in school-aged children, and to call for new study designs to integrate age, gender and ethnicity, while acknowledging there is not, and will likely never be a perfect method of dietary assessment (McPherson et al 2000).

Other researchers have noted particular difficulties with dietary assessment for older children and adolescents. While, unlike younger children, children aged eleven and older typically have the cognitive abilities to conduct a dietary recall, they often lack sufficiently detailed knowledge of food and food preparation methods (Foster and Adamson 2014). Additionally, as children move into adolescence, they spend more time away from home and have more irregular eating patterns than younger children, which can make recall difficult. Adolescents

tend to underreport nutritional intake, and this underreporting increases with age (Boushey et al. 2009; Foster and Adamson 2014). Older children tend to find less novelty or enjoyment in keeping food diaries than do younger children, and often resent or resist parental assistance (Boushey et al. 2009).

Boushey and colleagues (2009) conducted focus groups with adolescents who had been participating in a metabolic study involving a variety of food intake assessment methods, and found that the use of technology helped to keep participants engaged. In particular, the use of cameras (both digital and disposable) to record foods consumed was met with favourability by the study cohort, with most participants reporting that the cameras were easy to use, and did not find the process burdensome or embarrassing.

C. School Food Policy

Current England school food guidelines came into force in January 2015. The guidelines set forth what foods should be provided daily and weekly during the school day, and also dictate what must be limited and avoided. Guidelines fall into six categories: 1) starchy foods, 2) fruits and vegetables, 3) dairy, 4) non-dairy sources of protein, 5) foods high in fat, sugar and salt, and 6) healthier drinks (Table 1). While the first four categories apply primarily to school lunches, the latter two categories apply through the entire school day.

Starchy foods • 1 or more portions per day • 3 or more different starchy foods per week • 1 or more wholegrain starchy foods per week • Starchy food cooked in fat no more than 2 days per week • Bread with no added fat must be available daily	**Fruit and vegetables** • 1 or more portions of vegetables per day • 1 or more portions of fruit per day • Desserts containing at least 50% fruit 2 or more times per week • 3 or more different fruits and 3 or more different vegetables per week	**Milk and dairy** • 1 portion per day • Lower fat milk must be available at least one per day (during school hours)
Non-dairy sources of protein • 1 portion per day • Meat or poultry 3 or more days per week • Oily fish 1 or more times per every 3 weeks • Non-dairy protein must be provided for vegetarians 3 or more days per week • Meat or poultry products (manufactured or homemade) no more than 1 day per week in primary schools, 2 days per week in secondary schools	**Foods high in fat, sugar and salt (applies to entire school day)** • No more than 2 portions of deep fried or batter coated foods per week • No more than 2 portions of foods including pastry per week • Only snacks allowed: nuts, seeds, vegetables and fruit with no added salt, sugar, or fat • Savoury crackers or breadsticks allowed at lunch, if served with fruit, vegetables, or dairy • No confectionary or chocolate • Desserts including cakes and biscuits allowed at lunch time, but must not include confectionary • No salt should be made available to be added to cooked food • Condiments must be served in portions no larger than 10g or 1 teaspoon	**Healthier drinks (applies to entire school day)** • Permitted drinks: ○ Water (still or carbonated), must be free and available for entire school day ○ Lower fat milk ○ Fruit or vegetable juice (150 mls) ○ Plain, calcium-enriched soya, rice or oat drinks ○ Plain yoghurt drinks ○ Combination fruit or vegetable juice mixed with plain water, no added sugars (330ml) ○ Combination fruit or vegetable juice mixed with lower fat milk, yoghurt, soya, rice or oat drinks or flavoured lower fat milk, less than 5% added sugars ○ Tea, coffee, hot chocolate

Table 1. Summary of 2015 school food guidelines (School Food in England 2015)

Since September 2014, all students in Reception and Years 1 and 2 receive free school meals. Schools are also required to provide free meals for all financially eligible students in all grades, and in cases where "it would not be unreasonable for lunches to be provided" (School Food in England 2015, p6). There is no requirement for hot meals, but hot lunches should be provided wherever possible. Additionally, facilities for students to consume packed lunches must be provided. Children aged 4-6 are eligible for a daily free piece of fruit through the School Fruit and Vegetable Scheme; however, schools are not required to participate in this scheme (School Food in England 2015). Schools that have 35% or greater numbers of students receiving free school meals are eligible for funding to institute a breakfast club through the registered charity Magic Breakfast Club, which provides porridge, cereals, bagels and unsweetened juice (Magic Breakfast Club 2016).

Prior guidelines for English schools were put in place in 2008 for primary schools and 2009 for secondary. These standards for school lunches fell into two major categories: food-based and nutrient-based. Guidelines were set for children based on sex and age, with separate guidelines for boys and girls ages 4-6, 7-10, 11-14, and 15-18 (Parliamentary Office of Science and Technology 2009).

Food-based guidelines set forth specific portion sizes for each of the age groups. Guidance was also provided on the frequency of providing some foods. Many of these guidelines are the same as those detailed above in Table 1, with a few exceptions: meat products were only allowed once per fortnight (as opposed to once per week currently), while starchy foods cooked in fat were allowed to be served three times per week (two days per week currently). Additionally, current guidelines call for variety: three or more types per week of the categories of starchy foods, and fruits and vegetables must be served. Current guidelines also

limit the amount of fruit and vegetable juices (150ml) and combination drinks (330ml), which were not specified in the 2009 guidelines.

The second component of the 2009 guidelines, which is not included in current requirements, were the nutrient-based guidelines. These included overall energy (kilocalorie) intake for school lunches. For primary school students, this was 530kcal ± 5%. There were also maximum amounts set for fats, saturated fats, salt, and added sugars, and minimum amounts set for carbohydrate, protein, fibre, vitamins A and C, folate, calcium, iron and zinc (Evans and Harper 2009). The calculations of these nutrient-based guidelines required the use of a computer programme to input recipes and portion sizes to ensure that menus were meeting these guidelines. Subsequently, the removal of this component of the school food guidelines was undertaken for the 2015 guidelines after careful consideration in order to simplify the guidelines for schools, making them cheaper and easier to implement and enforce, and to allow schools more autonomy and flexibility in planning meals (Dimbelby and Vincent 2013).

One of the primary stated concerns of The School Food Plan is to improve the health concerns caused by poor diet, primarily obesity (Dimbelby and Vincent 2013). To combat these health concerns, goals of the plan include improving school meals and increasing uptake, and also expanding nutrition education throughout the school day, including teaching students how to cook.

Alvaro and colleagues provide an interesting alternative view into obesity policy interventions in their 2011 paper. Using the example of Canadian governmental policies related to obesity, the authors use complexity theory and critical theory to explore why

neoliberal western governments continue to focus on promoting change at the individual lifestyle level despite evidence that societal-level change is required to effectively combat obesity. The authors identify individual-level policies and interventions that have seen some success in reducing rates of obesity, however these types of interventions typically see much greater success with people who are otherwise advantaged. However, the societal mechanisms which shape the obesogenic environments, encouraging consumption of high calorie foods and sedentary lifestyles, have not been addressed by government policies thus far. The authors first used complexity theory to visualise governments as a network of interactive and continually changing subsystems comprising a larger whole, each with a history that informs current actions, and then next utilise critical theory to examine the dynamics of power that inform policymaking.

With complexity theory, it can be seen that government policies are 'stuck' at the level of trying to shape individual behaviour, primarily due to two issues: history and feedback loops. There is a long running programme encouraging physical activity in Canada called ParticipACTION, the initial success of which coincided with the rise of western neo-liberal politics, and at the time of writing had received renewed interest by the Canadian government. In the arena of public health, neo-liberal policies tended to emphasize personal responsibility for health of the individual rather than public responsibility for health of populations. In light of this history, it can be seen how governmental policies then become stuck in 'feedback loops,' wherein a policy that has some measure of success encourages the implementation of other, similar policies, and these loops can sometimes stifle change. This process can be exemplified by an initiative in Nova Scotia called 'Health Promoting Schools,' which is comprised of a number of programmes focused on the school environment: support for physical education and nutrition classes, improving school lunches

and removing junk food options from the entire school day. This programme has been successful in the pilot schools, and therefore has been expanded. However, Alvaro and colleagues (2011) emphasize that this total focus on the school environment is misguided: primarily as nutritional programmes often do not effectively reach disadvantaged populations and because the school programmes do little to address the obesogenic environments that exist beyond the school doors. In order to become unstuck from these feedback loops, complexity theory tells us that these government policies need to hit a critical point, where their ordered systems verge upon disorder and change becomes possible. The authors posit that the Canadian government's policies on obesity are nearing such a critical point, as the direct and indirect costs of the obesity epidemic are skyrocketing, and the Canadian healthcare system is swamped by patients with obesity's co-morbidities. Once this critical point has been reached, 'adjacent possibles' (similar systems that suggest other avenues for successful policies) can then be looked to for alternative approaches to the problem at hand. This is described as the Swedish model of public health, which focuses on societal-level determinants of health and disease in order to make healthy communities, rather than a more individual-focused approach. However, even with these 'adjacent possibles' existing to provide inspiration, it is hard to predict change within a system, in part due to power dynamics existing within and among these systems.

Critical theory can help to explain these power dynamics, can be used to explore why lifestyle-focused policies continue to flourish. In the Canadian government, the health departments have relatively less power than others more directly linked to economics and business. Due to this, resources are limited for public health programmes, and therefore responses to the obesity crisis have been more reactive (focusing on treatment of associated diseases) rather than preventative. Those policy makers who might advocate for preventative

policies that would address the whole of the obesogenic environment are relatively powerless within the government due to the strong bias towards understanding health as an individual issue. It is possible that a tipping point is nearing, where the impact of obesity and associated disease becomes so great that new avenues have to be explored. This means that health researchers and promoters should become more vocal in advocating for change, in order to help create a shift in thinking toward a more holistic approach to obesity prevention (Alvaro et al. 2011).

D. Place and population

1. Bangladeshi Migration to the United Kingdom

The first Bangladeshi immigrants to the United Kingdom were *lascars*, or sailors who jumped ship and settled in port cities (Hatton and Wheatley Price 2005). These first migrants primarily settled in the East End of London, around Tower Hamlets, which to this day remains home to the largest segment of the Bangladeshi-British population. The next wave of migration occurred in the late 1950s and early 1960s. This wave of migrants was comprised primarily of single men, sponsored by *lascar* relatives who were already settled in England. These migrants hailed almost universally from the Sylhet region of Bangladesh in the northeast of the country, and most came to England as labourers, intending to eventually return home to Bangladesh once their fortunes were made. As time went on, immigrants began to find the idea of return less feasible, and instead sought to bring their families to England (Carey and Shukur 1985). This sparked a third wave of Bangladeshi immigration, which peaked in the 1980s (Hatton and Wheatley Price 2005). The largest segment (approximately 47%) of the Bangladeshi-British population lives in central London; however,

there are now Bangladeshi-British communities all over England. Approximately 2% of the Bangladeshi-British population lives in the Northeast of England (Ballard 2004).

2. Bangladeshis in Sunderland

Sunderland is a mid-sized port city in the Northeast of England, population 275,300 (ONS Census 2011). The local government originally formed in the 1830s. The metropolitan borough formed in 1974, and was granted city status in 1992. Sunderland was historically reliant on two industries: shipbuilding and coal mining. Both industries went into dramatic decline in the twentieth century, and the region has been characterised by rising unemployment since the 1950s. Sunderland was almost entirely unaffected by the post-WWII migration from 'New Commonwealth' countries to England, and in fact instead suffered from outward migration as people left the region in search of work (Cookson 2010). The city undertook a massive public housing project starting in the 1960s, tearing down existing slums in the east end of the city and replacing them with public housing (Robson 1969). The city followed this with other campaigns to ease social deprivation in the region, and bring new industry to the area, including a Nissan plant and a number of call centres (Cookson 2010).

The Bangladeshi community in Sunderland is a relatively recent one. Although there is evidence that some *lascars* settled here during World War II (Carey and Shukur 1985), the community as it exists today really came into being in the 1980s during the height of Bangladeshi migration to the UK (Khatoon 2006; Cookson 2010). Known regionally as a conservative and closed community, the majority of Sunderland Bangladeshi immigrants come from a single village in the Sylhet region of Bangladesh (Khatoon 2006).

Other researchers have termed the Sunderland Bangladeshi community as a *gemeinschaft* community, a term used for a mutually supportive community in which kinship and friendship obligations are assumed rather than chosen (Crozier et al. 2003). Division of labour and family structures in this type of community are typically taken for granted, and tend to fall along traditionally assumed gender roles. The overwhelming majority of men in the Sunderland community work in the restaurant or catering trade, and married women almost universally do not work outside of the home, although younger women within the community often work as bilingual assistants or engage in community work (Crozier and Davies 2007).

The population of interest is approximately 2200 people, or 0.8% of the city's population, although despite its size it is the largest minority population in the city of Sunderland (ONS Census 2011). The Sunderland Bangladeshi community is religiously conservative, and has a number of large extended families. The majority of the Sunderland Bangladeshi community live in a particularly deprived area of the city. In the locality in which the community is situated, 31.3% of children under the age of 16 live in poverty, and eight of the locality's thirty-six Lower Super Output Areas are in the uppermost 10% of most deprived areas in England, and fifteen are in the top 20%, as classified by the Index of Multiple Deprivation (Sunderland City Council 2010).

E. Project structure and goals

In this chapter, a wide variety of literature has been reviewed: biocultural theory and perspectives, work on the relationship between food beliefs and consumption, obesity as a health issue and its co-morbidities, life history theory, transnational migration, governmentality and the anthropology of food, as well as background for the study

population. All of these areas of study are necessary to appropriately place this study into context.

This project is an exploration of both actual and perceived differences in bodily health and diet in the following groups:

1) Bangladeshi immigrant girls living in Sunderland, where access to traditional South Asian foods is limited in comparison to larger and more established Bangladeshi communities in London. The Northeast is also a region that has some of the highest rates of childhood obesity in the United Kingdom (NHS Information Centre 2008)

2) White British girls living in the same area of England.

During the course of fieldwork, it became apparent that there were a number of institutional, structural, and social factors that affected students' behaviour and food consumption in the lunchroom. While not specific to the Bangladeshi-British population of interest, these factors clearly play a major role in nutritional intake, and are therefore explored in detail in this thesis.

F. Project Aims

Through this investigation, I reveal some of the ways in which ethnicity, place and culture influence the health of children. The project aims are:

1. To investigate the health of Bangladeshi immigrant girls living in northeast England, particularly the prevalence of obesity and risk of metabolic disease.

2. To explore and understand how notions of overweight, health and health risk are understood by Bangladeshi-British children.

3. To understand how the environment of the school lunchroom impacts eating behaviours.

G. Study Impact

Childhood obesity is a serious health issue and one that is the focus of many medical anthropologists concerned with diseases of globalisation. Obesity is an urgent public health concern for South Asian populations, as they, like some other ethnic populations, appear to be not only at unusually high risk for developing obesity but also at a disproportionally increased risk for obesity-related co-morbidities such as DMII and cardiovascular disease. As such, this thesis has the potential to contribute to the literature examining how South Asian migrant populations transition to these risk phenotypes. Beyond these obvious contributions to public health, this project examines the ways in which both biological and cultural adaptations can impact health in new environments. It is apparent that Bangladeshis, like other South Asians, have a disposition towards abdominal obesity, a condition which may be linked to hypotheses around thrifty phenotypes (Hales and Barker 2001). Biological and cultural adaptations are in obvious conflict with the energetic abundance of western, obesogenic environments.

This project furthers understanding of how sociocultural influences can mitigate the impact of health and disease, especially with respect to migration and attendant cultural change. For immigrant families, children are often the ones most in contact with the prevailing culture through their school peer group, and this study illuminates the pathways through which children come into contact with cultural information about food, nutrition and health.

This study also demonstrates how structural features of the school lunchroom impact eating behaviour in children, and how children negotiate these features. Furthermore, the ways in which schools are potentially undermining their own stated nutritional goals for students are examined.

H. Structure of Thesis

Following this introductory chapter, there is a systematic review of the literature on socioeconomic status and obesity in South Asian children (chapter 2) which serves to situate the data presented later in this thesis. A third chapter details the methods used in the research for this project. There are two chapters of results: the first (chapter 4) presents the quantitative, anthropometric results, and the second (chapter 5) presents the more qualitative findings: dietary intake and behaviours, physical activity, and school lunchroom behaviours. All of these findings are then brought together and put into context in the discussion chapter (chapter 6). The conclusion then discusses policy implications of this project's findings, and suggests avenues for future research.

CHAPTER 2: SYSTEMATIC REVIEW: CHILDHOOD OBESITY IN SOUTH ASIAN POPULATIONS AND SOCIO-ECONOMIC STATUS: A SYSTEMATIC REVIEW OF THE LITERATURE

A. The systematic review as a method

The systematic review has long been recognized as a useful research tool in a number of disciplines. Traditional methods for conducting literature reviews are often open to the taint of (albeit unintentional) bias from the researcher in the way studies are identified, interpreted and disseminated (Khan et al. 2003). The systematic review is a means through which bias can be minimized, with goals clearly specified before the initiation of the review and a replicable, well-described methodology that attempts to be as inclusive as possible in order to capture any and all relevant research (Higgins and Green 2008). Further, the systematic review is a means through which one can make sense of large quantities of often conflicting research on a topic (the so- called "information mountain") and disseminate to a larger audience (Petticrew and Roberts 2006).

The systematic review process is commonly used in the health sciences in order to make better informed evidence-based practice and policy decisions (Khan et al. 2003; Higgins and Green 2008). The process has also gained popularity in the fields of education and business management for similar reasons (Hammersley 2001; Tranfield et al. 2003). Due to the fact that review searches are traditionally designed with preference for randomized controlled trials and other high-quality, quantitatively reported research, the systematic review has been criticized for overlooking or not fully incorporating relevant qualitative research (Hammersley 2001). However, there have been recent efforts to include qualitative data in systematic reviews when possible and germane in order to improve the richness and depth of

the information reported (Thomas et al. 2004; Harden et al. 2004). The use of the systematic review methodology has also gained popularity in the social sciences in recent years, as it becomes increasingly apparent how the process can be adapted to suit the kinds of question asked, such as using narrative description to describe qualitative results, and performing a theoretically-based analysis when appropriate to make better sense of socially oriented research (Petticrew and Roberts 2006).

B. Previous systematic reviews on the relationship between socioeconomic status and obesity

In their seminal 1989 review, Sobal and Stunkard evaluated data from societies all around the world (144 studies in all) in order to better understand the relationship between socioeconomic status [SES] and obesity. Acknowledging the difficulties in finding uniform measures for both SES and obesity (not the least of which is the fact that socio- economic status is highly variable in different parts of the world), the authors opted to evaluate the literature written on developed and developing societies separately, and within those divisions, addressed women, children and men as discrete groups. Substantial differences were found between these six groups.

In developed countries, the literature consistently reported a strong inverse relationship between socio-economic status and obesity for women, meaning that as SES decreased, the risk of obesity increased. For men and children, however, the relationships were less clear. In studies that considered men in developed countries, 52% of studies found an inverse relationship, while 30% found a positive relationship (high socio-economic status meaning higher risk of obesity) and 17% found no relationship between the two. With respect to

children in developed societies, relationships were mixed, but fairly even: approximately the same number of studies found an inverse relationship as found a positive relationship.

Despite this variability between studies, researchers found a marked consistency within studies, in that most of them found similar risks and relationships for boys as for girls. This suggests that there may be a confounding influence with respect to childhood obesity and socio-economic status in developed countries, but also indicates that boys and girls can be examined together at as a single group for the purposes of obesity studies.

In developing societies, however, it was apparent that socio-economic status was moderating obesity rates in a much clearer manner than it was in developed societies. Strong positive relationships between the two were found for men, women, and children. Furthermore, while a small number of studies found no consistent relationship between the two (between 9 and 16 percent), there were no studies concerning developing or non-western societies that reported an inverse relationship between SES and obesity.

In 1999, Parsons et al. produced an extensive review aimed at identifying the factors in childhood that influence adult obesity. The researchers located obesity as a problem of developed nations, meaning that, while not explicitly stated, its focus is on those factors in childhood in developed nations that affect adult obesity. Given the broad scope of this review, not all of the factors measured and discussed will be presented here. While there appeared to be a negative relationship between childhood SES and adult overweight (i.e. a low family SES in childhood appears to contribute to increased risk for fatness in adulthood), there was no consistent relationship found between childhood SES and childhood overweight. As previously, the correlation between SES and obesity appears to be stronger in women than

in men. However, Parsons and colleagues also noted that BMI in women tends to be more sensitive to social mobility, in that women are much more likely to reflect the obesity prevalence of the social class in which they currently reside than men.

Following Sobal and Stunkard, Monteiro et al. (2004) aimed to produce an updated review on the association between obesity and SES in adults in developing countries, citing obesity's increase both worldwide and especially in developing countries as a major cause for concern. Their findings paint a different picture than the one revealed in 1989: adult obesity in developing countries is no longer solely a problem of those of higher socio-economic status. Particularly, it seems that, as a country's gross national product (GNP) increases, so does the rate of adult obesity increase in those of lower SES. Further, this shift towards rising rates of obesity in poorer people as a country's GNP increases occurs more quickly in women than in men. This shift, for women, appears to occur right around a per capita GNP of US $2500, which is the mid- point GNP value for lower-middle income economies.

Noting that the 1989 Sobal and Stunkard review had not yet been updated for children, Shrewsbury and Wardle (2008) conducted a review of cross-sectional studies concerning childhood adiposity and socio-economic status in developed countries, overcoming a number of logistical barriers in the process. The authors used the term 'adiposity' to refer to any level of excess weight in children, as they found that the measures for, and classifications of, overweight and obesity were used inconsistently between the 45 included studies. BMI was the most common measure used, but some studies used relative weight, weight-for-height, skinfold thickness and waist girth and/or waist-hip ratio. Additionally, twelve different references for classifying overweight and obesity were used among the included studies, and

a number of different indicators of SES were used: parental education, parental occupation, family income, neighbourhood SES and composite measures of SES.

After allowing for all of these variations, analyses revealed that 42% of studies indicated an inverse relationship between adiposity and SES, and 27% identified no relationship between them. In the remaining 31% of studies, both inverse and no associations were found, depending on type of SES indicator, type of indicator for or level of obesity, or participant's age, ethnicity or gender. The strongest indicator of childhood obesity was parental education level (there was an inverse association found in 15 of the 20 studies that used this as an indicator). These results show a departure from the 1989 Sobal and Stunkard review, in that, while associations are neither clear nor strong, there is no longer a mix of positive and inverse associations being found in studies investigating childhood obesity and SES in developed countries.

A 2011 review evaluated the evidence for ethnic inequalities in obesity rates in the United Kingdom, for both children and adults (El-Sayed et al. 2011). There was no specific analysis of socioeconomic status in this review; however, the researchers drew on UK Census data from 2001 to note that ethnic minority populations on average tended to be younger and of a lower SES than the white British population, and were more likely to be unemployed. Additionally, they identified those of Pakistani and Bangladeshi origin as among those least likely to have 'professional' occupations, and Bangladeshi British as among those with the highest proportion of children eligible for free school meals.

In looking at ethnic differences in obesity rates among children, El Sayed and colleagues (2011) found no clear relationship between obesity prevalence in South Asian children and

adolescents and their white British counterparts, or with other groups. While some studies found overweight and obesity at substantially higher rates in South Asians than white British children, other studies suggested that South Asian children may be at lower risk for obesity and overweight than other groups. Many of these studies reporting lower rates in South Asian children were finding these lower incidences in specific populations: for example, 3-year-old Indian children in the UK Millennium Cohort Study (El Sayed et al. 2011 quoting Hawkins et al. 2009) were found to have a lower risk of overweight than white Britons in adjusted models, and a study looking at children in 11 London boroughs found the lowest obesity prevalence in Bangladeshi and Indian girls (quoting from Harding et al 2008). Additionally, the review reported on identified weight for height predictors for South Asian children, which included the consumption of school meals and the weight of both parents.

The balance of evidence indicates that South Asian boys and girls may have sexually dimorphic risk for childhood obesity, with girls appearing to have a lower risk, and boys a higher one (both relative to white British children). However, further findings in this review indicate that this dimorphic risk is reversed in adulthood, with women having higher, and men lower, risk (El Sayed et al. 2011).

Review authors explored the possibility that methods of obesity assessment may have biased present findings, as South Asians tend to have a higher adiposity at lower BMI than other groups, which suggests that weight for height measures may globally underestimate the rates of obesity in South Asians (El Sayed et al. 2011). Further, the reviewers highlighted the problems inherent with pooling all of South Asians into one single group for purposes of analysis, as indeed there exist problems with the pooling of any minority cohorts: there are important differences, including socioeconomic, cultural and geographical factors, which

exist between the groups that are often categorized simply as 'South Asian.' El Sayed and colleagues conclude their review by calling for further work that does not aggregate minority groups into broader categories, and that includes multiple metrics for the measurement of overweight.

While the scope of this present review is not inclusive of all developing countries, the intention is to build upon the work of these previous reviews in furthering understanding of the complex influence SES has over obesity and overweight, and in particular, the risk of obesity during childhood for people of South Asian origin. There are strong links between migration and SES in South Asian populations, as socioeconomic divisions are both clear cut and dramatic in South Asia, and migrants tend to come from middle to upper income groups in order to be able to afford the costs of migration (Kumar 1993). For these reasons studies that deal with migrant populations in developed countries will also be included.

C. Review Objectives and Methodology

1. Aims and Objectives

The aims and objectives underpinning this review are as follows:

1. To understand the breadth of research that has been conducted on factors contributing to childhood obesity in South Asian populations, and to determine whether there is a justifiable need for potential further research in this area.

2. To evaluate available evidence for the relationship between SES and childhood obesity in South Asian populations.

3. To determine what, if any, effect migration has on rates of obesity in South Asian populations (with the underlying assumption that a migrant from this area of the world will typically be of relatively high socio-economic background within the context of their country of origin but not necessarily within the country to which they migrate).

2. Search Strategy

A comprehensive search strategy was created surrounding the objectives of this review. A search strategy for a systematic review generally includes three kinds of criteria: population, exposure and outcome. The key ideas of childhood and South Asian ethnicity (as population criteria), as well as overweight or obesity (as an outcome criteria) were selected and from these concepts a list of key words and MeSH subject headings (for Medline) were developed. All experimental and observational studies fitting these search criteria were included. Due to the somewhat nebulous and diverse nature of factors that can be related to SES, as well as the relatively small pool of research dealing with South Asian populations, the identified exposure criteria (SES and migration) were not included in the initial search strategy. Instead, studies with the desired exposures were selected as part of the process of choosing appropriate studies for review (inclusion criteria outlined below).

When developing the above described search strategy, it was difficult to achieve a correct balance between search sensitivity (being able to discover all relevant studies) and search

precision (minimizing off- topic studies found), because of a specific terminology issue. The terms 'malnutrition,' and 'nutrition disorders,' while most often used to describe states of undernutrition, can also be used to describe states of overnutrition or overweight (de Onis and Blössner 2003). Owing to this overlap in terminology, all studies concerned with undernutrition could not effectively be excluded (using the 'NOT' Boolean operator) without also excluding potential relevant research. Therefore, while every effort was made to ensure precision of search strategy, it was not done so at a loss to sensitivity, meaning that many studies concerned with undernutrition were generated in the initial search.

Due to the nature of this inquiry and the fact that pertinent research straddles a number of the health sciences, including nutrition, psychology, and medical anthropology, the search strategy was executed on a variety of electronic databases: Medline, Embase, Anthropology Plus, Web of Science (which covers the Social Science Citation Index [SSCI], the Science Citation Index [SCI], the Arts and Humanities Citation Index [A&HCI], the Conference Proceedings Citation Index-Science [CPCI-S] and the Conference Proceedings Citation Index- Social Science and Humanities [CPCI-SSH]) and, via Ebscohost: PsycInfo, CINAHL, and the International Bibliography of the Social Sciences [IBSS]. Complete search strategies for each of the above- named databases can be found in Appendix A. The developed search strategy was initially executed in these electronic databases on July 24 and 25, 2009, yielding a total of 8993 citations. All citations were then uploaded into Endnote X3 bibliographic software, and duplicates were identified and deleted. The resulting 7677 citations were then scrutinized using a set of inclusion criteria, selected prior to the execution of the search strategy, which are described in Table 2.

Due to a noticeable surge in publications in this subject area, an update to the original review was performed. The original search strategy was rerun in all databases on January 4, 2013, limited between the years of 2009 and the present. This new search yielded 4053 citations, which were uploaded into Endnote X3. After duplicates were identified and deleted, a total of 3902 citations remained to be examined using the inclusion criteria.

Table 2. Predetermined inclusion criteria

All included studies had to exhibit the following characteristics:
1. Studies reporting primary empirical research, either experimental or observational in nature.
2. Studies that have undergone peer review.
3. Studies written in the English language.
4. Studies which focus on (human) children under the age of 18.
5. Studies that deal specifically with obesity, overweight or overnutrition rather than with other nutrition disorders or bodily states of being.
6. Studies undertaken in South Asian countries (India, Bangladesh or Pakistan) or concerning migrant populations from those countries.
7. Studies published after 1989 that investigate the links between childhood obesity and socio-economic status.

Due to time and budget constraints, only research that had been reported in the English language was considered. 'Childhood' can be a somewhat imprecise term, but for purposes of this review, research concerning all human sub-adults (under the age of 18) was included. Further to the above stated aims, all studies concerning nutrition disorders or physical states of being that were not or did not involve overweight or obesity were excluded. Inclusion was

limited to those studies conducted in or with the peoples of South Asia (India, Pakistan, Sri Lanka and Bangladesh) and to those studies concerned with migrant groups from South Asia. From that pool of otherwise relevant research, any study that did not address factors relating to socioeconomic status and/ or migration were excluded. The final criterion applied was to include only those studies published post-1989, after the landmark Sobal and Stunkard review was conducted.

Those studies that appeared to fulfil all of the above criteria on the basis of an analysis of citation data and abstracts were retrieved and the full text of those remaining were then scrutinized in order to establish the scope and quality of research that has been performed in this area of inquiry. From that pool of research, those which were ultimately verified as appropriate for the scope of this review underwent in-depth investigation to determine whether any conclusions can be made about the relationships between childhood obesity and socioeconomic status and migration in South Asian populations. After reviewing titles and abstracts, 45 papers were then retrieved for in-depth review (17 papers in 2009, and a further 28 papers in 2013). After review of the full text of the remaining articles, 24 articles were determined to fully meet all of the inclusion criteria.

Articles which met the inclusion criteria were then subject to a critical appraisal of the study design to ensure the quality of research included in the review. Critical appraisal criteria used here (see Table 3) were taken from the Joanna Briggs Institute's critical appraisal criteria for descriptive/case series studies (JBI Institute 2011). After the critical appraisal criteria were applied, two further articles were eliminated. In total, 22 articles, describing 19 studies, were chosen for the purposes of this review (13 from the original 2009 review, and 9 from the

2013 update). The full process of decision making that went into inclusion is demonstrated in Figure 1.

Table 3. Critical Appraisal Criteria

These criteria were used to determine the quality of the included studies
• **Was the study based on a random or pseudo-random sample?**
• **Were the inclusion criteria clearly defined?**
• **Were outcomes assessed using objective criteria?**
• **If there were comparisons between groups, were the differences clearly described?**
• **Were outcomes measured reliably?**
• **Were the appropriate statistical tests used?**

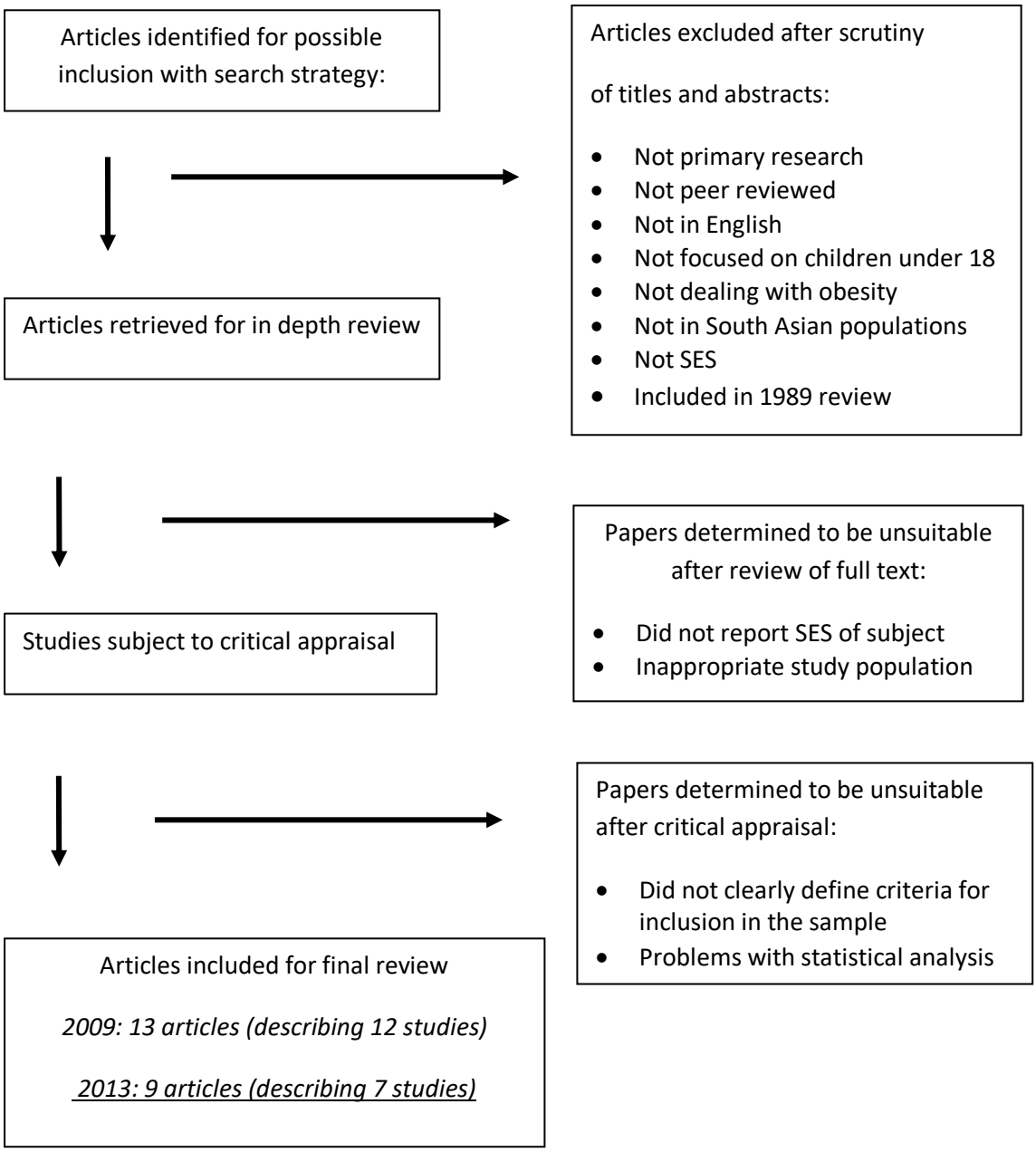


Figure 1. Flow diagram depicting process used to select relevant articles

D. Results

1. Features of those Articles Deemed Appropriate for Review

There are certain commonalities and differences that exist within the identified pool of research as a whole. All but three of the studies were conducted in South Asia: fifteen in India and two in Pakistan. Of the twenty-two papers published on these studies, twelve were published in South Asian English-language journals, while the remaining ten were published in western journals. All three studies involving South Asian migrant populations were conducted in the United Kingdom and all four resultant papers were published in international, English language journals. All of the twenty-two included papers have publication dates of 2002 or later.

Of the twenty-two articles selected for this review, eighteen of them addressed socio-economic status and obesity in South Asia, and four of them addressed obesity rates in South Asian migrant populations. In examining the papers that looked at SES and obesity in South Asia, two natural categories appeared: 1) papers that looked for an association between SES and obesity (11 papers, 9 studies), and 2) papers which aimed to identify the prevalence of obesity in an affluent South Asian population (7 papers). Findings from South Asia will thus be reported within these two categories. Next, all correlating factors to overweight, obesity and SES identified in these papers will be discussed. Three of the papers reporting an association between SES and obesity were generated from the same cross-sectional population study in Lahore, Pakistan, and therefore will be treated as a single unit for the purposes of reporting.

Finally, the remaining four papers which report on rates of obesity in South Asian migrant populations will be examined. It is important to note that two of those four papers, Taylor et al. (2005) and Viner et al. (2006) have been generated from the same study, the Research with East London Adolescents Community Health Survey (RELACHS). As with the three papers reporting on the Lahore study discussed above, while data from both of those papers will be provided, they will be treated here as an amalgam (rather than discrete reports contributing unique results) in order to provide a more complete picture of the relevant finding.

The most notable feature of the included studies is the heterogeneity of measures and standards used for defining overweight and obesity. This poses potential difficulties for the compilation of data, a fact which has been noted by previous reviewers (Sobal and Stunkard 1989; Monteiro et al. 2004). Height and weight were used to calculate body mass index in all studies, although approximately 30% of studies used a combination of BMI and/or some other measure, including waist circumference, middle upper arm circumference (MUAC), and/or triceps skin fold thickness (TSFT) or a sum of various bodily skinfold thicknesses. However, there was considerable variation in the references used to determine cut-off points for the identification of overweight and obesity. The International Obesity Task Force definitions (Cole et al. 2000) were those most frequently utilized—fourteen of the twenty-one reviewed studies cited the IOTF references, though half of those using the IOTF definitions chose to use that reference in combination with one or more other references, as can be seen in Table 4.

Table 4. Various measures and references used to assess obesity in review studies

Authors/ Publication Year	Obesity Measures Used[1]	Obesity Reference Used
Aggarwal et al. 2008	BMI	Rosner et al. 1998[2]
Aziz et al. 2009	BMI	CDC 2000
Balakrishnan et al. 2008	BMI	UK National Growth Reference 2005
Bishwalata et al 2010	BMI	IOTF *and* WHO 1995
Cherian et al. 2012	BMI	CDC 2000
Harding et al. 2008	BMI, WC	IOTF
Kapil et al. 2002	BMI, MUAC, TSFT	IOTF
Kaur et al. 2008	BMI, TSFT	IOTF; Must et al. 1991[3]
Khadilkar et al. 2011	BMI	IOTF *and* WHO 2007
Laxmaiah et al. 2007	BMI	IOTF
Marwaha et al. 2006	BMI	IOTF
Misra et al. 2011	BMI, WC	IOTF *and* WHO 2007; Fernandez et al. 2007[4]
Mushtaq et al. 2011a,2011b, 2011c	BMI	IOTF *and* WHO 2007
Patnaik et al. 2011	BMI	CDC 2000
Ramachandran et al. 2002	BMI	IOTF
Sharma et al. 2007	BMI, MUAC, TSFT	IOTF; WHO 1983 and NNMB[5]
Swaminathan et al. 2007	BMI	IOTF
Taylor et al. 2005 Viner et al. 2006	BMI	IOTF and UK 1990 Growth Reference
Thakre et al. 2011	BMI	CDC 2000

1 Abbreviations for obesity measures used are as follows:

BMI- body mass index; WC- waist circumference; MUAC- middle upper arm circumference; TSFT- triceps skinfold thickness

2Reference developed for US Children ages 5-17

3 Reference for (TSFT) measures

4 Reference for waist circumference

5 National Nutrition Monitoring Bureau [India] 2002

Additionally, while all studies reported levels of population obesity and overweight, differing methods and definitions were used to do so. Overweight was sometimes reported as overweight inclusive of obesity, and sometimes reported as overweight but not obese, with

rate of obesity being reported separately. Additionally, some studies also reported rates of overweight and obesity using definitions for triceps skinfold thickness (TSFT) as well as BMI. The topic of differing measures and their implications will be more thoroughly discussed in a later section.

2. Association between SES and Obesity/Overweight

The greatest proportion of studies selected for review sought to demonstrate an association between SES and obesity. These nine studies were all conducted in urban areas of India and Pakistan, although the Pakistani study also included a deprived rural cohort in their analyses. Studies were quite varied in sample size, from 307 subjects to 38,296 subjects, and all focused on school-aged children. Every survey population included an age range that extended into adolescence (the upper limit of included subjects ranged from 15 to 19). Two studies included children from age 5 all the way to age 18; lower age limits otherwise ranged from 6 to 13.

The factors used as indicators of socioeconomic status also varied. Three studies used parental income for classification, while the bulk of researchers reported SES using a composite of indicators. The most frequently used indicator that was used both alone and as part of composite measures, was the school of attendance (presumably as it was an easy and noninvasive indicator to obtain). Depending on the particular study, schools were either rated via fees paid or via the neighbourhood in which the school was located. Additionally, socio-economic stratifications were not consistent between studies. Five of these studies (four from India and one from Pakistan) employed a tertile stratification of 'upper,' 'middle' and 'lower,' though the methods used for determining these tertiles were inconsistent between

studies. The remaining studies each used a different stratification system. Two used a simple upper/lower division determined by school of attendance (private school students were classified as 'upper,' and government school attendees were 'lower'), while the remaining two studies used a combination of a number of proxy measures to divide study participants into lower, lower-middle, upper-middle and upper SES groups.

Reported associations between overweight/obesity and socio-economic status found in these studies were consistently positive. In each of the eleven studies looking at the relationship between SES and obesity in South Asia, percentage obesity was markedly higher in high SES groups than in lower SES groups. Prevalence of overweight was also consistently positively correlated with SES. Overall, prevalence of obesity was reported in the range of 0.5 to 7.5 percent, while rates of obesity in high SES children and adolescents were found to be from 3.7 and 17.6 percent. Likewise, prevalence of overweight (not including obesity) amongst all socio-economic groups were reported within the range of 3.5 to 18.7 percent, while overweight prevalence in the high SES group only ranged from 11.2 to 35.5 percent (see Table 5).

These findings indicate consistency with Sobal and Stunkard's 1989 review, and suggest that the situation for children in South Asia is currently much the same as it has been: that obesity remains almost exclusively a concern of the well off in this part of the world.

Table 5. Outcomes of studies that identify an association between SES and obesity

Authors/ Publication Year	Study Setting	Age Range	Total Sample Size	High SES Sample Size	Overall Obesity Prevalence[1] (%)	High SES Obesity Prevalence (%)	Overall Overweight Prevalence (%)	High SES Overweight Prevalence (%)	SES Indicators Used	SES Division Categories Used	Association
Bishwalata et al. 2010	Manipur INDIA	12-19	3356 1887F 1469M	[not given]	WHO 0.5F 1.2M IOTF 0.4F 1.0M	[not given]	WHO 4.8F 3.5M IOTF 4.7F 4.1M	[not given]	Household Income	I, II, III, IV	POSITIVE
Cherian et al. 2012	Kochi, Kerala INDIA	6-15	1634 778F 856M	528 263F 265M	5.3F 3.0M	7.5 10.0 F 5.0 M	12.1 F 10.2 M	28.0 F 16.0 M	Parental Income/ Occupation	Low/ Middle/ High	POSITIVE
Kaur et al. 2008	Delhi INDIA	5-18	16595 8161F 8434 M	6368 3070F 3298M	BMI 2.9 2.8F 2.8M TSFT 4.7 3.2F 6.2M	BMI 6.8 7.1F 6.5M TSFT 6.8 7.1F 6.5M	BMI 8.7 9.0F 8.5M TSFT 7.3 6.9F 7.7M	BMI 15.3 16.0F 14.7M TSFT 13.1 12.2F 13.4M	Composite	Low/ Middle/ High	POSITIVE
Laxmaiah et al. 2007	Hyderabad INDIA	12-17	1208 622F 586M	[not given]	1.3 1.6F 1.0M	3.7	5.9 6.6F 5.1M	11.2	Composite	L, L-M, U-M, H	POSITIVE
Marwaha et al. 2006	Delhi INDIA	5-18	21485 11722F 9763M	12645 6448F 6197M	[not given]	5.7F 5.6M	[not given]	19.0F 16.8M	School of Attendance	Lower, Upper	POSITIVE
Misra et al. 2011	New Delhi/ Jaipur/Agra/ Allahabad/ Mumbai INDIA	8-18	38296 15359 F 22937 M	25690 16113 M 9577 F	WHO 5.3 4.9 F 5.5 M IOTF 2.8 3.1 F 2.6 M	{not given]	WHO 18.5 18.7 F 18.2M IOTF 14.4 15.4 F 13.7 M	IOTF 20.7 F 16.9 M	School of Attendance	Lower, Upper	POSITIVE
Mushtaq et al. 2011a, 2011b, 2011c	Lahore PAKISTAN	5-12	1860 883 F 977 M	465	7.5	High: 17.6 Middle: 10.1	17.0	High: 35.5 Middle: 21.7	School of attendance	Low/ Middle/ High + rural deprived	POSITIVE
Ramachandran et al. 2002	(urban southern) INDIA	13-18	4700 2318F 2382M	[not given]	2.7F 3.6M	[not given]	15.8F[2] 17.8M[2]	21.5F[2] 23.5M[2]	School of Attendance/ Automobile Ownership	Low, Middle, High	POSITIVE
Swaminathan et al. 2007	Bangalore INDIA	7-15	307 165F 142M	[not given]	1.0	[not given]	7.2 6.7F 7.7M	[not given]	Composite	I, II, III	POSITIVE

Key: BMI- Body Mass Index; TSFT- triceps skinfold thickness; SES- socioeconomic status; WHO- World Health Organisation; IOTF- International Obesity Task Force

1: Unless noted, all prevalence of obesity and overweight has been determined by BMI

2: Ramchandran et al. 2002 reports overweight inclusive of obesity; all other studies shown in this table report rates of overweight not inclusive of obesity

3. Rates of Obesity in High SES South Asian Children and Adolescents

Given the apparent positive relationship between socioeconomic status and obesity in this area of the world, and recognizing that there are limited data on rates of obesity in South Asia, some researchers have opted to focus solely on determining the rates of obesity and overweight in children who come from high SES backgrounds. Seven such studies were found in the course of this review: six based in urban India, and one in urban Pakistan. In these studies, SES was determined by assessment of school fees paid or a composite of school fees and other factors such as parental income, though one study did not describe SES indicators used. Age ranges of study participants were varied: two focused only on adolescents, while the rest captured a larger age range of school-going children and adolescents, with lower limits between 2 and 6 and upper limits of 15 to 17. Sample sizes ranged from 398 to 4399.

As can be seen in Table 6, prevalence of obesity was found to be from 3.4 and 18.4 percent; and prevalence of overweight from 10.8 and 32.65 percent. The highest overall prevalence was found by Patnaik and colleagues (2011) in a study focused on pupils from a single English medium school in Orissa, India. The results were quite varied, and in all likelihood reflected the variety of study populations chosen.

Table 6. Outcomes of studies focusing solely on high SES children/adolescents

Authors/ Publication Year	Study Setting	Age Range	Sample Size	Obesity Prevalence (%)		Overweight* Prevalence (%)		SES Indicator
Aggarwal et al. 2008	Ludhiana, Punjab INDIA	[high-school aged]	**1000** 500F 500M	3.4		12.7		School Fees
Aziz et al. 2009	Kurachi PAKISTAN	6-17	**398**	6.0		19.35		Composite
Kapil et al. 2002	Delhi INDIA	10-16	**871** 309F 562M	7.4 5.5F 8.3M		24.7 27.7F 23.1M		School Fees
Khadilkar et al 2011	[10 cities] INDIA	2-17	**1823** 797F 1026M	WHO 15.9 12.8F 18.4M	IOTF 4.7 3.9F 5.4M	WHO 11.1 11.4F 10.8	IOTF 14.9 14.4F 15.2M	School Fees
Patnaik et al. 2011	Orissa INDIA	5-15	**468** 272F 196M	14.53		28.63 25.73F 32.65M		School Fees
Sharma et al. 2007	Delhi INDIA	4-17	**4399**	6.41		22.43		[not described]
Thakre et al. 2011	Nagpur City INDIA	5-16	**1524** 723F 801M	5.5		14.5		School Fees

*Rates of overweight reported in this table are not inclusive of obesity

4. Childhood Obesity and SES: Correlating Factors

The above described studies also used semi-structured questionnaires to identify factors which were then found to correlate both with affluent populations as a whole and the incidence of obesity in school aged children and adolescents from high socio-economic backgrounds.

Within the reviewed studies, a number of factors were found to be associated with high socioeconomic status (Table 7), and these suggest the development of an obesogenic environment in urban and affluent South Asia. The most common of these factors were attendance at a private school, regular television viewing and computer usage, as well as the regular/daily consumption of processed junk foods. Other features included daily video game

usage, daily attendance at a madrasah (school for Islamic religious instruction) or use of an after-school tutor, increased fat and carbohydrate intake and food intake that regularly exceeds recommended daily allowances.

In overweight or obese children and adolescents, there were yet more associations found. The most striking thing is that boys most often seem to have higher rates of overweight and obesity than girls. One study found higher rates of overweight in girls when using BMI as a sole measure but, even then, rates of obesity judged by triceps skinfold thickness were markedly higher in boys. The highest rates of overweight and obesity are also found in the pubertal years (roughly between 9 and 13) in both boys and girls. There are also apparently strong associations between childhood obesity and parental occupation in service or business, both parents working, mothers having high levels of education, and residence in metropolitan cities in urban South Asia.

Other related factors fell into two categories: activity level and consumption. Ramachandran et al. (2002) reported an inverse relationship between BMI and activity levels; this is supported by other findings. Lack of participation in both outdoor games and sports, as well as in household activities and chores, using a vehicle (car or motorbike) to get to and from school instead of walking or biking, and regular television viewing all were found to correlate with obesity/overweight in South Asians. In counterpoint to this, however, Kaur et al. (2008) also found that children from high SES families were nearly twice as likely to participate in any leisure time physical activities, presumably because space is at such a premium in urban Delhi (where this study was located) and accessible spaces appropriate for these activities are few and far between.

With regard to consumption, a number of interrelated features have been identified. Meals eaten outside of the home, snacks replacing regular meals, a stated preference for processed junk foods, a high intake of fats (at or above 35% of dietary intake) and carbohydrates (at or above 65% of dietary intake), and low consumption of milk all seem to be implicated in rates of overweight and obesity. Additionally, Aggarwal et al. (2008) and Thakre et al (2011) both report higher rates of obesity in adolescents living in non-vegetarian households than in vegetarian households.

Table 7. Identified associations between SES and obesity

Category	Risk Factors Identified
Demographic	▪ Male ▪ Pubertal age (approximately 9-13) ▪ Parental occupation in service or business ▪ Both parents working ▪ Living in a metropolitan city ▪ Mother obese ▪ Mother with high level of education ▪ Having 3 or fewer siblings ▪ Family history of obesity ▪ Family history of type II diabetes
Activity Level	▪ Limited participation in outdoor games ▪ Limited participation in household chores and activities ▪ Travelling in a vehicle to and from school ▪ Regular television viewing ▪ Sleeping less than 7 hours per night
Consumption	▪ Meals eaten outside the home ▪ Snacks replacing meals ▪ Skipping breakfast ▪ Preference for junk food ▪ Regular intake of restaurant food ▪ High daily intake of fats or carbohydrates ▪ Non-vegetarian diet ▪ Low daily intake of fruits and vegetables

5. Obesity and Overweight in South Asian Migrant Children and Adolescents

Four papers in which the study populations included South Asian immigrants (all in the United Kingdom) were selected for this review, with two of those four having been generated from the same study. Of these three studies, one looked at 'South Asian immigrants' as a single population, another examined Bangladeshi, Indian and Pakistani immigrants as separate groups, while the third combined Bangladeshi and Pakistani immigrants for

examination purposes (in order to have a group large enough to be statistically significant), but also looked at Indian immigrants separately.

Total study populations range from 2,482 to 29,641, with populations of interest numbering from 1,018 to 3,025. One study focused on an age range of 5 to 7, while the other two looked at early adolescence, from 11 to 13-14.

Balakrishnan et al. (2008) focused on children ages 5-7 and also had the largest overall study population of any included study. Their stated aim was the comparison of the health of white and South Asian children in Great Britain. The authors found prevalence of both overweight and obesity to be significantly higher in children of South Asian heritage than in white British children. Twenty-five percent of South Asian children were found to be overweight or obese, as opposed to twenty percent of the overall study population.

The other two studies, both reporting on ethnic differences in obesity/overweight prevalence in adolescents, also described their results not only by immigrants' country of origin but also by gender. Overall, there appeared to be a higher incidence of overweight in adolescents of Indian origin, as opposed to those whose families came from Bangladesh or Pakistan. Rates of obesity appeared fairly consistent between countries of origin, with males generally having a higher incidence, although one study found the highest incidence of obesity (by three percent) in Indian females. A full description of study findings can be found in the Table 8.

Table 8. Outcomes of studies involving South Asian migrant populations

Authors/ Publication Year	Study Setting	Population of Interest	Age Range	Sample Size	Overall [1] Obesity Prevalence (%)	Population Obesity Prevalence (%)	Overall[1] Overweight Prevalence (%)	Population Overweight Prevalence (%)
Balakrishnan et al. 2008	United Kingdom	South Asian	5-7	29641 total; 3025 S.A.	9.6	13.6	20.4[2]	25.0[2]
Harding et al. 2008	United Kingdom	Indian; Bangladeshi/ Pakistani[3]	11-13	6599 total; 491 *I* ; 628 *B/P*	[not given]	4.1 *I* F 7.0 *I* M 4.1 *B/P* F 8.4 *B/P* M	[not given]	20.6*I* F 18.3*I* M 17.6*B/P* F 19.5*B/P* M
Taylor et al. 2005[4]	United Kingdom	Bangladeshi Indian Pakistani	11-14	2482 total; 621 *B* 223 *I* 174 *P*	[not given]	7 *B* F 6 *B* M 11*I* F 8 *I* M 6 *P* F 3 *P* M	[not given]	21B F 25 *B* M 27I F 36 *I* M 19P F 16*P* M
Viner et al. 2006[4]	United Kingdom	Bangladeshi Indian Pakistani	11-14	2522 total 631 *B* 227 *I* 177 *P*	14M/15M	[not given]	[not given]	[not given]

1. Overall prevalence of obesity and overweight is for all study participants, of all ethnicities including white

2 Balakrishnan et al. 2008: reports overweight inclusive of obesity; other studies shown in this table report rates of overweight not inclusive of obesity

3: Bangladeshi and Pakistani immigrants were grouped together in these study data

4: Taylor et al. and Viner et al. were both reporting on the same study data

E. Discussion

1. Inconsistent measures and references in the assessment of childhood obesity

The main difficulty in effectively assessing the available literature on the topic of childhood obesity in South Asian populations, aside from the sparse literature available, is the absence of accurate, universally accepted and used measures and standards through which childhood obesity can be confidently assessed. As outlined in the previous chapter, there are a number of potential methods of measurement of childhood overweight and obesity, and there are yet more reference standards available for the assessment of those measures.

Zemel and Barden (2001) summarize the difficulties inherent in obesity assessment in general, and also specifically in children. First, weight as a measure is an inaccurate indicator of excess body fat, given that it does not differentiate between fat, bone, and other tissues of the body. As BMI is the most commonly used method through which obesity and overweight is determined, and weight is necessary for its calculation, it can be seen how BMI can be misleading in any case where an individual has any kind of nonstandard body composition: exceptional muscularity, low or high bone density, disproportionate limbs, etc. Essentially, it can be used to identify if an individual is overweight, but cannot determine whether they are over-fat. Additionally, if an individual has low bone density, excess adiposity may go undetected when BMI is the sole measure used. Despite these difficulties at predicting obesity and overweight on an individual level, BMI has proven a useful tool at a population level, providing a reasonably accurate picture of overweight quickly and inexpensively.

With respect to assessing children, BMI must be interpreted differently to adults. Due to the differences in body composition at various stages of growth, BMI in children and adolescents must be plotted according to age as well as sex to determine overweight. Additionally, despite usage that can sometimes imply the contrary, there is no universally agreed-upon definition for obesity in childhood. There have been recommendations made to utilize the 85^{th} percentile cut-off point to categorize 'at-risk for overweight' and the 95^{th} percentile to categorize 'overweight;' these categories roughly correspond with adult classifications of overweight and obese. Researchers also sometimes simply choose to report levels of overweight, which can refer to the cut-offs described above, but sometimes instead refer to overweight inclusive of obesity. BMI is sometimes used to identify overweight, with triceps skinfold thickness measurement (which is a more accurate measure of body fat than BMI) then used to define obesity (Cole and Rolland-Cachera 2002). Another approach has been

developed by the International Obesity Task Force (IOTF) (Cole et al. 2000), using pooled data from six countries to develop cut-off points that correspond to the established adult BMI cut-offs of 25 kg/m^2 for overweight and 30 kg/m^2 for obesity (Zemel and Barden 2001; Cole and Rolland-Cachera 2002).

The IOTF definitions are gaining increased acceptance, and this popularity is reflected here, in that the majority of studies reviewed used these cut-off point. The fact that pooled international data were used in the creation of the BMI-for-age tables makes them more broadly applicable than other reference standards. While three of the discussed studies used growth references developed for their own countries (two studies set in the United Kingdom referred to the UK National Growth Reference and one set in India used tables developed by the Indian National Nutrition Monitoring Bureau), two other studies set in South Asia utilized growth references that had been developed using data from US populations. The use of US-based references for non-US populations is potentially problematic, given the unique growth environment that the United States (Hill et al. 2008) provides. On top of these variations, it must be recalled that South Asians have been shown to have higher adiposity at lower BMIs than most other groups (Weisell 2002), so even the IOTF standards could potentially be misleading for understanding obesity rates for these populations.

Regardless of any difficulty in the accurate interpretation of BMI, it is clear that there are marked differences in the rates of childhood overweight between high SES groups and low SES groups in South Asia. Much has been made in recent years of the 'double burden' of nutrition in developing countries, where overnutrition and undernutrition exist side by side (Popkin 2001, Bell and Popkin 2001; Prentice 2006), and South Asia has not escaped this paradox (Shafique et al. 2007; Jehn and Brewis 2009). It appears that improved economic

conditions in developing countries tends to trade one nutritional disease for another, and research seems to indicate that the reasons that contribute to this situation are highly complex.

2. Interrelated Factors that Contribute to the Incidence of Obesity

In general, factors implicated in obesity risk can be classified into three general types: genetic/phenotypic, environmental and social. Genetic contributing factors were not selected for in this review. Although there is established evidence that fetal environment can contribute to later obesity (Barker 1992; Robinson 2001; Osmani and Sen 2003), genetics do not appear to account for the total increase in obesity risk in South Asians (Stunkard 2000). In the studies reviewed, the social and environmental features consistently associated with high SES groups were those that can be considered features of the western obesogenic environment: regular consumption of processed junk foods, increased fat and carbohydrate consumption, daily 'screen time' in the form of television viewing and computer usage and an overall sedentary existence.

Access to parks and other facilities for physical leisure time activities are, in urban South Asia, fairly limited to those who are in higher SES groups (Oke et al 1999). Despite this, any benefit gained from access to physical leisure time activities such as organized sports is outweighed by the largely sedentary lifestyles that upper SES tend to children lead in South Asia, with 6-7 hours of school possibly followed by 2-3 hours of private tutoring or madrasah, followed by television or computer time at home, all while being effortlessly ferried between these activities in a car or on a motorbike. These social and socio-economic factors are creating an environment in which little physical activity is necessary or even

possible. Low activity levels appear to have clear associations with rates of overweight and obesity in the studies reviewed.

Within this constructed environment, those that are most susceptible to overweight appear to have other commonalities. First of all, the overwhelmingly higher rates of obesity in boys seem to indicate underlying cultural practices that make overweight more likely. These could possibly include: fewer requirements to take part in household activities (another correlating factor to overweight), a tendency for sons to be indulged with high fat foods, or even perhaps that boys are under more pressure to perform academically and therefore necessarily spend more of their time in sedentary activities such as studying. This gendered difference in risk is a clear area for potential further research.

The dietary factors related to obesity also hint at a socioeconomic component. Stating a preference for junk food, replacing regular meals with processed snack foods, and frequently eating meals at restaurants—all of these things are only likely if one's family can afford these foods to begin with. Foods such as these, that may be more available to high SES children and adolescents, may be perceived to have higher 'prestige,' being largely western, exotic and more expensive. Another factor may be the sheer convenience of these types of food choices for busy families, who often have two working parents.

What seems clear is that the upper SES groups in South Asia appear to be constructing a version of the western obesogenic environment, in which weight gain can be expected due to the availability of excess energy and limited need for energy expenditure (Egger and Swinburn 1997). Higher SES families tend to live in very urban areas which, while necessary to maintain their careers and standard of living, limit the potential for outdoor games and

other incidental physical activity for their children. Adults' work and children's extended school commitments mean long hours of very limited physical activity, and common leisure time pursuits in these mid- to high SES groups (watching television, using computers, playing video games) encourage and extend this very sedentary lifestyle. Calorically dense junk foods are easily accessible and often highly preferable not only for their taste but also for their convenience and are therefore frequently consumed.

Evidence for the creation of an obesogenic South Asian environment is supported by the indication that children and adolescents of South Asian heritage growing up in the very western environment of the United Kingdom have rates of obesity that are similar to rates of obesity in high SES South Asian children and adolescents in South Asia.

3. The Necessity for Future Research

Given the unique needs of South Asian populations, it is clear that further research into causes and contributing factors of childhood obesity is necessary. What little research there has been done in this area is very recent: all studies located for this review were published in the past seven years. It appears that interventions to prevent childhood obesity generally have poor long term success (Brown and Summerbell 2009; Malina 2001), therefore it is vital to identify the root of the problem, in order to develop a different kind of intervention: heading off obesity before it develops, rather than attempting to intervene with already overweight or obese children.

Potential avenues of research include: the development of reference standards that better reflect risk in South Asian populations, more extensive study into those specific factors that

correlate with high SES and obesity in native South Asian populations, and also inquiry into the factors that create increased risk in South Asian immigrants elsewhere in the world. With respect to the latter two, a need for in-depth qualitative research can be seen. Given that social, cultural and environmental contributing factors comprise the majority of overall obesity risk, qualitative research is necessary to accurately identify relevant correlations, and then make sense of them by putting them into social, economic and historical context so that effective preventative interventions can then be designed.

F. Conclusion

1. Summary

This review was conducted in order to determine the current scope of available research on childhood obesity in South Asian populations and its association with socio-economic status. Childhood obesity is an escalating problem worldwide, one that increases the risk for both short and long term health problems. It has been demonstrated that certain ethnicities, including South Asians, have a higher incidence of obesity than people of European descent in western countries. Further, South Asians have been found to have higher percentages of body fat at lower body mass indices, as is discussed elsewhere in this thesis. With this in mind, a systematic review of all literature exploring the current links between obesity/overweight and SES and migration in South Asian populations was designed and execute.

After performing search strategies and applying pre-designed inclusion criteria, twenty one studies were identified for review: eleven identifying associations between SES and

childhood obesity in South Asia, seven measuring the rates of overweight and obesity in affluent South Asian schoolchildren, and three which looked at rates of obesity and overweight in South Asian immigrants (all in the United Kingdom). Results from these studies were inconsistent in regard to the measures and references used to determine overweight and obesity levels, therefore statistical inferences could not be made from the compiled data.

Associations between SES and obesity were found to be consistently positive in South Asian children and adolescents. Furthermore, rates of obesity and overweight were found to be similar in high SES South Asian populations and South Asian migrant populations. Incidence of overweight and obesity was found to be higher in boys overall and higher in boys and girls of pubertal age than in any other age group. Other associations found included those involving family history, parental education and occupation, physical activity level and food consumption. These associations indicate the development of an obesogenic environment in affluent South Asia. Given the health consequences of obesity/overweight and apparent increased risk in South Asians, it is vital to conduct more qualitative research, exploring the social, cultural and environmental factors which affect childhood obesity in these populations.

2. Key messages of this review

- Current literature supports findings from the landmark 1989 Sobal and Stunkard review that there is a positive relationship between SES and obesity in South Asia, which is comprised of developing countries.

- A synthesis of the available literature indicates that there are specific factors that correlate with obesity that, in South Asia, are also SES dependent. These factors suggest the development of an obesogenic environment in more affluent areas of South Asia.

- Children and adolescents in South Asian immigrant populations appear to have similar rates of obesity and overweight to high SES children and adolescents in South Asia. It also appears that these South Asian immigrants may have higher rates of obesity than native populations in western countries.

- Despite the fact that South Asians appear to be at high risk for obesity and obesity-related diseases when they are exposed to an obesogenic environment, there has been little research published that explores the sociocultural reasons for why this may be so.

The findings in this review were used to inform the choices of methodology used in the primary study, as described in the following chapter. In particular, the factors found to correlate with obesity in South Asia were used to develop the questionnaires used in this investigation.

CHAPTER 3: METHODS

A. Study Design and Population of Interest

This study was observational and cross-sectional, and utilized a biocultural, mixed-methods approach, focusing on the health and obesity rate of Bangladeshi-British and white British female school children in their final two years of primary school. The study region within the northeast of England was identified after searching census and council records, followed by an extensive literature search in order to determine what was already known about the region and target population.

The children targeted for this study were school girls in Years 5 and 6, and all were age 10 or 11 at the time of data collection. The girls and their parents were recruited from schools in the city of Sunderland in Northeast England from the following groups: a) Bangladeshi migrants living in Northeast England, and b) white British girls living in the same area of Northeast England. In total, 20 Bangladeshi British and 20 white British girls were recruited for anthropometric measurements, and of those, 11 Bangladeshi British and 13 white British girls were recruited for other components of the study as described below.

Socioeconomic status was controlled for through the choice of neighbourhoods and schools. Area-level socioeconomic information is reported elsewhere in this thesis.

B. Recruitment

Consultation was undertaken with specialist workers at Sunderland City Council and NHS South of Tyne, after which four schools (three primary schools and one junior school) were identified as having a sufficiently high proportion of British-Bangladeshi students to be appropriate for the study. Letters of recruitment were sent to the head teachers, followed up by email and phone contact. In this way, three of the four target schools were eventually recruited to the project, and two of those permitted a second round of student recruitment and participation. Heads and classroom teachers were consulted at each of the schools to develop the recruitment approach.

I visited participating schools with my primary research assistant, a Bangladeshi-British undergraduate student at Durham University, in order to speak to the female students in Years 5 and 6. All girls in the relevant year groups were invited to participate regardless of ethnicity so as not to make anyone feel excluded, with the intention of omitting ineligible participants from the final study. In the targeted schools, however, the overwhelming majority of pupils were either white British or Bangladeshi-British and, in fact, no girls of any other ethnicity elected to participate. Recruitment took place during the school day at a time of the individual school's discretion, either in a classroom or an assembly hall, sometimes to small pre-selected groups of girls, and sometimes to entire year groups. All aspects of the project were described, and then project information sheets and permission forms (in both English and Bangla) were distributed to be taken home to parents. Teachers and administrators provided support in gaining permission from parents by referring questions and sending reminders.

At the request of the administration at one of the study schools, a visit to Durham University was organised for their Year 6 group so that students could learn about available programmes and opportunities. At this visit, students took part in a workshop called 'Measure Me' in which they learned how to take anthropometric measurements and saliva samples. All measurements were taken and recorded under the direct supervision of myself and two research assistants. Precise methods used are described in section E of this chapter. Project consent forms and information sheets were sent home along with the permission forms from the school to attend the workshop day. Anthropometric data and saliva samples were only retained for eligible students who returned their consent forms on the day of the workshop.

C. Questionnaires, Focus Groups and Interviews

Parents of participants completed a questionnaire (see APPENDIX B) containing demographic information, migration history, health, activity level and food preferences of their child and family as a whole. Parents were also asked to provide information about the mother's health during pregnancy of the child in question, parental health histories, the child's birth weight if known, and early life growth trajectory. Nine parental questionnaires were returned for the Bangladeshi-British cohort; twelve were returned for the white British cohort.

Children also completed a questionnaire (APPENDIX C) and had a short discussion on food preferences, activity levels and health beliefs while in small focus groups of between three and six participants led by the investigator and the primary research assistant. Groups were formed on the spot, based on the order in which participants were released from their classrooms by teachers. Groups were generally comprised of members of both research

cohorts. Ten girls from each group participated in these focus groups, for a total of 20 completed questionnaires.

School administrators, teachers, and lunchroom staff, as well as community and local government workers were invited to take part in semi-structured interviews throughout the project when appropriate (see APPENDIX D for interview topic guides). School administrators (the head teacher of one school, and assistant head teachers of the other two participating schools) were each interviewed once prior to the commencement of work within their particular school, and then again just before research at their school concluded in order to clarify any issues of interest that arose during the observation and data collection period. They were first asked about any particular features of the cohort, and then, through a series of open-ended questions, asked to identify any issues regarding health, food and nutrition that they felt existed within the school, especially related to the local Bangladeshi community. Community and local government workers (n=8) were interviewed primarily in the recruitment stage of the project, providing background to the overall project. Government workers interviewed included NHS public health liaisons and local council workers who were engaged with child and health outreach. Teachers and lunchroom staff (n=6) provided on-the-spot interviews during or after observation periods as time and relevance arose. Interviews with lunchroom staff also involved tours of school kitchens.

Notes were made by the researcher and research assistants during lunchtime observations and other interactions with participants. Interviews were recorded and subsequently transcribed wherever possible; however, some interviews were granted on the spot in situations where recording was difficult or impossible, and sometimes interviewees declined to be recorded. As a rule, one-on-one interviews by appointment (interviews with school administrators, and

with local government and community workers) were recorded after gaining verbal permission from the informant, with the exception of one community worker who declined to be recorded. On-the-spot interviews with teachers and lunchroom workers were not recorded due to the circumstances of the interviews; all interviews occurred standing up while informants were at work in noisy rooms. Since it was not practical to record these interviews, in these cases notes were taken during the interviews as much as possible, and then detailed notes were written immediately subsequent to the interview.

Notes, transcriptions and questionnaire responses were input into NVivo 10 qualitative data analysis software (QSR International Pty Ltd. Version 10, 2012) or Microsoft Excel (2010). These were then coded thematically as themes emerged: in the categories of health beliefs, eating behaviours, policies and other structural influences, physical activity, cultural and neighbourhood influences, and economic factors. Long-form responses from the student questionnaires including reported favourite and least favourite foods, were coded for theme and content, and then developed into sociograms, which are graphical representations of linked ideas or relationships, to display the types of responses given by participants. Responses that occurred frequently appear in larger text, closer to the central concept, while responses that occurred less frequently are further away from the centre of the sociogram.

D. Dietary Observation and Analysis

1. Lunch box survey

Participants were observed over four lunchtimes (typically in the course of one calendar school week). Eleven Bangladeshi-British girls and twelve white British girls consented to

these lunchtime observations. Participants' lunches were photographed before and after eating on each of the four days of observation, and notes were made on food taken and consumed. A copy of the form used to record lunchtime observations can be found in Appendix E.

2. Lunchtime observations

Lunchtime interactions and behaviours were observed and noted by the researcher and research assistants. These included: lunchroom layout, traffic flow, food service, interactions between students and lunchroom staff, and the interactions between students. All observations were made with the permission of school administrators; no identifying details were taken of children who were not involved in the study. The physical layout of each lunchroom was diagrammed.

3. Twenty-four-hour photographic food diary

Each participant was given a disposable camera, and a 5.5-inch plastic frog to be used as a scale (Figure 2), and were instructed to photograph each meal and snack they consumed over a 24-hour period. Participants were asked to take one photograph before eating and another when they were finished, so that consumption could be estimated. A total of twenty-one participants participated in this portion of the project: eleven Bangladeshi-British girls and ten white British girls kept photographic food diaries. Each participant took between three and eight photographs to record their daily intake, with a total of 113 photographs in the twenty-one food diaries collected.

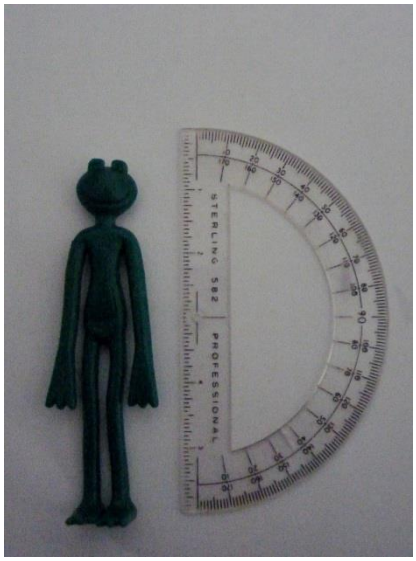


Figure 2. Scale provided to participants for use in food diary photos

The *Young Person's Food Atlas: Primary* (Foster et al. 2010), developed by researchers at Newcastle University for the assessment of portion size in children ages 4-11 years on behalf of the Food Standards Agency, was used to assist in the assessment of portion size of consumed foods for 24-hour food diaries. Food diaries were triangulated against parental questionnaires' reporting of 'typical meals' consumed in order to identify any atypical meals or meal formats.

Records of diaries were made in Microsoft Excel 2010, and then coded to group similar items together as categories emerged. Fast food and 'junk' food (crisps, chicken nuggets) were grouped together, as were starchy carbohydrates (roast potatoes, bread, rice), and sweets and desserts. Other groups included fruits, vegetables, sugar-sweetened beverages, proteins (chicken, sausages, pulses) and dairy (see Table 9). Frequency tables of servings of various food types consumed per girl per day were then developed. These same categories were then applied to participants' favourite' and 'least favourite' foods as described on their questionnaires.

Table 9. Food categories developed during coding

Food Category	Food Included
Starchy Carbohydrates	Roast or mashed potatoes Bread Rice Pasta Cereal
Protein	Sausages Chicken Pulses Fish Meat or fish curries Ham Quiche
Fruit	Raw fruits
Vegetables	Salad and raw vegetables Sweetcorn Cole slaw Vegetable curry
Dairy	Milk Cheese Butter
Junk/Fast Food	Crisps Chips Fried chicken and fish Pizza
Sweets/Desserts	Confectionery Cakes Biscuits Sweetened yoghurt Ice cream
Sugar Sweetened Drinks	Fruit juice Juice drinks Fizzy drinks Sweetened tea Squash

Using Douglas (1982), 'eating events' taken from the food diaries were classed as being one of three types 1) large meals, 2) small meals or 3) 'tertiary food events' or snacks. Large meals are typically hot, or with hot components, and contain a variety of foods, typically with at least some of these being prepared dishes. Small meals are scaled-down version of the large meal, containing fewer components, and/or smaller portions. Tertiary food events are

snacks rather than full meals, consisting of one or two items either simply prepared or pre-packaged, with or without a drink.

E. Anthropometric Measurements

Anthropometric measurements were taken by myself and one of three trained assistants working as a team. Participants (20 Bangladeshi-British and 20 white British) were measured at school in the late morning, in the hour before lunch. Height was measured using a portable Leicester Height Measure. Participants were asked to remove their shoes and stand on the measure in stocking feet, with back straight and head aligned to the Frankfurt plane (Gordon et al. 1988). Heights were recorded to the nearest 0.1 cm. Weight was measured using a digital, self-calibrating Tanita scale. Participants were asked to remove shoes, jumpers and any other bulky clothing prior to stepping on the scale. Measurements were all taken at approximately the same time of day (late morning) in order to minimise the impact of the diurnal variation of weight in this study. Weight was measured to the 0.1 kilogram.

Waist circumference was measured using a Seca standard, non-tearing, measuring tape, using current best practice as outlined by the World Health Organisation (WHO 2008). Measurement was taken at the midway point between the lowest rib and the iliac crest bones, or where these points could not be easily identified, at the level of the belly button. Participants were asked to remove their jumpers or any other bulky clothing, but measurements were taken over top of lightweight, school uniform tops. The tape was passed around the waist, held horizontal to the floor all the way around and was snugly placed without being constricting. Measurements were taken twice. In the case of variance between the two measurements, the difference between the two measures was taken if the difference

was < 1 cm. If the difference exceeded 1 cm, then the measurements were taken again by the second member of the research team present. Waist circumference values were recorded to the nearest 0.1 cm. In the case of the data collected during the workshop day, the children themselves were instructed in proper protocol for measurement as outlined above, and they then measured each other in pairs under the direct guidance of a trained research assistant. In the case of variance between the two measures exceeding 1 cm, the supervising research assistant took the second set of measurements.

F. Health Markers

One-time saliva samples were taken from all willing participants in order to assess levels of C-reactive protein (CRP), a marker of inflammation (Ouellet-Morin et al. 2011; Out et al. 2012). Participants were each given a polypropylene vial, and were also given the option of taking a short piece of straw to aid the transfer of saliva into the vial. Participants were instructed in the passive drool method, letting saliva pool underneath their tongues, then transferring the saliva into the vial, and repeating this process as many times as they felt they were able (typically 2-3 times) in order to maximize the sample given. Labelled samples were immediately stored in a cool box filled with ice packs, and transferred to a laboratory freezer in the Durham Endocrinology & Ecology Laboratory at the university within four hours of collection. All samples were collected in the hour prior to school lunch, thereby ensuring that subjects had fasted for at least an hour prior to sample collection. In total, 13 Bangladeshi-British girls and 14 white British girls attempted to provide saliva samples throughout various phases of the project, although one Bangladeshi-British participant failed to provide a sufficient quantity for analysis and was therefore excluded, leaving a total of 26 samples (12 Bangladeshi-British and 14 white British) for analysis.

Saliva samples were assayed in the Durham Endocrinology and Ecology Lab (DEEL) at the Wolfson Research Institute and Durham Department of Anthropology, by Dr Gill Cooper, the laboratory manager. These results were used to assess levels of bodily inflammation as they relate to metabolic syndrome and diabetes mellitus II, as CRP has been found to be useful in identifying chronic inflammation (Brasil et al. 2007; McDade et al. 2010) and there is evidence of a relationship between both generalized and abdominal obesity and elevated CRP levels in adolescent South Asian populations (Misra et al. 2007).

Salivary CRP was assessed using enzyme-linked immunoassay with the salivary CRP ELISA kit (Salimetrics Europe, UK). Samples were thawed, vortexed and centrifuged at 3000 rpm for fifteen minutes to remove mucins and any other particulate matter. Samples were diluted (1:10) using CRP sample diluent, before being transferred to microtitre plates that had been pre-coated with mouse anti-CRP antibodies, along with standards and controls. Enzyme conjugate was diluted 1:250 with CRP assay diluent and then 150 µl was added to each well, before incubating for two hours mixing constantly at 500 rpm using a microplate shaker/incubator. Plates were then washed four times using a buffered solution. Two hundred µl of tetramethylbenzidine solution was then added to each well for colour development before incubating for 30 minutes at room temperature and 500 rpm. Fifty µl of stop solution was then added and mixed for 3 minutes, and then plates were read in a microplate reader at 450 nm within 10 minutes of the addition of stop solution. The average optical density of wells was computed against the standard curve, using the linear curve fit. All but one sample was within the detection range. One sample was outside the upper limit of the scale, suggesting that the subject had an (unreported) infection at the time of collection. Coefficient

of variation (CV) between duplicate samples was below 5%. Within-assay CVs were all below 20%.

G. Statistical analysis

1. Calculation of sample size

Sample size was calculated using G*Power 3.1.2 analysis for ANOVA (fixed, omnibus) with a specified significance level of 0.05, a power of 0.80 and .374 effect size. Waist circumference was selected as the primary outcome, as the International Diabetes Federation (IDF) recommends this measure to define obesity, given its strong link to diabetes mellitus II and the metabolic syndrome. The first IDF diagnostic criterion for the metabolic syndrome for children is a waist circumference in excess of 90th percentile, using age and sex specific tables. The IDF also recommends using ethnically specific tables where available (International Diabetes Federation 2007). However, researchers have suggested a lower threshold of the 75th percentile as appropriate to identify children at risk for the metabolic syndrome and other immediate health concerns (Hirschler et al 2007; Kuriyan et al 2012) and, therefore, that is the threshold used here. McCarthy et al (2001) is the current established reference for waist circumference percentiles in British children, however, in order to look at Bangladeshi British children, a cohort from the 'ten towns heart health study was looked to (Whincup et al 2002). The cohort from the Ten Towns study had a mean age of 10.2, and mean waist circumference of 61.2 (SD 1.0), while McCarthy et al reported a mean waist circumference of 57.99 (SD 5.53). This provided an effect size of .374. This yielded a required sample of 60 participants, with 30 in each group (Bangladeshi British and white British).

2. Analysis of quantitative variables

Quantitative variables were analysed using IBM SPSS Statistics for Windows Version 20.0 (2011). The Body Mass Index (BMI) was calculated using WHO AnthroPlus anthropometrics software, in order to determine BMI percentiles and z-scores from the 2007 WHO tables. BMI-for-age centiles, waist circumference percentiles, waist to height ratio (WHtR), and levels of salivary CRP were all compared between groups (Bangladeshi-British and white British). After preliminary analysis, the plotting of these results revealed that the distributions of variables were nonparametric, therefore the Mann-Whitney U test for two independent samples was chosen as the most appropriate method of analysis for these data. As the sample size is small, the Monte Carlo algorithm for case resampling was also applied in order to all above-referenced variables to get a more precise estimate of the bootstrap statistic. Spearman's rank correlation coefficient was utilized to measure strength of association between the nonparametric variables of CRP and various measures of overweight. As the findings were nonparametric, median values rather than means will be reported in this thesis.

H. Ethical Approval

Ethical approval for this project was granted by the Durham University Department of Anthropology Research Ethics and Data Protection Committee. Enhanced Criminal Records Bureau (CRB) clearance was gained for the researcher and all research assistants. Detailed project information sheets and copies of consent forms were provided to school administrators and teachers, and all potential participant families in both English and Bangla (documents can be found in Appendix F). Signed consent forms for all participants were

stored in a locked file separate from coded data taken during research. All electronic data was stored on a password protected laptop.

CHAPTER 4: QUANTITIVE RESULTS: BIOMARKER MEASUREMENTS IN BANGLADESHI-BRITISH AND WHITE BRITISH GIRLS

A. Features of the study populations

A total of 40 girls, 20 Bangladeshi-British and 20 white British, consented to provide anthropometric measurements for this study. Of those 40, 11 Bangladeshi British and 13 white British participants and their parents provided the demographic information presented in this chapter, as well as participating in dietary and qualitative aspects of the study, the results of which are reported in Chapter 5. Twenty-six total participants, 12 Bangladeshi-British and 14 white British, provided saliva samples. 8 Bangladeshi-British and 10 white British subjects participated in every aspect of the study. Descriptive statistics for this sample are provided in Table 10.

The majority of the Sunderland Bangladeshi community originates from the same village in Sylhet, Bangladesh, and indeed this is true of the study population as well: all participating girls who provided family information had at least one parent who hailed from that particular village in Sylhet, and a number of participating families had extended families living in Sunderland. All Bangladeshi-British participants who provided demographic information lived with both of their parents. Mothers of all participating families identified themselves as homemakers or stay-at-home mothers. Nearly all fathers were employed outside the home, and the majority worked in the food service industry.

The family structures of white British participants were much more diverse than those of their Bangladeshi British counterparts. Two-thirds of participating households had one working parent, with half of those being single-parent households, and the other half with one stay-at-

home parent. All but one of these non-working parents were fathers, and responses indicated that the majority considered themselves ‘out of work’ rather than dedicated homemakers. The remainder of the cohort was comprised of a mix of dual income and no income families.

Table 10. Demographic features of study population

		Bangladeshi-British	White British
Cohort			
	Total	20	20
	Total with complete demographic data	10	12
Household			
	Two parent	10	7
	One parent	0	5
Income			
	Two income	0	3
	Single income (two parent)	9	4
	Single income (one parent)	0	4
	No income	1	1
Parents with GCSE* or higher education			
	Two	4	7
	One	4	5
	None	2	0
Median Anthropometric Measures of Cohort			
	Age Age range	11.20 10.07-11.84	10.89 10.08-11.73
	Height (m) Height range	1.45 1.25-1.56	1.43 1.28-1.56
	Weight (kg) Weight range	37.4 28.5-60.3	40.2 26.5-60.7
	BMI BMI range	18.31 16.29-26.38	19.27 13.73-27.53
	BMI-for-Age percentage BMI-for-Age range	64.50 32.20-99.10	79.75 1.80-99.40
	Waist circumference (cm) Waist circumference range	68.9 56.0-86.5	69.25 52.00-88.70
	Waist-to-Height ratio Waist-to-Height ratio range	0.48 0.40-0.57	0.48 0.37-0.60

*GSCE or equivalent qualification

B. Recruitment Difficulties

Uptake of the project was slow, and yielded fewer participants than anticipated. In the case of one school, multiple rounds of recruitment plus an additional direct appeal to parents from the head teacher were sometimes necessary in order to recruit a minimum number of

participants sufficient for research activities. Additional avenues of recruitment were explored including through the local Bangladeshi community centre. It was determined, however, that since the centre and other local services existed within the same neighbourhoods where the schools were located, recruitment efforts there would be duplicative of what was being done in schools already.

At one point, considerations were made as to whether it would be prudent to expand the field of research to include other Bangladeshi communities in nearby cities in order to fulfil the sample size requirements for quantitative analysis. However, due to the specific and somewhat unique nature of the Sunderland community, it was decided to keep the project focused on this community and work with them as intensively as possible in order to build up a more complete picture of the relevant issues within this small community. A posthoc analysis (ANOVA, fixed, omnibus) of the actual sample size of 40 participants (20 in each group) revealed an achieved power of .635. The in-depth qualitative findings will be presented in Chapter 5.

C. Measures of Overweight

1. Body Mass Index

BMI for age percentiles and associated z-scores were calculated using the WHO 2007 tables (Figure 3) for children and adolescents (de Onis et al. 2007). Seventy percent (n=14) of Bangladeshi-British girls had a BMI within the normal range. The remaining 30% (n=6) had BMI z-scores at or above 1, which is the cut-off for risk of overweight or obesity. Of that 30%, 2 subjects (10% of the total cohort) were more than two standard deviations above the

mean, which is considered the cut-off for risk of obesity. In contrast, 50% (n=10) of white British girls fell within the normal weight category, with 45% (n=9) overweight or obese, and the remaining 5% (1 subject) measuring as underweight by BMI (Figure 3). There was no significant difference in BMI between groups (U = 182.5; p = 0.640; Monte Carlo p = 0.331). Additionally, BMI does not appear to either increase or decrease with age in either cohort.

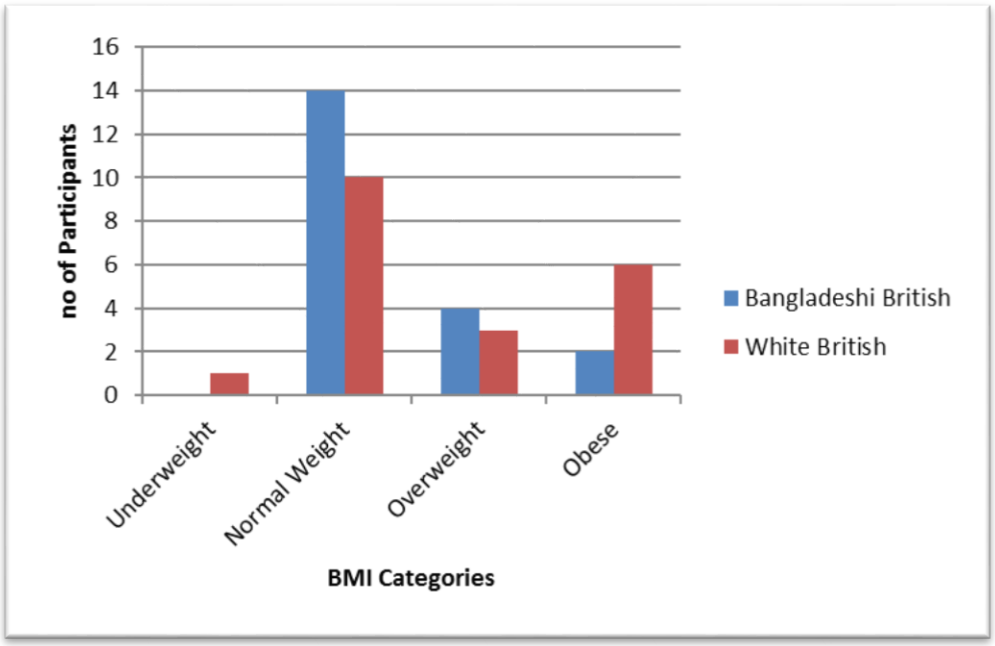


Figure 3. Distribution of groups according to 2007 WHO growth standard

2. Waist Circumference

Of the 40 participants measured, all but two Bangladeshi-British participants (n=18, or 90%) and all but three white British participants (n=17, or 85%) had a waist circumference (WC) at or above the 75th percentile for age, which is considered to be the cut-off for being at risk for metabolic disease at age ten and above (Hirschler et al 2007; Kuriyan et al 2012). The International Diabetes Federation (IDF) has designated a cut-off of WC at or above the 90th

percentile for age as the first diagnostic criterion for metabolic syndrome: 14 (70%) Bangladeshi British participants and 13 (65%) white British participants met this definition.

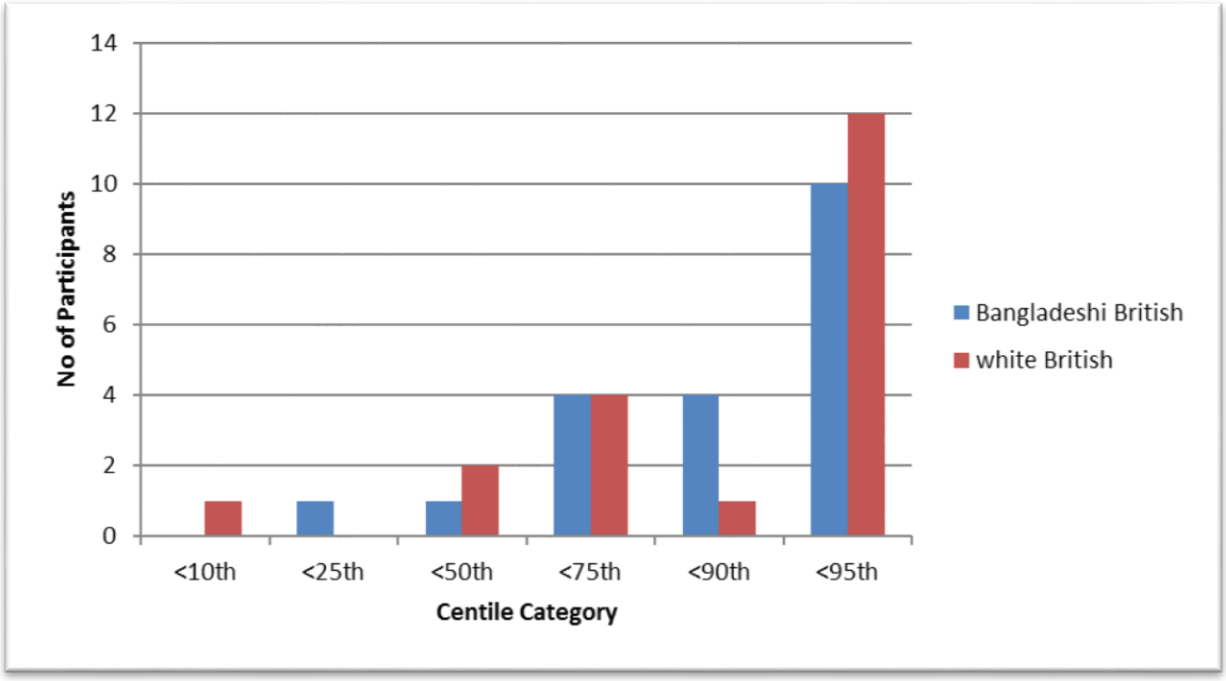


Figure 4. Comparison of Bangladeshi-British and white British waist circumference percentiles using the UK reference standard for children

The IDF also recommends using ethnicity-specific centile charts where available for the evaluation of waist circumference. While the UK charts (Figure 4) include measurements from all ethnic groups present in the UK, these charts did not include sufficiently representative samples of non-white British minorities (McCarthy et al. 2001). No comprehensive Bangladeshi centile charts existed at the time of analysis, so measurements of the Bangladeshi-British cohort were also compared against centile charts developed in urban south India. Using this set of measures, a total of eleven participants (55%), were at or above the 75th percentile, and seven of those (35%) at or above the 90th percentile.

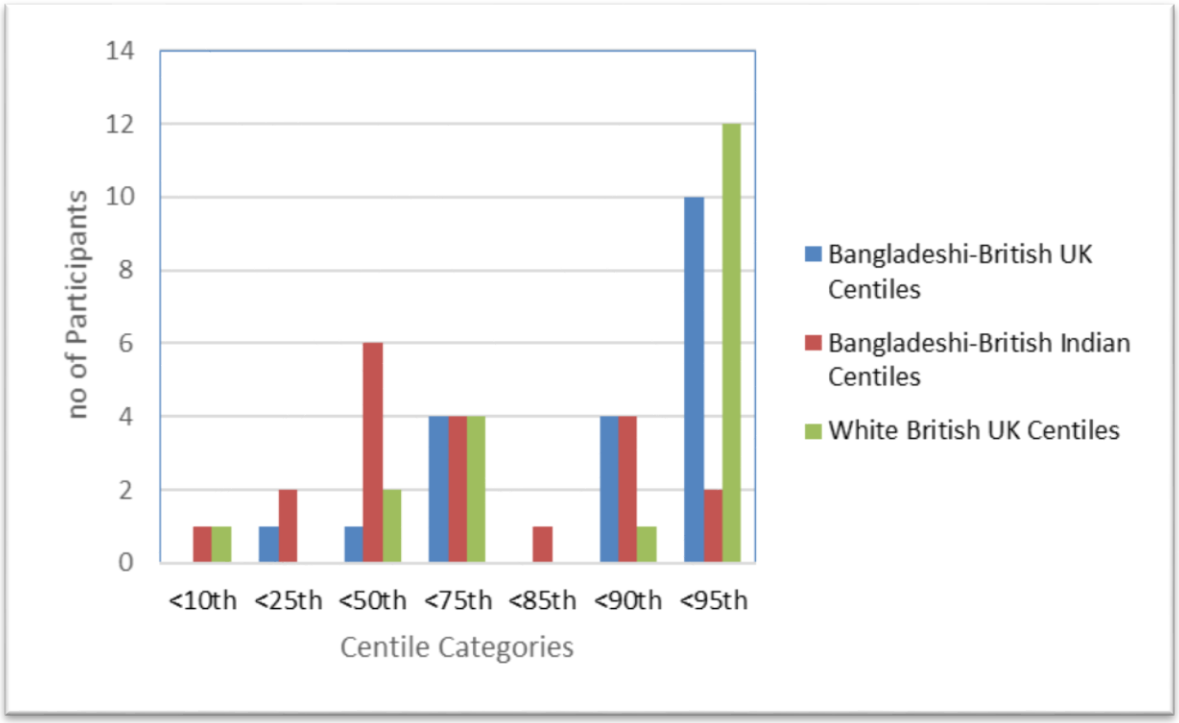


Figure 5. Comparison of WC percentiles between groups using both UK and Indian reference standards for evaluation of Bangladeshi-British cohort

Waist circumference percentiles captured a much larger group at risk for obesity than BMI within both cohorts, although all participants with a BMI z-score > 1 (the risk category for overweight or obesity) were contained within the groups with WC at or above the 75th percentile. Using the UK reference standard, there is no significant difference between the two groups (U=193.0; p=0.862; Monte Carlo p= 0. 422). However, if the Bangladeshi-British cohort is evaluated using the Indian reference in the interest of ethnic specificity (while still using the UK reference for the white British cohort) (Figure 5), the Bangladeshi-British cohort appears to be at much lower risk for overweight. This leads to a significant difference in obesity risk as assessed by waist circumference between the two groups (U= 97.5; p=0.005; Monte Carlo p=0.002), with the Bangladeshi-British cohort at much lower risk. The apparent variation in risk category as assessed by BMI and WC will be discussed in depth in Chapter 6.

3. Waist for Height Ratio

The mean Waist for Height Ratio (WHtR) for the Bangladeshi-British cohort was 0.4853 with 9 of 20 participants having a ratio ≥ 0.50 or greater. The mean WHtR for the white British cohort was 0.4923, with 8 (of 20) participants having a ratio ≥ 0.50.

In the Bangladeshi-British cohort, 5 of the 9 participants with a WHtR ≥ 0.50 also had a BMI z-score > 1, while the remaining four had BMI within normal range. There was one participant with a BMI z-score >1 that did not have an at-risk WHtR. In the white British cohort, all but one (n=7) of the participants with an at-risk WHtR had BMI z-scores > 1. There were two participants with high BMI with WHtR < 0.50; both of these participants had BMI z-scores >2, which is the cutoff for obesity. There is no significant difference in obesity risk between the Bangladeshi-British and the white British groups as evaluated by WHtR (U=189.0; p=0.779; Monte Carlo p=0.391).

D. Markers of Inflammation

Levels of salivary CRP concentrations ranged from 712pg/ml to 19068pg/ml for the British Bangladeshi girls with a median value of 2739 pg/ml, and a mean of 4704pg/ml. CRP concentrations for the white British girls ranged between 1025 and 13169pg/ml, with a median value of 2302pg/ml and a mean value of 3929.

Spearman's correlations were run to determine the relationship between salivary CRP and measures of overweight employed in this study: BMI-for-age, WC centiles and WHtR. For the Bangladeshi cohort, only BMI exhibited a significant correlation with CRP: there was a moderate, negative, monotonic correlation (r_s= -0.510, n=12, p= 0.045). For the white British

cohort, there was a moderate, positive, monotonic correlation found between CRP and BMI (r_s= 0.580, n=13, p= 0.019). Additionally, there was a strong significant positive correlation found between CRP and WHtR (r= 0.670, n=13, p= 0.006) in the white British cohort. No significant correlation was found between WC and CRP in either cohort.

CHAPTER 5. QUALITATIVE RESULTS: FOOD, BEHAVIOUR, AND THE SCHOOL LUNCHROOM

A. Food Diaries

A total of twenty-one participants (eleven from Bangladeshi-British participants, ten from white British participants) completed photo diaries and returned them for analysis. All food diaries were recorded on school days, and therefore reflect the types of meals consumed on those days. Food diaries were coded by meal type (large meal, small meal, or tertiary meal events), and foods consumed were also coded by type. These types included: proteins, starchy carbohydrates, fruits, vegetables, dairy, junk or fast food, sweets/desserts, and sugar-sweetened drinks. Food items were determined to be in the junk/fast food category if they were breaded and/or deep-fried, or if they came from a fast food or takeaway outlet. Items in this category included: crisps, chips, fish fingers, chicken nuggets, pizza, and samosas.

In comparing the food diaries of the Bangladeshi-British and white British cohorts, the most striking difference was that of the daily meal schedule, as can be seen in Table 11. Some, but not all, Bangladeshi-British girls consumed a light breakfast, then lunch at school. This was followed by a large, home cooked meal immediately after school (around 4pm). A light snack and a separate dessert are frequently consumed during the evening, and then all participants consumed a late supper (see Figures 6-11). In contrast, white British participants consumed breakfast, lunch, a snack, supper (colloquially referred to as tea by participants) and dessert. Some participants would eat supper shortly after arriving home from school, and then a snack later in the evening (Figures 12-17).

Figure 6. Photograph of breakfast from a 24-hour food diary depicting typical meal structure of Bangladeshi-British participants. Photo contains: cereal with milk, orange juice

Figure 7. Photograph of lunch from a 24-hour food diary depicting typical meal structure of Bangladeshi-British participants. Photograph contains: jacket potato with sweet corn

Figure 8. Photograph of tea from a 24-hour food diary depicting typical meal structure of Bangladeshi-British participants. Photograph contains chicken nuggets, chips, baked beans

Figure 9. Photograph of dessert from a 24-hour food diary depicting typical meal structure of Bangladeshi-British participants. Photograph contains: sweetened yoghurt.

Figure 10. Photograph of late supper from a 24-hour food diary depicting typical meal structure of Bangladeshi-British participants. Photograph contains: small serving of vegetable curry and white rice.

Figure 11. Photograph of snack from a 24-hour food diary depicting typical meal structure of Bangladeshi-British participants. Photograph contains: crisps.

Figure 12. Photograph of breakfast from a 24-hour food diary depicting typical meal structure of white British participants. Photograph contains: wholemeal toast with butter and jam.

Figure 13. Photograph of lunch from a 24-hour food diary depicting typical meal structure of white British participants. Photograph contains: chicken with roast potatoes and gravy, baguette slice, chocolate cake.

Figure 14. Photograph of tea from a 24-hour food diary depicting typical meal structure of white British participants. Photograph contains: pasta with tomato sauce and cheese.

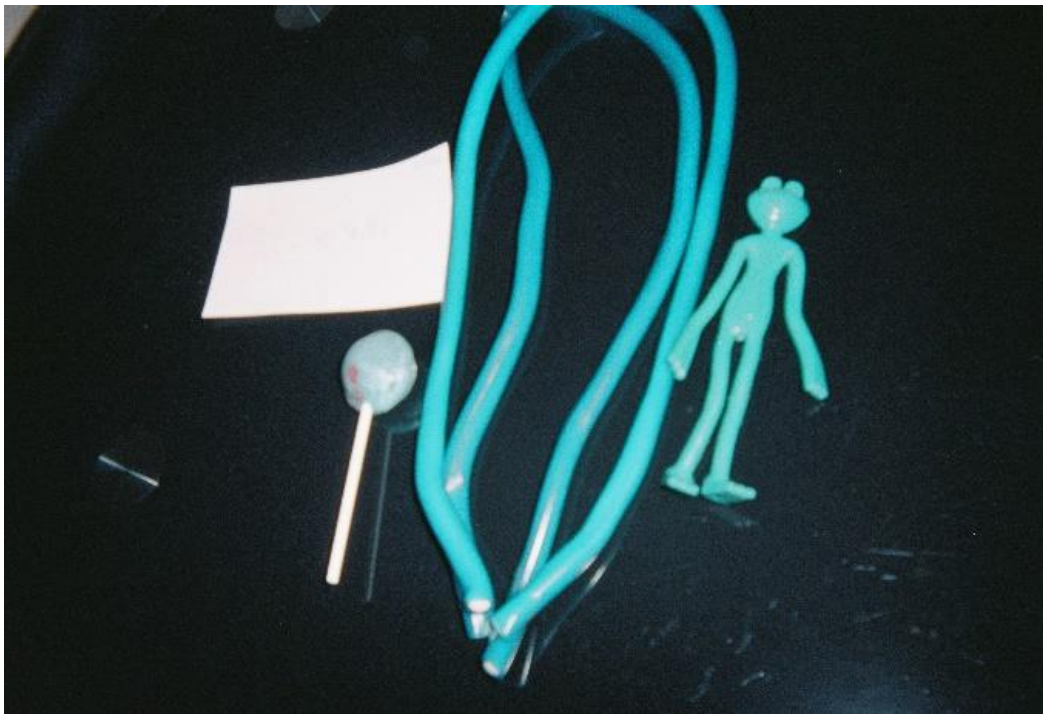


Figure 15. Photograph of dessert from a 24-hour food diary depicting typical meal structure of white British participants. Photograph contains: liquorice whips and lolly.

Figure 16. Photograph of drink from a 24-hour food diary depicting typical meal structure of white British participants. Photograph contains: juice pouch.

Figure 17. Photograph of snack from a 24-hour food diary depicting typical meal structure of white British participants. Photograph contains: sliced melon.

Table 11. Comparison of typical meal formats between participant groups

Bangladeshi-British	White British
Breakfast*	Breakfast
Lunch/School Dinner	Lunch/School Dinner
Tea	Snack*
Snack*	Tea
Dessert*	Dessert
Late Supper	

*Starred meals do not appear in all food diaries

In the 11 food diaries returned by Bangladeshi-British participants there were a total of 64 discrete instances of eating (hereafter 'eating events'); of the 10 food diaries from white British participants there were 49 total eating events. All eating events in food diaries were classed as being one of three types 1) large meals, 2) small meals or 3) 'tertiary food events,' or snacks. Breakfast most frequently fell into this latter category in both study groups. The most commonly consumed meal type overall was the tertiary food event, although the difference was more marked with the Bangladeshi-British group: 35 of 64 total eating events, as compared to 23 of 49 in the white British cohort. One Bangladeshi-British participant's entire food diary was quite unusual as she reported 'not being hungry' that day, and comprised of tertiary eating events (Figures 18-21). Large meals were the next most commonly consumed meal type in both groups, comprising 18 of 64 meals in the Bangladeshi-British group and 19 of 49 meals consumed in the white British group. Small meals comprised the remaining 11 of 64 (Bangladeshi-British) and seven of 49 (white British) of total meals eaten.

Figure 18. Photograph of breakfast from a 24-hour food diary of participant who consumed only 'tertiary' meals during the recording period. Photograph contains: chocolate cereal with milk.

Figure 19. Photograph of lunch from a 24-hour food diary of participant who consumed only 'tertiary' meals during the recording period. Photograph contains: potato crisps (2 packets), chocolate bar, mango juice.

Figure 20. Photograph of afternoon snack from a 24-hour food diary of participant who consumed only 'tertiary' meals during the recording period. Photograph contains: clementine orange.

Figure 21. Photograph of late snack from a 24-hour food diary of participant who consumed only 'tertiary' meals during the recording period. Photograph contains: apple.

Median daily intake per food type is displayed in Table 12 below. Despite differences in foods consumed, overall intake was quite similar. The most frequently consumed food type in both groups was sweets/desserts, with a median intake of 3 servings per subject per day for both participant groups, followed by starchy carbohydrates (breads, rice, pasta) and sugar sweetened drinks. The least consumed food types were fruits and vegetables, with a median intake of 1 serving per day for Bangladeshi-British girls and 0.5 servings per day for white British girls of both food types. Only 2 servings of whole grain foods were found in all of the food diaries, both of which were consumed by white British participants. Only one diary (belonging to a white British participant) contained the recommended minimum '5 a day' of fruits and vegetables (see Figures 22-25). It is worth mentioning that the white British participant who consumed her recommended '5 a day' did not have weight within a normal range, but rather had a BMI-for-age in the 99th percentile. Of the twenty-one diaries analysed, 6 (1 Bangladeshi-British and 5 white British) contained no fruits or vegetables at all.

Table 12. Median and range of servings per participant per 24-hour period of various food types

Food Type	Bangladeshi British	White British
Starchy Carbohydrates	2 (r: 0-7)	3.5 (r: 2-5)
Protein	2 (r: 0-3)	1.5 (r: 0-2)
Fruit	2 (r: 0-2)	0.5 (r: 0-2)
Vegetables	1 (r: 0-2)	0.5 (r: 0-4)
Dairy	1 (r: 0-2)	1.5 (r: 0-3)
Junk/Fast Food	2 (r: 0-4)	1.5 (r: 0-4)
Sweets/Desserts	3 (r: 1-5)	3 (r: 0-7)
Sugar Sweetened Drinks	2 (r: 0-5)	2 (r: 0-4)

Figure 22. Photograph of breakfast from a food diary containing the recommended '5 a day' fruits and vegetables. Photograph contains: puffed cereal with milk, and orange juice.

Figure 23. Photograph of lunch from a food diary containing the recommended '5 a day' fruits and vegetables. Photograph contains: beef mince pie, boiled potatoes, cooked cabbage, cucumber slices, and sweetened yoghurt.

Figure 24. Photograph of drink from a food diary containing the recommended '5 a day' fruits and vegetables. Photograph contains: orange juice.

Figure 25. Photograph of lunch from a food diary containing the recommended '5 a day' fruits and vegetables. Photograph contains:) ham slices, boiled potatoes, coleslaw, sliced tomatoes, sliced cucumbers, yogurt, banana slices, and apple slices.

B. Lunchtime Observations

A total of 10 Bangladeshi British and 13 white British participants had their lunches recorded over a 4-day period. In the case of all but two, these eating events were observed by the researcher and at least one research assistant, and lunches before and after eating were photographed in order to estimate actual consumption. The two remaining participants, both Bangladeshi British, left school to eat lunch at home every day, which made observation impossible. Participants eating at home were equipped with daily record sheets and a disposable camera so that their intake was recorded in a similar fashion to their counterparts eating at school.

In the Bangladeshi British cohort, six participants regularly brought packed lunch from home, while two regularly ate school dinners and two ate lunch at home. In the white British group, seven participants regularly brought a packed lunch from home, with the remaining six eating school dinners. In a few cases, students who routinely brought lunch from home would eat an occasional school dinner due to either a forgotten lunch, or a 'special' school dinner being available on a particular day; however, no participants who routinely ate school dinners brought a packed lunch during the observation period or reported doing so at any other time.

A total of 40 lunch periods for the Bangladeshi-British cohort, and 52 lunch periods for the white British cohort, were analysed for fruit and vegetable consumption (Table 13). Among the Bangladeshi British girls, four of ten participants had no fruit or vegetables in any of their lunches. None of the cohort had fruit or vegetables on every single day; 27 of the 40 total recorded lunches contained no servings of fruit or vegetables. Only two lunches contained two portions of fruit/vegetables, with none having more than two. There were 15 total

servings of fruit or vegetables in the 40 recorded lunches, with only one serving of those 15 going uneaten. The large majority of fruit or vegetables consumed, 11 of 15 servings, came from school dinners, with two servings in packed lunches and two servings in home dinners.

In the white British cohort, there were 40 total servings of fruit and vegetables, 23 in school dinners and 17 in packed lunches. Seven servings of fruit/vegetables went uneaten. Only one participant had no fruit or vegetables in any of their lunches, while three participants had servings in their lunches every day. Five school dinners and one packed lunch contained two servings, and no lunch contained more than two. Eighteen of the 52 recorded lunches had no servings of fruit or vegetables.

Table 13. Observed lunchtime fruit and vegetable consumption

	Lunch periods observed	Total servings of F/V	Lunches with no F/V	Lunches with 1 serving F/V	Lunches with 2 servings F/V
Bangladeshi British	40	15	27	11	2
White British	52	40	18	28	6

C. Understandings of 'Healthy' and 'Unhealthy' Foods

While working in groups of 3-5 with the researcher, participants were invited to answer the following questions: 1) "Tell me what you know about healthy food," and 2) "Tell me what you know about unhealthy food" (see Appendix A for complete questionnaire). Ten girls

from each cohort (for a total of 20) participated in these small group sessions. Common answers are displayed in the sociograms below (Figures 26, 27, 28, and 29).

Overall, Bangladeshi-British participants provided longer and more detailed responses to these queries than did their white British counterparts, as seen in Figures 26, 27, 28, and 29. When describing healthy foods, both groups used the general term 'good for you,' but also things that such food would provide: energy, vitamins, and protein. Bangladeshi-British participants went on to detail what effects healthy foods can have on one's body: growth, strong bones, strong muscles, brain stimulation. Other terms used by white British participants were more general: 'makes you fit,' and repeating the government's '5 a day' slogan for fruits and vegetables.

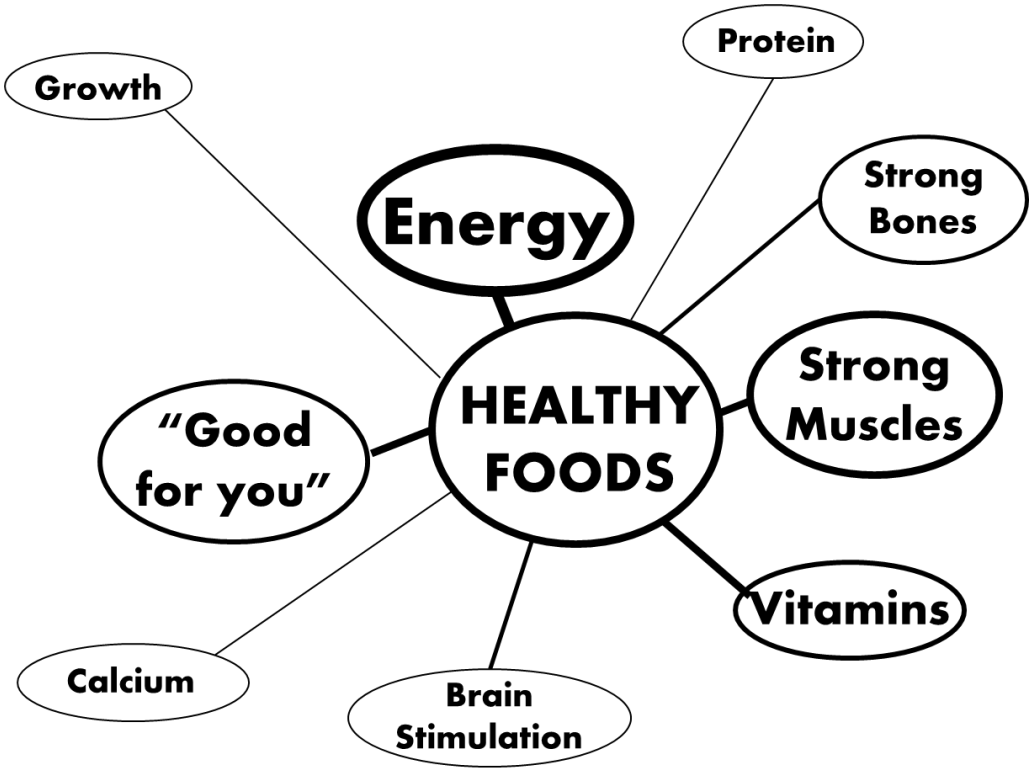


Figure 26. Sociogram of word associations made with the term 'healthy food' by Sunderland Bangladeshi British girls aged 10-12

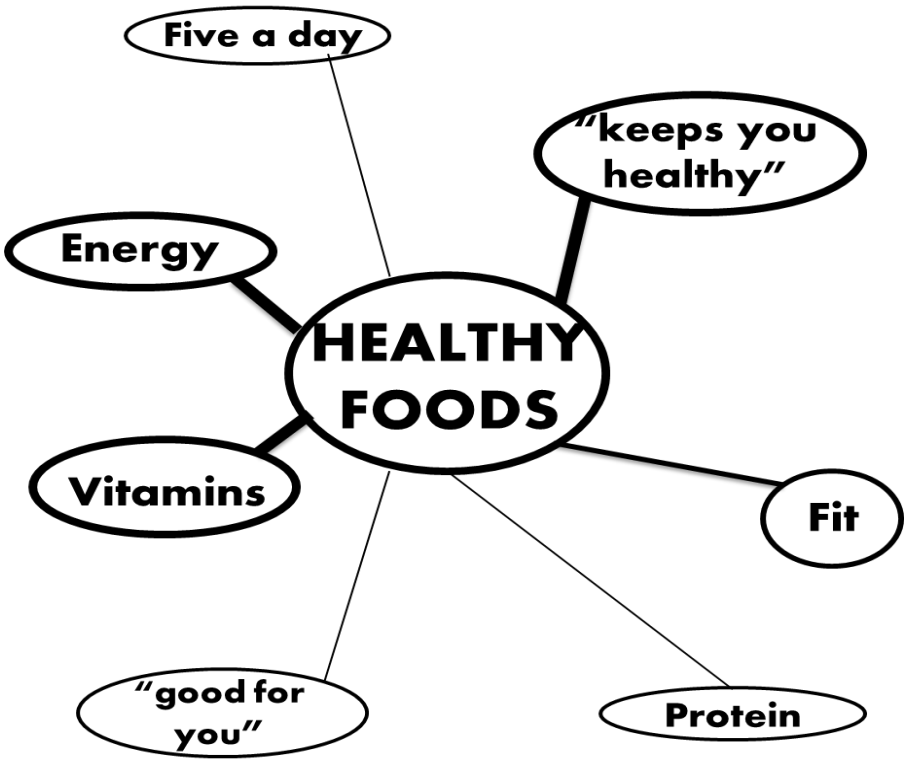


Figure 27. Sociogram of word associations made with the term 'healthy food' by Sunderland white British girls aged 10-12

When describing unhealthy foods, the differences in detail provided by the two groups was even more pronounced. The most common association for both groups was the word fat, while white British participants also mentioned salt and sugar, and characterized unhealthy foods as draining one of energy and making one become unwell. Several Bangladeshi-British participants used the phrase 'bad for you,' as well as 'makes you unfit' and 'damages your body. A number of more specific concepts were also used, that unhealthy food will cause poor growth, weak bones, slow recovery from illness, damage to your heart, and that 'sweets will rot your teeth.' Interestingly, one girl also used the phrase 'tastes nice' to characterize unhealthy food, which caused laughter and verbal agreement in the group in which she was participating.

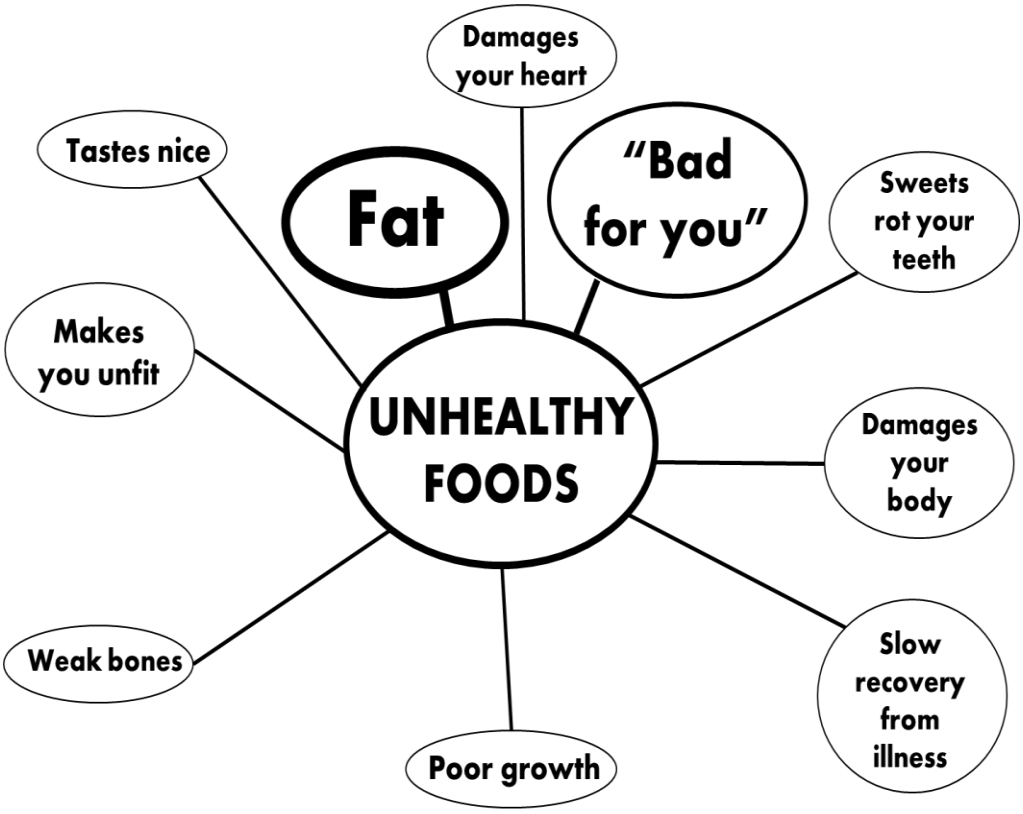


Figure 28. Sociogram of word associations made with the term 'unhealthy food' by Sunderland Bangladeshi British girls aged 10-12

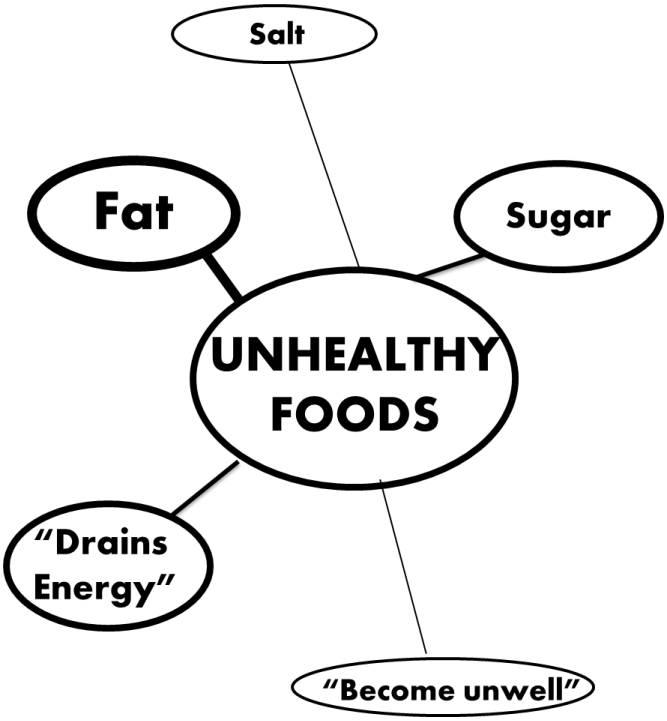


Figure 29. Sociogram of word associations made with the term 'unhealthy food' by Sunderland white British girls aged 10-12

D. Favourite and Least Favourite Foods

As part of the student questionnaire completed in focus groups (20 participants: 10 Bangladeshi-British, 10 white British), participants were asked to enumerate their favourite and least favourite foods. Responses are reported in Tables 14 and 15 below.

Responses for favourite and least favourite foods were coded using the same categories used to categorise food diaries (see Table 9 on page 94). Two additional categories have been included here: 1) 'home-cooked dishes' to denote where a participant specified that their favourite or least favourite was something cooked by a parent at home, and 2) 'relishes,' as olives and pickles were both responses given. In both cohorts, the most commonly named type of favourite food was junk or fast food. For the Bangladeshi-British cohort, the second most common favourite food type was desserts, followed by home-cooked dishes, whereas the white British's second most favoured type of food was home-cooked dishes, and third, desserts. Remaining preferred food categories in both groups were fruit and proteins (Figures 30 and 31).

Table 14. Frequency table of reported favourite foods of Bangladeshi-British and white British girls aged 10-12

Bangladeshi-British	Frequency	White British	Frequency
Pizza	7	Pizza	4
Chips	2	Chips	3
Ice Cream	2	Curry	3
Pasta	2	Spaghetti	3
Bananas	1	Apples	1
Biscuits	1	Beans	1
Cake	1	Biscuits	1
Chocolate	1	Blackberries	1
Crisps	1	Carrot Cake	1
Eggs	1	Chicken Nuggets	1
Fish	1	Chocolate	1
Fish Fingers	1	Crisps	1
Garlic Bread	1	Fish & Chips	1
Mango	1	Garlic Bread	1
Rice*	1	Ice Cream	1
Salami	1	Raspberries	1
Sausages	1	Strawberries	1
Sorbet	1	Toad in the Hole	1
Strawberries	1	Yoghurt	1
Tuna Sandwiches	1		

*"Rice" is a term used colloquially by Bangladeshi-British children to refer to a dish of curry served with rice

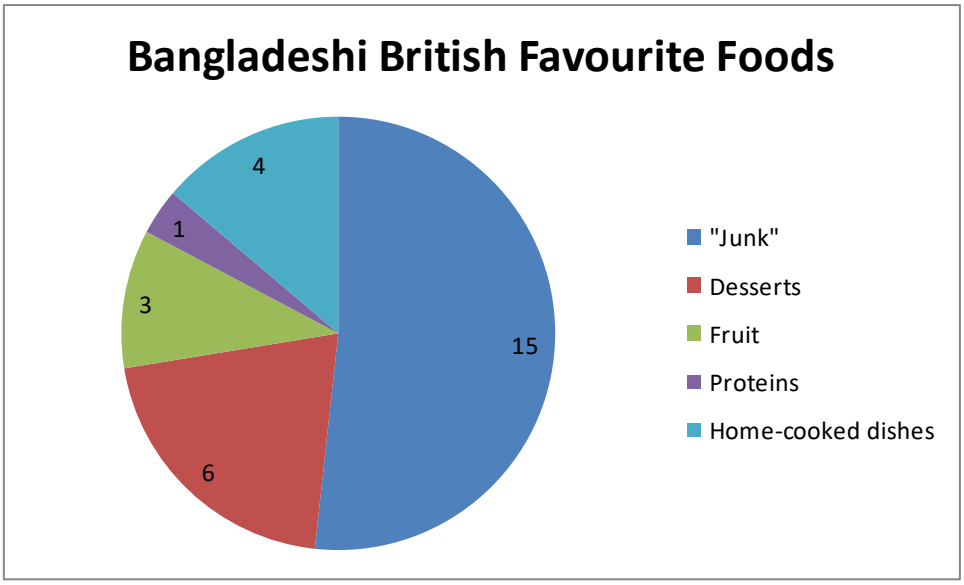


Figure 30. Types of favourite foods described by Bangladeshi-British girls aged 10-12

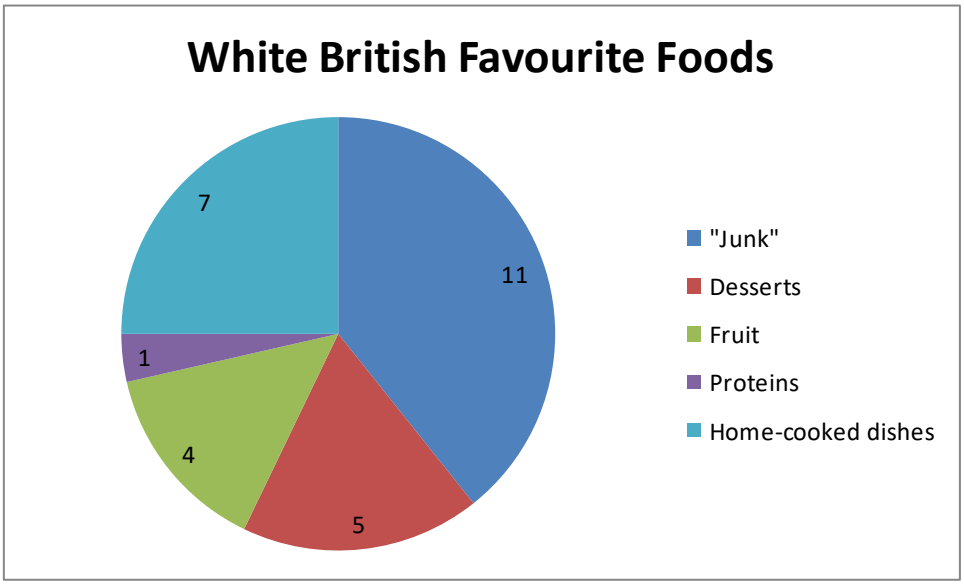


Figure 31. Types of favourite foods described by white British girls aged 10-12

Table 15. Frequency table of reported least favourite foods of Bangladeshi-British and white British girls aged 10-12

Bangladeshi-British	Frequency	White British	Frequency
Olives	3	Brussels Sprouts	4
Cheese	2	Fish	3
Eggs	2	Meat	3
Pasta	2	Beans	2
Pickles	2	Olives	2
Brussels Sprouts	1	Peppers	2
Chips	1	Salad	2
Jack Fruit	1	Cheese	1
Pineapple	1	Eggs	1
Pizza	1	Garlic Bread	1
Rice*	1	Parsnips	1
Strawberries	1	Pasta	1
		Quiche	1
		Tomato Soup	1
		Sausages	1

*"Rice" is a term used colloquially by Bangladeshi-British children to refer to a dish of curry served with rice

The most commonly named category of least favourite foods in the Bangladeshi-British group can be termed as relishes (pickles and olives), followed by fruits and home-cooked dishes (Figure 32). In the white British group, proteins were the most common category of disliked foods, followed by vegetables and home-cooked dishes (Figure 33). While no vegetables were named as favourite foods by either group, vegetables were named by both groups as least favourite, the most common of which was Brussels sprouts.

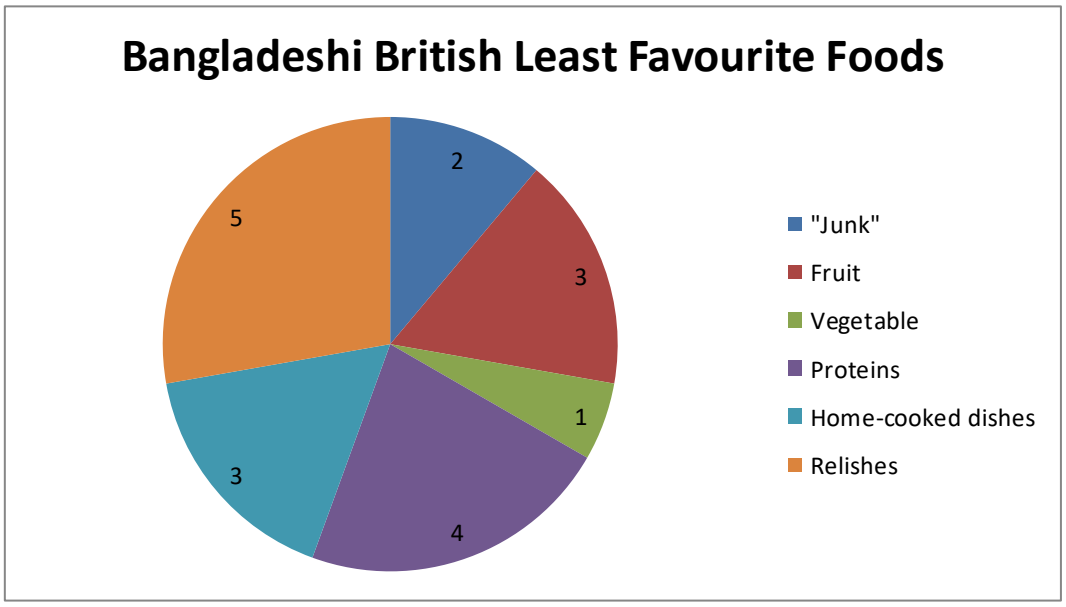


Figure 32. Types of least favourite foods described by Bangladeshi-British girls aged 10-12

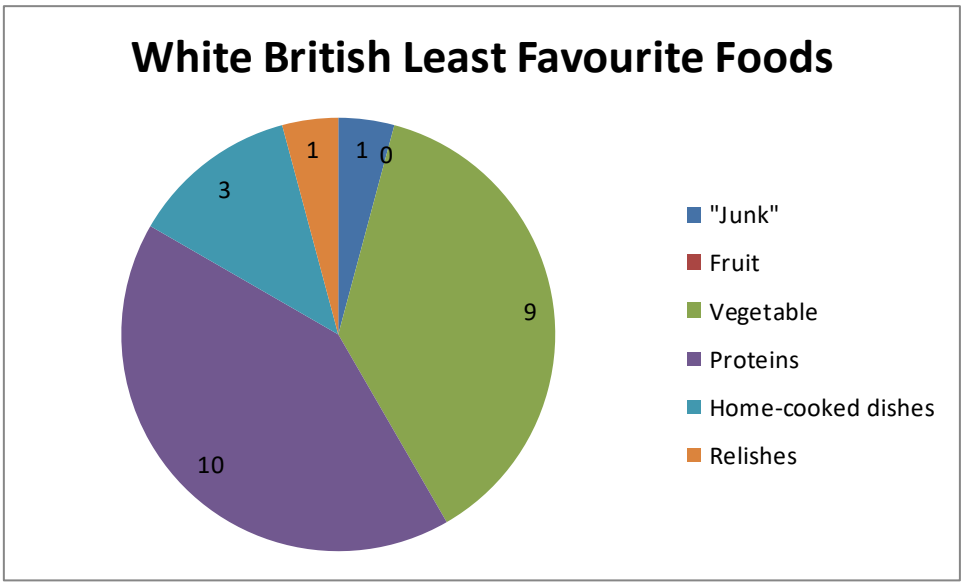


Figure 33. Types of least favourite foods described by white British girls aged 10-12

E. Physical Activity

In the parental questionnaire, parents were asked to report on the types of physical activity their daughters (study participants) engaged in on a weekly basis. Nine Bangladeshi-British parent questionnaires and 12 white British parent questionnaires were returned. Of the Bangladeshi-British parent questionnaires, seven of them were completed by the participant; these participants reported that their parents could not write in English, so they recorded the responses their parents gave. Of these seven questionnaires, four of them were only partially completed upon return; some additional answers were given by the participants during private interviews prior to focus group sessions. Parents were also asked to estimate the amount of time study participants spent in front of screens weekly, including television viewing, video games, and time spent on computers and handheld devices. Participants were also asked about these topics when in small focus groups while completing their own questionnaires.

In the Bangladeshi-British cohort, the majority of physical activities reported by parents were types of informal play (see Table 16). This was supported by participants' responses: all participants described playing with siblings or neighbours in their gardens, neighbourhoods or neighbourhood parks on a daily basis. Only two participants were in any sort of formal lessons (one took tennis lessons and one took gymnastics). While the majority of participants reported enjoying other sports, including football, netball, swimming, and cricket, none of them were involved in any sporting teams, and only one participant played a sport casually (football) on a regular basis. Only one parent included PE lessons as a regular activity, although all study participants engaged in these weekly. Likewise, only one other parent listed walking as a regular physical activity. All but two of the 10 Bangladeshi participants

for whom complete information was obtained reported walking to and from school daily; the remaining two were driven.

Table 16. Frequency table of weekly activities engaged in by Bangladeshi-British participants as reported by parents

Type of Activity	n of participants
'Normal Play'	3
Running	3
Bike Riding	1
Football	1
Gymnastics[1]	1
PE lessons	1
Scooter riding	1
Skipping	1
Tennis[1]	1
Walking	1

1 denotes private lessons or an organized club activity

In the white British cohort, parents provided more, and more specific, responses regarding weekly physical activities than the Bangladeshi-British parents. All white British participants engaged in at least one type of weekly lessons or an organized club sport, including swim lessons or swim team, dance lessons, netball, football, and regular exercise at a fitness gym (Table 17). More white British parents also reported PE lessons and walking as regular activities, however only three casual activities ('normal play,' using a hula hoop, and bike riding) were reported. This is consistent with reporting by participants, who said that the majority of free time at home was spent indoors. Of the 12 participating girls in this cohort, eight of them only discussed organized sports or activities when discussing the physical

activities they liked and regularly engaged in. The majority (seven) of white British participants walked to and from school daily; four participants were driven to and from school and one participant rode a bus.

Table 17. Frequency table of weekly activities engaged in by white British participants as reported by parents

Type of Activity	n of participants
Swimming[1]	5
Dance[1]	4
Netball[1]	4
PE lessons	4
Walking	4
Exercise at a fitness gym[1]	3
Football[1]	3
Trampolining[1]	3
Bike riding	1
Cheerleading[1]	1
Gymnastics[1]	1
Hula Hooping	1
'Normal Play'	1
Tennis[1]	1

1 denotes private lessons or an organized club activity

All participants in both cohorts reported spending daily screen time. Parental reports of weekly screen time ranged from four to twenty-four hours in the Bangladeshi-British cohort, with an average of 13 hours per week and a median of 14 hours per week. In the white British

cohort, reported screen time ranged from seven to 50 hours per week, with an average of 20 hours per week and a median of 17 hours per week.

F. School Lunchroom Geography

Of the three participating schools, schools A and B served dinners in multi-function halls that served other purposes throughout the day, and the third (School C) had a dedicated lunchroom that was rarely used for other purposes. The two schools with multi-function halls shared similar layouts: school dinners served out of hatches connected to the school kitchen at one end, and a number of long tables with attached benches arranged throughout the hall (Figures 34 and 35). In both halls, students were allowed to sit where and with whom they chose, and there was no segregation between those students eating school dinner and those eating lunches packed from home. In School B, students had the option to eat their lunches outside in an adjacent courtyard on nice days: the lunchroom was noticeably louder and more crowded on rainy or windy days when this option was not possible.

Both schools served similar meal options (provided through a citywide catering service): three hot meal options (standard, with meat, halal and vegetarian) and a cold sandwich option. School B rarely provided the halal option, as they found that most Muslim students eating school dinners preferred the vegetarian option. Each of the two schools also had a small salad bar from which students could add items to their meal: in School A, students were welcome to return to the salad bar later in the service if they were still hungry, while in School B students were only allowed to select things from the salad bar as they were leaving the dinner queue.

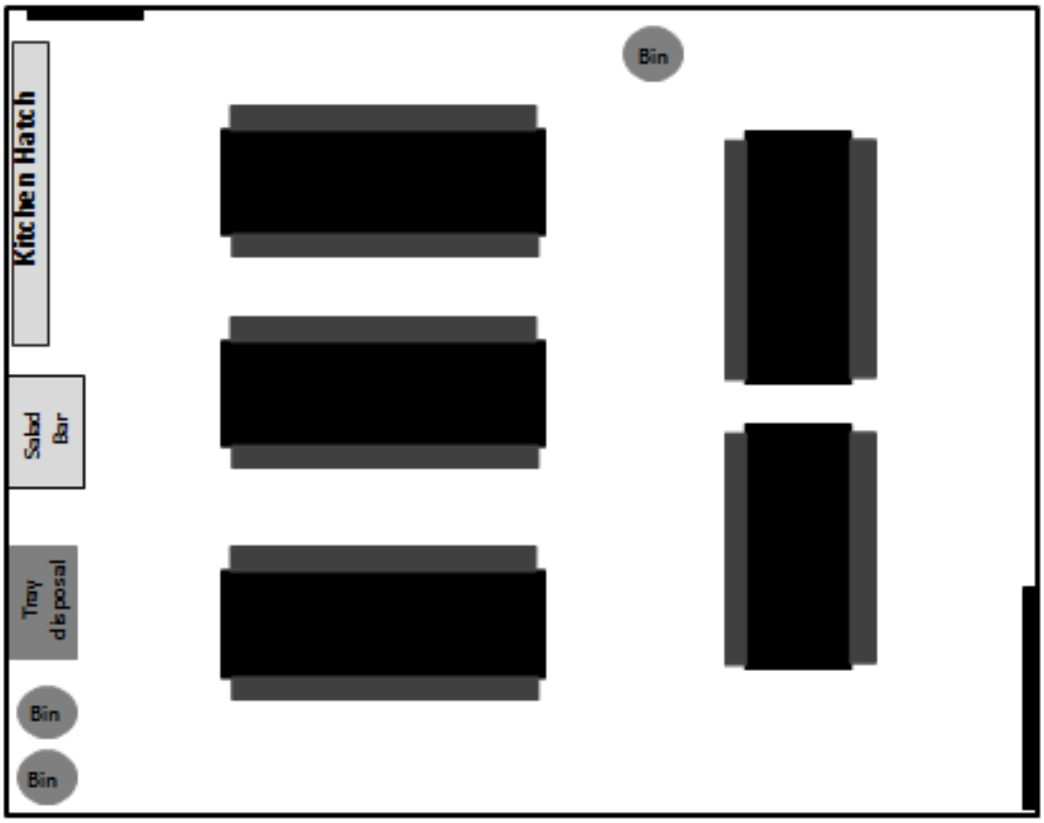


Figure 34. Diagram of School A lunchroom

The third school was a larger than average primary school, and its large size and subsequent need to serve a larger number of children quickly and efficiently influenced its layout (see Figure 36). The main lunchroom was filled with long, rectangular tables, and meals were served from three 'stations' in different corners of the room: standard hot dinners from the kitchen hatch, pre-packed 'sack lunches' (containing a cold sandwich, fruit, biscuit and a drink), and a 'pasta station' where students could get a bowl of pasta with a choice of 2-3 sauces. In this lunchroom, all students eating school dinners were grouped together, and were tightly controlled whilst they were in the lunchroom: students were seated in the order in which they entered the lunchroom, and told when they could get up to queue for food. Lunchtime supervisors, along with a rota of Key Stage 2 students (years three though six in

primary school, students aged 7 to 11), provided assistance refilling drinks, opening packages, and helping to clear up spills in order to eliminate the need for students to get up once they sat down to eat.

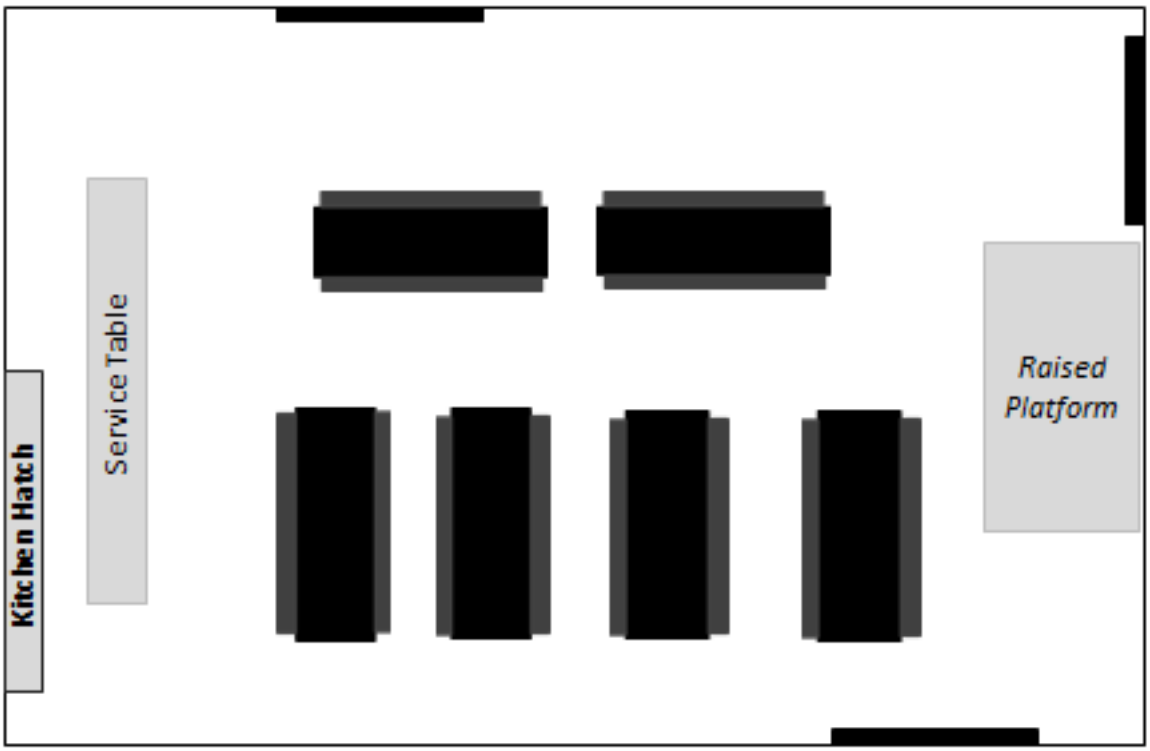


Figure 35. Diagram of School B Lunchroom

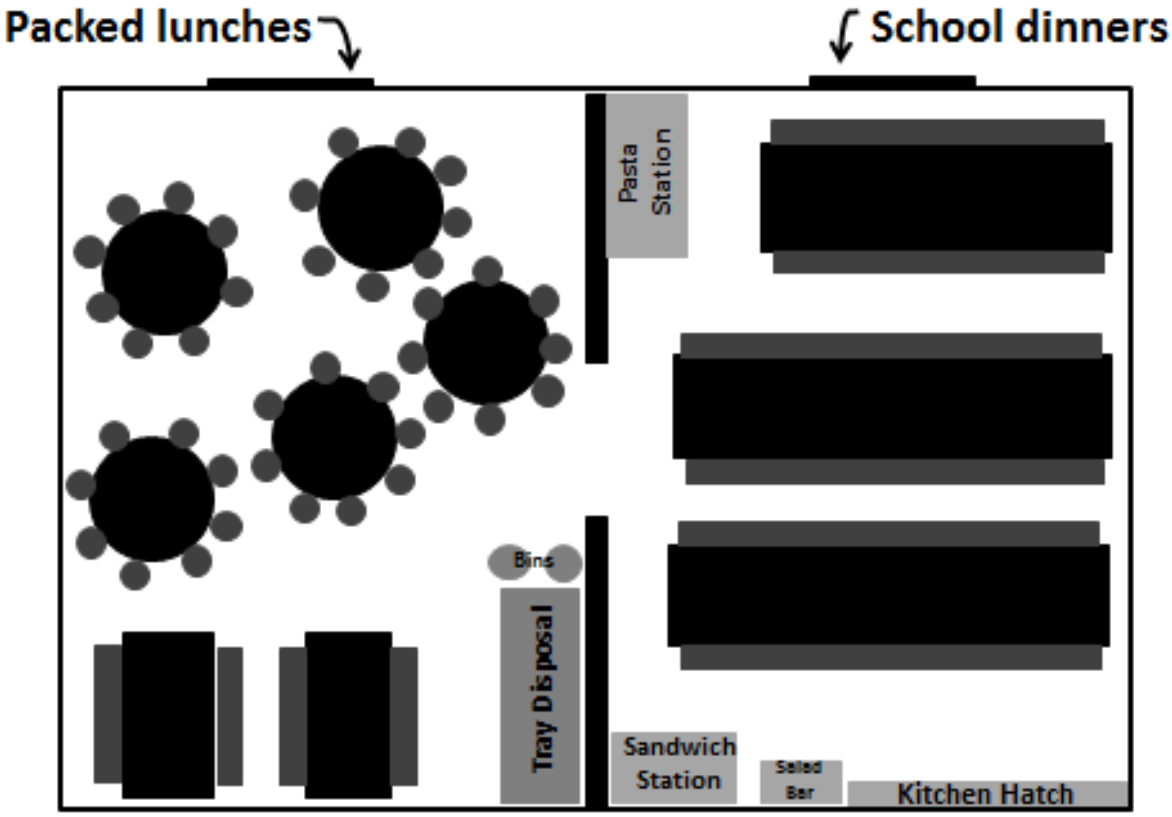


Figure 36. Diagram of School C lunchroom

Students eating packed lunches ate in an adjoining room filled with round tables and short rectangular tables; this room also served as an overflow for school dinner-eaters on days when popular meals were served (e.g. fish and chips on Fridays). A smaller number of lunchtime supervisors and Key Stage 2 assistants circulated in this room, offering assistance opening packages, fetching cutlery, and clearing rubbish and spills.

All three schools employed a number of lunchtime supervisors generally called ‘dinner nannies’ or ‘dinner ladies,’ in addition to their cook and kitchen staff. These dinner nannies were always women, and frequently mothers of students in the schools. Their tasks included directing traffic flow, refilling pitchers of water, and maintaining standards of behaviour.

Dinner nannies could also frequently be seen reminding students to eat instead of talk, and younger students would often apparently be required to gain permission from dinner nannies to move from their dinner to dessert. As mentioned above, in School C nannies would actively engage with students eating packed lunches while, in the other two schools, packed lunch students would have to raise their hands to attract the attention of a dinner nanny and request assistance before it was given.

G. Student Lunchroom Behaviours

When students were seated with their friends, they would often pace their eating in order to make sure they stayed with those friends for the duration of the lunch period. Particularly with students eating packed lunches, we observed study participants using crisps to moderate the speed of their eating so that they were able to stay with their friends in lunchrooms where dinner ladies would require students to leave once they had finished eating. A number of our study participants at School A brought packed lunches every day, and sat together at lunch time. All of these girls would bring crisps with their lunch, and the majority of their time spent at the lunch table was spent eating these while chatting. One day during the observation period, one of these participants opened her lunch to find no crisp packet, and she struggled for the entire lunch period to make her lunch (sandwich, yoghurt and a packet of biscuits) last as long as those of her friends. In the end, she was made to leave the lunchroom ahead of her table mates by the dinner ladies, and she was quite visibly unhappy about the situation. Additionally, students -- both those who ate school dinners and those who brought packed lunches -- would also engage in food exchanges. These exchanges were primarily a gift of food from one student to another rather than traded items.

A number of students were observed using their relationships with lunchroom staff to get extra servings of preferred foods. Additionally, students did a number of things to disguise unwanted food when they sensed they were under surveillance by staff. In Schools A and B, students eating packed lunches would get up midway through the meal to discard uneaten items, or would rewrap items and hide them in their lunch bag rather than leaving them on the table to be packed up at the end of the meal. In all three schools, students eating school dinners were observed cutting up untasted food to give the impression that it had been partially eaten (see Figure 37). One Bangladeshi-British participant typically brought a packed lunch to school; however, during one day of observation she had been informed by her parents that she was to have a school dinner that day. This was such an issue that her parents had called the school to get the support of the administration to convince her to attempt to eat a school dinner. She was in tears when she entered the lunchroom, and was accompanied by the head teacher who helped her select foods, and then went to find a friend to sit with her. The participant was very resistant to even trying the food (a vegetarian pasty, garlic bread and a clementine), and sat silently for most of the lunch period. Eventually, her friend, who had been summoned by the head teacher, showed her how to best to make her unwanted, untouched lunch appear partially eaten by cutting it up so that she would be allowed to leave the lunchroom (Figure 37). On the next day of observation, this participant was again eating a packed lunch brought from home.

Figure 37. Photo of uneaten school dinner disguised by student to appear eaten

H. School Administration and Staff: Interviews and Observations

1. Administration

One administrator from each of the three study schools was interviewed for this study. Each of them were interviewed twice: once prior to recruitment in their respective schools, and once just before research at their school was concluded. All three school administrators interviewed (one head teacher, two assistant head teachers) were white British.

When evaluating the interviews done with school administrators, it became apparent that the strongest and most common concern expressed involved both the uptake of school dinners, and the quality of packed lunches, and particularly the packed lunches brought by Bangladeshi-British students. Administrators in all three schools mentioned concern over these packed lunches, and proposed solutions which generally involved increasing uptake of school dinners and, less preferentially, improving the quality of lunches brought from home. School A, in particular, noted difficulty convincing Bangladeshi parents of the value of the lunchtime meal. School officials characterized parents as believing that any cold or English

food was ‘not a proper meal.’ This would result in parents preventing children from eating school meals (including some students eligible for free school meals), and often sending only packaged snack food in lunchboxes. The school in question had been running an intervention for several years in which they invited parents to attend a workshop about the importance of a midday meal for school performance, and also provided a “What can I pack in my lunchbox?” pamphlet that detailed the school’s lunch policy. The pamphlet contained suggestions for sandwich fillings, fruit, dairy side items and “cake treats,” and also contained a “no thank you” section that itemized unapproved items such as confectionary, crisps, ‘sugary cakes or pastries’ and fizzy drinks. The pamphlet also had brightly coloured boxes in multiple places recommending students opt for school dinners, and providing information on how to check for free school meal eligibility (see Figure 38). School A also allowed students living within walking distance to go home during the lunch hour, an option primarily chosen by Bangladeshi-British students, including two girls participating in the study.

School C, which is much larger than the other two participating schools, has approximately 65% of students eligible for free school meals, with a further 10% of students who purchased school meals, but typically carried a large unpaid balance. To this end, School C found it more economical to source their own meals. This plan allows them to retain the profit on lunches sold, which, according to school administrators, subsequently allows them to break even on meals for the year. Their primary focus, as stated by both administrators and lunchroom staff, was ensuring that food was provided for all of their students, rather than meeting any particular nutritional goals. According to the Assistant Head Teacher of School C, they were able to opt out of the citywide catering option with some resistance from the local council. This was done by developing their own menus with the help of a contract

nutritionist; they were also subject to twice yearly external review (by the council) to ensure they adhered to the food-based and nutrient-based school food guidelines.

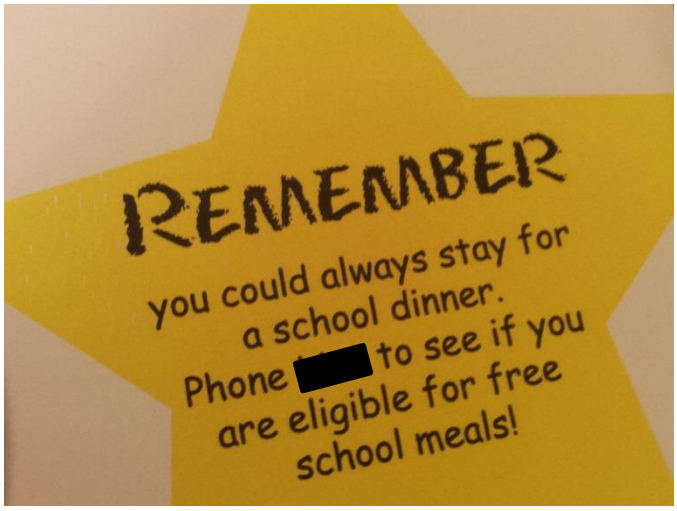


Figure 38. Language from School A's 'What Can I Put in My Lunchbox' Pamphlet encouraging students to opt for school meals instead of packed lunches

2. Lunchroom Staff

A total of five members of lunchroom staff were interviewed in the course of this study: two school cooks and three lunchtime supervisors. Both school cooks and two of the lunchtime supervisors interviewed were white British, the other participating lunchtime supervisor was Bangladeshi-British. In this section, information given by lunchroom staff is presented alongside relevant observations made during the lunchtime observation period.

In interviewing these lunchroom staff, concerns primarily revolved around consumption of school dinners. School cooks' concerns fell into two categories: 1) promoting uptake of halal meals, and 2) minimizing wastage. To the first point, the head cook at School A had invested considerable time and effort finding affordable halal meat options that were enjoyed by the

students, particularly sausages. She reported that having a "decent sausage for sausage day," was key to increasing uptake of school dinners, and had gone through several different suppliers to find halal chicken sausages that students found palatable. This head cook had also changed recipes to better suit the tastes of the Bangladeshi-British students: for example, the halal chicken curry was much spicier than the 'regular' chicken curry, and as a result had become quite popular with teachers in the school as well as students.

The other two participating schools were less concerned with providing halal options for students and, instead, would typically provide more vegetarian options. Both administrators and cooks claimed that this was preferred by parents, as many parents either had no confidence that the halal options provided were in fact halal, or were worried that serving mistakes would be made (or that the cooks would allow a Muslim student haram (forbidden) food if they asked for it). These concerns coincided with the other primary concerns expressed by lunchroom staff, which involved the wastage of food, and keeping reign over their food spending in order to keep within their allotted budgets.

These concerns over wastage could be seen reflected in the practices of lunchroom staff in the study schools. In all three schools, children were rarely served any food they did not explicitly request, which frequently resulted in dinners being served that were devoid of any fruits or vegetables. Tight controls over the amount of food prepared also resulted in: 1) limited availability in later sittings, and 2) students being unable to choose the vegetarian option on days when a popular choice was on offer, unless they were a known regular consumer of the vegetarian option. On sausage day in School B, for example, only "halal" (lunchtime workers' term for observant Muslim students) or vegetarian students were allowed to choose the vegetarian sausage option. Additionally, servings of the (more costly)

vegetarian sausages were limited to two per student, while students choosing pork sausages were given three.

At later lunch sittings, there would often be limited options remaining for consumption. Students at these later sittings (almost always Years 5 and 6 students) were often given large portions of the foods remaining upon request: for example, entire plates of mashed potatoes or chips, or scoops of tuna mayonnaise. Some students at Schools A and B were able to negotiate second servings at no cost once the final sitting was completed. Acquisition of larger portions and second helpings appeared to be largely dependent on the particular student's relationship with the lunchroom staff. Certain students, most often boys, were able to acquire additional food frequently, while other students would be turned away after making the same request. At one occasion, this apparent favouritism led to an argument with lunchtime staff that escalated to the degree that it required intervention from the school's Head Teacher. Possibly as a function of the way in which School C maintained tighter controls over how students moved within the lunchroom, no negotiation for additional portions occurred at the end of service.

CHAPTER 6: DISCUSSION

In this thesis, I have compared levels of overweight and obesity, risk for metabolic disorders in later life, and attitudes towards food among Bangladeshi girls aged 10-12 and a similar group of white children attending the same schools in Sunderland, northeast England. I also set out to explore how the school environment in the context of school meals might affect eating behaviours among these girls. As stated in the preface, access to traditional South Asian foods is limited in this location compared to the larger and more established Bangladeshi communities in London. Northeast England also has among the highest rates of childhood obesity in the United Kingdom (NHS 2008). Through this investigation, I aimed to reveal some of the ways in which ethnicity, place and culture have the potential to influence the health of children.

A. Measures of Overweight and Obesity

Of the various measures of overweight used (BMI, WC centiles, WHtR), there are no significant differences between the Bangladeshi-British and white British groups. Rates of overweight and obesity as evaluated by BMI are compared to results from the 2012-13 National Child Measurement Programme (NCMP) in Table 18 below. Rates of overweight and obesity in the white British cohort in this study match closely with those found in the ward-level data where the entire study population resides. Additionally, rates from the combined study sample closely match those found in girls across the local authority (HSCIC 2013). In this way, the study population appears reflective of the local area as a whole. As discussed in the systematic review in this thesis, BMI has a consistent association with SES in children in developed countries, with those of lower SES having a higher BMI than those

of higher SES. Participants in the study here come from an area of relative deprivation within the UK, and are primarily of low SES which may help to explain the relatively high proportion of children who can be classified as overweight or obese

Table 18. Comparison of overweight and obesity by BMI in study cohorts and 2012-13 NCMP data

	Number measured	% overweight or obese[1]	% obese[1]
Bangladeshi-British	20	30 (6/20)	10 (2/20)
White British	20	45 (9/20)	30 (6/20)
Combined	40	37.5 (15/40)	20 (8/40)
Ward (girls)	413	42.6	30.0
Local Authority (girls)	8002	37.1	22.4
Asian or Asian British (boys and girls)	45338	37.8	23.0
UK (girls)	238421	31.8	17.4

1 Due to small sample size rates of overweight and obesity for study participants is also presented as a fraction

Using BMI, there is no significant difference in rates of overweight between Bangladeshi-British and white, British groups in this study. These findings are consistent with recent work by Houghton and colleagues with Bangladeshi-British girls aged five to sixteen living in East London (Houghton et al. 2014). Average BMI z-score for second generation immigrant Bangladeshi girls was 0.6, with a z-score of 0.7 for first generation Bangladeshi girls and a z-score of 1.0 for white European girls (Houghton et al. 2014); here, average z-score for Bangladeshi-British girls (all second generation) was 0.6 and white British girls was 0.8.

Given the widespread use of BMI in obesity studies, it is impossible to look at obesity rates in any population without calculating BMI. That being said, there is a growing body of evidence suggesting that measures of central adiposity are vital to understanding the primary comorbidities of obesity, metabolic and cardiovascular diseases. WC is a better measure of

central adiposity, and becomes more useful as more studies use this metric. WHtR is not currently as well studied as the other two, and typically only provides a single boundary (> 0.5 being 'at risk'), so its comparative value is unclear. Arguments for the use of WHtR as opposed to BMI or WC centiles have been made in recent years, especially as the at-risk boundary value for WHtR is the same for as children as adults, and it does not appear to be variable by ethnic group (Ashwell and Hsieh 2005; Brambilla et al. 2013). The at-risk group identified by WHtR in this study is larger than the risk group identified by BMI, but smaller than the group identified by WC. Given that WHtR moderates WC by height instead of age, this is perhaps a more useful for identifying risk in children verging on adolescence such as this study population, despite the fact that it doesn't have much diagnostic specificity.

However, when analysing WC, a much larger percentage of both cohorts fell into the at-risk category using WC centile charts. 14/20 of the white British cohort had a WC at or above the 75th percentile, as opposed to 9/20 being at or above the 85th percentile for BMI (the cut-off for being classified as overweight). In the Bangladeshi-British cohort, the difference was even more marked. As compared to the 6/20 overweight or obese by BMI, 17/20 was at or above the 75th percentile for WC using the UK centile charts, and 11/20 at or above the 75th percentile using the Indian centile charts. The use of WC centile charts identifies a different, at-risk segment of the study population compared to BMI. Rather than identifying overweight and obese individuals, the WC centile charts are primarily useful in identifying individuals at risk for Metabolic Syndrome (MetS). This indicates that a greater proportion of the study population is at risk for MetS than identified by BMI alone. This falls in line with observations made by myself and my research assistants during data collection: when taking waist measurements, we often found that girls who appeared to be of normal weight would have substantially more abdominal fat than would be expected of a child their size and frame.

Similar to findings for an association between SES and weight status, the Whitehall II study has also found an association between low SES and central obesity in adults, as it relates to coronary risk and MetS (Brunner et al. 1997). However, findings from the Avon Longitudinal Study of Parents and Children (ALSPAC) in children at 9.9 years did not find a social gradient to central obesity, despite finding a familiar negative association between overall fat mass and SES (Ness et al. 2006). Therefore, it appears that the higher rates of central obesity as measured by WC centiles in the sample here cannot be explained by SES alone.

Griffiths et al. (2011) evaluated obesity prevalence as measured by BMI, WC and WHtR in children aged 11-12 years over a 3-year period, in order to further understand the relationship between BMI and WC as these two measures relate to health risk in children. Similar to findings here, central obesity (as assessed through WC) was significantly higher than obesity (as assessed through BMI): in their 2005 measurement group, 18% of female subjects were obese by BMI, versus 35.6% by WC. Other research suggests that central adiposity is increasing in adolescents, especially in girls (McCarthy et al. 2001), despite the apparent levelling off of overweight by BMI. Given the evidence that WC is a predictor of insulin resistance in children and adolescents as well as adults (Hirschler et al. 2005; de Lorenzo et al. 2011), this trend warrants both concern and further exploration.

The Ten Towns Heart Health Study was a cross-sectional study looking at indicators of future heart health in children aged 8 to 11 in 10 cities across England and Wales (Whincup et al. 2002). Researchers from this study found that, while white British children were both heavier and taller on average than children of South Asian heritage, both groups had a similar WC, which suggests greater central adiposity in the South Asian group, even at lower weights. The

South Asian cohort also showed higher insulin resistance, and this difference was more pronounced in girls than in boys.

In the study presented here and elsewhere, South Asian children show higher levels of central adiposity even when they are within what is considered normal range for overall adiposity. This tendency toward greater central adiposity, often coupled with lower muscle mass, has been found at birth in Indian babies (Yajnik et al. 2003), and continues into adulthood (Bhardwaj et al. 2008). Persistent low birth weight has been found in South Asians in the UK in the second generation born in the UK, suggesting that the problem has complex causes (Margetts et al. 2002). There is a strong association between central adiposity and insulin resistance in South Asians (Whincup et al. 2002), which indicates that the Bangladeshi-British participants in this study are at high risk for developing diabetes mellitus II and MetS.

The difference, however, between the UK and Indian centile charts for WC is noteworthy. The Indian centile charts are more ethnically specific for the Bangladeshi-British cohort in this study than the UK charts (which are compiled from a sample that includes all ethnicities in the UK, but primarily white British children), but the Indian charts identify a much smaller group as being at risk than the UK charts. This reason why this is of concern is twofold: 1) it is well documented that South Asians have greater central adiposity at lower BMI across age groups (Whincup et al. 2002; Misra et al. 2004; Gray et al. 2011), and 2) rates of childhood and adolescent obesity and overweight in urban southern India (where the Indian centile charts were compiled) are high, particularly in high SES children, but increasingly across the socioeconomic spectrum (Kuriyan et al. 2007; Kotian et al. 2010). This implies that there may be an inherent skew to centile charts developed in a population with such high rates of overweight that could mask a substantial portion of the at-risk population, both in urban south

India and anywhere where these centile charts are employed. If a population has a higher than anticipated segment with central adiposity, then identifying only the uppermost 25% as being at risk is no longer adequate. Given that being above the 75th centile category for age is the first diagnostic criterion for MetS in children aged 10 and above, it is problematic that use of these centile charts may obscure the picture of children at risk for insulin resistance and MetS.

Ethnically specific centile charts for WC in children are important: people of different ethnicities may be taller or shorter on average, and if general charts were used, a tall child may be incorrectly identified as at-risk, while a shorter child's increased risk may go unnoticed using WC-for-age centile charts (McCarthy 2006). However, if the population used to develop these ethnic-specific charts does not have a normal distribution of overweight, then the potential for failing to identify a segment of the actual at-risk population becomes great. It is beyond the scope of this thesis to consider the ways in which more suitable WC centile charts might be accurately developed, but if such charts are meant to be used as part of a diagnostic battery for metabolic disease, steps must be taken to ensure that the information they provide accurately represents real risk. This highlights an important avenue for future research, in the United Kingdom and South Asian countries, and elsewhere. As the obesity epidemic becomes more entrenched, it seems clear that the identification of obesity's co-morbidities is more important than the identification of obesity itself. Given the potential problems with the use of WC centile charts, it may be more appropriate for health organizations to move to the use of WHtR for diagnostic purposes of individuals at risk for metabolic disorder. More research into WHtR is also appropriate to ensure that the at-risk boundary currently used accurately reflects increased risk of metabolic disease.

B. Systemic Bodily Inflammation: an indicator of insulin resistance

Given the relationship between WC and insulin resistance, one would expect that as WC increases, so would levels of inflammation. However, there was no clear relationship between measures of C-reactive protein (CRP) and WC in either cohort. This is possibly due to the fact that the sample size is too small to elucidate fully any directional relationships, or that such a large proportion of both cohorts was found to be above the 75th percentile for WC. The white British cohort had a very wide range of CRP concentrations, from 712pg/ml to 19068pg/ml. However, the median concentrations were very similar between groups: 2302pg/ml for the white British cohort and 2739 pg/ml for the Bangladeshi-British cohort. The high concentration found in the one subject at the upper end of the range suggests acute, rather than chronic inflammation, meaning that this subject was most likely ill.

For the white British cohort, both BMI and WHtR are positively associated with CRP, indicating that as overall adiposity increases, so does bodily inflammation. This is the sort of relationship one expects to see between these two variables. However, in the Bangladeshi-British cohort, WHtR has no apparent relationship with CRP, and an inverse relationship with BMI, which would seem to indicate that, for this population, as BMI increases, bodily inflammation decreases. This is unusual, and this relationship has not been found elsewhere.

The majority of research looking for a relationship between adiposity and inflammation using CRP has used serum CRP as opposed to salivary CRP; however, there is evidence that salivary CRP is an appropriate substitute for serum CRP in cases such as this study when blood draws are not appropriate due to non-clinical settings (Ouellet-Morin et al. 2011). Using data from the 10 Towns Children's Study, Cook and et al. (2000), looked at the

relationship between serum CRP, adiposity, and other cardiovascular risk factors in children aged 10-11. They found that CRP levels increased with age, even within their limited age range, and that levels were 42% higher in girls than in boys. There was an apparent association between CRP and breast development, although the authors attributed this to overall increased adiposity rather than breast development itself. Strikingly, the small subset of South Asian children included in this study (n=56, with 699 total study participants) had an average CRP level 104% higher than the average for white British participants. Vikram et al. (2003) looked at correlates of CRP levels in adolescents and young adults (ages 14-25) in north India, and found that overweight individuals had an adjusted odds ratio of 2.3 for having elevated CRP levels. Furthermore, 28.6% of female participants with high WC had elevated CRP levels. Visser et al. (2001) looked at CRP levels in the cohort for the US third National Health and Nutrition Examination Survey (NHANES III). Participants were aged 8-16, and elevated CRP levels were found in 6.1% of girls. Adjusted odds ratio for elevated CRP levels in overweight girls was 3.17. There has been one large scale study looking at correlates to salivary CRP, in black South African children with average participant age 9.41 years (Naidoo et al. 2012). Researchers found overweight to be an independent predictor of elevated CRP, with an adjusted odds ratio of 2.5. Chronic inflammation is causally linked with the development of metabolic disease (Hotamisligil 2006), so the identification of elevated CRP levels, as a marker of inflammation, in overweight children suggests the impending development of metabolic disorders such as insulin resistance. That the Bangladeshi-British participants in this study do not exhibit a positive correlation between overweight and CRP levels is unusual. A larger study would be required to determine if this lack of relationship is typical in this community, and if so, what other contributing factors underlie this unusual finding.

C. Physical activity

When looking at parent-reported physical activity, there appear to be substantial differences between the two study groups. Outside of school hours, Bangladeshi-British participants primarily engaged in casual play as physical activity, typically with siblings or near neighbours. In focus group discussion, this was affirmed by many of the girls themselves, who reported spending much of their free time at home out of doors whenever possible. Only two Bangladeshi-British participants took active formal lessons, and none of them played organized sports. Several Bangladeshi-British participants from the same schools lived quite near each other, and many reported living near extended family, as well, making outdoor play more appealing.

In contrast, the majority of parent-reported physical activity for white British participants were formal paid lessons or team sports, with few parents reporting that their daughters engaged in casual play of any kind. White British subjects themselves reported spending very little time out of doors when at home. Additionally, parental report of 'screen time' (inclusive of time spent watching television, playing video games and using computers) indicates that white British participants spend more time in front of screens, ranging from seven to fifty hours per week with a median of seventeen hours per week, than their Bangladeshi-British counterparts, who ranged from four to twenty-four hours of screen time per week with a median of fourteen hours.

This suggests that, despite living in the same neighbourhoods, Bangladeshi-British and white British families may experience those neighbourhoods very differently. All participants in this study lived in a relatively deprived area of Sunderland within a mile of Sunderland city

centre, which is locally understood to be rowdy and unsafe, especially at night and especially for minorities (Saeed 2007). The locality of the city in which all three study schools are located has high rates of crime: the number of people in the area that are arrested and charged with crimes is nearly three times the citywide average, and risk of victimization in this area is the second highest in the city. This area also has high rates of reported hate incidents and reported domestic violence, as well as high numbers of deliberate property fires (Sunderland City Council: 2013).

A number of studies has linked children's physical activity levels to parental perception of neighbourhood safety. Burdette and Whitaker (2005) looked at this relationship between parentally-perceived safety and overweight, television viewing and outdoor play in preschool-aged children across the US. After adjusting for sociodemographic factors, authors found no relationship between mothers' perceptions of neighbourhood safety and outdoor play or obesity, but children living in areas perceived to be less safe watched more television than children living in areas their mothers perceived to be safe. It is important to note that the children in this study were quite young, and presumably all outdoor play would have been supervised. It is reasonable to assume that when these children are old enough to play unattended, their parents' concerns about the safety of their environments might factor more heavily.

Weir and colleagues (2006) explored parental perceptions of children's safety and physical activity in children aged 5-10 in two neighbourhoods: 1) a lower income, primarily minority, inner city community, and 2) a mostly middle class, mostly white, nearby suburb community. They found that inner city children engaged in less physical activity overall. Fifty-eight percent of inner city children did not participate in any sort of organized sport or activity, as

opposed to 30% of suburban children. Of that 58% of the inner city cohort, 21% also did not engage in any kind of outdoor play unless accompanied by a parent. Inner city parents also expressed much more anxiety about neighbourhood safety than did their suburban counterparts, with 48% of inner city parents even feeling personally unsafe in their own neighbourhoods. In the inner city cohort, authors found a weak negative correlation between children's total physical activity and parental anxiety over safety.

Johnson Dias and Whitaker (2013) interviewed single black mothers of preadolescent daughters in a low-income housing development in urban New Jersey in the US. These interviews were conducted with a view to understanding how their perceptions of safety in their neighbourhoods affected their willingness to allow their daughters to play outdoors. Questions posed in interview explored neighbourhood conditions, their daughters' activities, and proposed solutions to neighbourhood safety problems. Of the women interviewed, all but one reported not allowing their daughters to engage in any outdoor play near home during the school year. Primary reasons cited were the unpredictability of neighbourhood violence and fear of the influence of older teenagers, who were largely perceived as gang members and drug users. Overall, participating women believed that keeping their daughters indoors was vital to keeping them safe from harm, and generally left their neighbourhoods entirely to find safe outdoor spaces in which their children could play.

These studies demonstrate that perception of safety figures heavily in parents' decision making when allowing or encouraging their children to play outdoors. While the link between regular outdoor play and obesity is not clear, the fact remains that access to outdoor play is an important factor in children's ability to keep active overall. In this study, the different behaviour of the two cohorts suggests that the Bangladeshi-British families may perceive

their immediate neighbourhoods as more safe than do the white British families living in the same area. The Bangladeshi-British community in Sunderland is quite close-knit and contains many extended families (Crozier et al. 2003). It can be assumed that knowing and feeling connected to near neighbours fosters a feeling of community that makes parents more comfortable letting their children play freely outdoors. Other potential contributing factors to the difference between types of activities Bangladeshi-British and white British girls engage in could be cultural; some of the activities in which the white British girls in this study engage, such as swimming or gymnastics, require clothing that Muslim families may feel are immodest or inappropriate for their daughters to wear in public, or in mixed-gender activities (Dagkas et al. 2013). There may also be economic barriers to paying for formal lessons, or language barriers to accessing activities at all, as many Bangladeshi parents in the community do not speak fluent English.

D. Food Intake at School and at Home

The NHS recommends what they call the 'Eatwell Plate' (Figure 39) as a dietary guideline for everyone aged 5 and over. Recommendations include at least five servings of fruits and vegetables per day, choosing whole grain starchy foods wherever possible, low-fat dairy whenever possible, non-dairy sources of protein, and only small amounts of food/drink high in fat and/or sugar (NHS Choices 2013). In this study, fruit and vegetable consumption was an average of 2.2 servings per day for Bangladeshi-British participants, and 1.9 servings per day for white British participants. Only one participant (white British) fulfilled the UK's '5 a day' recommendation during the recorded 24-hour period. Consumption of whole grain foods was minimal (only two servings among all participants), and participants from both

cohorts consumed an average of three or more servings of sugar laden desserts or confectionery per day, and two or more servings of sugar sweetened drinks per day.

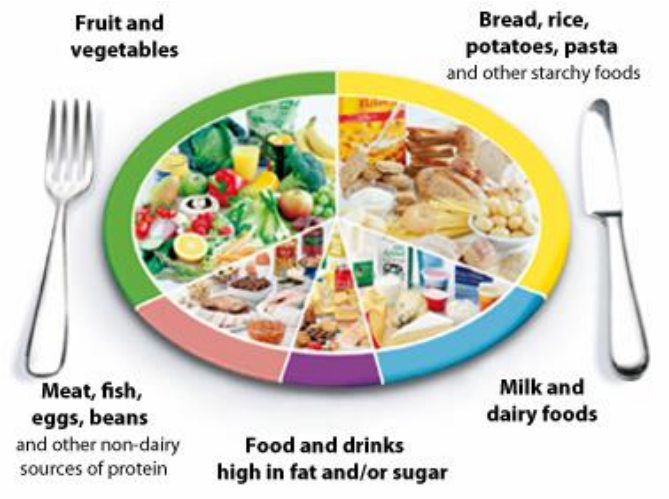


Figure 39. NHS Choices Eatwell Plate (http://www.nhs.uk/Livewell/Goodfood/Pages/eatwell-plate.aspx)

A commonly expressed concern from school administrators during this project was that most Bangladeshi-British students: 1) did not eat school dinners, even when eligible for free meals, and 2) brought packed lunches that were nutritionally unacceptable. One school had a longstanding intervention with parents designed to improve the quality of packed lunches, with limited success. A review of the lunchtime food survey bears out this concern: only 3 Bangladeshi-British study participants ate school dinners, and every packed lunch we observed contained some combination of crisps, biscuits, cakes and chocolate. One Bangladeshi-British participant brought the same lunch every day, consisting of two bags of crisps and a small chocolate bar (Figure 40). At the time, government school food standards did not explicitly cover packed lunches: the 2008 guidelines for primary schools noted that packed lunches were typically not as nutritionally balanced as school dinners, and provided guidance for schools on how to increase uptake of school meals (Parliamentary Office of Science and Technology 2009; School Food Trust 2008). To this end, one of the study

schools (School A) had developed their own guidance for students on packed lunches, which discouraged crisps, confectionery and fizzy drinks, and encouraged parents to contact the school about free school meal eligibility. It is important to note that School A did not appear to enforce this policy in the lunchroom; crisps and confectionery were common items in packed lunches in all three schools.

Figure 40. Lunch of Bangladeshi-British participant

Taken on its own, this lunchtime survey paints a worrying picture regarding the nutrition of Bangladeshi-British students in Sunderland. However, when put in context of daily intake, as provided by the 24-hour food diaries, this specific concern about Bangladeshi-British students becomes less clear. While their lunchtime food choices are very poor, and appear worse than those of their white British counterparts, over the entire day their intake of fruit and vegetables, as well as intake of sweets and junk food, is very similar for both groups.

Bangladeshi-British families in this study followed a different meal pattern from that of their white British peers, consuming two meals after the school day had ended: one immediately after arriving home from school, and one late in the evening before bed. For every participant, at least one of these meals was cooked from scratch in the home, most often

consisting of rice and a vegetable-based curry. The majority of fruit and vegetable consumption for Bangladeshi-British participants occurred from these two meals. This is consistent with findings by Lofink (2012), who reported that children in Bangladeshi-British families living in Tower Hamlets in East London consumed rice and curry twice a day, typically upon arriving home from school, and then in the evening before bed. Lofink's informants reported that this regular consumption of rice and curry was considered vital to 'eating well,' by their mothers, and that this was an important way for families to feel connected to their culture.

Bangladeshi-British participants generally ate more home cooked meals, while white British participants were more likely to eat evening meals that were partially home-cooked (i.e., prepared at home from packaged sauces or from meal kits). Additionally, the majority of Bangladeshi participants reported eating restaurant food once a month or less often, while the majority of white British participants reporting eating restaurant food once a week, or more often. While both cohorts displayed poor nutritional choices during the study period, Bangladeshi-British participants ate much more healthily in the home, whereas for white British participants, school dinners and to a lesser extent packed lunches contributed a significant percentage of overall intake of fruits and vegetables. While the amount of high fat, high salt, high sugar convenience food consumed by both cohorts is worrying, there is evidence that this strong preference for packaged convenience food does not necessarily last into adulthood. Gold (2007) found that, in refugee populations in the northern US, younger adolescents preferred American-style fast food and convenience items, but as they moved into adulthood, older adolescents seemed to rediscover a preference for foods traditional to their culture, often mixing traditional preparations with American ingredients.

School administrators characterized the lunchtime meal as not being seen as important by Bangladeshi-British parents; this view was supported by the participants themselves. One girl reported her mother's belief that a meal 'wasn't proper' unless it came with rice. A number of participants also reported parental barriers to purchasing school dinners. One Bangladeshi-British participant said that she wished she could have school dinners because they have foods on offer such as pizza that she liked but did not regularly get at home, and claimed she did not know why her mother refused to allow her to buy them. Two other participants reported the reason why they were not allowed to purchase school dinners was their parents' concern that halal lunch options were not truly *halal*. Given that all three schools offered vegetarian as well as halal lunch options, this indicates a possible lack of trust by parents that their children would choose appropriate foods on their own.

E. Lunchroom Behaviour

Social facilitation is one of the oldest paradigmatic concepts in social psychology, and its purpose is to examine the consequences of the presence of other individuals upon behaviour. There are two forms of social facilitation: co-action effects and audience effects. Co-action effects are the effects on an individual's behaviour whilst in the presence of others engaged in the same activity, while audience effects are the effects on behaviour whilst in the presence of non-participating spectators (Zajonc 1965). Co-action effects typically encourage a person to eat more than they would otherwise, while audience effects generally have the opposite effect (Herman 2015). Social facilitation of eating behaviours is most commonly seen through co-action effects, although in the school lunchroom students are impacted by both: co-action effects by their peers, and audience effects by teachers and lunchroom supervisors, and in this case, researchers.

The presence of others has been shown to have a powerful impact on consumption. Both humans and other animals have been observed to eat more in the presence of others; however, humans have also been observed to eat less than normal when paired with another person who only eats a very small amount (Zajonc 1965; Conger et al. 1980). Clendenen and colleagues (1994) looked at social facilitation in both friends and strangers, and found that subjects in pairs or larger groups ate more than when dining alone, regardless of whether their dining companions were friends or strangers. However, participants ate more dessert only when dining with friends, suggesting that the social relationship an individual has with his or her dining companions does have an impact on the types of foods selected. It has also been found that, in a cafeteria style environment, people in groups are more likely to take more food than people dining alone, and that people are more likely to eat snacks and desserts when with friends than when alone or with strangers (Herman 2015). Brindal et al. (2015) observed adults eating in a fast food outlet and found that in larger groups, women eat less if the group is mixed gender than if their group is composed of only women. Men ate more when eating in larger groups than they did when eating in pairs or alone. Authors suggested that, since fast food is well known to be 'bad for you,' and high calorie, it may be that self-presentational concerns may encourage women to eat less so that they appear to exhibiting the 'correct' behaviour in mixed company.

Student behaviour in the lunchroom is what guides food selection and consumption. These behaviours are generally governed by three sets of factors: 1) institutional, 2) geographical and 3) social. Institutional factors include policies laid down by the government, local authority, and the schools themselves, which govern the specific foods served, what children bringing packed lunches are allowed to bring (and also whether these guidelines are adhered to), as well as the time allotted for eating, number of students per seating, whether students

are allowed to choose their seats, and whether they are allowed to move around the room during the lunch period. Geographical factors include the size and layout of the room, traffic flow, and size and shape of tables. Social factors are much less consistent across student populations, but they are primarily the influences of the friends and peers seated at the table where a student eats, which will be expanded upon below. In the three study schools, the variable influence of all these factors can be seen clearly.

In a 2006 speech on healthy living, part of a lecture series entitled "Our Nation's Future," then Prime Minister Tony Blair declared that "… these campaigns [to improve school dinners] are central to our nation's health," thereby signalling a governmental interest in targeting school dinners as a means to intervene on child health issues such as childhood obesity and health inequalities. The 2008 school food guidelines went on to lay down standards for school dinners (Figure 41).

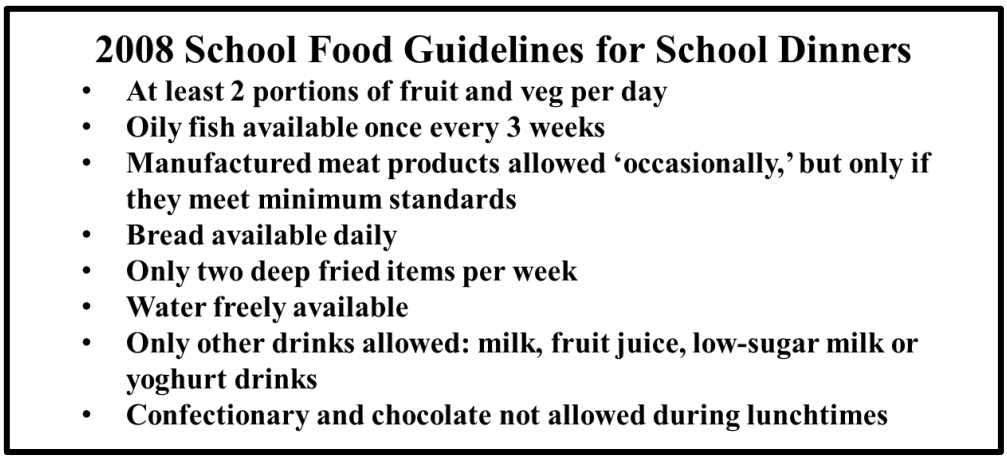


Figure 41. 2008 school food guidelines from the School Meals Review Panel and the School Food Trust (adapted from http://www.childrensfoodtrust.org.uk/assets/sft_nutrition_guide.pdf)

The guidelines go on to state, "[s]chools and local authorities should aim for complete take-up of free school meal entitlement; and schools should aim to have at least 10% increase in school meals take-up by the end of the implementation period." (School Food Trust 2008). The underlying message to this goal is that packed lunches present a problem for reaching healthy eating goals. Even for schools providing packed lunch guidelines, schools have minimal influence over what parents choose to send with their children as these guidelines are not consistently enforced within the lunchroom at any of the study schools.

A primary objective of lunchroom staff in all three schools, expressed both in interview and acted upon during lunchtime periods, was that of waste reduction. Particularly with School C, which did not use the catering option provided through the local council, cost constraints were of paramount concern to school administrators, and this translated into wastage concerns for lunchroom staff. School cooks planned meals tightly around the number of students expected to eat school dinners on any given day, typically planning for only a few extra meals to account for spillage. This aversion to wastage was carried over into the manner in which students were served their meals. Students in all three schools were largely allowed to dictate exactly what was put on their tray, frequently resulting in meals devoid of fruit or vegetables. While the School Foods Standards Guidelines recommend lunches including at least one serving of vegetables and one of fruit with every school dinner, and meals are planned around this concept, the actual food served to students does not always fall in line with these ideals.

Institutional factors overlap with geographical ones in a number of ways that can be exemplified in the study schools. School C was a large primary school, and had a regimented lunchtime routine to manage the volume of students coming through. Their lunch hall was a

dedicated space instead of a multifunction hall, which eliminated the clutter of excess furniture stacked in the corners, and made more room for students. Students eating packed lunches came in to the room through a separate entrance away from the queue for school dinners, which minimized traffic clogs coming into and out of the room. Dinner ladies in this school kept tight controls over students' comings and goings: no student was allowed to be out of their seat unless they had express permission to do so, either to collect their food or to leave the lunchroom once dismissed. Student helpers from upper grades would circulate, along with dinner ladies, to refill water glasses and clean spills to eliminate the need for students to move during the lunch hour. The impression of the lunchroom was that of a well-oiled machine—but this highly regimented system does not always uphold the precept of good nutrition. Students would elect to queue at one of three stations; and at two of those three stations (the pasta station and the packed lunch station), no vegetables were available to select, and no fruit was available at the pasta station.

Standing in contrast to School C's regimented system, the lunchtime process at School A gave the appearance of being quite relaxed. A much smaller school than C, lunch sittings were likewise considerably smaller (approximately 40 students per sitting, as opposed to over 100 per sitting), and while the lunch hall was a multifunction hall with excess stored furniture and equipment, it never felt particularly crowded during the lunch period, even during the busiest sittings. While the very youngest students were made to stay seated during the lunch period, most students were free to move about so long as they were not being disruptive; they were also free to sit with friends, and packed lunches were not segregated to one side of the room. One major effect of this policy to allow freedom of movement was that students eating school dinners would frequently return to the salad bar midway through the meal for more food. This meal addition was most often a piece of baguette that the student then hollowed

and filled with coleslaw, but many students also returned for crudités such as cucumber, celery and carrots. School A also allowed older students to leave the lunchroom as soon as they finished eating rather than waiting to be dismissed, although pupils were not allowed to linger with friends once they had finished eating. At this school, Reception and Years 1 and 2 students eating school dinners would wait to be given permission (from dinner ladies or supervising teachers) before beginning to eat their dessert, after they had eaten 'enough' of their main meal. With the one notable exception described in the previous chapter, this was the only type of direct intervention regarding consumption observed in any of the three study schools.

School B was slightly larger than School A, and their lunchroom was a long multipurpose hall with a raised stage at one end, with lunch tables clustered together in the centre of the hall to allow for traffic to move around the outside edges. Tables were placed quite close to one another and it was very difficult to move within the seating area during the lunch period. Students eating packed lunches or choosing the cold 'packed lunch' selection had the option to eat their lunch at benches or tables in the adjacent outdoor courtyard when the weather was accommodating; when the weather was poor the lunchroom was exceptionally loud and chaotic. Few students moved around once seated for lunch; while there was limited freedom of movement allowed here, dinner ladies had a lower tolerance for what constituted 'disruptive behaviour,' and as noted previously it was difficult to move around the seating area, so most students opted to stay seated for the duration of the lunch period. While School B had a salad bar available to everyone eating school dinner, it was awkwardly placed and did not see as much traffic as the salad bar at School A. Dinner nannies at School B were the least involved with students of any of the three schools, primarily staying to the sides of the room with an eye only for major disciplinary issues. It was our observation that students here

finished eating faster than at either of the other participating schools: turnover was frequently fast enough that some of our study participants would have to wait for us to complete our lunchtime recordkeeping (photos and notes taken at the beginning and end of each meal), an issue we did not have at either of the other two schools.

Through these three examples, it can be seen how varying school policies interact with the geography of the particular space to create unique issues and challenges. The relaxed and easy approach to guiding student behaviour at School A appeared to be highly successful, while a similar approach at School B resulted in a loud and chaotic lunchtime. Likewise, School C's highly regulated approach would have been unnecessarily draconian in a school with fewer pupils or more lunch sittings.

In School C, the highly regimented approach to managing the crowded school lunchroom undermined fruit and vegetable consumption, as students who queued for two of the three school dinner options had no access to either cooked or salad bar vegetables. Likewise, schools A and B allowed students to leave for the playground as soon as they were finished eating, which frequently led to students eating quickly so that they had more time to play. A recent case-control study in US school lunchrooms has shown that the simple change of moving recess before the lunch period has the effect of increasing fruit and vegetable consumption during lunch by an average of 0.19 servings per child (Price and Just 2015). Children were hungrier when coming to lunch after having been outside, and also spent more time eating. Given that children tend to first eat the more calorie-dense foods on their plate prior to moving to less calorie-dense foods such and fruits and vegetables (Forero et al. 2009; Price and Just 2015), the more time spent eating, the more fruit and vegetable consumption is likely.

In this study, School A can be seen to be encouraging fruit and vegetable intake by making the salad bar accessible to students throughout the lunch period. During the observation period, students were often seen to return to the salad bar for more food midway through their meal.

This type of environmental difference can be understood as a 'nudge' to preferred behaviour. Nudging is changing an environment or its 'choice architecture' in order to make a preferred choice more favourable, rather than regulating choices (Marteau 2011). There is debate as to whether nudging is an effective public health strategy (Oliver 2011) or merely a 'smokescreen for inaction' (Rayner and Lang 2011), and there is limited evidence to support the idea that nudging can actually improve population health (Marteau 2011). However, in this study, as well as in Price and Just (2015), it does appear that small changes such as moving recess before lunchtime or making the salad bar available for return visits can increase fruit and vegetable intake during school hours.

The primary social influence on an individual student in the lunchroom is the peer group immediately surrounding the individual at their table. Depending on the lunchroom, and the day, these peers are often friends. Even when friends are not the peer group at the lunch table, however, their influence is felt during the lunch period. Students not seated with their friends would often rush through their meal if they had the option to leave for the playground when they had finished eating. Shorter time spent at the lunch table largely resulted in lower fruit and vegetable consumption (Price and Just 2015) and more consumption of 'high value,' more calorific options that could be eaten quickly (Forero et al. 2009).

Following Pike (2008), we can see how these factors governing behaviour can be viewed through the lens of Foucault's concept of governmentality (Foucault 1991). The geography of the space itself is a part of governance, and physical features of the space both reflect and shape the policies that govern the space. In this paradigm, children are seen as inherently bad decision makers that must be guided to the correct choices (Gibson and Dempsey 2015), and in some cases, parents are also viewed as poor decision makers that must also be guided. Vander Schee (2005) engaged in a qualitative study on health practices in a small rural school in a deprived area in the Northeastern US. This school had implemented a number of policies aimed at improving the health and nutrition of its students. Administrators and parents in this school characterized these interventions as being necessary primarily due to their perception that poor parenting at home led to poor eating habits. These school programmes attempted to govern not only the behaviour of its students, but also their parents, by encouraging correct behaviour both at school and at home. Vander Schee postulated that the limited success of the school's programmes was due in part to the school's positioning of families as bad actors that must be governed so that they will act correctly.

We can understand the students as social actors who create and constitute a social space within the structures that dictate the limits of that space. Students' positioning as actors within this social space allows them not only to work within the structural and institutional dictates of the space, as above, but also to resist and modify them. As described in the previous chapter, one study participant was able to successfully resist expectations, from her parents and the head teacher, for her to eat a school dinner instead of her preferred packed lunch despite her very clear wishes to the contrary. Rather than change her behaviour to accommodate their wishes, she instead learned from a friend how to disguise her uneaten

meal to appear partially eaten. In this way, she appeared to be exhibiting the 'correct' behaviour (eating her school dinner) while successful resisting expectations.

As has been demonstrated, there are a wide variety of factors that influence the types and amount of food students eat at school. While there is some concern that school based nutrition interventions focusing on changing individual behaviour may not effectively address the obesity crisis in the absence of policies that enact societal change (Alvaro et al. 2011), it seems obvious that improving the diet of children is a worthwhile goal in and of itself. To that end, it is necessary to look at areas in which improvements and interventions could be made to improve the uptake of healthy food in schools. Factors that have been identified in this study and elsewhere that appear to influence food selection and consumption are shown in Figure 42. Potential points of intervention are also suggested.

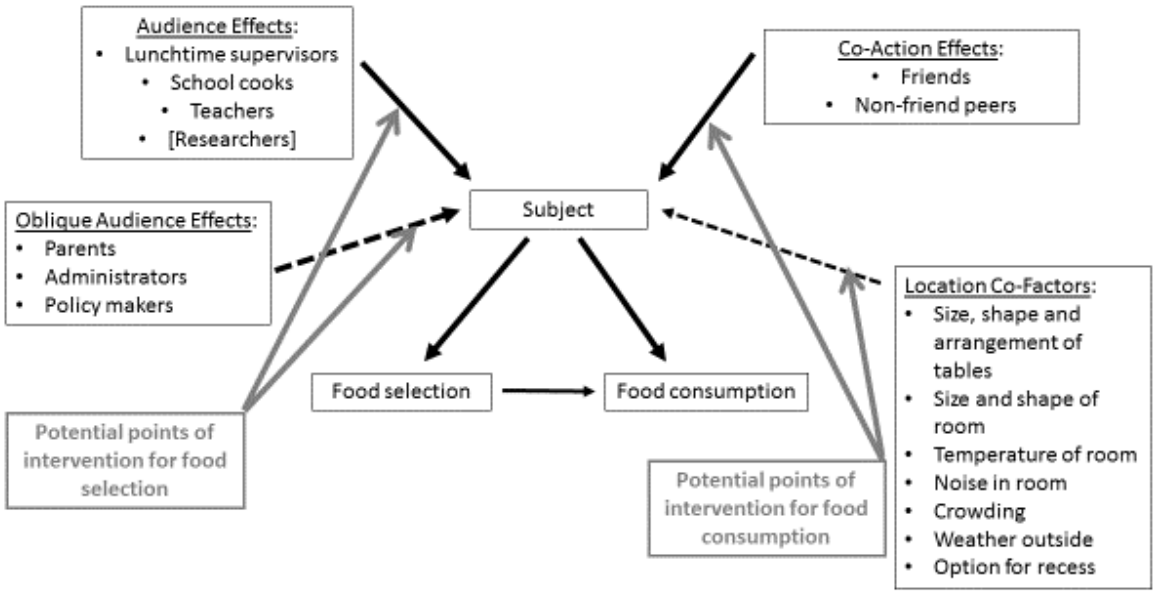


Figure 42. Types of social facilitation and location factors that influence food selection and consumption in the school lunchroom.

Food selection can be improved by the 'observers' in the school lunchroom. These observers include lunchtime supervisors and school cooks who are physically in the lunchroom, but also the administrators, parents and policy makers who are the oblique 'audience' of the students' choices. The oblique audience can improve food selection in a number of ways: increasing uptake of school meals, improving the quality of packed lunches brought from home, and increasing budgets for school meal provision to free school cooks from the financial constraints that lead them to be unwilling to serve food that may go uneaten. Likewise, the direct audience of school cooks and lunchtime supervisors can ensure that each school dinner taken by a student is balanced and contains servings of fruit and vegetables, and also enforce guidelines for packed lunches. Interventions that could improve consumption of balanced meals include improving the layout of the lunchroom itself so that is a relaxed and minimally crowded environment, and students are encouraged to remain in the lunchroom for the entirety of their lunch period, rather than having the option to leave for the playground. Allowing students to sit with friends also appears to increase the amount of time they remain in the lunchroom. Finally, as seen in one of the participating study schools, increasing access to the salad bar appears to increase both selection and consumption of vegetables at lunchtime.

F. Health Knowledge and Beliefs

Overall, the Bangladeshi-British cohort appeared to be much more knowledgeable with regard to health. As a group, they provided much more detailed answers to questions concerning health during focus groups. Additionally, many of the Bangladeshi-British girls appeared to be concerned with giving the 'correct' answers, and looked to myself or a research assistant for validation after giving an answer.

During lunch period observations, none of the Bangladeshi-British participants displayed any noticeable self-consciousness about being observed eating. In contrast, seven of the white British girls were visibly uncomfortable with our observations at least once during the observation period. Two white British participants, both of whom brought packed lunches, assumed a secretive posture whilst eating, keeping parts of their lunches hidden away in their lunch sacks while eating, and discarding unwanted food mid-meal. The remaining five made comments to us while they were eating in order to justify certain food choices, such as the lack of vegetables on their lunch tray or their choice to abandon their main meal in favour of their dessert. One participant talked to us every day during the observation week about her desire to 'go on a diet' and 'be more healthy.' On the third day of observation she sat down with her school dinner for us to photograph her meal before she began eating (Figure 43), and after observing her tray, she returned to the salad bar for a handful of celery sticks, saying, "Wait, I need to get some celery from the salad bar to have with my dinner. When my mum asks about what I had, I want to tell her that I ate vegetables."

Figure 43. A white British participant's lunch, prior to the late addition of vegetables from the salad bar

In numerous cases, participants displayed awareness of the 'correct' behaviour (making healthy choices), and wished to justify to us (the researchers) their choice to act in a way that was not 'correct.' In the analysis of participant questionnaires, a similar pattern can be found. In response to the question, "are your favourite foods healthy or unhealthy,' 70% of Bangladeshi-British participants and 80% of white British participants responded 'healthy' or 'sometimes healthy.' However, when asked to list their favourite foods, responses were overwhelmingly foods that the children themselves classed as 'unhealthy:' junk food such as pizza or chips, or dessert and confectionery items. This appears to be a form of resistance to the governance of these children's behaviour: by giving the 'correct answers' and displaying the 'correct knowledge' they were attempting to diminish the fact that their preferred behaviour is 'incorrect' (Pike 2010). Furthermore, this conflict between knowledge and behaviour suggests that health interventions based solely around education may not be sufficient to effectively change behaviour.

G. Limitations

Given the small achieved sample size in this study, only limited conclusions can be drawn from quantitative analysis of anthropometric data, particularly with regard to the relationships between those measures. Recruitment to the study proved difficult, due to the small target population, and the fact that not all schools supported recruitment efforts. Overall, approximately 60% of potential recruits for both cohorts declined participation; there was limited follow-up possible with non-participants, and two visibly overweight Bangladeshi-British girls disclosed to me during recruitment that they did not feel comfortable being measured. Additionally, the population of interest is small and fairly unique in its composition so potential for generalizability is limited.

Increased interaction with parents, which could have helped to provide more complete information on child health and home environment, was limited. The primary barrier was language-related: many parents of the Bangladeshi-British participants spoke little or no English. I do not speak Bengali, and while my primary research assistant is Bangladeshi and speaks fluent Bengali, she does not speak the Sylheti dialect that is spoken by community members. This difference in dialect created discomfort in parents that was difficult to overcome. Further, while parent questionnaires were provided in both English and Bengali, no Bengali language questionnaires were completed. We were told by some participants that their parents relied on the study participant or an older sibling to translate and complete the questionnaires for them, as they did with most school-related forms. This led to missing or incomplete answers that prevented more complete profiles of study participants from being developed that could have better linked current health issues to early life and/or family health history. Parents of every participating student were asked if they would consent to participating in focus groups or allow a home visit from researchers: while 40% of white British parents indicated interest in at least one of these options, no Bangladeshi-British parents gave consent for us to follow up with them.

CHAPTER 7: CONCLUSIONS

The systematic review of the literature on socioeconomic status (SES) and obesity in South Asian children revealed there yet remains a positive relationship between SES and obesity for children in South Asia. For South Asian migrant children in the UK, rates of obesity are similar to those found in South Asian sedentee children, even though in the UK there is a negative relationship between SES and obesity in children. Additionally, the systematic review revealed that a western-style obesogenic environment is developing in many parts of South Asia and is contributing to the rapid rise in obesity rates in that region. Factors that contributed to this obesogenic environment were of two types, activity-related and consumption-related. Activity related factors included: households with two working parents, lack of regular physical activity, taking a vehicle to and from school, and regular screen time, while consumption related factors included: frequent restaurant meals, snacks replacing regular meals, and high intake of fats and carbohydrates.

In this study, no significant differences were found in rates of overweight between the Bangladesh-British and white British cohort as measured by body mass index (BMI), waist circumference centiles (WC), or waist for height ratio (WHtR).

Despite relatively lower rates of overweight by BMI, 90% of Bangladeshi-British participants were overweight according to WC centiles. This high rate of central adiposity indicates a serious risk of future metabolic disease for this population that is particularly susceptible to insulin resistance. Interestingly, equally high rates of central adiposity were found in the white British group (85% of participants). Given the fact that central adiposity is strongly correlated with metabolic disorders, this points to a worrying trend that warrants further

investigation. Further, a positive correlation between both BMI and WHtR and levels of salivary CRP were found in the white British cohort, which indicates increased subclinical bodily inflammation (a marker for risk of insulin resistance) with increased adiposity. This suggests that white British girls living in this environment face similar risk of metabolic disease as their Bangladeshi-British peers.

While Bangladeshi-British girls tended to eat more poorly than their white British counterparts during school hours, overall composition of diets were similar in the two groups, with Bangladeshi-British girls eating more home-cooked meals. Bangladeshi-British families in this study followed a different format of daily meals than was found in the participating white British families. Additionally, Bangladeshi-British participants displayed more knowledge about health and nutrition than did their white British peers.

Both cohorts exhibited a gap between health beliefs and behaviour. Participants could accurately describe the importance of good nutrition and give the 'correct' answers on health topics while continuing to make poor food choices.

The most striking finding from this study was the impact of the school lunchroom context on consumption and behaviour (see also Meiselman et al. 2000), and further, how the context of the room itself can undermine stated aims laid down by the school, local authority or government. "It is sometimes assumed that effective implementation of government policy with respect to the foods offered in schools would make it possible for children to choose healthy foods. However, choices are always context specific…"(Forero et al. 2009).

Children are also strongly affected by the behaviour of their dining companions. In this study, participants tended to eat similar lunches as their dining partners. While these peer effects were sometimes positive, for example taking extra lunch items from the salad bar, they were most often negative: bringing crisps and/or sweets in packed lunches, or only eating quickly and minimally in order to leave for the playground.

Childhood obesity is a serious public health issue, and a particular risk for South Asian populations, given their increased risks for obesity co-morbidities. In this thesis, I have shown that both Bangladeshi-British and white British girls living in a deprived area of Sunderland are at risk for central obesity and obesity-related metabolic disease. I have demonstrated that both cohorts had similar fruit and vegetable intake, but Bangladeshi-British participants consumed more home-cooked meals and fewer restaurant meals. I have also demonstrated that the school lunchroom environment has a profound impact on behaviours and consumption, and often the impact of the lunchroom environment runs counter to goals laid down by school administrators and government agencies.

This study contributes to the growing body of literature on obesity and health in South Asian migrants in the UK. It also provides insight for public health and school officials looking to engage with or improve services for Bangladeshi-British children in the UK. Additionally, findings here raise interesting questions about the ways in which the school lunchroom environment affects student behaviour that is of interest to behavioural researchers, school administrators and policy makers.

Future research avenues of research include larger scale studies investigating the relationship between overweight and markers of inflammation including salivary CRP in Bangladeshi-

British populations. More research is needed into the use of WC and WHtR, particularly the development of ethnically specific WC centile charts that are appropriately sensitive to risk. The Sunderland Bangladeshi community is unique in many ways and further in-depth qualitative research into this enclave community could form a useful contribution to the body of research on how migrants reshape their new communities to reflect their needs. Findings in this study suggest that Bangladeshi-British and white British girls of similar SES engage in different types of physical activity. As it has been shown that an active lifestyle is vital to preventing obesity, further research into this topic could help to appropriately shape future interventions.

Key messages for potential policy and intervention development

- Findings in this study suggest that the use of BMI by the National Child Measurement Programme and other health organisations may be obscuring the number of children who are truly at risk for metabolic disease.

- Bangladeshi British girls in this study were much less likely to engage in team sports or formal active lessons than their white British peers. As children move into adolescence and become less likely to engage in casual play, this difference becomes potentially problematic.

- While all participants displayed age-appropriate health and nutrition knowledge, very few of them put this knowledge into action.

- Bangladeshi-British families in this study followed a different meal structure than white British families. Large, often home cooked, meals are eaten in the afternoon and again in the late evening, while breakfast and lunch are not generally considered important meals. Participants also reported their parents lacked trust in the quality and appropriateness of available school dinners. Any dedicated efforts to increase uptake of school meals should address these differences and concerns.

- When viewing the school lunchroom as a location for intervention, it is important to note the myriad factors that influence food selection and consumption in such a space. Students are influenced by adult 'observers,' as well as their peers. Additionally, the school lunchroom environment factors heavily in what and how much children eat during the lunch period.

APPENDIX A: SYSTEMATIC REVIEW SEARCH STRATEGIES FOR ELECTRONIC DATABASES

Search Strategy used for Web of Knowledge and Anthropology Plus

(obes* OR weight-gain OR weight-loss OR overweight OR over-weight OR overeat* OR over-eat* OR weight-change OR BMI OR body mass* OR body-fat* OR bodyfat* OR anthropometric-measur* OR waist-circumference OR "waist hip ratio" OR skin-fold thickness OR skinfold thickness OR adiposity OR adipose-tissue) AND (child* OR infant* OR toddler* OR baby OR babies OR girl* OR boy* OR youth OR young* OR teen* OR adolescen* OR preadolescen* OR school* OR junior-high OR pre-school OR preschool OR kindergarten OR pediactr* OR paediactr*) AND (Bangladesh* OR Asian OR India* OR Pakistan* OR Sri Lanka*) NOT (anorexia OR bulimia OR undernutrition OR undernourish* OR food-deprivation OR underweight OR thinness)

Search Strategy Used for EBSCOhost

((obes* OR weight gain OR weight loss OR overweight OR over weight OR overeat* OR over eat* OR weight change OR bmi OR body mass index OR body mass* OR body fat* OR bodyfat* OR anthropometric measure OR waist circumfrence OR waist to hip ratio OR skin-fold thickness OR skin fold thickness OR skinfold thickness OR adiposity) and (sri lanka* OR bangladeshi* OR bangla* OR asian OR asian british OR asian american OR south asian OR asian other OR india* OR pakistan*) and (child* OR kid* OR infant* OR toddler* OR baby OR babies OR school children OR schoolchildren OR girl* OR boy* OR birth weight OR birthweight OR preschool OR school-aged OR school aged OR youth OR youngster OR young person OR young people OR young adult teen* teenager* OR adolescen* OR preadolescen* OR early adolescen* OR primary school OR secondary school OR nursery school OR elementary school OR middle school OR junior high OR high school OR pre-school OR preschool OR kindergarten OR pediactr* OR paediactr*)) not (anorexia or bulimia or undern* or thinness or food deprivation or matlab thana)

Search Strategy used for Medline

Searches	Results
1	exp Obesity/
2	exp Body Composition/
3	exp Obesity, Morbid/
4	exp Adipose Tissue/
5	exp Body Mass Index/
6	obes*.mp.
7	exp Weight Gain/
8	exp Weight Loss/
9	exp Overweight/
10	exp Body Weight/
11	overweight.mp.
12	exp Energy Intake/
13	exp Eating/
14	exp Feeding Behavior/
15	overeat*.mp.
16	exp Diet/
17	weight change.mp.
18	BMI.mp.
19	body mass*.mp.
20	exp Body Fat Distribution/
21	exp Skinfold Thickness/
22	exp Anthropometry/
23	body fat.mp.
24	bodyfat.mp.
25	anthropometric measure.mp.
26	exp Waist Circumference/
27	exp Waist-Hip Ratio/
28	waist to hip ratio.mp.
29	waist: hip ratio.mp.
30	exp Skinfold Thickness/
31	exp Adiposity/
32	adiposity.mp.
33	exp Overnutrition/
34	exp Anorexia Nervosa/
35	exp Bulimia Nervosa/

36	exp Anorexia/
37	exp Bulimia/
38	exp Food Deprivation/
39	undernutrition.mp.
40	undernourish*.mp.
41	exp Thinness/
42	underweight.mp.
43	matlab thana.mp.
44	exp Child/
45	child.mp.
46	exp Infant/
47	toddler.mp.
48	baby.mp.
49	babies.mp.
50	girl.mp.
51	boy.mp.
52	exp Child, Preschool/
53	preschool.mp.
54	exp Adolescent/
55	adolescen*.mp.
56	school-age*.mp.
57	pre-adolescent.mp.
58	exp Minors/
59	youth.mp.
60	youngster.mp.
61	exp Young Adult/
62	young adult.mp.
63	teen.mp.
64	teenager.mp.
65	exp Schools/
66	exp Schools, Nursery/
67	primary school.mp.
68	elementary school.mp.
69	middle school.mp.
70	junior high.mp.
71	nursery school.mp.
72	preschool.mp.

73	kindergarten.mp.
74	pediatric*.mp.
75	paediatric*.mp.
76	exp Pediatrics/
77	exp Bangladesh/
78	bangladesh*.mp.
79	exp India/
80	india.mp.
81	exp Pakistan/
82	pakistan*.mp.
83	exp Sri Lanka/
84	sri lanka*.mp.
85	exp Asian Continental Ancestry Group/
86	exp Asian Americans/
87	asian british.mp.
88	south asia*.mp.
89	asian other.mp.
90	33 or 32 or 21 or 7 or 26 or 17 or 2 or 1 or 18 or 30 or 16 or 27 or 25 or 28 or 20 or 14 or 24 or 10 or 31 or 11 or 22 or 13 or 23 or 29 or 6 or 3 or 9 or 12 or 15 or 8 or 4 or 19 or 5
91	35 or 39 or 40 or 36 or 41 or 38 or 42 or 34 or 37 or 43
92	90 not 91
93	67 or 63 or 71 or 70 or 68 or 72 or 44 or 55 or 74 or 75 or 57 or 61 or 69 or 59 or 49 or 53 or 48 or 46 or 65 or 50 or 64 or 51 or 58 or 47 or 52 or 60 or 56 or 45 or 66 or 73 or 76 or 62 or 54
94	84 or 85 or 83 or 80 or 78 or 79 or 81 or 87 or 88 or 77 or 89 or 86 or 82
95	92 and 93 and 94

Search Strategy used for EMBASE

1	exp Obesity/
2	exp Body Composition/
3	exp Obesity, Morbid/
4	exp Adipose Tissue/
5	exp Body Mass Index/
6	obes*.mp.
7	exp Weight Gain/
8	exp Weight Loss/
9	exp Overweight/
10	exp Body Weight/
11	overweight.mp.
12	exp Energy Intake/
13	exp Eating/
14	exp Feeding Behavior/
15	overeat*.mp.
16	exp Diet/
17	weight change.mp.
18	BMI.mp.
19	body mass*.mp.
20	exp Body Fat Distribution/
21	exp Skinfold Thickness/
22	exp Anthropometry/
23	body fat.mp.
24	bodyfat.mp.
25	anthropometric measure.mp.
26	exp Waist Circumference/
27	exp Waist-Hip Ratio/
28	waist to hip ratio.mp.
29	waist: hip ratio.mp.
30	exp Skinfold Thickness/
31	exp Adiposity/
32	adiposity.mp.
33	exp Overnutrition/
34	exp Anorexia Nervosa/
35	exp Bulimia Nervosa/

36	exp Anorexia/
37	exp Bulimia/
38	exp Food Deprivation/
39	undernutrition.mp.
40	undernourish*.mp.
41	exp Thinness/
42	underweight.mp.
43	matlab thana.mp.
44	exp Child/
45	child.mp.
46	exp Infant/
47	toddler.mp.
48	baby.mp.
49	babies.mp.
50	girl.mp.
51	boy.mp.
52	exp Child, Preschool/
53	preschool.mp.
54	exp Adolescent/
55	adolescen*.mp.
56	school-age*.mp.
57	pre-adolescent.mp.
58	exp Minors/
59	youth.mp.
60	youngster.mp.
61	exp Young Adult/
62	young adult.mp.
63	teen.mp.
64	teenager.mp.
65	exp Schools/
66	exp Schools, Nursery/
67	primary school.mp.
68	elementary school.mp.
69	middle school.mp.
70	junior high.mp.
71	nursery school.mp.
72	preschool.mp.

73	kindergarten.mp.
74	pediatric*.mp.
75	paediatric*.mp.
76	exp Pediatrics/
77	exp Bangladesh/
78	bangladesh*.mp.
79	exp India/
80	india.mp.
81	exp Pakistan/
82	pakistan*.mp.
83	exp Sri Lanka/
84	sri lanka*.mp.
85	exp Asian Continental Ancestry Group/
86	exp Asian Americans/
87	asian british.mp.
88	south asia*.mp.
89	asian other.mp.
90	33 or 32 or 21 or 7 or 26 or 17 or 2 or 1 or 18 or 30 or 16 or 27 or 25 or 28 or 20 or 14 or 24 or 10 or 31 or 11 or 22 or 13 or 23 or 29 or 6 or 3 or 9 or 12 or 15 or 8 or 4 or 19 or 5
91	35 or 39 or 40 or 36 or 41 or 38 or 42 or 34 or 37 or 43
92	90 not 91
93	67 or 63 or 71 or 70 or 68 or 72 or 44 or 55 or 74 or 75 or 57 or 61 or 69 or 59 or 49 or 53 or 48 or 46 or 65 or 50 or 64 or 51 or 58 or 47 or 52 or 60 or 56 or 45 or 66 or 73 or 76 or 62 or 54
94	84 or 85 or 83 or 80 or 78 or 79 or 81 or 87 or 88 or 77 or 89 or 86 or 82
95	92 and 93 and 94

APPENDIX B: PARENT QUESTIONNAIRE

The CHBI Project

Questionnaire for Parents

Information about child participating in this study

Name of child: _____

Age of child: _____ When was your child born? _____(day/month/year)

Is your child first born, second born, etc? □ only child □1st □2nd □3rd □4th □ 5th+

Where was your child born? (city and country)_____

If your child was born outside of the UK, how old was she when your family moved here?

_____

Was your child born prematurely? □ Yes □No If yes, what week gestation? _____

Weight of child at birth (if known): _____

Was your child breastfed or formula-fed as an infant, or both?_____

If breastfed, how long (weeks or months)?_____

The next few questions ask about your child's physical activity and general health:

In an average week, what sorts of physical activity does your child engage in?

_____

_____

Does your child enjoy sports and/or other types of active play? If not, what sorts of activities do they prefer? _____

_____

In an average week, does your child have any "screen time" (time spent in front of computers, video games and television)? YES □ NO □

If so, how much?

Television: _____

Video Games:_____-

Computers:_____

How does your child get to and from school? (Select option used most frequently)

□ Walk □ Bike □ Car □ Bus or other public transportation

Do you feel your child is: □ underweight □ a healthy weight □ over a healthy weight

Has your child ever been diagnosed with any health problems? YES □ NO □

If yes, then please describe: _____

_____

_____

Does your child ever complain of aches and pains? YES □ NO □

If yes, how often? _____

Would you describe your child 'accident-prone' or 'clumsy?' YES □ NO □

The next few questions will be about your child's diet:

Do you feel your child eats □ not enough □ an appropriate amount □ too much

Who cooks the food your child eats at home? (eg mother, father)

_____

Who does the food shopping for your household?_____

Where (what shops) is your family's food usually purchased?_____

_____

_____

Does your family usually eat meals together, or separately? _____

_____

_____

Please describe average family meals in your household:

Breakfast _____

_____

Lunch (when home) _____

_____

Dinner _____

_____

What types of snacks (any non-'meal' eating) do you eat at home? _____

_____

_____

How frequently does your child consume snack foods? _____

How frequently does your family eat at a restaurant or order takeaway on average?

□ 4 or more times per week □ 1-3 times per week □ weekly □ 2-3 times per month □ once a month or less often

Is the kind of food offered for your child's school lunches similar to or different from the kind of food you typically eat at home? □ Similar □ Somewhat different □ Different

If different, please describe differences. _____

_____

The next section includes statements that you are asked to mark as true or false.

I am happy with the kinds of foods my child prefers to eat. □ True □ False

Family meals are planned based on my child's preferences. □ True □ False

My child asks for foods s/he learns about at school or from friends □ True □ False

My child asks for foods s/he sees advertised on television. □ True □ False

I am happy to buy foods that my child asks for if the budget allows. □ True □ False

Information about mother:

Where were you born? (city and country) _____

If born outside of the UK, at what age did you move here? _____

Where were your parents born? _____

What is your highest level of education achieved? _____

Occupation?_____

What is your first language? _____

Have you ever been diagnosed with any of the following?

□ Diabetes □ Heart Disease □ High Blood Pressure □ High Cholesterol

□ Polycystic Ovarian Syndrome (PCOS)

Did you suffer from Gestational Diabetes while pregnant with your child (the one participating in this study)? □ Yes □ No

Were there any complications during the birth of your child (the one participating in this study) for you or your child? If yes, please describe to the best of your ability.

_____

_____

Information about father:

Where were you born? (city and country) _____

If born outside of UK, at what age did you move here?_____

Where were your parents born? _____

What is your highest level of education achieved? _____

Occupation?_____

What is your first language? _____

Have you ever been diagnosed with any of the following?

□ Diabetes □ Heart Disease □ High Blood Pressure □ High Cholesterol

THANK YOU FOR YOUR REPLIES!

APPENDIX C: PARTICIPANT QUESTIONNAIRE

GHNE/CHBI Questionnaire

Name_____

Activity

How do you get to school?
□ Walk □ Bike □ Car □ Bus □ Other (please list _____)

Do you like sports? □ Yes □ No

What sorts of physical activities do you like do?_____

_____

_____

Do you like to:		How often do you watch or play?
Watch TV?	□ Yes □ No	_____
Use the computer?	□ Yes □ No	_____
Play video games?	□ Yes □ No	_____

Do you like to be outside? □ Yes □ No

Eating

What are your favourite foods?

_____

_____

What do you usually neat for...

Breakfast?

_____

_____

Lunch?

_____

_____

Dinner/Tea?

_____

_____

Snacks?

_____

_____

How often do you eat takeaway or at a restaurant? □ a few times per week

□ once or twice a week □ a few times per month □ once a month or less often

Are your favourite foods healthy? □ Yes □ No

At about what time do you eat dinner? _____

What are your LEAST favourite foods?

_____

_____

Tell me what you know about healthy food.

_____

_____

_____

Tell me what you know about unhealthy food

_____

_____

APPENDIX D: INTERVIEW TOPIC GUIDES

CHBI Project
Interview Topic Guide: School Administrators and Teachers

- How do you think this project might coincide with your [project, program, etc] goals?

- Tell me about childhood obesity and overweight in this region.

- What are the primary child health issues do you perceive in your school?

- What are the primary health issues Bangladeshi students from this school face?

- What are the primary social/cultural issues Bangladeshi families in this community face?

- What health challenges do you think the local Bangladeshi community faces?

- Do you think there are any barriers to accessing the Bangladeshi community? If so, what?
    - Suggestions on how to overcome these barriers?
    - [details of access/permissions within school]

- Tell me about your school food program
    - Any challenges?
    - Issues with packed lunches?

- Is there anything that this project can do to help your school?

- Questions? Comments?

CHBI Project
Interview Topic Guide: School Lunchroom Workers

- [ask for tour of kitchen]

- Tell me about your school food program

- What challenges do you face?
    - From administration
    - With students
    - Other challenges?

- Issues with packed lunches?

- What are the primary issues that you see with school dinners in this school?

- What changes would you make if you were able to do so?

- Tell me about how you've dealt with the problem of uptake of school meals by Bangladeshi students?

- Questions? Comments?

CHBI Project
Interview Topic Guide: Government and Community Workers

- How do you think this project might coincide with your [project, program, etc] goals?

- What are the primary child health issues in this [area, community, etc]

- Tell me about childhood obesity and overweight in this region.

- What health challenges do you think the local Bangladeshi community faces?

- Do you think there are any barriers to accessing the Bangladeshi community? If so, what?

    - Suggestions on how to overcome these barriers?

- Which schools have appropriate student populations?

- Suggestions for:

    - Other community/government contacts?
    - Who to contact at local schools?
    - Recruitment recommendations?

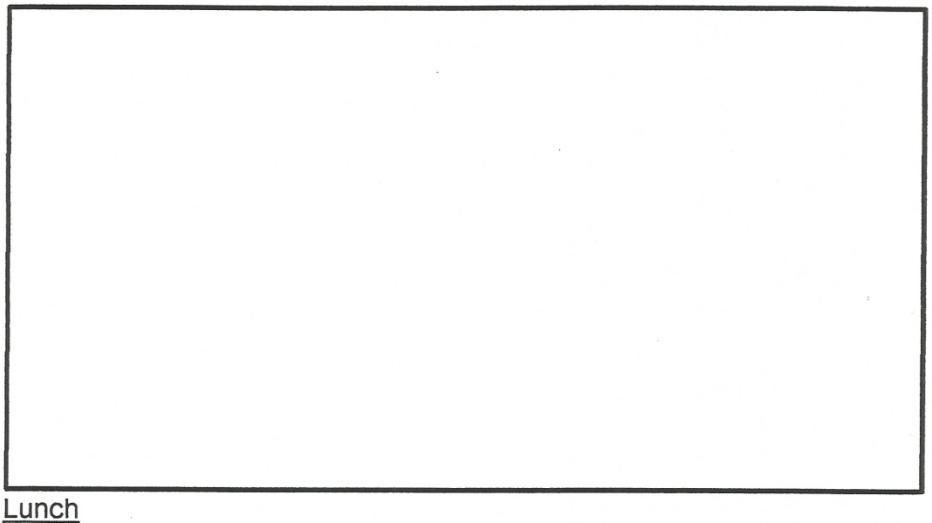
- Any questions or comments?

APPENDIX E: LUNCHTIME FOOD SURVEY DATA COLLECTION SHEET

Lunchtime food survey data collection sheet

Subject:_____

School Dinner ☐ Lunch from home ☐



Lunch

Taken:

Consumed:

Drink:

Dessert?

Taken: Consumed:

Notes:

APPENDIX F: PARENTAL INFORMATION SHEETS AND CONSENT FORMS

Durham University
Department of Anthropology

Childhood Health in Bangladeshi Immigrants: A Biocultural Investigation

Introduction

We are inviting you to take part in a research study conducted by Erika McClure, MSc of Durham University, Professor Gillian Bentley of Durham University and Dr Louisa Ells of the Northeast Public Health Observatory, UK. The purpose of this study is to see how diet and activity level relate to overall health and habits in Bangladeshi and Bangladeshi-British children and their families.

What will happen during the study

- First, your child will be measured and physical health characteristics will be assessed. Your child will also be asked questions about diet, activity level and overall health, and will be asked to complete some activities concerning food and diet.

- We will also ask you questions about your child's health and habits, as well as those of your family. You may also be asked to participate in a focus group about children's diet and health, and may also be asked if a project member can visit you in your home while a meal is being prepared

- Some children will also be asked to give saliva and blood samples, and/or wear an activity monitor for a 48 hour time period. ***PLEASE NOTE that, since a trained nurse or medical doctor will be taking your child's blood, there may be a delay between the day when questionnaires and are given and when your child is asked to give the blood sample, although we will try to schedule these together where possible***. .

How participants' privacy is protected

We will make every effort to protect your privacy. We will not use your name or your child's name in any of the information that we have from this study or in any of the research reports and people will only be identified by code numbers. During the study the key that tells us which code number goes with your information will be kept in a locked drawer. The key will always be kept separate from the data. All our computers are also protected with passwords. Data from this study might be used

for additional research later, and may be stored for several years, but will still be confidential and anonymous.

Risks and discomforts

- The questions may cause embarrassment because the information is personal.
- Being weighed and measured can also be embarrassing, but we will do our best to minimize any discomfort.
- For the subgroup of children asked to give blood, the blood draw can be uncomfortable and there is a risk of infection. The blood draw will be performed by a trained phlebotomist, however, so the risk of infection is very small.

The study will help us understand how changing diet and activity levels impact the health of children during and after migration. This will lead to an increased understanding of the health and physiology of children in general and particularly of South Asian migrants.

Your rights

You should decide on your own whether or not you want your child and family to be in this study. If you do decide to be in the study, you don't have to answer all of the questions during the interview and you may stop participating in the study at any time without incurring any penalty or losses. *You will be given a copy of this Information Sheet and your signed Consent Sheet to keep prior to your participation in the study.*

Where to go with questions

If you have any questions or concerns about the study please contact Ms. McClure, Professor Bentley or Dr Ells at 074941 399048 or 0191 334 6200.

Please DO NOT call the Anthropology Department with questions about the Project, since the office staff there deal with teaching and administrative issues in the department and are not familiar with all the Research Projects that are carried out by the faculty. They will only refer you back to us.

Ethical approval

[section will be completed when ethical approval is granted]

The CHBI Project
Durham University Department of Anthropology
Parental Consent Form

I henceforth give permission for my child, _____ to take part in the above named Durham University research project. I have had the project explained to me, and I have been given the project information sheet, which I may keep for my records. I understand that agreeing to take part means that I am willing for my child to:

- Have his/her physical activity assessed
- Have his/her physical measurements of health assessed
- Have his/her body measurements taken
- Complete or orally answer questionnaires about health, diet and activity
- Participate in focus groups talking about health and nutrition
- Have his/her diet assessed

Additionally:
I **agree/do not agree** (line out as necessary) to participate in interviews or focus groups concerning the health of my child and my family.
I **agree/do not agree** (line out as necessary) to allow the researcher to visit my home and spend time in my kitchen while meals are being cooked.

Data Protection
This information will be held and processed solely for academic research and dissemination purposes.

I understand that any information I or my child provides is confidential, and that no information that could lead to the identification of any individual will be disclosed in any reports on the project, or to any other party. No identifiable personal data will be published. The identifiable data will not be shared with any other organisation

I consent to the recording and processing of information about my child and/or my family. I understand that this information will be used only for the purpose set out in this statement and my consent is conditional on these terms.

Withdrawal from study
I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalised or disadvantaged in any way.

Child's name: ..... (please print)

Name:.....(please print)

Signature:..... Date:.....

You will be given a copy of your signed Consent Sheet and the Project Information Sheet to keep for your records. If you have any questions or concerns about the study please contact Ms. McClure, Professor Bentley or Dr Ells at 074941 399048 or 0191 334 6200.

The CHBI Project
Durham University Department of Anthropology
Parental Consent Form
Saliva Samples

I henceforth give permission for my child,_____
to take part in the above named Durham University research project. I have had the project explained to me, and I have been given the project information sheet, which I may keep for my records. I understand that agreeing to take part means that I am willing for my child to do the following (please tick and initial each item you consent to).

- ☐ Provide a saliva sample _____ (initials)

Data Protection
This information will be held and processed solely for academic research and dissemination purposes.

I understand that any biological sample provided by my child will be stored securely and disposed of in a safe manner once the sample has been analyzed.

Further, I understand that any information I or my child provides is confidential, and that no information that could lead to the identification of any individual will be disclosed in any reports on the project, or to any other party. No identifiable personal data will be published. The identifiable data will not be shared with any other organisation

I consent to the recording and processing of information about my child and/or my family. I understand that this information will be used only for the purpose set out in this statement and my consent is conditional on these terms.

Withdrawal from study
I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalised or disadvantaged in any way.

Child's name: ..... (please print)

Name:.....(please print)

Signature:..... Date:.....

You will be given a copy of your signed Consent Sheet and the Project Information Sheet to keep for your records. If you have any questions or concerns about the study please contact Ms. McClure, Professor Bentley or Dr Ells at 074941 399048 or 0191 334 6200.

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