DIETARY INTAKE, LIFESTYLES AND RISK OF NUTRITION-RELATED NON-COMMUNICABLE DISEASES IN A PUNJABI SOUTH ASIAN MALE POPULATION IN KENT, UNITED KINGDOM

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ABSTRACT

Chronic nutrition related non-communicable diseases (NR-NCDs) are more prevalent in south Asians living in the United Kingdom compared to the general UK population. Observed differences have been attributed to inter-generational nutritional experiences and pattern of lifestyle changes which affect the risk of adult disease in later life.

The aim of this research is to investigate socio-demographic variables, their food culture, dietary intakes, lifestyles, physical activity and experiences that contribute to the risk factor of NR-NCDs. Therefore, this study was designed in three phases. Phase I: A focus group study involving male participants (n=40) were used to collect sample population-wide data about food-related attitudes, habits and choices, methods of recipe formulation, food preparation and eating behaviours. Phase II: A randomly selected sample of adult males (n=137) of Punjabi origin were used to collect population-wide data using modified a pre-validated food frequency questionnaire (FFQ) previously used in Europe and a 24-hour recall dietary intake questionnaire. A modified version of the validated WHO Global Physical Activity Questionnaire (GPAQ) was used to assess physical activity. Anthropometric and blood pressure measurements were also taken to examine physical and physiological indicators of risk. Phase III: a quasi-randomly selected sub-group (n=30) then undertook physiological and biochemical tests including blood pressure, fasting serum lipid and glucose measurements. Later data from phase II and phase III were analysed based on first and second generation migrant status. Statistical comparisons including non-parametric qualitative analysis of focus group data; qualitative and quantitative tests comparing within and between first and second generation migrant groups, analysis of variances and multiple regression analysis were used to establish relationships to the risk factors for NR-NCDs.

Overall data suggest this Punjabi migrant population analysed in phase II and III have significantly high energy intake, low physical activity, elevated blood pressure and fasting serum glucose level compared to recommend energy intake, physical activity level, blood pressure and fasting serum glucose cut-off. Significant differences were observed between first and second generation migrants. A significant higher intake of energy was seen among the second generation ($p=0.045$). Low level of energy expenditure with a physical activity level of 1.55 was seen across both generations of migrants. Reported fruits and vegetable consumption was low compared to 400g per day proposed intake for UK general population. Overall fibre intake among first and second generation migrants (15.23 g/day) was below the RNI of 18 g in the UK. This population reported low to moderate income of £15,999-£24,999 annually. Among the Punjabi migrant population the rate of OW+OB was 91% compared to 62.3% in UK general population. Physical measurements among first and second generation migrant indicate a pre-hypertensive state with mean SBP of 138 mm/Hg. SBP and DBP were significantly influenced by age ($p=0.016$; $p=0.018$) respectively. Overall there was no significant difference among first and second generation BMI. However, BMI was higher among young (21-25 years) people compared to other age groups.

The following dietary and biochemical parameters were observed among phase II and phase III of the research: overall SFAs contributed >2-fold of the recommended intake; Sugar contributed nearly 1/3 of total energy intake; Sodium intake exceeded recommended intakes by >400 mg/day; excess protein intake of 32.62 g / day exceeding above recommended intake for weight and level of activity; serum fasting glucose and total cholesterol (TC) levels were raised above upper limit of normal cut-off ; TC and non-HDL cholesterol showed significant inter-generational differences ($p=0.016$ and $p=0.015$) respectively with first generation being higher than second generation migrants.

This population has provided evidence that supports the nutrition transition and indicates high risk of NR-NCDs which merits further investigation and may lead to interventions aimed at awareness, lifestyle, behaviour change and increase in physical activity.

CONTENTS

TABLES

TABLES

TABLES

FIGURES

APPENDICES

ABBREVIATIONS

ABBREVIATION	MEANING
AI	Average Intake
ARC	Agricultural Research Centre
BMI	Body mass index
BNF	British Nutrition Foundation
BP	Blood Pressure
BP	Blood Pressure
CI	Confidence intervals
CVD	Cardiovascular disease
DAFNE	Dose adjustment for normal eating
DBP	Diastolic Blood Pressure
DESMOND	Diabetes education and self-management for on-going and newly diagnosed
DM	Diabetes mellitus
EAR	Estimated average requirements
EI	Energy Intake
FAO	Food and Agricultural Organization
FSA	Food Standards Agency
GI	Glycaemic index
GL	Glycaemic index
HDL	High density lipoprotein
LDL	Low density lipoprotein
LRNI	Lower Regular Nutrient Intake
MUFA	Monounsaturated fatty acids
MUFA	Mono unsaturated fatty acid
NHS	National Health Service

NS	Nutrition Society
OB	Obesity
OW	Over weight
PUFA	Poly unsaturated fatty acid
RNI	Regular nutrient intake
SBP	Systolic Blood Pressure
SCFA	Short chain fatty acid
SD	Standard Deviation
SFA	Saturated Fatty Acid
T2DM	Type 2 Diabetes Mellitus
USDA	United States Drug Administration
W/H	Waist to Hip Ratio
WHO	World Health Organization

Chapter One: Introduction

1.0 Introduction

The *south Asia* region which includes India, Pakistan, Bangladesh, Sri Lanka, and Nepal has a combined total population of approximately 1.5 billion of whom a small but significant and six fold greater risk of suffer from diabetes (Gupta and Kumar, 2007; Mishra and Kurana, 2011 Dhillon et al., 2012; Nair et al., 2012) and other chronic nutrition-related non-communicable diseases (NRNCDs). This increasing trend has also been observed among south Asian migrants in other parts of the world including the United Kingdom where prevalence of type 2 diabetes is five times higher amongst south Asians compared to general UK population (Tillin, et al., 2010). Diabetes for instance remains a major and growing public health challenge due to its worldwide distribution and increasing prevalence across six WHO regions (Mohan and Pradeepa, 2009; IDF, 2010; WHO, 2010) with an apparent disproportionate distribution among south Asians in the United Kingdom (Feltblower 1et al., 2002). The underlying reasons for this 'excess' vulnerability among south Asian, is in fact, a culturally and religiously diverse group of people, who though genetically heterogeneous nonetheless on the Indian sub-continent, share common economic, ecological and other environmental experiences across the life cycle is therefore a subject of particular interest.

Epidemiological evidence and health statistics also show a NR-NCDs in Non-European countries in economic transition, for example in many Middle-to-High Income (MHI) countries in Asia and the Arab Gulf (Ramachandran, et al., 2012), thus further raising questions as to the interplay between genetics (genotype) and the environment and in particular, the role of economic wellbeing or fortunes as drivers of risk among vulnerable populations as expressed in NR-NCD phenotypes. The co-existence of type 2 diabetes which constitutes about 90 per cent of all diagnosed cases of diabetes, with other NCDs such as ischemic heart disease, hypertension and

stroke and which together contribute to the burden of disease in developing, compared to developed countries (Pradeepa et al., 2012; Mathur et al., 2012; WHO, 2010) suggests possible complex but inter-related aetiological and pathophysiological processes at play. The health care costs of these co-morbidities and the economic burden and their impact on the cost of treatment and management of complications are enormous. (Hex et al., 2012). Recent World Health Statistics (WHS) which estimate that 7.9 per cent of the world's population (of over 7 billion people) currently suffers from impaired glucose intolerance and this number is projected to rise to 8.4 per cent by 2030 population (IDF, 2010) puts this huge burden of disease into perspective as shown in Table 1.1 which shows a summary of worldwide incidence and prevalence of diabetes (WHO, 2010).

Relationships between the increasing prevalence of diabetes and population growth, ageing, urbanization, and increasing prevalence of obesity and physical inactivity (WHO, 2010) have variously been reported. More recently, it is becoming increasingly clear that epigenetic factors (Nitert et al. 2012; Stöger, 2012) which relate to the aforementioned environmental determinants may be at play and might help us to understand these underlying contributory factors as well as elucidate the possible cellular level mechanisms involved. For example, increasingly at the molecular level, the role of one-carbon transfer reactions and more specifically methylation and the roles of various polymerase enzymes in gene expression (Giacco and Brownlee, 2012) and insulin activity (Manoel-Caetano et al. 2012) are increasingly implicated in a number of patho-physiological mechanistic hypotheses for NCDs including type 2 diabetes.

Table 1.1 Current and projected global prevalence of diabetes in different WHO regions (WHO, 2010)

Continents	**2000**	**2030**
South-east Asia	46,903,000	119,541,000
Euro countries	33,332,000	47,973,000
African regions	7,020,000	18,234,000
United States of America	17,702,000	30,312,000.
Eastern Mediterranean Region	15,188,000	42,600,000
Western Pacific Region	35,771,000	71,050,100
World Total	**171,000,000**	**366,000,000**

1.1 Diabetes Prevalence among South Asians in the United Kingdom

South Asian communities in the United Kingdom are culturally and socially diverse consisting among others, of people of Indian, Bangladeshi and Pakistani origin whose first generation migrated directly from the Indian sub-continent to the UK. There are other groups e.g. the Ismaili community who although retain their Indian sub-continent roots, migrated mainly from the Eastern and Southern Africa regions to the UK

(Tillin, 2012). Other smaller groups include Sri Lankans, Nepalese and Bhutanese. Among the UK Indian Society, there are further ethnic, religious and regional differences as well as social classes. Despite their cultural diversity, they nonetheless retain certain common social, lifestyle and physical activity characteristics, particularly among the first migrant generation. The second (and indeed third) generations among these communities are likely to be more educated and may

have adapted to many mainstream "western" and 'early 21st Century' lifestyles of young people in the United Kingdom including dietary and lifestyle preferences and behaviours (Patel, 2012), different from those of earlier generations.

Individuals from the south Asian communities in the UK appear to have a disproportionate risk for type 2 diabetes (Feltbower et al., 2002) and other NRNCDs. Certain areas of the UK with high south Asian populations have showed incidence of diabetes from 3.1 per 100,000 per year to 11.7 per 100,000 per year within a decade (Feltbower, 2002). Other studies have found that South Asian communities living outside their natural domicile tend to develop diabetes ten years earlier then European counterpart, 20-25% of Indo-Asian adults over the age of 50 years are likely to be suffering from type 2 diabetes in the UK alone (Radia, 2009). Compared to the general UK population, doctor-diagnosed diabetes is 2.5–5 times higher among the south Asian population (Diabetes UK, 2010). For purposes of comparison with the situation in the South-East Asia Region, the distribution and projected incidence of diabetes in different South East Asian countries are shown in Table 1.2 below.

Table 1.2 Distribution of diabetes patients in different countries of South-East Asia in year 2000 and projected for the year 2030 (WHO, 2010)

Country	2000	2030
Bangladesh	3,196,000	11,140,000
Bhutan	35,000	109,000
Dem. People's Rep. of Korea	367,000	635,000
India	31,705,000	79,441,000
Indonesia	8,426,000	21,257,000
Maldives	6,000	25,000
Myanmar	543,000	1,330,000
Nepal	436,000	1,328,000
Sri Lanka	653,000	1,537,000
Thailand	1,536,000	2,739,000
Total	46,903,000	119,541,000

The underlying risk factors among this high risk population need to be examined in order to better understand their dynamics and provide insights into risk prediction and their potential mitigation.

1.2 Major physical risk factors for type 2 diabetes

Increased body weight (Carey et al., 2012) and particularly abdominal adiposity have been shown to be major risk factors as evidenced by strong correlations between e.g. the waist circumference and diabetes-related morbidity (Wei, 1997; Björntorp,1998 Okosun et.al., 2001; Krishnan et.al., 2007) and mortality (Kuk, et.al., 2006; Reis et.al.,2009; Boggs, et.al., 2011). The association between obesity and prevalence of diabetes is strong with some reports suggesting that approximately 80% of people with type 2 diabetes are likely to be overweight or obese (Hensrud, 2012). Obese individuals are 3 to 7 times more likely to develop diabetes compared with non-obese individuals (Kopelma, 2000) and people with a body mass index (BMI) greater than 35 Kg/m^2 are at the greatest risk (Scopinaro et al., 2007). Life course analysis also shows consistently strong associations between early childhood obesity, its persistence in adolescence and adult risks of obesity and diabetes (Deckelbaum et al., 2012). It has also been estimated that the risk of type 2 diabetes increases for each kilogram (kg) of adult weight gained; and increasing abdominal fatness as estimated by the waist circumference (WC) measurement or the waist to hip ratio (WHR), may be an even stronger proxy indicator of risk than BMI on its own, for the development of type 2 diabetes (Qiao, 2009). It is also worth noting that whereas BMI cut-offs have typically ranged between BMI 20 – 25 for ideal range and appear to confer the lowest NCD risk especially in European populations, there is strong scientific evidence to suggest that for the typical South Asian, an exponential risk profile is more commonly seen from a BMI of 23 and above (WHO, 2004). Thus in screening and assessing risk of NCDs using BMI,

these racial and cultural differences in body composition and regional adiposity need to be taken into account, in addition to identifying the best combination of screening tools and methods to give the best prediction of 'physical risk' e.g. BMI in combination with WC measurement among south Asians.

Scientific evidence suggests that regular physical activity (PA) sufficient to cause an individual to sweat is protective against developing type 2 diabetes due to its effect on body weight and cardiovascular fitness and function; but the relationship appears not to be as strong as with the inverse relationship of body weight increases (Barengo, 2012). Physical activity per se has numerous other benefits apart from weight reduction which bring about improvements in overall health. Physical activity also has an independent effect on improving muscle insulin sensitivity (Mayer-Davis, et.al. 1998; Dubé, et.al., 2011). However to ensure good energy balance and better body weight management, PA has to be combined with nutritional and dietary factors/interventions, be at a sufficiently good level e.g. low to moderate; and be sustained over time to confer the most benefit (Hensrud, 2012). Indeed PA should be a lifelong pastime and be routinely built into one's daily activities to confer the lowest overall health and diabetes risk (WHO, 2010).

1.3 Dietary risk factors in the development of type 2 diabetes

1.3.1 Total calorie intake

It has been argued that chronic excess of total calorie intake relative to energy expenditure promotes weight gain and is an important overall dietary risk factor (Lawson et al., 2012). Energy balance studies (Prentice et.al., 2004; Hensrud 2001; Harris et.al., 1994) have long established the impact of energy restriction coupled with increased expenditure on weight loss over time both in animal and human (Bish et.al., 2005; King et.al.,2007) studies. Experimental studies and the gains however do not necessarily translate into population gains over the medium

to long term if human behaviour and personal psychological and motivational factors are not taken into account in any long term strategies to promote weight management. Energy intake and expenditure also have occupational and culture dimensions which reflect social dynamics which indirectly may act as proxy contributors to the problem of overweight and obesity within any environmental context. Thus controlling total calorie intake whilst maintaining normal body weight remains one of the major individual and population nutritional strategies to prevent NR-NCDs. Whilst not all people who gain weight will develop diabetes, there are many other complications of obesity that collectively make efforts to prevent primary weight gain in the entire population worthwhile.

1.3.2 Dietary fat

Food choices and dietary habits may contribute to positive energy balance and risk of nutrition related chronic disease. Diet composition may have an effect on insulin sensitivity and the risk of type 2 diabetes (Horton, 2012). These relationships have been examined in relation to total dietary intake and particularly saturated fat intake which were shown to have at best a modest inverse correlation with insulin sensitivity (Parillo, 2004). Monounsaturated (MUFA) and polyunsaturated (PUFA) dietary fats have been studied less, but recent available data seem to show that trans fatty acid intake is associated with decreased insulin sensitivity whilst MUFA and PUFA have been associated with increased insulin sensitivity (Risérus, 2009). Increased saturated and decreased PUFA intake has also been associated with increased risk of type 2 diabetes in prospective study (Risérus, 2009). In trying to examine, dietary intake and risk profiling among adult south Asian migrants, and to link these to dietary risk factors, one objective of the present study is therefore to examine dietary fat intake and to attempt to draw correlations between intake and risk profiles.

1.3.3 Dietary carbohydrate

It has been suggested that dietary carbohydrate when substituted iso-calorically for dietary fat, results in a rise in glucose and triglyceride levels, and a concomitant fall in high density lipoprotein (HDL) cholesterol levels in the short term (Parodi, 2009). Subjects with diabetes or the metabolic syndrome may be particularly susceptible to these responses from dietary carbohydrate. In rural china in the early 1980's plant-based diets were more commonly consumed and carbohydrates provided maximum calories. The prevalence of obesity and type 2 diabetes was low. Over the last two decades however with increasing levels of total energy, dietary fat and meat intakes, there have been reports of higher levels of obesity and NCDs including type 2 diabetes. Data linking these trends with the nutrition transition have been well reported by Barry Popkin (Mattei et al., 2012; Neal, 2012; Oken and Gillman, 2012; Popkin, 2012). In this situation, it is possible that insulin sensitivity was maintained because of low body weight and in particular low body fatness and active lifestyles including increased in low to moderate level of physical activity (PA).

The type and composition of carbohydrate appear to be more important than total energy from carbohydrates per se, in terms of risk of type 2 diabetes. This assertion is supported by the inverse relationship between dietary fibre intake and the risk of type 2 diabetes demonstrated by Schulz et.al. in 2010. High intake of refined carbohydrate, particularly corn syrup, and low intake of diary fibre have been associated with increased risk of type 2 diabetes independent of total energy intake (Weber et al., 2012; Garduño-Diaz et al., 2012; Bloomgarden, 2004). The glycaemic properties of foods containing these from various forms of carbohydrate may play a significant role.

Observational studies have reported a positive correlation between the glycaemix index (GI) and glycaemic load (GL) of a diet and risk of type 2 diabetes (Barclay et al., 2008; Woudenbergh et al., 2011). Despite this, not all data are consistent and there are issues around prescription and implementation of such diets in the UK as part of meal planning for people with diabetes (Weber et al, 2012).

1.4 Specific foods & food groups

The risk of NCDs such as type 2 diabetes have been associated with intake of specific foods or with individual nutrients contained in these foods. For instance a number of observational studies have reported an inverse relation between intake of vegetables, fruits, whole grains and risk of type 2 diabetes (Fung, et.al., 2002; Bazzano, et.al., 2008; Yu et al.,2011). Some ecological studies have also reported that fish and seafood consumption can reduce the risk of type 2 diabetes in populations with a high prevalence of obesity (Villegas et al., 2011; Salas-Salvadóa et al., 2011). When all the evidence is gathered about the relationships between foods and risk of diabetes, it would appear that ultimately a healthy, balanced diet compared to the right amounts and proportions of energy sources and the components of these sources, types and amounts of complex carbohydrates e.g. non-starch polysaccharides (dietary fibre), unsaturated fatty acids (MUFA and PUFA), vegetables, fruits and their respective mineral and vitamin contents, all have a significant role to play in defining food-based risk of diabetes. Collectively, it might be worth examining the individual and synergistic effects of those components of food that promote health and reduce diabetes risk as well as those that individually or synergistically have a negative impact on health and risk of diabetes. In examining population risk of diabetes, perhaps these are the important issues to consider in defining the balance of the risk, as a basis for planning population-based and targeted strategies for prevention.

1.5 Weight loss

Reversing current trends in body weight gain will require promotion of healthy diets, lifestyle behaviours and physical activity at all levels, and requires multidisciplinary, multi-sectoral approaches including physicians' public health practitioners, psychologists, health educators, exercise physiologists and physical trainers, the fitness and food industries and policy makers. Occupational or work-related physical activity or the lack of it as a contributor to energy balance may also be an important determinant of risk. Such occupational risk factors may also be related to educational attainment and / or opportunities on the employment market especially among migrant population in Europe. Thus an individual who works 10 hours daily, six days a week and over 52 weeks in a year as a taxi driver, a largely sedentary occupation, may be doing so because their level of educational attainment would not lend itself to a job with more flexibility for non-occupational physically of their own choosing, without compromising their income.

Data from observational and clinical studies suggest that using a variety of interventions including pharmacotherapy and surgery, result in modest weight loss, improves insulin sensitivity and reduces the risk of type 2 diabetes (Lawson et al., 2012; Ross et.al., 2004, Sjöström et.al., 1999; Lee et.al., 1988). In the majority of cases, the improvement in insulin sensitivity is proportional to the degree of weight loss and benefits are seen only as long as weight loss is maintained (Lawson et al., 2012). In general, among non diabetics, about two thirds of weight loss is maintained at one year and a vast majority of people who lose weight regain weight eventually if they do not maintain the protocols employed in weight reduction in the first place (Lawson et al., 2012). Nevertheless even in such situations where lost weight is eventually regained, the appearance of diabetes may be delayed for quite some time.

1.6 Study Rationale

Chronic nutrition related non-communicable diseases (NR-NCDs) such as type 2 diabetes mellitus are more prevalent in minority migrants of South Asian origin compared to indigenous Caucasian populations in the United Kingdom and Europe. The observed differences have been attributed to the nutrition transition which essentially links inter-generational nutritional experiences and in-utero programming to the risk of adult disease in later life.

The literature suggests an overall worldwide increase in diabetes risk and prevalence across cultures. The burden of disease among people of South Asian origin is likely to rise much higher than the average e.g. in the UK population. Given the current economic costs of NR-NCDs and diabetes management and the likely escalation of costs especially in view of the co-morbidities of diabetes, it is economically sound that primary, secondary and tertiary preventive strategies and models of care that work are found and applied to reduce disease burden more generally and among south Asians in particular.

Understanding dietary behaviour and shifts in food consumption patterns especially among migrants with a high risk profile for type 2 diabetes and other NR-NCDs and components of the metabolic syndrome is an important first step in identifying and planning primary (and secondary) preventive strategies for them. In this study, the focus is therefore to employ standard protocols to explore dietary related behaviours, physical activity levels and other lifestyle behaviours which may have implications for chronic disease risk.

In examining dietary behaviour, it would be useful to link these to cultural norms and practices and to look back in time to see if recent migrants are more likely to make any significant changes or modifications in their eating patterns and dietary habits. The energy sources, types and composition of fats and carbohydrates consumed and the glycaemic properties of the diets are also of interest as they will help to elucidate individual (and culturally-related) food-related

behaviours and intake which although from a biochemical standpoint may impact on risk among the population, are nonetheless unknown to the individual and community through lack of technical knowledge.

Within the context of south Asians in Medway, there is anecdotal evidence that there has been a gradual shift in meal patterns, eating habits and behaviors and meal composition (reflected in changes in recipe formulation) across the different south Asian groups present in Medway, Kent, UK. As part of this enquiry therefore, the use of focus groups is proposed to help identify current food-related behavior and in particular, any time-related trends in meal composition and eating behavior. The present study also seeks to make use of evidence from the literature on established nutrition related risk factors for the South Asian communities and to identify culture-specific factors which should be factored into any future interventions.

Ultimately, establishing risk profiles and understanding fully natural or inherited risk and the actual manifestations or expressions of such risk in the form of NR-NCDs would require an examination of the evidence from biological, environmental, cultural, psychological, lifestyle and objective biochemical markers of risk. In this study, the focus on a male Punjabi group is to provide an assumption of similarity in genetic make-up and the biological and molecular mechanisms are not examined but a subject for other research scientists. A study of the environmental determinants would require a closer look at energy balance, dietary and lifestyle risk factors, physical activity (occupational and non-occupation) and their relationship to physical measures of nutritional status (e.g. body weight, MBI,WC, WHR), physiological measures (e.g. blood pressure) and biochemical measures (e.g. blood lipids, serum glucose). Elucidating the interactive processes involved in risk prediction would serve as a basis for developing appropriate and culturally appropriate risk models which should aid future interventions for this, and other populations.

1.7 Study Aims

The Specific aims were to:

1) Employ a focus group approach to assess current food choice, meal planning and traditional recipe formulation among South Asian male migrants of Punjabi origin in order examine food-related attitudes, habits and choices, methods of recipe formulation, food preparation and eating behaviours.
2) Assess dietary intake, the amounts and components of energy and overall nutritional quality of diets consumed by migrant Punjabi adult males in Medway (compared to current UK, guidelines).
3) Ascertain socio-demographic characteristics and lifestyles of a first and second generation migrant Punjabi male population in Medway Kent.
4) Assess physical, physiological characteristics of nutritional status (anthropometry), across first and second generation Punjabi males.
5) Assess physical activity levels among Punjabi adult males in Medway, Kent, UK.
6) Undertake biochemical measurements to ascertain fasting serum lipid and glucose levels of migrant Punjabi adult males in Medway, Kent, UK

1.8 Study Objectives

The specific objectives of this study were to:

Study Objectives:

1) Examining food-related attitudes, habits and choices, methods of recipe formulation, food preparation and eating behaviours among South Asian male migrants of Punjabi origin.

2) Examine the energy intakes and nutritional quality of current diets among this cohort of individuals with the view to identifying specific dietary components which are health-promoting and any associations with increased risk of NCDs.
3) Attempt to establish relationships between dietary practices, food choices, energy intake and NCD risk.
4) Establish associations between energy intake, physical activity levels and physical measures of NCD risk.
5) Examining age-related and inter-generational contributors to NCD risk.
6) Examining the existence of evidence of the determinants and components of the nutrition transition in this population.

1.9 Research Questions

1) Can changing trends in food-related behaviour, physical activity and lifestyles explain current patterns of chronic disease and predict future risk among Punjabi male migrants living in Kent?

2) Are there components of the current diets of adult male South Asians of Punjab origin in Medway which are likely to increase risk of type 2 diabetes and other nutrition-related non-communicable diseases (NCDs)?

3) Are there specific and age-related dietary practices, lifestyle factors and physical activity patterns among this cohort of subjects which contribute to risk of NCDS?

4) What environmental potential mediators of NCD risk are particularly important in this particular homogenous group of adult males?

5) To what extent does NCD relate to age, generation (first v. second) and occupation-related physical activity?

6) Are there strong associations between dietary intakes, physical activity levels and serum lipids and glucose?

7) Are there specific cultural factors which act as potential mediators of chronic disease risk in this population and if so, how important are these in designing interventions for risk reduction?

Chapter Two: Dietary, Physical, Physiological, Physical activity and Biochemical risk factors in nutrition related non communicable diseases

2.1 Chronic Disease and Diabetes in the South Asia Region

Increasing economic prosperity is associated with changing lifestyles even in the most traditional cultures globally, with major changes in diet habits, adoption of sedentary lifestyles, increase dependence on alcohol, tobacco and increase in levels of exposure to environmental pollutants in countries such as China and India. These changing trends in human ecology and behaviour have also been strongly associated with increased burden of chronic nutrition related non-communicable diseases (NR-NCDs) in developing countries. This phenomenon of shifting trends in NR-NCDs associated with demographic transitions were described by Omran (1971) as the "epidemiological transition" which is characterised by increases in chronic NR-NCDs with a concomitant decrease in infectious and communicable diseases as the economic fortunes, income levels and the ability to afford modern health care increase, with better environmental spaces. This remarkable shift in disease patterns was earlier observed in rich European countries and North America in the late 1800s to early 1900s (Madison, 2010) following the early industrial revolution in those regions, but now is occurring throughout the world.

This burden of NR-NCDs over communicable diseases comes at a huge price with rising economic costs on health systems and services, households and individuals particularly in low and middle-income countries with fewer social safety nets. A significant number of developing countries are facing further challenges of a multiple disease burden in which in addition to

tackling existing communicable diseases (diseases of poverty and under-development), low and middle income countries are battling with the growing burden of NR-NCDs in country level.

Data suggest that over the last few decades deaths from NR-NCD's have increased remarkably. In 2008, out of total deaths recorded, nearly 55% were due to NCD's and based on current situational analyses and model projections, the NCD burden is projected to further increase to 72 percent worldwide by 2030 (WHO, 2011) (Figure 2.1). It is also estimated that a large percentage (30%) of all-cause mortality by 2030 will be premature and largely preventable worldwide.

Increasing incidence of NR-NCD's at younger ages as low as 7 to 8 years are increasingly being reported worldwide (Brown, et.al., 1983; Green, et.al., 1992; Kelishadi, 2007) resulting in premature deaths, lowering economic productivity and imposing a heavier burden on economic growth and development. Recent reports suggest that large numbers of NR-NCD related deaths occur before the age of 60 years, thus indicating its burden on younger populations worldwide (WHO, 2009). According to the report, 34% of deaths in south Asian countries occurred before 60 years in 2008, compared to 23% in the rest of the world; and only 16% in the European region (WHO, 2011). A recent study in 52 countries, has concluded that south Asians experience, a 6 years earlier incidence of their first heart attack (53 vs. 59 years) compared to other countries globally (Goyal and Yusuf 2006; Ramaraj and Chellappa 2008) (Figure 2.2). The majority of deaths with NR-NCDs occur between 45 to 69 years (WHO, 2011). Table 2.1 below shows a summary of the NCD burden in developing regions of the world.

Table 2.1 Rising NCD's challenge in developing regions includes younger populations (World Bank, 2012)

Rank	Cause	Total deaths	Total %	Rank	Cause	Total DALYs	Total %-
1	Ischemic heart disease	1,018,869	16.2	1	Ischemic heart disease	28,782,078	8.9
2	Cerebrovascular disease	417,870	6.7	2	Tuberculosis	16,373,869	5.1
3	COPD	415,215	6.6	3	Unipolar depressive disorders	13,833,204	4.3
4	Tuberculosis	407,593	6.5	4	Lower respiratory infections	12,546,419	3.9
5	Lower respiratory infections	362,723	5.8	5	Hearing loss, adult onset	11,902,501	3.7
6	Self-inflicted injuries	213,644	3.4	6	COPD	11,746,661	3.7
7	Road traffic accidents	199,871	3.2	7	Self-inflicted injuries	11,129,697	3.5
8	Fires	146,068	2.3	8	Cerebrovascular disease	10,681,431	3.3
9	Cirrhosis of the liver	133,945	2.1	9	Road traffic accidents	9,935,226	3.1
10	Diabetes mellitus	118,175	1.9	10	Refractive errors	9,224,506	2.9
	All Causes	6,280,515	100%		*All Causes*	321,635,048	100%

Non-communicable disease prevalence including diabetes is rapidly increasing in developing countries and countries in economic transition in particular to the so-called BRICS countries (i.e. Brazil, Russia, India, China and South Africa). On the Indian sub-continent, diabetes incidence and prevalence particularly of type 2 diabetes over the last two decades have reached alarming rates (Gupta and Kumar, 2007).

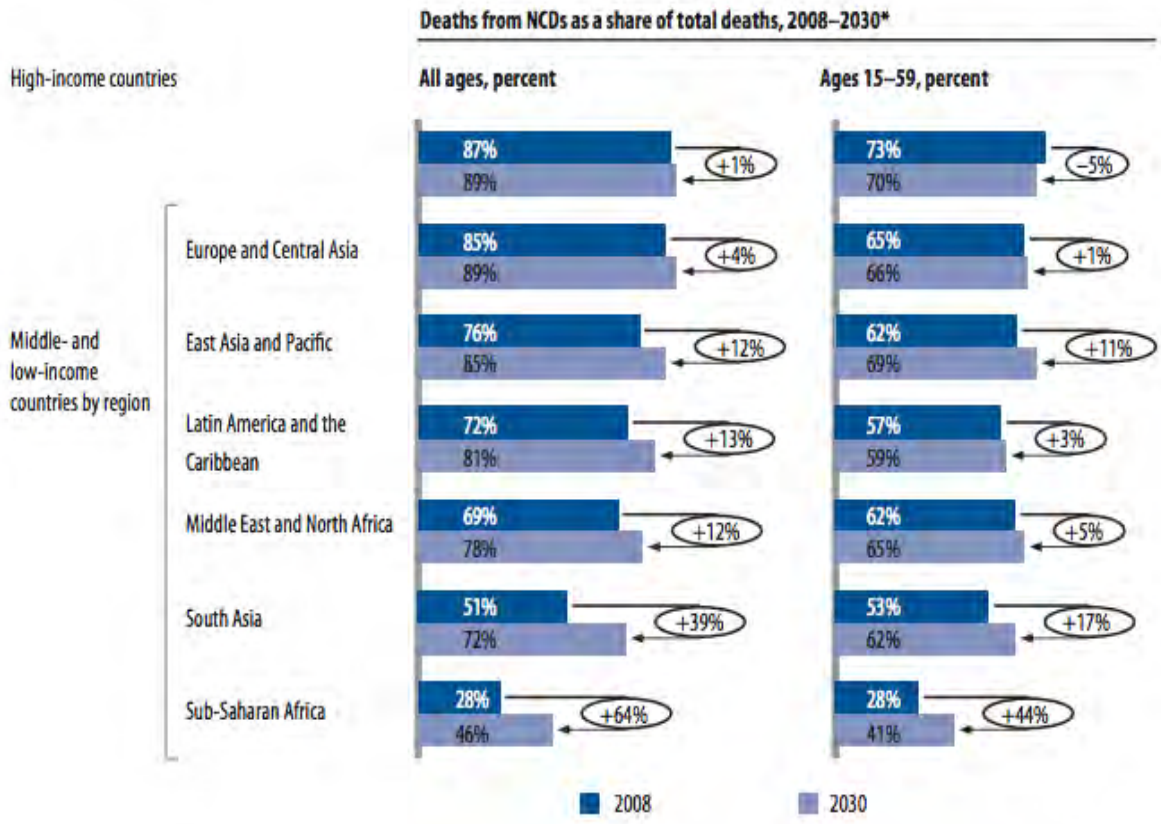

Figure 2.1 Estimated percentages of deaths, by cause, Member countries of the South-East Asia Region, 2008 (WHO, 2011)

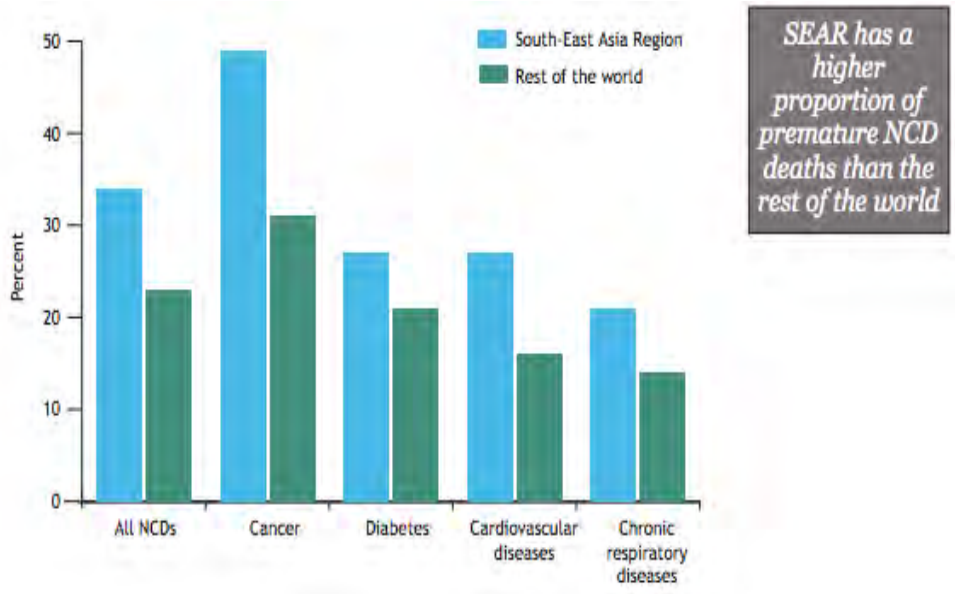

Figure 2.2 Estimated percentage of premature deaths (under 60 years of age), by cause, South-East Asia Region vs. the rest of the world, 2008 (WHO, 2011)

In all these countries the rates of chronic disease and especially the trends suggest that demographic and economic changes may be influencing lifestyles and diet with impact on health and wellbeing. There is also evidence to support the phenomenon of the nutrition transition (Popkin et al., 2012) in these countries. This phenomenon of increasing NCDs appears to also follow among south Asians living in Europe and North America.

2.2 NCD's among migrants of south Asians

South Asians living in the European and North American region carry a relatively higher pre-deposition to NCD risk. It is also observed that south Asians experience higher incidence of NDC's in North America, and Europe compared to the host populations and populations from the country of origin (Patel et al. 2006; Jeemon et al. 2009). These observations seem to suggest that there may be genetic (and perhaps early life environmental exposures of risk) among these populations in-country / region, but that such genetic risk is 'accelerated' with a change of environment e.g. from a relatively poor South Asian country e.g. the Punjab in India to a more economically stable and relatively rich country e.g. United Kingdom. In terms of anatomical body constructs, South Asian populations though culturally variable, tend to have higher body fat, with a preponderant truncal distribution, higher subcutaneous and intra-abdominal fat, and low muscle mass as observed by McKeigue (1991). Hyperinsulinemia, hyperglycemia, dyslipidemia, hyperleptinemia, low levels of adiponectin and high levels of C-reactive protein; and early onset of type 2 diabetes and coronary heart disease has also been reported at lower levels of body mass index (BMI) and waist circumference (WC) compared to European white Caucasians (Forouhi, et.al., 2006). It has also been argued that the incidence of NCDs may also be influenced by social, psychological and other environment factors including meal composition. Due to migration change in environment, food availability and cost, economic status and lifestyles are also postulated as contributory factors. Other differences between south

Asians and white Caucasian are: socioeconomic status, lower disease awareness and health-seeking behaviour. Language barriers, religious and socio-cultural factors are reported to have direct impact on risk of NCDs (WHO, 2008). A recent UK population census report also suggested that South Asians had higher rates of unemployment and were more likely to be unskilled and in low-income households (WHO, 2010). This might act as a barrier to accessing social and health services and a decreasing capacity to pay for preventative and curative care overall affecting to their quality of life.

2.2.1 Cardiovascular disease risk among south Asians in the UK

Ischemic heart disease, stroke and hypertension account for a major cause of injury and death from cardiovascular diseases (CVD). The burden of cardiovascular disease is consistently high among south Asian migrants living in developed countries. A review from 1976-2003 shows that South Asians in the UK are experienced a high mortality rate due to CVD and stroke compared to white Caucasians (Harding, et. al., 2008). Over the last half century, marked increases in mortality rate due to coronary heart disease with decreasing age has been observed among South Asians (Balarajan,1991; Harding et. al., 2008) in United Kingdom. This population experiences a three to four fold increased risk of ischemic heart disease with an earlier age of onset of CVD. Results from the INTERHEART study showed higher levels of conventional risk factors present at younger ages which might explain the reason for early incidence of myocardial infarction among this population (Joshi et.al., 2007). The mean age for myocardial infarction is 5 years earlier for South Asians than the indigenous UK population (50.2 vs 55.5 years) (Hughes et.al., 1989). This population also have comparatively higher premature incidence of arteriosclerosis (Anand et.al., 2000). The Health Survey of England report of 2004 data showed the highest prevalence of CVD among Pakistani men and Indian Women compared to any other ethnic group in England. The risk of CHD is 50 to 200% higher among south Asians compared to European populations (McKeigue, et.al., 1989; 1993; Forouhi, et.al., 2006). Among South

Asians sub-groups, Indians are least and Bangladeshi has a highest risk and incidence of CHD (Bhopal, et.al.,1999; Wild, et.al., 2007). Among Indians, the highest mortality with CVD has been observed among the Punjabi population living in Punjab, Indian (The World Bank, 2012). However, data suggests that risk of CHD and CVD is not uniform among South Asians (The World Bank, 2012).

There are differences in geographical distribution, lifestyle and food among populations from Indian sub-continent. Thus, to consider inter-state differences is important in understanding coronary risk factors. Similar to CHD, incidence of stroke is higher among South Asians. In the UK, mortality from stroke is 40% higher among south Asians compared to European populations (Wild and McKeigue, 1997; Gunarathne, et.al. 2008).

2.2.2 Diabetes among south Asians globally and in the UK

World Health Organization (WHO) reported India as ranked only 2nd in the world to China, with 50 million diabetics in India. Earlier WHO estimates in 2004 suggested that 32 million people in India alone had diabetes in 2000 (Wild, 2004). The International Diabetes Federation (IDF) estimates the total number of people living with diabetes is further set to rise to 69.9 million by the year 2025 (Mohan et al., 2007) if present trends continue. Several studies have focused on the differences in prevalence of diabetes in urban and rural populations of India. Urban residents with abdominal obesity and sedentary lifestyles have the highest prevalence of self-reported diabetes (11.3%) while rural residents without abdominal obesity performing vigorous activity have the lowest prevalence (0.7%) (Mohan.et.al., 2009).

A National Urban Diabetes Survey (NUDS) (Ramachandra, et al., 2001) study conducted in 6 large cities from different regions of India showed the prevalence of type 2 diabetes was highest in Hyderabad 16.6% followed by Chennai 13.5%, Bengaluru 12.4%, Kolkata 11.7%, New Delhi 11.6% and Mumbai 19.3% respectively. Prevalence of Diabetes in India Study (PODIS) in 2004 done in 108 centres of India (59- rural centre) reported the prevalence of diabetes is 2.7 % and

1.9% in rural areas according to WHO criteria and ADA criteria respectively (Sadikot, et al., 2004). Thus, the rate of diabetes increases considerably from rural to semi urban to urban to cosmopolitan areas (Gupta and Kumar; 2007). This data gives the picture of prevalence of diabetes in urban and rural areas of India.

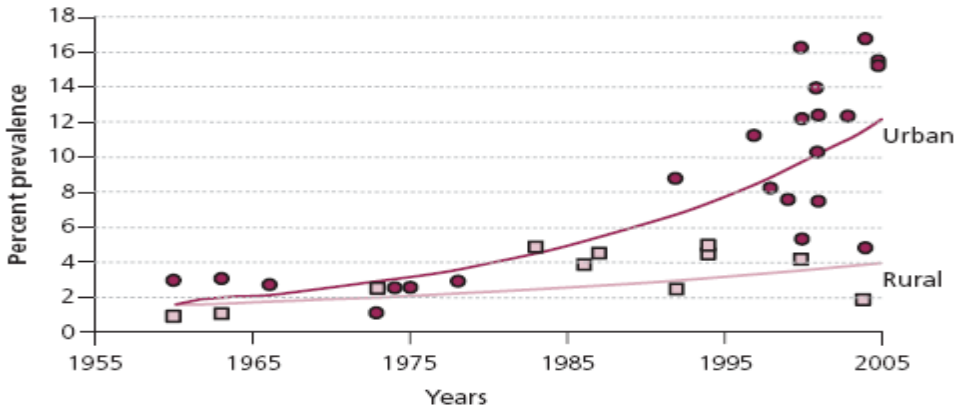

Figure 2.3 Prevalence of diabetes in urban and rural areas of India (Gupta & Kumar, 2007)

WHO also reported that Pakistan is ranked 7th in the world with 6.9 million people affected with diabetes. Further International Diabetes Federation (IDF) estimated that this number will grow up to 11.5 million by 2025 (IDF, 2010). The trend for diabetes incidence is similar to India. It is more prevalent in urban than in rural areas. In 2000 nearly 2.45 million people were suffering from diabetes which is estimated to increase up to 4.23million by 2025 in rural areas. The incidence of diabetes is reported to be higher among people of Indian origin from Delhi (India) and Southall (UK) than among whites living in the United Kingdom (Gupta; 2007). Previous results of the Health Survey of England (HSE) (1999) had suggested that the prevalence of diabetes in British Indian men and women was 19.2% and 15.3% respectively. The 2004 HSE report also concluded that prevalence of diabetes in Indians was three times higher than the general UK population (Diabetes UK, 2010). Out of the total self-reported, doctor diagnosed cases of diabetes from minority ethnic groups, 10.1% Indian men and 5.9% of Indian women suffer from diabetes in England (Diabetes UK, 2010).

Decades earlier, a survey in Coventry on 4395 resident Asians, found that Gujarati Muslims had the highest prevalence of diabetes with 160 males and 204 females followed by Punjabi Sikhs with 89 males and 75 females. Among Pakistani Muslims, there were 91 males and 103 females. Among Guajarati Hindus 84 male and 88 female; and Punjabi Hindus showed 113 males and 116 females respectively. The above study concluded that irrespective of their known dietary, cultural, and socioeconomic differences, South Asian Communities have a high prevalence and incidence of diabetes (Simmons et al., 1991).

The incidence of diabetes was found to be high among Pakistani migrants compared to the local population in developed countries (Hjellset, 2011). The HSE (1999) reported that the prevalence of diabetes in British Pakistani men was 39% and British Pakistani women was 28.3%. Pakistani women are five times more likely to develop type 2 diabetes compared to the general population (Diabetes UK, 2010). Diabetes is also three times more prevalent in Pakistani men compared to the general population (Diabetes UK, 2010. The prevalence of self-reported doctor diagnosed diabetic cases is 7.3% in Pakistani men and 8.3% in Pakistani women (Health Survey of England 2004). Thus, compared to Europeans, South Asians have four to six times greater risk of Diabetes (Mather and Keen, 1985; McKeigue, et.al., 1991;1993; Cappuccio, 1998; Diabetes UK, 2009) and a 5-10 year early diabetes risk compared to European populations (Coutinho, et.al., 1999; UK Prospective Diabetes Study Group, 1994; Vyas, et.al., 2012).

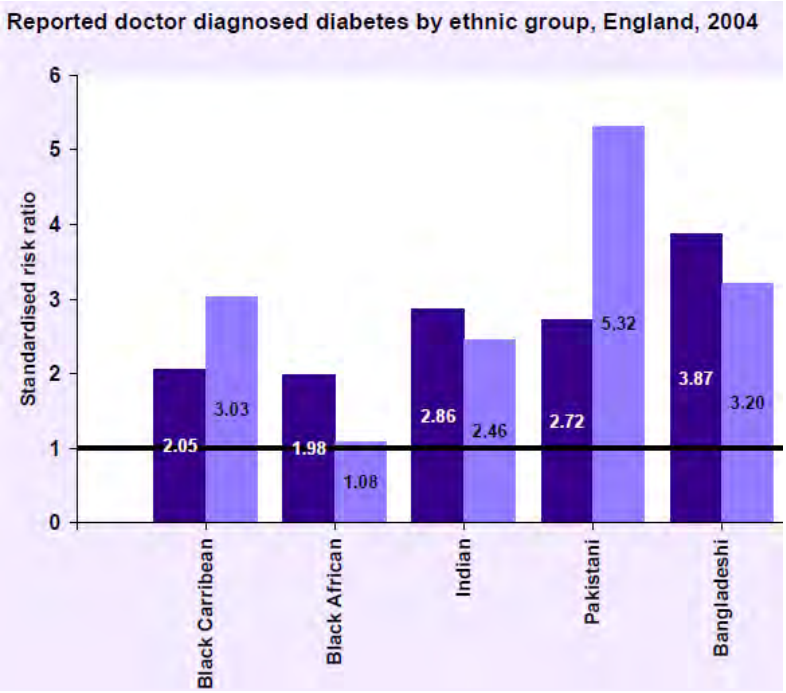

Figure 2.4 Reported doctor diagnosed diabetes by ethnic group England, 2004

The increasing prevelance of diabetes is associated with a rising incidence of its related complications (IDF, 2003; HSE, 2004). Prolonged disturbance in glucose metabolism is associated with progression of cardiovascular, stroke and peripheral vascular disease risk (PVD) (Diabetes UK, 2009). The presence of diabetes has been shown to increase risk of cardiovascular disease by two to four fold (Haffner, 1998; Coutinho,1999) and the prevalence of CVD risk has recently been observed to be high among South Asian diabetes patients compared to White Europeans (Khunti, 2013). People admitted with acute coronary syndrome (ACS) are identified mostly as diabetic or newly diagnosed with abnormal glucose metabolism (Fuller, et.al., 1980; Anantharaman, et.al. 2009). This can be explained by adverse effects of hyperglycemia including increased oxidative stress, a prothrombotic and proinflammatory environment and microvascular dysfunction (Anantharaman, et.al. 2009). Asymptomatic left ventricular hypertrophy, diastolic dysfunction and heart failure with normal ejection fraction are also commonly observed among south Asian diabetes patients (Waugh, 1988).

2.2.3 Elevated blood pressure among south Asians in the UK

Elevated blood pressure is an important risk factor for CVD which is high among South Asians in the UK. Thus, early and efficient management of hypertension is important in this, as well as other populations. Increments of 20/10 mmHg of blood pressure can double the risk of CVD. Results of studies comparing blood pressure levels between South Asians and indigenous populations are inconsistent (Cruickshank, et al.,1983; Miller, et al.,1988; Cruickshank, et al., 1991; Knight, et al.,1992; Williams, et.al., 1993; Cappuccio, et.al.,1998; Bhopal, et al.,1999; Whitty, et al.,1999; Primatesta, et.al., 2000; Karlsen, et.al., 2001). However, most of these studies suggest that on average south Asians experience elevated blood pressure (SBP $\geq$ 125 mmHg and DBP $\geq$ 80 mmHg) (Miller, et al.,1988; Cruickshank, et al., 1991; Knight, et al.,1992; Williams, et.al., 1993; Cappuccio, et.al.,1998; Whitty, et al.,1999; Primatesta, et.al., 2000). Recommended optimal adult blood pressure should not exceed 120 mmHg (systolic) and 80 mmHg (diastolic). Given this cut off for optimum cardiovascular health, it can be argued that the average apparently healthy south Asian is at a pre-hypertensive stage. Since this population has a high risk of CVD and stroke, it is important to control blood pressure to reduce the risk of CVD and other complications. Among all south Asian sub-groups, high prevalence of elevated blood pressure is observed among men than women (Bhopal, et al.,1999; Karlsen, et.al., 2001).

Common complications experienced with high blood pressure are: heart failure, peripheral vascular disease, renal impairment, retinal haemorrhage and visual impairment (Roger, et.al., 2011). Treating elevated blood pressure until they are less than 140/90 mmHg, can help to reduce cardiovascular complications (WHO, 2013). Punjabi Sikhs, experiencing elevated blood pressure compare to any other sub-groups of south Asians and Caucasians origin had been reported in many studies (Khan, et.al., 2005). Therefore, it is worth noting that blood pressure can be a physiological biomarker for risk predictor of NCD's.

2.3 Dietary habits of south Asian populations living in the United Kingdom

South Asians in the UK, particularly of the first generation follow both their traditional and western diets and food habits and lifestyle are greatly influenced by religion, culture, economic status, and health beliefs including alternative medicine such as Ayurveda and Homeopathy. The second generation tend to have adopted "western" lifestyles along with dietary habits (Jethma et al., 2012). Religion, culture and their customs have a great influence on dietary habits; the three major religions being: Hinduism, Islam and Sikhism. Guajarati Hindus are largely strict vegetarians and would avoid meat and fish products. However, among this population group, there are also ovo-lacto vegetarians who may have milk products and / or eggs as part of the diet. Animal derived fat such as dipping and lard are also not acceptable but Ghee (clarified butter) and vegetable oil are preferred for cooking (Jethma et al., 2012).

Muslims would avoid non-halal food i.e. animal products not prepared following standard Islamic protocols e.g. in the way the animal is slaughtered. Certain foods are regarded as "Haram" or taboo foods e.g. pork. These strict religious and cultural norms relating to acceptable and non-acceptable foods are not dissimilar from the Jewish practice of only consuming Kosher meals. Among Muslims, alcohols are to be avoided including that used in cooking, in confectioneries e.g. some chocolates and medicines (Jethma et al., 2012)). Among the Punjabis, there are lacto-vegetarians especially women, but others consume chicken, lamb and fish. Pork and beef are generally avoided. Excessive alcohol consumption has however been observed among this population (Jethma et al., 2012)).

Among South Asians, typical meal patterns on the Indian sub-continent have been summarised by Jethma et al., 2012 (Box 2.1):

Box 2.1 UK traditional meal replaced by south Asian culturally accepted food matrix in the United Kingdom

Main Course	Rice or Chapattis Fish or chicken curry Several vegetable curries cooked with pulses and potatoes.
Snacks	Fried products: Samosa, Pakoras, Chivda (similar too Bombay mix), consumption of western style biscuits, cake, chocolate are also becoming popular among young generation.

Among migrant communities the younger generation are rapidly shifting from the traditional to more "western" diets or European continental meals. Traditional south Asian diets tend to be rich in starchy carbohydrates, pulses and vegetables (Jethma et al., 2012). The western modified diet of South Asians include e.g. chips as a substitute for pulses or vegetables. Liberal use of butter/ oil/ ghee in cooking could lead to increased intake of fat and energy. Potatoes have become a major component of the staple diet accompanied by chapattis or rice, thus increasing the overall intake of carbohydrates (Jethma et al., 2012). Constant changes are continually being observed in South Asian diets from traditionally healthy diets to those characterised by high fat, salt and sugar (Vaughan, 2008).

The implications of shifts in dietary intake and nutrient content of the meals would include increased risk of diet-related chronic conditions especially where intakes of energy and the macronutrient components of the diet are consistently high. High fat, low fibre, low vegetable and fruits consumption result over time would result in nutritional imbalances (Jethma et al., 2012) with adverse health consequences.

2.4 Dietary, physical, physical activity and biochemical Risk Assessments

Risk factors can be assessed by various methods that analyze diet intake, physical attribute, physiological measurement, physical activity level and biochemical markers. A sample of these are described below:

2.4.1 Dietary Assessment

The 24 hours dietary recall technique is used to assess and quantify current dietary intake among targeted populations. This instrument has been used to validate food frequency questionnaires (FFQ) and other diet recall techniques e.g. food record diaries and diet histories of different types. The SABRE study conducted among a Punjabi population based in South Hall and Brent in the UK is one of many which have used the 24-Hour technique (Tillin et al, 2010). A previous study conducted by Sevak et.al, (2004) also employed a 24-Hour diet recall to collect dietary information to match data with the FFQ. This tool can be very useful to identify recipes and foods that are not commonly consumed by an ethnic minority group from a heterogeneous population. Therefore, further probing and the design of the 24-Hour recall can actually help to get a complete picture of a person and later on a population's dietary habit on a per day basis. Therefore a full picture of a population's dietary behaviour can be understood using this tool and conducting a FFQ can give the complete picture of a particular population's dietary habit for a year although either method is not without limitations and inherent errors (Kuhnle, 2012; Caroll, et al., 2012).

2.4.2 Overweight (OW) and Obesity (OB)

Body Mass Index (BMI) is an index of weight-for-height, commonly used as a proxy measure to classify underweight, overweight (OW) and obesity (OB) in adults and more increasingly children as well. It is defined as the weight in kilograms divided by the square of the height in

metres (kg/m^2). A WHO expert consultation on body mass index (BMI) concluded that the proportion of Asian people with a high risk of type 2 diabetes and cardiovascular disease is substantial at BMI's lower than the existing WHO cut-off point for overweight (25 kg/m^2). BMI ≥25 can be an independent risk factor NCDs. However, the cut-off point for observed risk varies from 22 kg/m^2 to 25 kg/m^2 in different Asian populations and for high risk, it varies from 26 kg/m^2 to 31 kg/m^2 (WHO, 2013). At specific BMI, South Asians have been found to have higher body fat percentage, abdominal fat (WHO, 2004, Lear, et.al., 2007) and risk of diabetes (Chiu, et.al., 2011). High body fat percentage and increase in waist circumference is associated with increased risk of CVD.

Abdominal obesity is a known predisposing risk factor for NCDs. It can be measured using the waist circumference (WC) or Waist–hip ratio (WHR) and can vary within a narrow range of total body fat and body mass index (BMI) (WHO, 2008). It is suggested to be an additional measure for body fat distribution. The WC, WHR and BMI have been used as proxy measures for the prediction of obesity and increase risk of obesity-related diseases due to the accumulation of abdominal fat (WHO, 2008). Studies have shown that South Asians have more visceral adipose tissue, Waist circumference and Waist-hip ratio at a give BMI compared to Europeans (Lear, et al.,2007; Lear, et al., 2009). Asians appear to have an increased metabolic risk at lower waist circumference and waist–hip ratio than Europeans (Joshi, et al., 2007). Visceral adipose tissue is metabolically active and is associated with decreased glucose tolerance, reduced insulin sensitivity and adverse lipid profiles and therefore increases risk of NIDDM and CVD among this population (Seidell, 1990;Taksali, et.al., 2008;; Qiao and Nyamdorj, 2010 b; Qiao and Nyamdorj, 2010 a; Huxley, et al., 2010).

2.4.3 Physical Activity Assessment

Physical activity is an important marker of health risk overall and lifelong cardiovascular fitness and diabetes risk. Direct physical activity measurements can be difficult and complex, requiring instruments e.g. laboratory based assessments of physical activity for which various protocols exist (Lacroix, et.al. 2008). However more recently, there has been a lot of interest in field-based direct measurements of PA including the use of axial accelerometers which record 24-hour activity (Umstattd et al., 2012; Doherty et al., 2013). Validation studies have found these techniques to be reliable and widely applicable as criterion methods for PA measurements in populations (Friedenreich, et al.,2012; Hoos T. et al., 2012). For population level physical activity measurements, indirect methods are preferable as they are cheaper and more feasible overall.

The Global Physical Activity Questionnaire (GPAQ) developed by the WHO and applied in national physical activity assessments as part of demographic and health surveys (DHS) is increasingly being applied globally after recent validity studies and revisions of the protocol components (Trinh et al., 2009; Bull et al., 2009; Hoos et al., 2012;). Physical activity measurement among diverse populations is challenging, but considering population dynamics, the GPAQ is a suitable and method for measurement of PA (Armstrong and Bull 2009). GPAQ is used for physical activity surveillance. Developed by WHO, the GPAQ helps to identify the level of physical activity in three settings: **Activity at work, travel** (e.g. to and from work) and **recreational** (non-occupational) activity. This instrument has mainly been developed for use in developing countries, where people experience diverse ways for life (Armstrong and Bull 2009; WHO, 2013) although a modified version of a similar questionnaire, (the international physical activity questionnaire, IPAQ) has also been applied in the European Prospective Intervention on Cancer (EPIC) (Craig, et al., 2003). The target subjects for the present study are essentially migrants from developing countries living in the United Kingdom. A study conducted by Bull,

et.al., in 2009 reported strong correlations between the GPAQ and the International Physical Activity Questionnaire (IPAQ), a previously validated and acceptable measure of physical activity. The GPAQ has also been used to measure population physical activity in five Asian countries - Bangladesh, India, Indonesia, Thailand, and Vietnam (Yadav and Krishnan, 2008; Nawi, et.al., 2009). Due to the availability of data from 52 counties including present study group is available inform of GPAQ which will allow to make possible comparison of physical activity level in country and among similar migrant population.

2.4.4 Biochemical Measures of NCD Risk

Fasting blood glucose can help to identify possible disturbances in glucose metabolism. Fasting blood glucose more than 5.5 mmol/L is associated with increased risk of diabetes (American Diabetes Association , 2012). The cut-off points for fasting blood glucose are presented in **Table 2.2** below. Untreated prolonged high blood glucose levels can increase the risk of diabetes and its complications e.g. micro-vascular and macro-vascular disease. South Asians are identified as a high-risk group for diabetes and its complications in the UK.

Table 2.2 Fasting blood glucose cut-offs

Fasting Blood Glucose	Cut offs
Normal (non- diabetic)	3.9-5.5mmols/L
Pre-diabetic	5.6-6.9mmols/L
Diagnosed with diabetes	>7.0mmols/L

Diet and physical activity are key components that influence serum lipid levels. Disturbances in lipid levels with above-normal values of TG, LDL and TC are associated with increased risk of CVD and other NCDs. A state of dyslipidaemia results when serum lipid levels are not within the normal range. South Asians are considered a high-risk group in the United Kingdom with a high incidence of CVD is observed among populations from the Indian sub-continent than

among Europeans. The lipid profile is an important risk predictor for the incidence of CVD among this population. Cut-off for serum lipids are presented in **Table 2.3**

Table 2.3 Components of lipids and its cut-offs for high risk groups

Components of Lipid	Normal	Borderline	High	Very High
Triglycerides (TG) (mmol/L)	≤1.69	1.70-2.24	2.58-5.63	≥5.64
Low Density Lipoprotein (LDL) (mmol/L)	≤3.33	3.34-4.11	4.13-4.88	>4.91
High Density Lipoprotein (HDL) (mmol/L)	Men: 1.03-1.29			
Total Cholesterol (TC) (mmol/L)	< 5.17	5.17 - 6.18	> 6.19	
non-HDL (mmol/L)	<3.36	3.37-4.11	4.13-4.88	≥4.91
TC/HDL ratio	<4.5			

2.5 The Nutrition Transition among south Asian populations in country and migrated country

Analysis of national dietary and nutritional survey data over a twenty year period in India between 1975 and 2005 suggest that not much difference in the intake of cereals had occurred whereas the intake of pulses, a major source of protein in Indian diets has declined greatly (Ramchandran, 2007). The average intake of cereals is as per recommendation whereas, intake of pulses, vegetables and fruits are considerably lower than recommended. Overall, percentage of total energy from carbohydrates has decreased and percentage of dietary energy from fat has increased. Furthermore increase in per capita milk intake has been very small, in spite of massive production of milk in the country (Ramchandran, 2007), thus raising the question as to whether population growth is matching with the volume of production and thus distribution per capita and the focus of milk production for export versus domestic consumption in India. In Urban areas, intake of oil and sugar/jiggery has increased but not in rural areas (Ramchandran, 2007). Reduction in intake of all nutrients has been observed in urban compared to rural populations.

Intake of Protein, iron, calcium, vitamin A and folate is lower than recommended intakes (Ramchandran, 2007). Recently the WHO has produced a global monitoring framework for the control and prevention of NCDs (WHO, 2012). This has followed recent high profile debates and exposure at governmental level within the United Nations system following the Lancet series on chronic disease (Lancet, 2005; 2007; 2010;2013) and other reports. In pursuance of the objectives of reducing the burden of NCDs, outcomes of particular interest and focus by WHO include cancer incidence and type; premature mortality from CVDs, cancer, diabetes and chronic renal disease. The exposure variables of particular interest in tackling chronic NCDs within the WHO framework include alcohol, fat intake, low fruit and vegetable consumption, overweight and obesity, physical inactivity, raised blood glucose, blood pressure and total cholesterol; salt intake levels and tobacco use (WHO, 2012). These exposure variables have a direct relationship to human dietary behaviour, lifestyles and activity levels and their associated influences on physiological, physical and biochemical markers of health and health status as captured by the phenomenon of the nutrition transition. These very issues are at the heart of the present study which seeks to examine the experiences and exposures of Punjabi populations with a recent history of migration from a relatively low-income and food-insecure environment (Punjab, India) to a more prosperous and largely food-secure one (Kent, UK).

2.6 Macro Nutrient intake among South Asian Communities

2.6.1 Dietary carbohydrate intake in South Asians

Carbohydrate foods are the staples and major sources of dietary energy supplies (DES). Primary energy metabolism involves glycolysis which in turn is linked to fatty acid and amino acid metabolism, the pentose phosphate pathway, lactate production and indeed the Citric Acid (Krebs) cycle and electron transport. Carbohydrates are therefore central to the process under both anaerobic and aerobic conditions in health and disease.

Two types of carbohydrate of particular energy significance are: 1) sugars and 2) starches. High sugar products commonly found on the market include jam, jelly, cakes and other confectioneries. Starch can be found from rice, wheat and other carbohydrate based products which are consumed as a staple food. During the process of digestion these carbohydrates are broken down to glucose which is absorbed into the blood stream. These carbohydrate foods are ranked according to the extent to which they raise the blood sugar level after eating i.e. according to their glycaemic properties.

In south Asian diets a great proportion of energy comes from carbohydrates although the distribution of carbohydrate in daily meals is quite uneven with little consumption during the day and more carbohydrate-rich meals in the evenings (Diabetes UK, 2010). Dietary intake measurement among adolescents in India showed that 60% to 70% of energy was derived from carbohydrates, whereas fibre intake was only 8.6 to 11.6 g. A dietary study on south Asian men in England also suggested that the mean percentage of energy from carbohydrates was around 46.4% of which a high proportion was from sucrose (17.5%). The average fibre intake was found to be only 3.2g/MJ (Sevak, et.al. 1994) which is much lower than the RNI of 25 g/day (Lairon, et.al.*;* 2005) In addition to the quantity of carbohydrate consumed, it is important to know the nature and quality of carbohydrates as well. For instance meeting the needs of complex carbohydrates with adequate amounts of soluble fibre, potassium and other minerals is important for diabetes patients. Complex sugars are preferable to the simple sugars whose glycaemic indices are much higher and thus are more likely to raise blood glucose levels much quicker post-parandially. Refined carbohydrates are also thought to elevate blood pressure by increasing adrenalin production in response to a meal, which increases constriction of blood vessels and sodium retention (Lawrence et al., 2005; Gopinatn, et.al., 2012)

2.6.2 Dietary fat intake in South Asians

Previous dietary surveys in India (NIN, 2011) suggest that fat contributes between 10 and 22% of energy among the Indian population. Daily visible fat intake is around 3g to 9g and invisible fat intake ranges from 20 to 50 g, thus the total fat intake ranges from 25 to 54 g/day (NIN, 2011). The average intake of linoleic acid is 4.8 g, whereas intake of linolenic acid is much smaller i.e. 0.28 g. Increasing urbanization and westernization has resulted in higher consumption of calories, fat , simple sugars and lower intake of fibre (Wasir, 2004). Fat contributes around 25 to 35% of energy among Indian adolescents, of which 9% to 13% are saturated fats, 6.9 to 7.3% are mono-unsaturated fatty acids (MUFA) and 8.3% to 11.7% from poly-unsaturated fats (PUFA) with the percentage of energy from omega-3 PUFAs 0.7% and omega 6 PUFAs 4.3%. Total cholesterol intake was around 94 mg/day (Isharwal, 2008).

According to the Indian recommended daily allowance (RDA), fat should contribute between 15 to 30% of total energy, of which less than 10% should be from saturated fat, 10% to 15% from MUFA, less than 8% from PUFA, more than 1% from omega 3 PUFA's and 3% to 7.5% from omega 6 PUFAs. Thus, intake of saturated fat, PUFAs was higher and omega 6 to omega 3 ratio was at the upper limit and omega 3 intake was lower than the RDA for Indian adults. Sources of saturated fatty acids include coconut oil, ghee (clarified butter) and palm oil commonly consumed among South Asians. The intake of flaxseed, mustard, and canola oils, fish and fish oils remain very low especially among vegetarians and the intake of omega 3 is low among vegetarian Indians (Misra, 2010).

PUFA intake is more, omega 3 intakes (0.08% of energy) is much less than among Europeans (Sevak, et.al.,1994). However, with adaptations following migration in the United Kingdom, nutrient intake (especially fat intake) among South Asians are becoming similar to the host

population (Anderson et .al., 2005). When the diet of British South Asian children was analysed, high total energy intake was observed, and more from total fat and polyunsaturated fat than from saturated fat and carbohydrates. When a recent comparison was made among south Asian sub-groups, the total calorie intake was highest among Bangladeshis followed by Pakistanis and Indians. Whereas, the percentage of energy from saturated fat and carbohydrate was highest among Indians followed by Pakistanis and Bangladeshis, total fat and polyunsaturated fat intake was highest among Bangladeshis followed by Pakistanis and Indians (Donin, et. al., 2010). The percentage of total daily energy from fat among the British Pakistani population is around 36% which is much higher than in the general population. A previous study in East London suggested that the intake of fat in Bangladeshi men is as high as 200 g/day i.e. twice the intake of the general population and accounting for nearly 60% of total energy intake (Silman, et.al., 1985).

High fat diet promotes weight gain and this in turn promotes insulin resistance. It is not only the quantity of fat but the type of fat also plays an important role in weight management, insulin action and prevention of diabetes. Saturated fatty acids are the independent predictor of fasting and postprandial insulin concentrations (Maron et al., 1991)

2.7 Micronutrient intake among South Asian

2.7.1 Vitamin D intake among South Asian community

Vitamin D deficiency and its consequences are commonly observed among South Asian populations. Serum 25-hydroxyvitamin D (25[OH]D) is an important indicator of the vitamin D status of an individual. Nearly 69 to 82% of south Asians are reported to have lower plasma 25(OH)D than the acceptable level 20 ng/ml (Masood, et.al., 2008). Not only in India, but also in Pakistan, and south Asian migrants in the UK experience similar problems (Harinarayan, 2005). In a study of pregnant Indian women, intake of calcium was below RDA values and there was not dietary source of vitamin D in this group (Panwar, et.al., 2000). Similar results findings have

been obtained in postmenopausal Indian women among whom nearly 30% had low plasma 25 (OH)D (Harinarayan, 2005). The condition is similar among UK South Asian women in whom a study found that out of 72 women studied, 94% showed signs of vitamin D deficiency (Roy, et.al.,2010). Numerious factors can cause vitamin D deficiency including unbalanced diet, excessive cooking of food and limited exposure to the sunshine, excessive clothing, gastrointestinal problems leading to malabsorption and impaired hepatic 25 hydroxylation of vitamin D3.

2.7.2 Vitamin D status and non communicable disease

A study of vitamin D status has been included in this report because of apparent links between hypovitaminosis D and glucose intolerance (Baynes, 1997). A high concentration of plasma 25(OH) D helps to improve insulin sensitivity (Lind, 1995; Boucher 1998; Chiu, et. al., 2004) and deficiency of vitamin D can impair insulin sensitivity and secretion (Mathieu, 2005). An inverse co-relation has being found between insulin concentration during OGGT and concentration of 25(OH)vitamin D (Baynes 1997). Moreover, Serum concentration of 1,25(OH) vitamin D is inversely correlated with Blood pressure, and VLDL (Lind, 1995). Vitamin D level also influence the incidence of complications among diabetes subjects, with evidence of a strong positive correlation between the serum concentration of 25(OH) vitamin D and the number of complications among diabetic subjects (Major, 2007). Suzuki (2006) was able to demonstrate that in diabetes subjects whose serum 25(OH)vitamin D level was >17ng/ml there was no incidence of complications but those with 25(OH) vitamin D level around 12 µg/ml had up to 3 diabetes complications (Suzuki, 2006). Supplementation with calcium and vitamin D has been shown to markedly improve lipid profiles (increased HDL, Decreased LDL cholesterol, total cholesterol and triglycerides) (Major, 2007).

2.7.3 Sodium (Na) intake and salt reduction Strategies

Dietary salt reduction may help hypertensive diabetic patients and this has been shown to reduce blood pressure significantly among South Asians. In a recent study it was reported that typically two Bangladeshi meals contained nearly 10 g of salt, excluding the salt content of breakfast and snacks, which is much higher than the recommended daily intake (Brito, et.al., 2009).

In the WHO global framework for reducing NCDs (WHO, 2012), the target is to achieve a 30 per cent relative reduction in mean population intake of salt, with the aim of achieving a target of less than 5 grams per day (equivalent to about 2 g of Na) in adults aged 18 years and above for the prevention of cardiovascular disease. The 30% reduction proposed is also based on the WHO recommendation for the prevention of cardiovascular disease that states that "all individuals should be strongly encouraged to reduce daily salt intake by at least one third". Current available data suggest however that that population dietary salt intake is between 9 and 12 grams per day (Cappuccio et.al., 2003; Brown et.al., 2011). WHO has suggested that to achieve the goals and targets, countries will need to implement salt reduction interventions including mass media campaigns to inform and empower consumers to make informed choices; and work with the food industry to ensure reduced salt content in processed foods through product reformulation. A limited number of countries have implemented salt/sodium reduction strategies and data from these countries (e.g. Finland, United Kingdom) have shown that over a period of 7 - 10 years mean population intake of salt per day can be reduced by up to 30 per cent. A number of low to middle income countries (LMICs) are also now implementing or planning to implement salt/sodium reduction strategies in the near future. He and McGregor have provided a very comprehensive review on salt and health, and reduction strategies (He and MacGregor , 2009).

2.7.4 Iron Intake among south Asian community

Low intake of iron is associated with a high incidence of anaemia. The prevalence of anaemia in India is very high; nearly 85% among preschool children, pregnant and lactating women and adolescent girls (FAO, 2006). The incidence of iron deficiency anaemia among south Asians is not only high in people living on the Indian sub-continent but also living in other countries. On the Indian sub-continent, the incidence of anaemia is highest among Bangladeshis followed by Indians and Pakistanis (Fischbache, et.al., 2001). Compared to men, prevalence of anaemia is high among women and more among women of child bearing age and pre-menopausal women (Fischbache, et.al., 2001).

2.4.7.1 Iron and Diabetes

Iron deficiency anaemia is associated with high concentrations of HbA1c in both type 1 diabetics and non-diabetic subjects (Tarim, 1999). Anaemia is common among diabetes patients and especially among patients with diabetic nephropathy (Thomas, 2003). An observational study by Ishimura et. al. (1998) concluded that the incidence of anaemia was more among type 2 diabetes subjects than non-diabetic patients. A similar conclusion was drawn by Vecchia, et. al. (2007) among diabetes patients with CKD who had a higher prevalence of anaemia than non-diabetic subjects. Thus diabetes appears to be an independent risk factor for anaemia or at least anaemia may be considered a likely co-morbidity of diabetes. In contrast, excess iron in diabetes can increase the risk of complications as can cause oxidative stress in the body (Swaminathan; et. al., 2007). Anaemia can also increases the risk of cardiovascular diseases (Sarnak, et. al., 2002). In end stage renal disease, with 1g/dl decrease in haemoglobin, risk of heart failure increases by 28% and risk of death by 14% (Foley, 1996).

2.8 Physical activity among South Asian adults

Physical activity plays a crucial role in reducing the risk of non-communicable diseases and sedentary lifestyle is associated with increase in serum insulin and insulin resistance, triglycerides and body mass index and increased risk of hypertension (Lakka, et.al., 2003) . However, South Asians in the UK have been found to be less physically active compared to the general population (Yates, et. al., 2010). Self-reported physical activity patterns in South Asians suggest that nearly 35% of South Asian men were doing office (service-based) jobs a decade ago, where usually they are sitting with very little physical activity (Hayes, et.al., 2002). Moderate physical activity such as light lifting, climbing stairs and outdoor in the hills is low among south Asian men compared to Europeans. Walking and cycling preference is also very low among South Asian men. Previous studies have suggested that in comparison with the general population, overall participation in sports and recreational activity was less among South Asian men (Dhawan, et.al., 1997). Among all the minority ethnic groups in England, South Asians were found to be living the most sedentary life (Dhawan, et. al., 1997). Comparisons between South Asian subgroups in the UK showed that Bangladeshis were the least physically active followed by Pakistanis and those of Indian origin. Only 17% of Indians, 16% of Pakistanis and 10% of Bangladeshis met current physical activity recommendations (Hayes, et. al., 2002). Level of physical activity is very low among Bangladeshis, as they believe that exercise and physical activity can increase or exacerbate illness (Greenhalgh, et.al., 1998). In a cross sectional study, South Asian women were found to be the least active outside their work place, with only 22% of them walking at least of 2.5 Km/day (Pomerleau, et.al., 1999).

Similar trends have been observed among UK south Asian children when lifestyle and physical activity levels were measured. using self-reported techniques it was found that they spend nearly four hours a day watching television. Most of the south Asian children preferred motorised transport for travelling to and from school and preference for walking and cycling is much less

among this group compared to European children. Active behaviour during school breaks was very low and most of the children engaged in chatting with friends.

Overall south Asians were reported as less active than white populations (Hayes, et.al., 2002, Yatesa, et.al., 2010; Williams, et.al., 2011). Total MET min/week was found to be only 973 on average among south Asians compared to 1463 among white participants in a study conducted by William et al., (2011). Similar observation has been reported among south Asians migrants living in USA (Kandula, et.al., 2005). Data by Hayes, et.al., (2002) show that nearly 71% of Indians, 88 % of Pakistanis and 87% of Bangladeshis do not meet current guidelines for participation in physical activity (Hayes, et.al., 2002). Thus, overall south Asians migrants are less active in western countries. However South Asians born in the UK are reported to be more active than those born elsewhere (Williams, et.al., 2011). Physical activity levels also decrease with age (Fischbacher, et.al., 2004) and are lower for unemployed, retired or economically inactive men compared to employed. Among woman, physical activity levels were lower for retired or economically inactive women compared to employed (Higgins and Dale 2010).

South Asians are less likely to participate in sports and recreation compared to White Europeans. Among south Asians groups, Bangladeshi and Pakistani women were less likely to participate in sports than Indians due to social, cultural and religious beliefs (Hayes, et.al., 2002; Lawton, et.al. 2006, Long, et.al., 2009).

2.9 Factors responsible for low physical active among South Asians

There are a number of possible explanations for low physical activity among South Asians. Leisure time physical activity is given low priority over other responsibilities and religious activities among South Asians. It has been shown that Asian parents do not encourage their children to participate in sports but success in academic work is given greater priority (Chappell, et.al., 2002). Some of the reasons given by South Asian men and women for not participating in

exercise are: No time because of work; Not sporty; No companion with similar language; Children to look after; and disapproval from family and partner.

Factors like, identifying cost, location, mixed sex facility and cultural environment prove to be barriers and influence participation in physical activity. Factors such as dress codes, modesty and lack of single-sex facilities act as a barriers to physical activity among South Asian women (Long, et.al., 2009). Other reported reasons are; identifying suitable and safe walking routes (Darr, et.al., 2008), limited knowledge of English (Hine, 1995); lack of culturally acceptable physical activity in a cold country like England (Khanam, et.al., 2008), time constraints, dependent relatives or availability of childcare (Grace, et.al., 2009) and also parents negative attitude towards female involving in physical activity (Johnson, et.al., 2000; Rojas, et.al., 2010). Moreover, motivation and encouragement to engage in physical activity for healthy life is found to be low among this population.

2.10 Socio-economic status and Physical activity among South Asians

Substantial differences exist among different racial and ethnic groups and sexes in the UK labour market. Indians living in UK are mostly economically better-off, having work regularly whereas the situation is opposite in the case of Bangladeshis and Pakistani migrants. Similar trends have been observed among Indian, Bangladeshi and Pakistani women. The overall percentages of women who are employed is much lower than the men in all the three communities. The rate of self employment is high among South Asian groups and most of the Indian who are self employed have employees. A high proportion of Pakistani and Bangladeshi migrant women from each age group are more likely to be looking after the home or family full time and domestic responsibilities. This trend of employment is parallel to the trend of physical activity explained

by Louise Hayes, et.al. (2002). They concluded that the highest level of physical activity was among Indian followed by Pakistani and Bangladeshi migrants.

Along with the level of employment, type of job also plays an important role in physical activity and overall health status. In South Asian men especially Indian men are mainly engaged in managerial and professional work rather than manual occupations. Among Bangladeshis, 40% of men are working in the restaurant business and personal service e.g. waiters or cooks. Whilst more Indian women were involved in skilled and semi skilled manual jobs, Pakistani women were mainly involved in sales or personal service occupations, and the bulk of working Punjabi women were involved in clerical and secretarial jobs (Hayes, et.al. 2002).

2.11 Physical Activity and Obesity

Obesity and excessive abdominal and visceral adiposity are associated with increased risk of CVD and diabetes (Haffner, 2007). Exercise for 30 min/day to 60 min /day helps to reduce total and abdominal fat and thereby improve metabolic profile. With 370 min/wk (men) and 295 min/wk (women) of exercise helps to reduce total fat mass, weight, BMI and waist circumference (McTiernan, 2007). Comparisons between physically active and inactive individuals have shown that intense physical exercise (e.g jogging 20 miles/wk) can reduce visceral, subcutaneous and abdominal fat whereas those who are inactive for 6 months would gain extra visceral fat (Slentz, et.al., 2005).

Lifestyle and community structure play important roles in the incidence of obesity among the population. Evidence suggests that each hour spent in a car per day is associated with 6% increase in the risk of obesity whereas each kilometre walked per day is associated with 4.8% decrease in the risk of obesity. By reducing obesity and central fat distribution, physical activity helps in reducing the overall incidence of diabetes. A study reported that people with diabetes were found to be less physically active than non-diabetic subjects (Kriska, et.al., 1993).

Sedentary behaviour and lifestyle increases the CHD mortality risk by 20% among the South Asian population (Williams, et.al., 2011). Low physical activity, high energy intake and socio-demographic condition may escalate the risk of diabetes, cardiovascular diseases and other NCD risk among the high risk groups of south Asian communities, living in a typical western obesogenic environment with less active lifestyles (Melinda, et.al., 2002; Ford, et.al., 2005). Sedentary lifestyle is strongly associated with increase waist circumference and high LDL cholesterol, C-reactive protein, secretory phospholipase A2, fibrinogen and adiponectin levels (Yatesa, et.al., 2010).

It has been postulated that moderate to vigorous physical activity can significantly reduce liver fat, leptin levels, fasting insulin and waist circumference (Rennie, et.al., 2003; Alderete, et.al., 2012). With low physical activity levels, South Asians carry comparatively higher visceral adipose deposition at a given BMI than Chinese and Europeans (Lesser, et.al.,2012). Such high levels of adiposity among South Asian has been associated with a higher risk of atherosclerosis.

Physical activity may influence serum lipid profiles depending on the type of activity as well as its intensity (Henson, et al, 2013). Sedentary behaviours have been associated with high levels of serum triglycerides, total cholesterol and lipid profile disturbance (Henson, et al., 2013). Increase in physical activity from sedentary to moderate activity with a balanced diet may help reduce obesity and associated complications. However physical activity can independently improve serum lipid profile and help to reduce cardiovascular risks (Chudyk and Petrella, 2011; Mora, et.al., 2013; Kujala, et.al., 2013). Aerobics, in the form of moderate to vigorous physical activity over an hour for a few days in a week has been shown to improve serum lipid profile (Yoshida, et.al., 2010). High intensity aerobic exercise with resistance exercises shows mark improvement in HDL cholesterol, which is anti-atherogenic (Balducci et.al., 2010) and moderate to vagorious physical activity can help to reduce triglycerides, LDL cholesterol and total cholesterol (Rennie, et.al., 2003; Bouillon, et.al., 2011; Kujala, et.al. 2011).

Current scientific evidence has linked mechanisms for the development of atherosclerotic plaque with chronic inflammation and inflammatory markers are known to be associated with the process of plaque formation and atherogenesis. Low physical activity levels have also been associated with higher levels of inflammatory markers (Geffken, et.al.,2001; Lavie, et.al., 2011; Mora, et.al., 2013). Increase in energy expenditure during physical activity can help to reduce various inflammatory markers e.g. Highly-sensitive C-reactive protein, haptoglobin (Lavoie, et.al., 2010), interleukin-6 (Hamer, et.al., 2012), secretory phospholipase A2, fibrinogen and adiponectin (Balducci et.al., 2010; Rana, et.al., 2011). Regular physical activity also improves heart health and cardiovascular fitness as demonstrated by a 17-year follow-up of the Copenhagen male study which associated physical activity of at-least 4 hr/ week with a decrease in the risk of ischaemic heart disease (Hein, et.al., 1992). It has also been shown that increase in moderate to vigorous physical activity is inversely associated with major chronic diseases risk overall (Chomistek, et.al., 2012).

2.11.1 Physical Activity and Hypertension

Incidence of hypertension is high among south Asians and a sedentary lifestyle and physical inactivity might be major contributory factors for early onset of hypertension and arterial stiffness among this population (Asferg, et.al., 2010; Gando, et.al., 2010). Increase in physical activity by overweight and obese subjects can help to reduce BMI and weight management has been strongly associated with risk reduction in hypertension (Hu, et.al., 2004). Active lifestyle is also associated with reduction in C- reactive protein (CRP), an independent marker for hypertension (Leonelo, et.al., 2001). Long term, regular physical activity can help to attenuate BP reaction to psychosocial stressors and thereby, help to reduce the risk of hypertension under psychological stressful situations (Paoloa, et.al., 2010). Haapanen et.al (1997), have previously shown that vigorous activity for a few days in a week is inversely associated with the risk of hypertension (Haapanen, et.al., 1997). On the contrary, sedentary behaviour in hypertensive

patients is positively associated with a high pulse wave velocity (PWV) and augmentation indeX (AIx), resulting in a reduction in arterial stiffness among adults with hypertension (O'Donovan, et.al., 2012).

Physical activity is also associated with insulin activity and glucose metabolism. Sedentary behaviour with more sitting time correlates strongly with higher fasting insulin levels (Helmerhorst, et.al., 2009) and 2 hr fasting serum glucose concentration (Gill, et.al., 2011) independent of moderate to vigorous physical activity (Henson, et al., 2013). Thus, with regular exercise, staying physically active throughout the day is important to maintain healthy glucose metabolism. Furthermore, increase in physical activity with low glycemic index diets can help to suppress postprandial response of glucose-dependent insulinotropic polypeptide and thereby increase insulin sensitivity (Solomon, et.al., 2010). Moderate to vigorous physical activity has also been shown to independently decrease insulin resistance and other inflammatory biomarkers including leucocyte count, Highly sensitive-CRP, coagulation, and fibrinolysis (Tsvetan et.al., 2012). South Asians have been identified to be less physically active and have higher incidence of diabetes compared to other minorities and Europeans living in the United Kingdom. Considering the adverse effects of physical inactivity, this state of physical inactivity among South Asians might be a very important contributory factor for the high incidence of NCDs and diabetes among South Asians.

2.12 Relation between dyslipidaemia and CVD

Dysipidemia is one of the important factors implicated in the aetiology of CHD and CVD. Conventional lipid profile includes parameters like total cholesterol (TC), LDL- C, VLDL- C, HDL-C, and ratio of total cholesterol to HDL-c. Total cholesterol levels are found to be significantly higher in Indians compared to other Asians (Robert, 1995; Enas et. al., 1997). However, certain reports show that total cholesterol often appears lower in South Asians due to low HDL values prompting some experts to suggest that the total cholesterol(TC) to high density

lipoprotein (HDL) cholesterol ratio would be a better predictor of CHD in South Asian populations compared to just the total cholesterol levels (Khunti & Kumar 2009). LDL cholesterol is another important determinant of risk strongly associated with myocardial infarction even at lower baseline levels in both cases and controls (McQueen et. al., 2008) Apolipoprotein measurement is essential in prediction of artherogenic risk (Sniderman et. al., 2003). The INTERHEART study which included nine risk factors for CHD showed that the ratio of Apo B100 to Apo A1 has strong risk associations with myocardial infarction in South Asian Populations (Karthikeyan, 2009).

Coronary disease is very common in south Asians coming from different geographical regions, religions and languages (Ranganathan et. al., 2005) and the incidence has increased significantly since the 1950s. Indians also seem to develop CVD 5 to 10 years earlier than other populations (Hoogeveen et.al., 2001). In England and Wales, data from the 2001 census on mortality by country of birth indicated highest CHD associated mortality in South Asians (Wild, et. al., 2007). Studies show that dyslipedemia, lipoprotein(a), hypertriglyceredemia and low high density lipoprotein levels are more prevalent among Asian Indians. (Roberts 1995; Enas et. al., 1996). Increasing evidence suggests that physical activity and physical fitness are negative predictors of CVD, CHD and associated risk factors such as blood pressure, C-reactive Protein, cholesterol and LDL c.(Haapanen, et.al., 2000; Stamatakis, et.al.,2007).

2.13 Physical Activity and Diabetes

Compared to white European population, South Asians in the UK are up to six times more likely to have Type 2 diabetes and predicted to increase by 47 per cent by 2025, the condition will continue to have a considerable impact on South Asian communities across the UK (Diabetes UK, 2010). Furthermore diabetes among South Asians occurs 5–10years earlier than general population and they are prone to diabetes complication at an earlier stage compared to the general population (The Health Survey for England, 2004; Forouhi, et. al., 2006). Obesity plays

an important role in the incidence of diabetes; waist-hip ratio is strongly correlated with glucose intolerance, insulin, blood pressure, and triglyceride (McKeigue, et. al., 1991). Thus, in the control of obesity, adequate physical activity plays a very important role in prevention of diabetes and its complications in South Asians.

Physical activity alone or in combination with controlled diet can help to reduce the incidence of type 2 diabetes (Tuomilehto et. al, 2001). Studies on non-diabetic obese subjects have show that exercise can reduce insulin sensitivity among obese children. Vigorous activity has been shown to improve insulin sensitivity and secretion in (Bell, et. al., 2007). Postmenopausal women with type 2 diabetes have shown marked improvement in the insulin sensitivity associated with decrease in subcutaneous fat, visceral fat and increase in muscle density with the combination of resistance training and aerobic exercise. Thus, physical activity helps to reduce the risk of complications in type 2 diabetic subjects by maintaining blood glucose through improved insulin sensitivity (Cuff, et.al., 2003).

Low intensity exercise therapy has led to marked improvement in insulinogenic index in overweight subjects with IGT and diabetes and helps to improve β cell function thereby promoting early phase iNsulIn sECretion in diabetic subjects (Dula, et. al., 2004). Aerobic and resistance training have led to improvements in HbA1c l%vels in typE 2 diabetes subjects, however the effect of resistance training is more pronounced in these subjects (Bweir, et. al., 2009). Low HbA1c with high physical activity is an indicator of improvement in glycemic control in type 2 diabetes subjects (Bweir, et. al., 2009). Diabetes patients have shown marked reduction in fasting blood sugar, 2 hr postprandial and HbA1c following regular physical activity for the period of 2 months (Seyyednozadi, 2007). Among subjects with impaired glucose tolerance (IGT) it was found that among those who adopTeD an adequate diet with physical activity, the incidence of type 2 diabetes was reduced by 46% compared to those following only diet (44%) and only exercise (41%) respectively (Sigal, et .al., 2004 .

Chapter Three: Methodology

3.0 Methodology

3.1 Introduction and rationale

In this study the focus was to examine demographic, food ch/ice, diet, physical activity and other lifestyle relationships in South Asian male mig2ants to the UK whose early nutritional exposure and experiences in childhood may have laid down the potential risks for chronic disease (Kaikkonen et al., 2012) in !n enabling environment i.e. of food, changing lifestyles and stress. The target group for this study was adult males of Punjabi origin living in Medway, Kent. To test our hypothesis of intergenerational differences linking diet and lifestyles to physical and physiological ris+ of chronic disease and in particular type 2 diabetes risk, this study was structurEd into three pARts as summarized below:

Phase I:

First was to uNdertake a desk review of the nutrient composition of commonly consumed South Asian recipes among people of Punjabi origin to identify particular components of the diet that may have potential implications for chronic disease. The findings served as a basis for undertaking focus group studies (n= 40 subjects) to ascertain what the target population were commonly consuming and to examine their own perceptions, behaviors and dietary practices as a basis for: Understanding issues of food habits and choices.

Phase II:

The focus group study was followed by an observational study involving (n=137 subjects) randomly selected free-living male adults of Punjabi Origin resident in the Medway area of Kent. This aspect of the study included in-depth assessment of individual (rather than group) socio-

demographic, dietary intake, physical activity surveys and physiological and biochemical measurements of markers of chronic disease risk including blood pressure, fasting serum lipid and glucose. This part of the study involved the design and use of a modified food frequency questionnaires (FFQ) from a previously validated questionnaire employed in the European Prospective Intervention on Cancer (EPIC) (Bingham, et al., 2003; Khaw, et al., 2006; Purslow, et al., 2007) and a repeat 24-hour recall dietary intake questionnaires (Zamora-Ros, et al., 2012; Pollard, et al., 2012) ; Physical activity was quantified by proxy measurements using a modified version of the validated WHO Global Physical Activity Questionnaire (GPAQ) and translating (Bull, et al., 2009; Trinh, et al., 2009; Guthold, et al., 2011)

Phase III:

The findings from Phase I and the data generated provide a basis for further in-depth study of a sub-sample of the population. This aspect of the study formed a major part of the PhD. Relationships to the observed food intake data, blood lipid profiles and measurements of serum glucose in a sub-group of this sample population (n=30) to enable clinical / biochemical comparisons. Furthermore, data on physical activity which have been collected in the sample population are being analysed and quantified to make comparisons. Statistical analyses including uni- and multivariate analyses, Student's t-test, z-test and Pearson's correlation coefficient for parametric data. Spearman's rho was employed to ascertain the strength of association between variables which were tested and found to be non-parametric following normality of distribution test with Kolmogorov-Smirnoff goodness of fit test. Single and multiple linear regression analysis was also employed to estimate the relationship between and among group variables to establish predictive risk for chronic disease in this population. The demographic profiles of the subjects were also factored into further analysis on predicting risk.

3.2 Design of the Study

3.2.1 Literature Search Strategy

The criteria for selection of literature include its relevance to the research topic and the year of publication. Public and private libraries as well as online libraries were visited to access data. The following flow diagram (**Figure 3.1**) shows the stages of the literature review strategy.

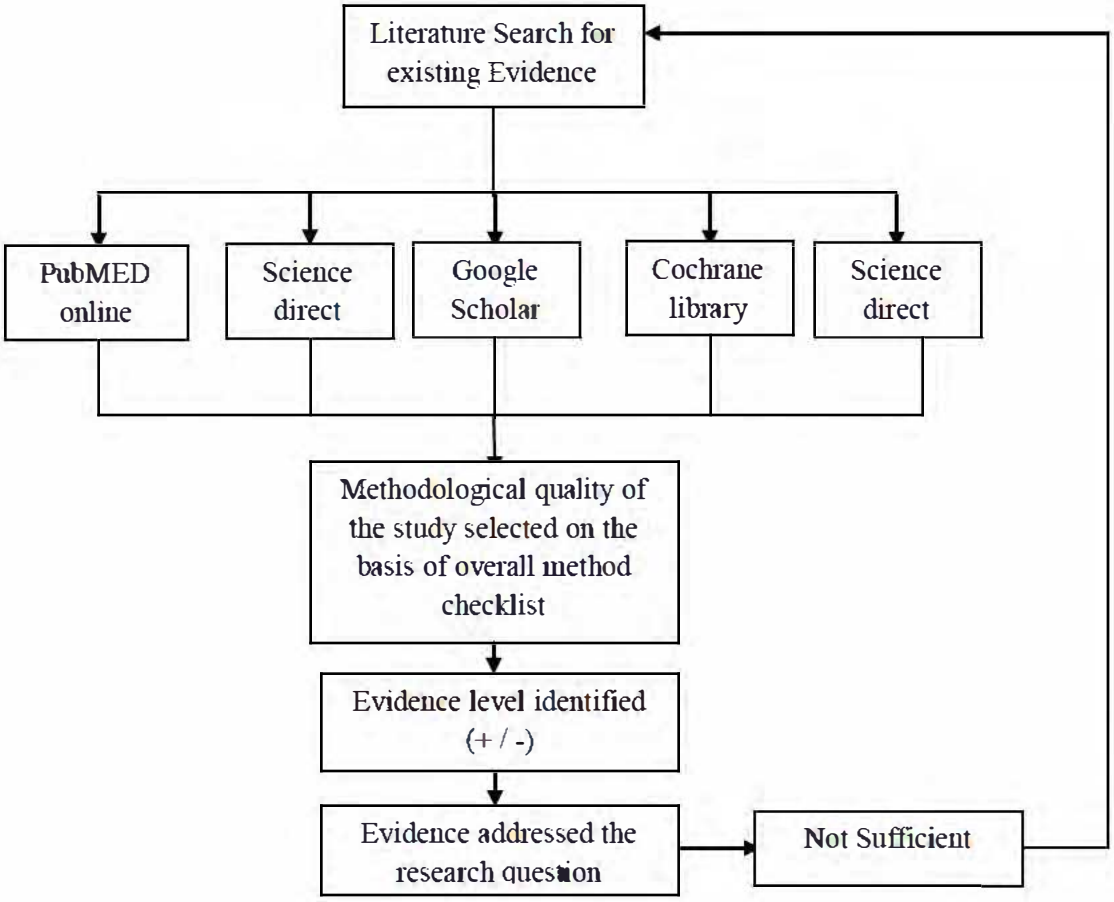

Figure 3.1 Schematic diagram for literature Search Strategy

3.2.2 Study Design

Sample subjects were drawn from the population list of Punjabis in Medway, Kent. Subjects were identified and recruited from two local Gurudwara (Sikh temple), where the local Punjab population often attend cultural and religious events at two different locations in the Medway towns. Of the total attendees at both Sikh temples, a total of 565 adult males aged between 20 and 60 years met the eligibility criteria to participate (n=565) and were recruited using a stratified sampling procedure as follows: Cohort A (Gillingham Gurudwara) n= 325; and cohort B (Rochester Gurudwara) n =240 respectively to form the combined total for the study. From this, a further breakdown of the sample sizes for the three phases of the study are provided in **Figure 3.2** below.

In **Phase I**, a sub-sample of fifty seven eligible adult males aged 20 – 60 years were randomly selected from the sample population (n=565) of whom forty (n=40) agreed to take part. This sub-sample (n=40) was split into five (5) groups of eight (n=8 each) to explore food-related behaviour and related trends, and individual dietary information. This focus group study was important to assess current dietary patterns, cooking and eating habits, e.g. of traditional meals or modified traditional food preparation procedures.

Subjects recruited for the focus group study were automatically excluded from the main study groups in **Phase II** where a total of 225 (out of 525) subjects were randomly selected (Rochester n=113; and Gillingham n=112) for screening for eligibility and selection to participate in the full study. Of this number, one hundred and thirty seven (n=137) were selected for inclusion in the study and eighty eight (n=88) were excluded (Figures 2.2; 2.3). The age distribution of selected participants was as follows: 21-25 (n=6); 26-30 (n=29); 31-35 (n=30); 36-40 (n=31); 41-45 (n=23); 46-50 (n=15); and 51-55 (n=4).

In **Phase II**, the 137 participants were assessed for socio-demographic information, dietary intake analysis (24-Hour Recall, FFQ), physical and physiological measurements (height, weight, hip, waist, SBP, DBP) and physical activity (GPAQ).

In **Phase III**, a sub-sample of n=30 were selected from the main study group (n=137) to participate (Figures 2.2; 2.3). In order to allow a balance in numbers from all age groups, a quasi-random selection process was adopted to allow e.g. for the age group 21-25 to be fairly well represented without introducing unnecessary bias. Dietary intake, physical activity, body composition data and blood pressure measurements were pooled and collated for this sample, as well as biochemical analyses including fasting plasma lipids [total triacylglycerols (TG), total cholesterol (TC), low density lipoprotein-cholesterol (LDL-C) and high density lipoprotein-cholesterol (HDL-C)] and Glucose profiles. The biochemical variables were matched with their respective socio-demographic information, dietary data, physical and physiological (height, weight, hip, waist, SBP, DBP) and physical activity data to determine independent and cumulative risk factors for chronic disease risk in this sample population.

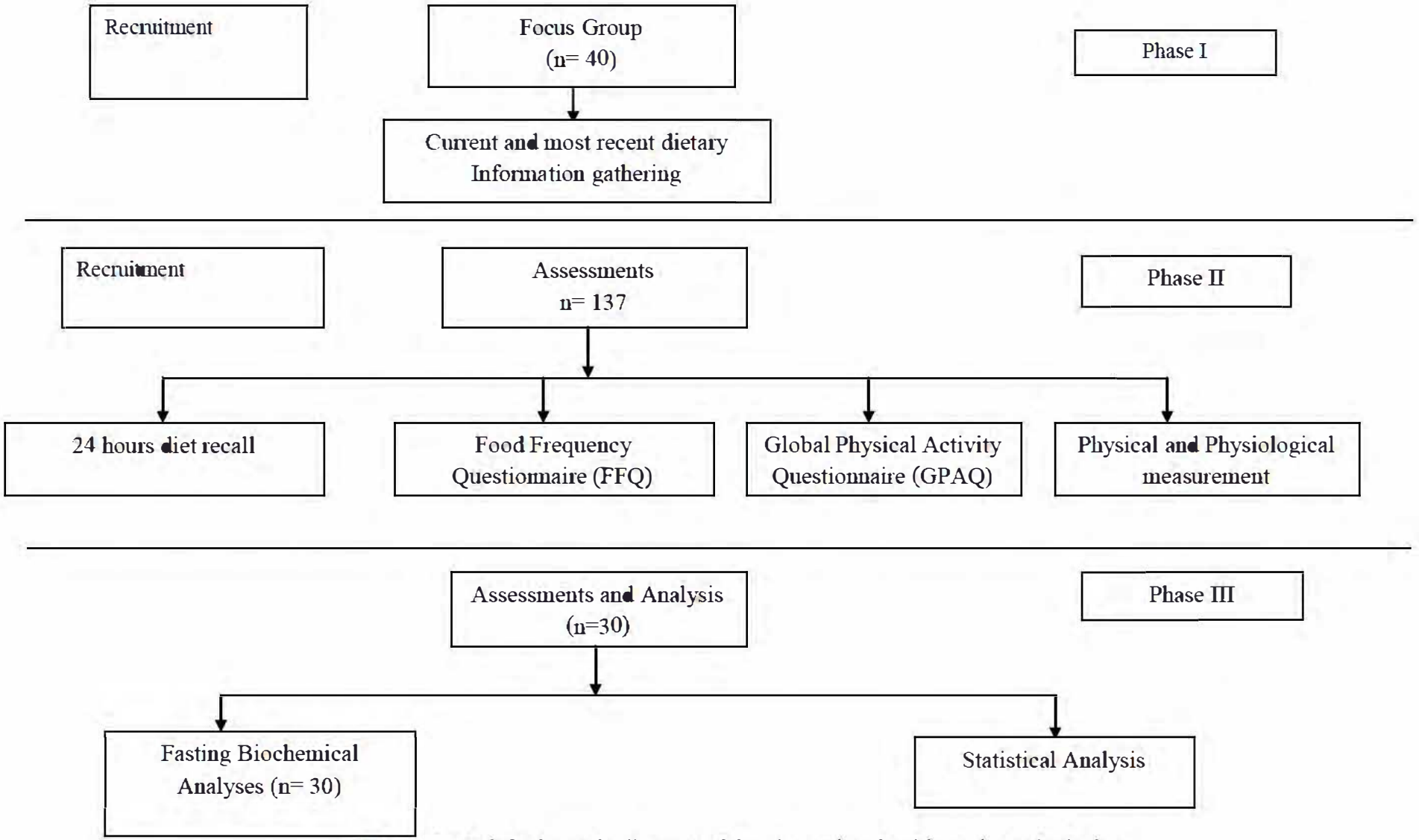

Figure 3.2 Brief schematic diagram of the phases involved in main study design

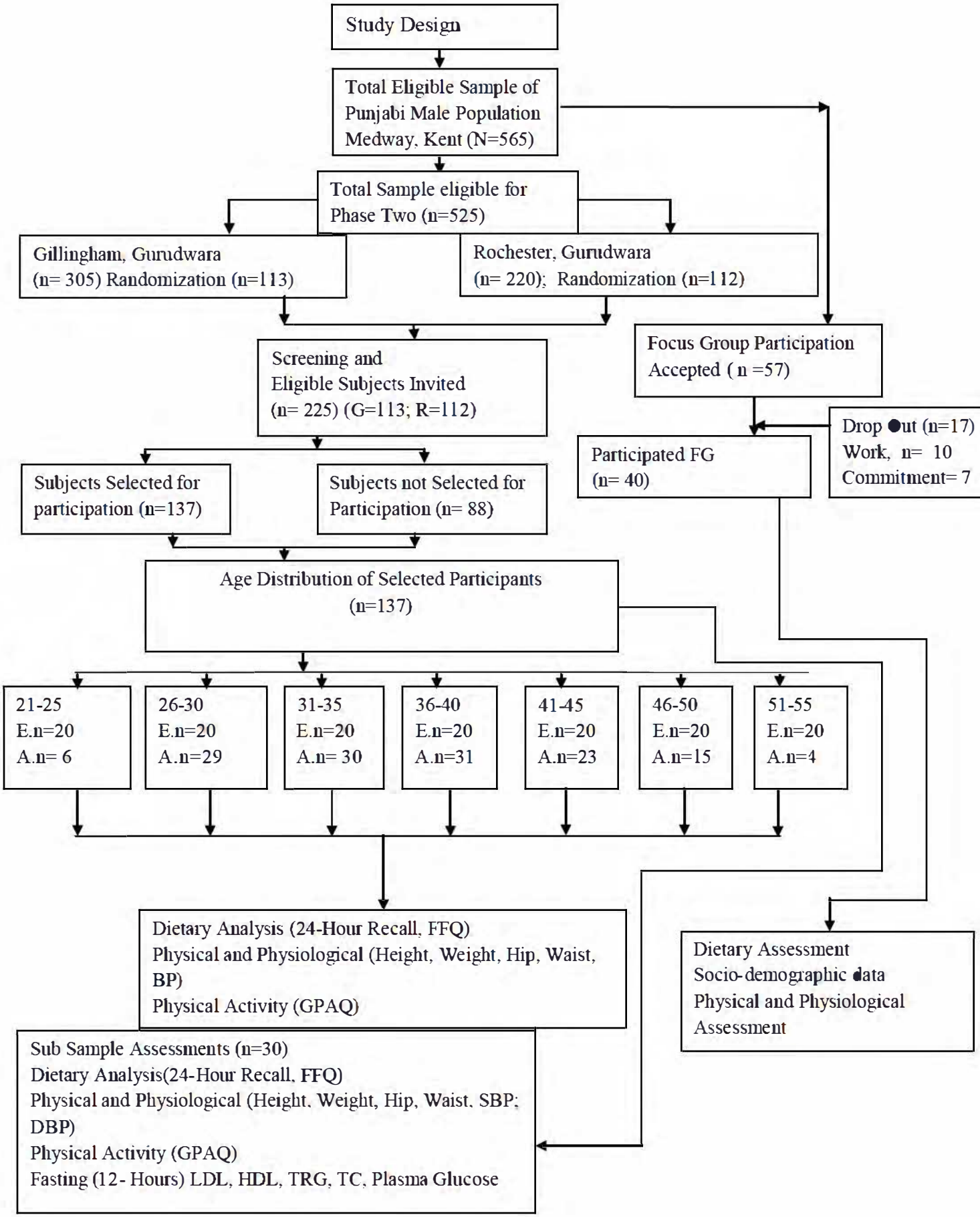

Figure 3.3 Schematic diagram for the main study design and recruitment stages (NB: E n=equal distribution number; A n = actual number of subjects)

3.3 Focus group study design

A focus group approach was used in the first stage of the study to collect sample population-wide data about food-related attitudes, habits, choices, methods of recipe formulation, food preparation and eating behaviours among people of Punjabi origin in Medway.

3.3.1 Type of focus group

The dual moderator approach was used to ensure smooth progression of sessions and to ensure that all the topics were covered. One moderator was from the investigating team and the second moderator was selected from the focus group participants. To avoid any bias, the moderator from the research team played the role of a participant-observer and did not interfere with the discussions except where necessary to help steer the process within the terms of reference.

3.3.2 Focus Group Recruitment and Sampling

Forty (n=40 subjects) participated were recruited at random from Sikh temples in Medway and randomly allocated to five focus groups (n=8 in each group), each with a specific task to explore food-based issues and generate up to 40 recipes per group. Each of the five groups focused one of: cereal-based; legume-based; fish-based; meat and dairy-based and sweets-based recipes. A CONSORT / Flow diagram **(Figure 3.4)** below shows a summary of the sampling process and subject allocation. Each member of the group was free to discuss their opinions which they obtained previously from their family discussion about the recipe and then carried forward with other group members with the end point being a consensus reached by the group about each recipe that was discussed. By this process, data was collected on current and most recent meal consumption, food habits, recipes information as well as cooking procedures. Participants discussed questions about a range of recipes commonly consumed by the Punjabi population

including e.g. rice and cereals, pulses and legumes, fish, sweets, meat and dairy, vegetable and snack recipes. By asking each group to provide information only in one category of foods commonly consumed by the South Asians Punjabi community in Medway, participants were able to focus on specific issues.

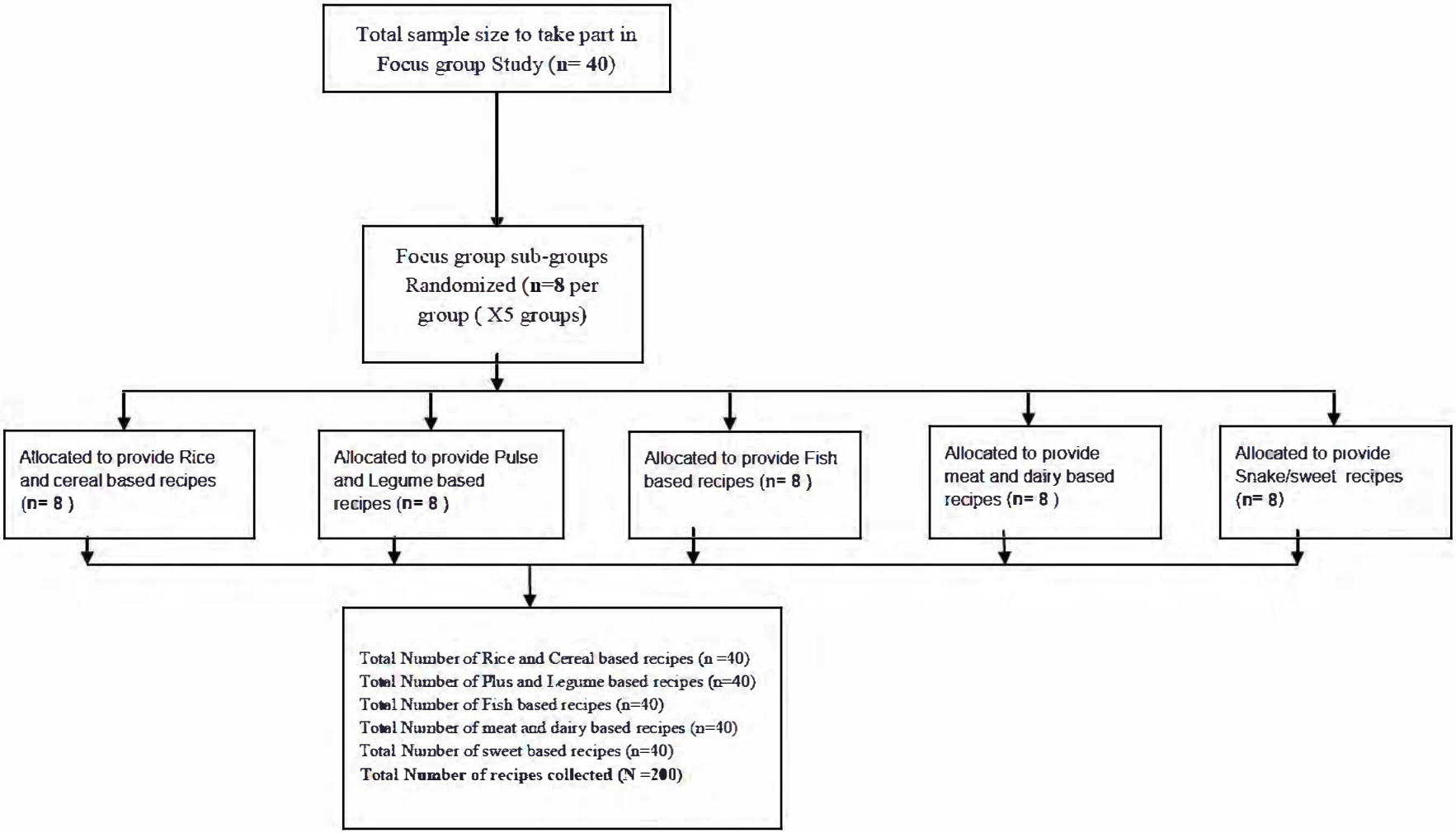

Figure 3.4 A schematic (process flow) diagram for the focus group study showing group allocation

3.3.3 Focus group study exclusion and inclusion criteria

Below is a summary of the criteria for inclusion in the study. Each participant was selected on the basis of following criteria (**Table 3.1**):

Table 3.1: Study inclusion and exclusion criteria

Variables	Inclusion	Exclusion	Remarks
Sex	Male Adults	NA	As long as they can provide us with dietary intake & food preparation information.
Age	N/A	(18-60 years)	Identification of diet commonly consumed by this population.
Health status	Apparently healthy individuals with no disorder/disease and therefore, not on restricted diet	Already diagnosed patients with diabetes and/or other chronic NCD	Must be familiar with traditionally consumed diet
Languages (s)	Must be fluent in Punjabi; Able to communicate in basic English	Non Punjabi-speaking; not able to communicate in basic English	
Lifestyle	Any & no restriction on religion	None	
Medication	Must be declared to be included in study	Individuals on current treatment for known NCDs excluded	
Time in the UK	Either born in the UK or resident for ≥8 years	Less than <8 years in the UK.	This cut off was used on the basis of time-related lifestyle moderation and adjustment with the UK culture
Immigration Status	Permanently Resident	Temporary and Visitor	

3.3.4 Setting and administration of the focus group study

For each focus group, sessions were organised at Sikh Temples in Chatham, Chatham and Rochester where the religious leaders (Granthiji/Mahapursh) had provided facilities including private rooms to support the process. Prior to each session, selected participants were briefed on the nature of the study and what was expected of them. They were also given time and materials to prepare before attending the sessions.

During the 'brainstorming session' on food-related behaviours and recipe formulation, the facilitator in each focus group had a checklist of questions (Appendix 1a) to help guide the discussions and to allow participants to contribute to the debate on foods consumed by the population and their methods of preparation. Each brainstorming session lasted approximately 7 hours (whole day) with breaks in-between. In these sessions, each member of a group was asked to come up with five (5) recipes for discussion and refinement. Thus each focus group was able to compile a recipe pool of 40 recipes for this population giving a total of 5 X 8 X 5 = 200 recipes.

Procedures: Each focus group was guided by a set of pre-prepared questions which were administered by the moderator (facilitator). Each group focused only on one of several 'meal groups' i.e. rice/cereal-based; legume/pulse-based; fish/meat-based etc. Each member of a focus group was (total per group = 8) was asked to provide up to five (5) recipes for the specific meal group. The group then discussed the composition of the recipe and reached a consensus with the help of the moderator. The agreed recipe was then recorded and included in the data set which was collated and later analysed to provide information about food consumption, meal type, patterns and food habits among this sample population. Comparisons were then made between the current meal recipe composition and food preparation methods with secondary data from a previous study nearly 20 years earlier (Judd et al., 2000) among different South Asian communities in London.

3.3.5 Assessment of Individual Food Intake (within focus groups)

24-hour Dietary Recall: Each focus group member was also asked to provide information about their own food intake over the previous 24-hour period via a short interview lasting approximately 20 minutes using a 24-hour dietary recall questionnaire, a description of which is given in **Tables 3.2 and 3.3** below **(Appendix 1b)**. This aspect of the focus group investigation enabled us to inquire about individual current food intake in addition to the information gathered about food habits, meal patterns, food choice and meal preparation methods during the group discussions. The 24-hour recall data was collected in English (although the interviews were conducted in both English and Punjabi). This data was collated and later analysed to provide information about individual energy and nutrient intake among the group. A worked example of how to complete the 24-hr recall form **(Appendix1b)** was provided and the procedures explained to each focus group.

Table 3.2 A sample 24-hours dietary recall form for the South Asian population living in the United Kingdom

Is it a typical day? Yes / No			Participant ID					
	24- Hours dietary recall and recipes collection sheet							
	Please enter today's date here				DD	MM	YYYY	
Are you on a special diet?	Yes	No						
Which day of the week is it? (Please circle)	SAT	SUN		MON	TUE	WED	THU	FRI
Time	Qty eaten (grams, cups, glass) Please Insert S/M/L*		Cup/ Mug/ Bowl Please Insert C/ M/B	Details of Food and drink		Where was it bought from or made		

*A Food portion size booklet was provided with reference weight value

Table 3.3 Instructions for 24-Hour Recall Interviews detailed description of fields[†]

	Description
Details of the Food:	• Detailed description (type, form, brand name) • Amount consumed • Any other foods eaten with it • Time • Occasion for eating (i.e. Breakfast, lunch, dinner) • Food source (where obtained) • Whether food was eaten at home
Information specific to the recall day:	• Day of the week (recall day) • Amount and type of water consumed, including total plain water, tap water, and plain carbonated water • Recall day's consumption amount compared to typical diet
Information specific to a participant's overall diet:	• Added salt: Frequency and type of salt added at the table and when preparing food • Whether on a special diet and type of diet • Recipes formulation information

[†]The above table was adopted from Key Concepts about NHANES dietary data collection (NHANCE, 2013)

3.4 Subject Recruitment for the Main Study

To examine dietary and lifestyle risk factors for chronic disease among recent adult South Asian male migrants in Medway, subjects aged between 18 and 60 years who met the inclusion criteria were recruited following ethical approval and informed consent.

3.4.1 Sampling, Sample size calculation and subject recruitment

In line with the study criteria, apparently normal healthy male adults (aged 20 – 60 years) who met the criteria were to be recruited using a two-stage random sampling procedure. Stage one involved the recruitment of 50 % of subjects from each of two Sikh Temples in Medway. Sample

size needed was calculated based on the use of the following provisions: A statistical power of 90% (i.e. 1 - β =0.9) was sought with a medium effect size ρ = 0.30 and Type I error (α =0.05) with non-centrality parameter δ of 3.28. Using a point biserial model to allow for t-tests and correlation (two tailed), the sample size required was computed as = 109. Allowing for an attrition rate of 25% (based on experience from previous similar population-based studies), the total sample size calculated was 136.25. A total of 138 subjects were therefore recruited to take part in this part of the study.

Calculation method:

Point biserial : A Priori : Sample size calclation

$\rho = ((\mu 1 - \mu 0)\sqrt{(\pi(1 - \pi))})/\sigma x$

where $\sigma x = \sigma + (\mu 1 - \mu 0)2/4$.

The statistical model is the same as that underlying a test for a difference in means μ0 and μ1 in two independent groups. The relation between the effect size $d = (\mu 1 - \mu 0)/\sigma$ used in that test and the point biserial correlation ρ considered here is given by:

$\rho = d/\sqrt{(d2 + (N2/(n1\ n2)))}$

where n1 and n2 denote the sizes of the two groups and N = n1 + n2. The power procedure refers to a t test used to evaluate the null hypothesis that there is no (point-biserial) correlation in the population (ρ = 0). The alternative hypothesis is that the correlation coefficient has a non-zero value r.

Effect size index

The effect size index |ρ| is the absolute value of the correlation coefficient in the population as postulated in the alternative hypothesis. From this definition it follows that $0 \leq |\rho| < 1$. (Cohen, 1969)

Effect size conventions for |ρ|:
small $\rho = 0.1$
medium $\rho = 0.3$
large $\rho = 0.5$
It is worth noting that this sample population excludes all individuals who took part in the focus group study.

Subject recruitment took place in two Sikh Temples in Medway where one hundred and thirty seven (137) subjects were recruited from temples via a simple random procedure involving male subjects within the specified age range (20 – 60 years). A skip method (as applied in systematic random sampling) where every third subject was selected was employed in this study. Following recruitment, subjects were briefed in some detail about the study and what was expected of them. They were allowed to ask questions which were answered by the investigator. They were also allowed time to study the subject information and to decide if they wanted to take part. Subjects then provided informed consent by signing the relevant part of the Consent Form (**Appendix1c**).

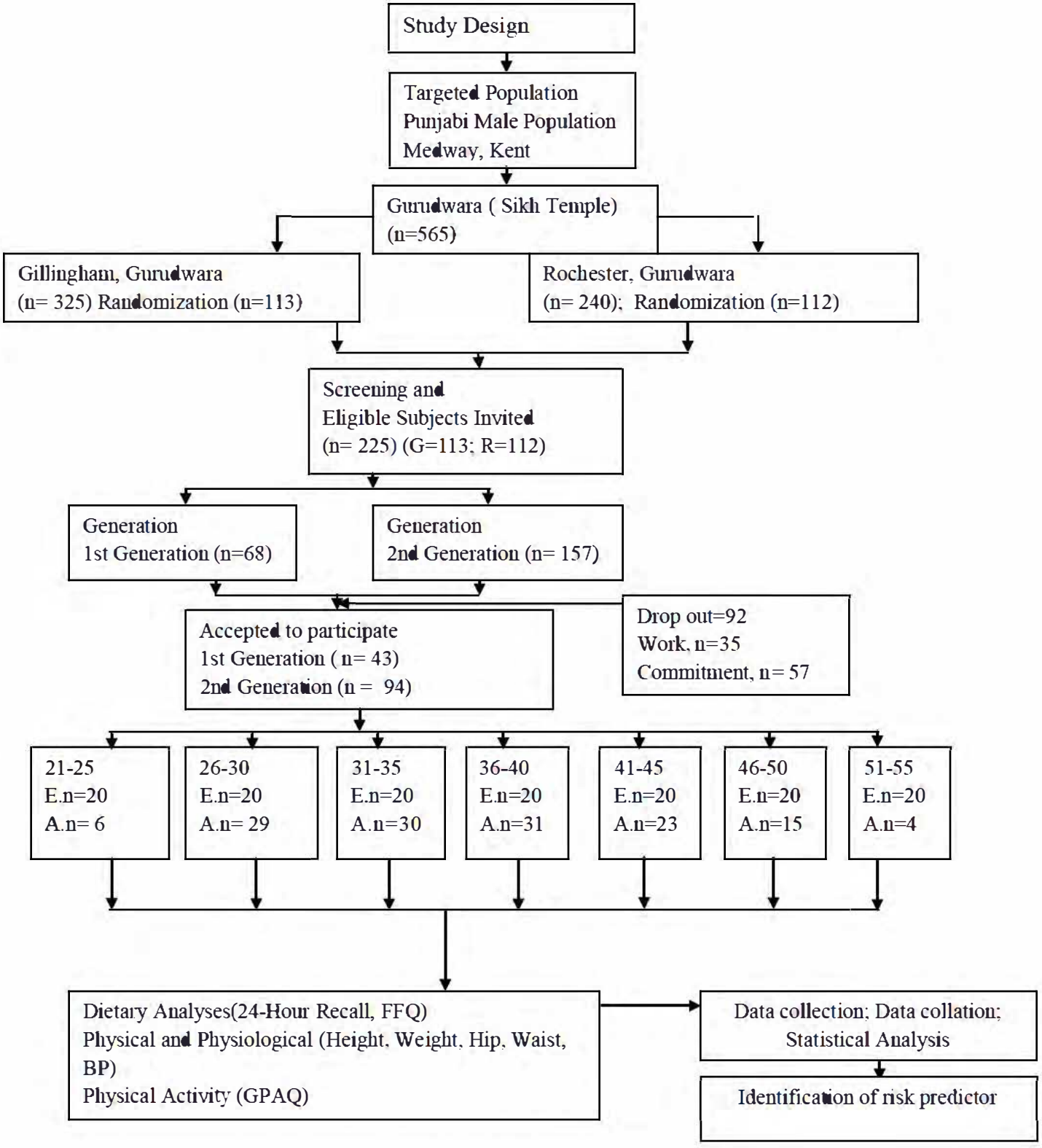

Figure 3.5 Schematic diagram for main study procedure

3.4.2 Study Procedures for individuals

The following information was collected and procedures were carried out in each subject:

- Socio-demographic information
- Dietary intake data (repeat 24-hour recall and food frequency questionnaire)
- Self-reported physical activity measurements (GPAQ Questionnaire)
- Physical measurements (anthropometry)
- Physiological measurements (systolic and diastolic blood pressure)
- Biochemical measurements

3.4.3 Socio-demographic data collection

Using a standard previously validated socio-demographic questionnaire (Bull, 2009) attached to the 24-hour recall form (**Appendix 1d**), information about: age, marital status, occupation , monthly household income and migration generation i.e. whether first or second generation migrant were collected for the purposes of this study. Information about family size was not included in this study, nor was any information about spouse or children. Occupational status was divided into seven different categories which reflect the Social occupational classification used in the United Kingdom i.e. from manual less skilled through skilled, technical and professional groups. Such data was later matched with types, levels and frequency of physical activity.

Key Information Required:

The following general information were collected:

1) Date of Birth

2) Household earning

3) Occupation status

4) Marital status

Data Collection Procedure

1) Subjects were given clear instructions on the contents of the socio-demographic information form.

2) Instructions on how to complete the form was also given.

3) Each completed form was checked and individuals were interviewed to check that each field on the form had been filled correctly.

Data Entry Procedure

Data were coded according to Participant ID was assigned at the point of sampling and subjects were given participant ID.

3.4.4 Assessment of individual dietary intake

A. Dietary intake assessment via 24-Hour Recall. Recent dietary intake was measured using 24-hour dietary recall technique (as previously described under focus groups; **Tables 3.2; 3.3**) above. The procedure involved a 20 minute interview in English with Punjabi translation where required. However the latter situation occurred in very few instances. Subjects were asked to recall all food, drink and snacks consumed in the previous 24 hours to the time of the interview including the amounts taken. Where known, labels on packaged food products and snacks consumed and information about actual quantities was obtained from packs to help with accuracy of the data. Standard food portion size reference models (FSA, 2002) were used to help subjects recall accurately their intake and where there were left-over's, subjects estimated amounts consumed.

Repeat 24-hour dietary intake data was collected several times throughout the study (a total of three (3) times per subject). This was to enable individual variations in intake over time to be assessed and to test the repeatability of this method in allowing accurate collection of dietary intake data.

Food intake information from 24-hr recalls was analysed for nutrient content using standard nutritional analysis software (Dietplan 6.2 **Forestfield Software Ltd, Sussex,UK**). This nutrient analysis software allows for estimation of energy and nutrient content of the diet including the different components of energy, dietary non-starch polysaccharides (NSP; dietary fibre), vitamins and minerals.

It is also noteworthy that in addition to food, snack, drink and non-alcoholic beverage intake, in this study subjects were also specifically asked about alcohol intake to enable a better capture of total energy intake (to include the contribution of alcohol) as well as ascertain individual lifestyle behaviours which may have implications for the nutrition transition and risk of chronic disease.

Key Information Required

In general the following information was elicited from subjects:

1) What type of food and drink was consumed?

2) The amount of food consumed (quantity)?

3) How much extrinsic sugar and salt was added to the food?

Data Collection Procedure

1) Subjects were given clear instruction about the 24-hours dietary information collection .

2) Subjects were interviewed (approximately 20 minutes) to collect dietary information and this was performed in three different occasions.

3) Probing questions were asked during 24 hours recall.

4) FSA standard Portion size booklet was used for the portion size estimation.

Data Entry Procedures

1) Data were coded according to participant ID which was assigned at the beginning when sampling was done and subjects were given participant ID.

2) Diet Plan 6.2 was used to encode each participant's data with participant ID number for anonymity.

3) Data from Diet Plan 6 were exported to Microsoft Excel for data cleaning and analysis.

B. Dietary intake and food habits via Food frequency Questionnaire (FFQ)

To understand food choices, habits and patterns of food consumption over time, a modified semi-quantitative food frequency questionnaire was designed from a previously validated FFQ used in the European Prospective Intervention on Cancer (EPIC) (Romieu, et, al., 2012). This FFQ was modified and the new list included specific foods, drinks, snacks and recipes commonly consumed by the Punjabi community of the South Asian population in the UK (**Appendix 2**). The questionnaire included a variety of items ranging from staple foods to snacks, cakes and sweets. Columns were provided for subjects to enter the amounts eaten (using the Food Portion Sizes guide) and the frequency of consumption (number of times per day, per week, per month or seldom). A food portion booklet was used to determine the amounts consumed (Crawley, 1994).

The FFQ data was collated and transformed to enable analysis of daily intakes. The data also learnt itself to studying individual variations in food intake, differences in food related behaviour, food choices and age-related differences in food choice, intake and pattern of behaviour.

Subjects were also asked to provide information about intake of alcoholic beverages (including spirits) including amounts, types, frequency of consumption and the social contexts. Food frequency (FFQ) data was subsequently analysed for nutrient content using the Dietplan 6.2 (Foresoft, UK))Nutrition analysis Software.

3.4.5 Global Physical Activity Questionnaire (GPAQ)

To quantify physical activity among the subjects, an ***indirect*** method of physical activity measurement was employed. The Global Physical Activity Questionnaire (GPAQ) developed by the World Health Organisation (WHO, 2012) for physical activity surveillance among populations was employed. This is a previously validated (Bull, et al., 2009) and universal tool used to collect information on individual physical activity and enables national, regional and global comparisons to be made. The ***domains of physical activity*** on the GPAQ questionnaire include: occupational, transport (to and fro) and recreational activity. There are in all ***sixteen questions*** covering these three main domains **(Appendix 3)**. Physical activity data so collected is converted into ***MET equivalents*** where 1 MET equals the energy cost of sitting quietly without much activity i.e. a completely sedentary scenario. This can further be quantified as equivalent to the consumption of **1 kcal/kg/hr**.

Procedures: each subject was interviewed using the GPAQ and asked all sixteen questions under the three domains. Each interview lasted approximately 20 minutes and was conducted in English with Punjabi translation where required. Interviews took place in a quiet room provided at the Temple where subjects were invited for the study and were done in confidence.

Physical activity questionnaires were repeated (maximum of three per individual) to allow an examination of reproducibility of the instrument and any trends or changes in physical activity among subjects over time.

Data collected was collated and transformed to allow conversion of 24-hour physical activity data into MET equivalents and to quantify the energy costs of daily individual activities in k cal/day with a breakdown into kcal/kg/day. GPAQ data was also used to categorise subjects into different levels of physical activity i.e. **Low, Moderate** and **High** activity groups respectively. The data also enabled a distinction between the contributions of occupational and recreational physical activity as well as age-related differences in levels of physical activity.

3.4.6 Physical and physiological measurements

All anthropometric measurements were taken using standard procedures similar to the approach used in the US National Health and Nutrition Examination Survey III (NHANES III; 2012). All measurements were taken by trained individuals throughout the study.

Weight Measurement: Weights were measured using a standard electronic weighing balance (Seca Model 770; Vogel & Halke, Germany). Measurements of weight were taken in kilograms (kg). The instrument measures to within ±100 g. Measurements took place in a quiet private room provided at the Temple and subjects were measured with minimal clothing. Subjects were given prior instructions including the type of attire to wear for measurements (light shorts and vest). Measurements were taken in the morning when subjects attended for the study, before they had their breakfast. Each weight measurement was taken three times and the average of two concordant readings recorded as the weight of the individual in kilograms.

Height Measurements: A standard Seca stadiometer calibrated and attached to the Seca weighing balance (Model 770) was used to measure height. Height was measured with the subject barefoot and without wearing a hat or any form of head gear. Subjects stood in the anatomical position (i.e. standing straight at attention with arms by the side, thumbs facing outwards and the feet together at a $45^{'}$ angle and asked to focus straight on at an imaginary object). Heights were measured in centimetres (metres) and to the nearest 0.2 cm. Each height measurement was repeated twice and the average of two concordant readings recorded as the height of the individual. The weight and height data collated was later used to compute the body mass index (**BMI**) in kgm^{-2}.

Girth measurements: The waist and hip circumferences were measured using a standard anthropometric flexible measuring tape which measures to within 0.2 cm. The landmark for waist measurement was taken from a point marked mid-way between the umbilicus and the edge of the xiphisternum i.e. representing the 'narrowest part' of the upper body (abdomen). Each measurement was repeated twice and the average of two readings taken as the waist circumference. The hip i.e. the 'widest part' of the lower body was measured by wrapping the anthropometric tape around the hip using the right and left greater trochanters as landmarks / reference points. Each measurement was taken three times and the average of two concordant readings recorded as the hip circumference in centimetres.

Physiological (Blood Pressure) Measurements

Blood pressure(BP) was measured using a standard manual sphygmomanometer (Yamasu, Model MS001, Japan**)** by a trained individual. BP measurements were taken at set times in the morning when the subjects attended the Temple for the study. Subjects were made to relax in a quiet room and then when they were settled, the investigator prepared them and wrapped the cuff of the sphygmomanometer around their right arm, then inflated the cuff until the pressure reached 200 mm Hg and the cuff valve firmly shut. With a Litmann II Classic stethoscope (3M, USA) plugged into the ear, the diaphragm was placed in the ante-cubital fossa and the BP cuff valve slowly released to allow the gentle lowering of the pressure in the cuff whilst listening for the first Korotkow sound (i.e. at the instant of the systolic blood pressure, SBP), followed by the second sound (at the point of the diastolic pressure, DBP) at which point a muffled sound was heard. This procedure was repeated twice and the average of two concordant readings recorded as the SBP and DBP of the individual.

3.5 Biochemical measurements of nutritional status

For Phase III of the study, finger prick blood samples were collected in special heparinised capillary tubes in a sub-sample (n=30) of the study group in order to undertake further in-depth analysis of biochemical variables / markers (lipids and glucose) of risk of chronic disease.

Procedure: 30 subjects selected at random (following ethical approval) were invited and agreed to take part in this part of the study. They were asked to attend the exercise physiology / Sports science laboratories on the Medway campus of the University of Greenwich in the morning, after an overnight fast (12 hours post-prandial) and before they had had their breakfast. Fasting samples of capillary blood (40 μl) were collected using a sharp lancet to pierce the pulp of the thumb after wiping the area with antiseptic (alcohol wipes) and massaging the area for blood capillaries to fill up. The capillary blood collection was aided by gravity and each heparinised capillary tube was filled to the required mark to ensure that there was sufficient blood sample to allow accurate detection of the presence of biochemical markers by the instrument (LDX Cholestech Instrument, Alere, USA). The instrument was first calibrated, first thing in the morning using a test cassette and the calibration repeated after every five tests to ensure consistency in the readings.

Blood glucose Measurement: the fresh capillary blood sample collected from the subject was prepared and then injected into an appropriate cassette well, a multi marker cassette (Lipid; GLU; ALT-AST cassette) which operates via a spectrophotometric method. Readings of blood glucose concentration were recorded on the screen of the Alere Cholestech – LDX instrument (Alere, USA) and a printout saved for data collation. Readings of blood glucose took approximately 5 minutes to be completed from the machine and these were recorded on each occasion. Each individual's samples were tested twice for reproducibility.

Serum Lipid Profile: Similarly blood lipids (total triacylglycerols, total cholesterol and fractions – LDL; HDL) were measured using the Alere Cholestech instrument. The procedure for blood collection and preparation for measurement was similar to that of serum glucose described above and the same instrument provided all these results. Measurement of total cholesterol (TC), a measure of the total amount of cholesterol in the blood, high density lipoprotein (HDL) cholesterol, and triglycerides or TRG. The instrument also calculates the TC/HDL ratio, non-HDL cholesterol, and estimates the level of LDL cholesterol. Utilizes a fasting lipid panel – a total cholesterol (TC), HDL-C and triglyceride (TRG) are measured – to obtain a calculated LDL-C.

Friedewald formula as follows:

LDL-C = TC – HDL-C – (TRG/5)

The fasting triglyceride value is divided by 5 to estimate VLDL-C levels. This model is based on the fact that most of the circulating triglyceride is carried by VLDL, the composition of which is relatively constant. The Friedewald formula is valid when triglycerides are below 400 mg/dL or 4.51 mmol/L.

3.6 Methods of data collection, collation and statistical analysis

3.6.1 Socio-demographic Data: These data were mainly qualitative, collected and collated for all subjects in the main study to provide baseline information and enable social status classification as well as age distribution, education, and from which first and second generation migrants could be distinguished. Grouping of subjects into social / occupational / income groups was done using standard descriptive statistical methods and these have been presented in relevant tables and figures in the results chapters.

3.6.2 Food Consumption Data: Data collected from the focus groups on foods, food choices, consumption and recipes were grouped and analysed to allow identification of all the food groups from which this sample population obtain their daily diet. This has enabled tables and figures to be developed showing the population's most common food sources, methods of preparation of foods and patterns of consumption.

3.6.3 Nutrient composition of food intake: Both from the Focus Groups and individual 24-hour recall data collected, it has been possible to undertake nutrient analysis to show the daily energy and nutrient intakes. This has enabled the use of descriptive statistics to calculate mean and median values of energy, macronutrient, mineral and vitamin intake as well as intake of alcoholic beverages among the group. These nutrient intake values have also been compared with dietary recommendations i.e. UK estimated average requirements (EAR), reference nutrient intake (RNI) and the lower reference nutrient intake (LRNI). Nutrient intake has also been stratified according to age groups and occupational groups and these have been displayed in tables and figures in the results chapter. In addition to descriptive statistics, Pearson's correlation coefficient of determination has been applied in inferential statistics to make comparisons within and between these groups and to assess the pattern of intakes among the whole group e.g. in relation to body mass index.

3.6.4 Anthropometric data: including BMI, waist circumference (WC) and the waist-hip ratio (WHR) have been grouped as means, (SD; SEM) and median values to enable further statistical comparisons including correlation coefficients and tests of association. These are reported in the results section.

3.6.5 Energy balance comparisons: Energy intake data collected was compared with the daily energy expenditure data estimated from the physical activity (GPAQ) survey. Energy expenditure data was transformed into METs equivalents using GPAQ MET-Minutes calculation (Bull, 2009) and then into kcal per day and kcal/kg/d) values to enable correlations to be drawn

between intake and expenditure. Furthermore data calculated on physical activity levels was incorporated into the calculation of total daily energy expenditure (TDEE) employing WHO and the Schofield equation for the basal (resting) metabolic rate (Schofield, 1985). This approach was to help establish whether the subjects were in positive or negative energy balance.

Positive energy balance i.e. excess intake over expenditure could also be quantified e.g. as storage energy in the form of excess body fat. Positive energy balance is a known risk factor for weight gain, overweight (OW) and obesity (OB) (e.g. as measured by proxy in the form of the BMI and / or abdominal adiposity measured by the waist circumference (WC), are known independent risk factors for chronic disease.

Example: Energy Balance = Total Energy Intake (EI) - Total Energy Expenditure (TEE)

Calculation of Total Energy Expenditure (TEE) (Schofield, 1985):

TEE = PAL X BMR [PAL = Physical Activity Level ; BMR = Basal Metabolic Rate]

Table 3.4 Basal Metabolic Rate male equation

Age (Years)	**Male Equation (BMR)**
18-30	15.057kg + 692.2
31-60	11.472kg + 873.1

Table 3.5 Physical Activity Level (PAL calculation)

Activity Type	**Time Allocation (hours)**	**Energy Cost (PAR)**	**Time X Energy Cost**	**Mean PAL**
Sedentary or light activity lifestyle				
Sleeping	8	1	8	
Sitting (office work, selling produce, tending shop)	8	1.5	12	
General household work	1	2.8	2.8	
Walking at varying paces without a load	1	3.2	3.2	26/24= 1.08

If a male subject is 25 years old with a body weight of 63 Kg and PAL of 1.08 then that person's energy expenditure will be:

TEE = [1.08] X [15.057 * 63(kg) + 692]

Therefore, TEE = 1771.83 Kcal / day

3.6.6 Regression modelling

The biochemical (outcome) variables measured were matched with predictive risk factor variables and subjected to multi-factorial analysis of variance and the development of a chronic disease risk model using multiple linear regression analysis. The outcome to establish diet, lifestyle, body composition and disease relationships and for disease risk factor profile modelling to be developed for this population was prefered.

3.7 Statistical Analysis

The data collected throughout the study were collated, grouped and presented in the form of tables in Excel and SPSS databases created for further data analysis. The Statistical Package for Social Sciences (SPSS, Version 20) for windows and Microsoft Excel software were used as tools for all statistical analysis. All variables were tested for normality distribution with a Kolmogrov-Smirnov Goodness of fit test. Descriptive statistics were performed and more specific significance testing using student t-test (both paired independent) were employed. Z-tests were conducted to test the significance of observed differences between the 1st generation and 2nd generation parameters. Pearson's Moment correlation analysis (and for non-parametric data, Spearman's rho) was employed to ascertain strengths of association between variables and multiple liner regression analysis employed to estimate the relationships between and among the group variables. Specific tests as applied are described under the relevant sections. Results of quantitative analyses obtained are presented as means, standard deviation with their 95%

confidence intervals. Intergenerational differences in means of variables and their respective 95% CIs were also computed. Differences of means compared using the Z-test, were considered to be statistically significant at p values of ≤ 0.05.

3.8 Ethical considerations

This study involved human subjects and there were both intrusive and invasive procedures involved. All subjects recruited were apparently healthy normal adults between the ages of 20 and 60 years. Subjects were not hospital patients and all provided informed consent prior to recruitment and inclusion in the study once they met the study criteria. First, ethical permission was sought and obtained for both the Focus Group and main individual subject parts of the study (Phases One and Two) (REC Reference: UREC/10/11.4.5.2); and a second ethical permission was applied for and approval granted to enable the biochemical (blood) analyses to take place (REC Reference: UREC/12.2.5.11) by the University of Greenwich Research Ethics Committee (UREC) for all aspects of the study.

Permission and cooperation was also granted by the leaders (Granti-Ji) at two Sikh temples in Medway, Kent including private, secure space for subjects to be interviewed and for measurements for which we are greatly indebted and grateful. All data collected was handled anonymously and kept in strict confidence under lock and key by the researcher and all electronic data kept in a password-protected folder on the researcher's computer. At no time was any data disclosed to any individual nor was any measurement taken in the view of others.

Chapter 4: Focus Group Study Results

4.0 Introduction

The focus group study was carried out to provide an insight into food habits, choices and dietary practices among an adult healthy male Punjabi migrant population in Medway, Kent. The results presented here cover a number of areas including demographic information, dietary behaviours and food-based practices. This approach has helped to explore relationships between potential environmental and personal mediators and exposure factors in a homogenous group such as culture, lifestyles, beliefs and practices which may enhance or hinder health and well being among this population, including risk of chronic disease.

4.1 Demographic Characteristics of the Focus Group

Of the total 40 subjects who took part in the focus group study, 11 (27.5%) were first generation migrants with a minimum UK residency of at least 8 years and 29 (72.5%) were second generation, born in the UK or migrated with parents as infants or young children. The second generation tended to be younger. There was a fairly even age distribution (4 – 7 people) in each age group ranging between 21 and 55 years of whom 29 (72.5%) were married (Table 4.1). Annual household income varied between £9500.00 p/a and >£50,000.00 pa with the median range of (19/40; 47.5%) earning between £15,500.00 and £19,999. Another 25% (10/40) earn between £20,000.00 and £25,999.00 p/a. Occupations varied between manual labour (n=14; 35%) and the service industry (n=26; 65%) with jobs ranging from office/administrative, own business (e.g. shops, developers/builders) to the professions. This occupational split of 65:35 for service v. manual labour is in sharp contrast to the 30:70 split which has been reported for people living in the Punjab in India from recent Indian national Demographic and Health Survey data

(Karla and Unnikrishnan, 2012). In relation to educational attainment, 5 (12.5%) focus group participants had attained up to High School Certificates or less; the majority (n=22; 55%) had vocational qualifications and 13 of them (32.5%) had college / University level qualifications.

Lifestyle factors examined include smoking and alcohol consumption. Seventeen focus group members (42.5%) both smoke and regularly consume alcohol; 7 (17.5%) subjects do not take alcohol at all and 21 subjects (52.5%) were non-smokers. Of the 19 (47.5%) smokers in the focus groups, 11 (27.5%) reported being "chain smokers". Of the 33 (82.5%) subjects who drink alcohol, 7 (17.5%) characterised themselves as "occasional drinkers"; 17 of them (42.5% of total subjects) were "light, infrequent drinkers"; 5 (12.5%) were "moderate drinkers" and only 2 subjects (5%) characterised themselves as "heavy drinkers".

Measurement of **physical characteristics** of the focus group showed that 67.5% (n=27) were in the Overweight (OW) category using the universal (WHO) BMI cut-offs (BMI 25-29.9 kgm^{-2}) with another 15% (n=6) with BMI in the Obese (OB) category (BMI $\geq$30kgm^{-2}) and the rest (7; 17.5%) were in Normal category (BMI <25kgm^{-2}) (Figure 4.1). This gives an overall OW + OB total of 82.5% (n=33) of the 40 subjects.

Table 4.1 Shows the distribution of subjects according to socio-demographic characteristics. Socio-demographic characteristics of the focus group study (n = 40)

Variables	Subjects (n=40)	Variables	Subjects (n= 40)	Variables	Subjects (n=40)	Variables	Subjects (n=40)	Variable	Subjects (n=40)	Variable	Subjects (n=40)
Age(yrs)		**Marital Status**		**Annual household income (£)**		**Occupation (n=40)**		**BMI (Kg/m^2)**		**Generation**	
21-25	5	Never married	11	<9,499	0	Retired/Not Working	0	Normal (<25)	7		
26-30	6	Married	29	9,500-15,499	2	Business	11	Overweight (25-29.9)	27	1st Generation	11
31-35	6	Divorced	0	15,500-19,999	19	Administrative	4	Obese (≥30)	6	2nd Generation	29
36-40	7	**Education**		20,000-25,999	10	Military/ Police	0	**Smoking**		**Alcohol**	
41-45	5	SSC / O-Level	3	26,000-39,999	4	Builder Developer	6	Smoker	19	Occasional	7
46-50	7	HSC / A-Level	2	40,000-49,999	3	Professional	5	Non-Smoker	21	Infrequent light	12
51-55	4	Graduate / Post Graduate (i.e. BSc, MSc)	13	>50,000	2	Manual labour	14	Chain Smoker	11 (>10 cigarette)	Frequent Light	7
		Vocational (HND, HNC, BTEC, Electrician, Building, Plumbing)	22			**Smoke and Alcohol consumer**	17	Casual Smoker	8 (< 9 cigarette)	Moderate	5
										Heavier	2
										No Alcohol	7

4.2 Distribution of most common food sources, groups, recipes, meal composition and macronutrient sources in the daily diet

The most common carbohydrate sources include: wheat, potatoes and rice, with the occasional use of corn or mixed flours to prepare chapattis. Extrinsic sugar is often added to foods and although a variety of mixed vegetable curries are used, they are not a major source of carbohydrate except non-starch polysaccharides (NSPs) of dietary fibre. Dairy sources of sugar are mainly from milk.

Protein sources in this sample population include animal sources of meat and poultry – particularly lamb, mutton and chicken, minced meat and eggs. Plant sources of protein include mainly legumes – chickpeas and lentils (dhal) e.g. Channa Rajma, Masoor. Milk protein is another source since milk is commonly consumed. However it is notable that cheese (except paneer) and other dairy products do not form part of the main diet of this population.

Fat sources are mostly purified butter (ghee), vegetable oils, paneer (cheese), lamb, chicken and milk. These fat sources are used in combination in meals.

Vegetable sources include a variety of Punjabi mixed vegetables presented in the form of curries – e.g. spinach + potato curry, aubergine (± potato) curry, potato + onion/green pepper + tomato curry cooked with spices and oil.

Most common meat-based diets include – meat curries (lamb, chicken, mutton), meat chops e.g. lamb, mutton; and minced meat (keema). Diets made from pulses / legumes are a common feature including masoor dhal (with masoor + onion) of different varieties and thickness, including low-fat options; mixed dhal (e.g. masoor + mung + channa). Common cereal-based recipes include a variety of Punjab pilau e.g. meat pilau, peas pilau, mixed-vegetables pilau as well as chicken biryani, parathas and methi parathas. All these recipes have their low fat alternatives.

Sample tables showing the commonly eaten food sources, groups and recipes are displayed in Tables 4.2.

Sample meals for breakfast, lunch and dinner were also presented by the focus group and the information collated and presented in Tables 4.3 – 4.9. For example, a typical breakfast recipe (Table 4.7) will include: chapatti (wheat/carbohydrate/staple source), ghee (butter/fat source), chicken curry (protein source) with potato, milk and extrinsic sugar. The typical total weight of a recipe is 468 g providing on average 35 g protein, 26 g total fat (SFA=8.66 g; MUFA=11.55 g; PUFA=6.04 g); total cholesterol 46 mg, carbohydrate content of 70 g, total energy of 656 kcal, percentage fat of 36% and a fibre content of 2.39 g.

Similarly, a typical lunch recipe (Table 4.8) will include: chapatti and rice (wheat/carbohydrate/staple source), ghee (butter/fat source), mixed vegetable, chicken curry (protein source) with potato, masoor-morng dhal and papadum (a lentil-based fried product similar to prawn crackers). The typical total weight of a cooked meal recipe is 680 g providing on average 49 g protein, 69 g total fat (SFA=22.6 g; MUFA=30.13 g; PUFA=15.75 g); carbohydrate content of 191 g, total energy of 1576 kcal, percentage fat of 49%, total cholesterol 124 mg and a fibre content of 8.14 g.

A typical dinner / supper recipe (Table 4.9) will include: paratha (carbohydrate/staple source), ghee (butter/fat source), mixed vegetable, lamb curry (protein source), and Punjab mixed vegetable dhal (a lentil-based product). The typical total weight of the this cooked meal recipe is 660 g providing on average 62 g protein, 79 g total fat (SFA=25.9 g; MUFA=34.53 g; PUFA=18.05 g); carbohydrate content of 140 g, total energy of 1512 kcal, percentage fat of 47%, total cholesterol 239 mg and a fibre content of 3.29 g.

A computation of the energy and macronutrient content of a typical breakfast, lunch and dinner provides a daily average of 2744 kcal energy, 183 g fat (contributing an average of 44% of daily

energy intake), 401 g carbohydrate, 146 g of protein, 409 mg total dietary cholesterol, 57 g saturated fatty acids (SFA), 77 g MUFA and 40 g PUFA.

From this information provided by the focus groups, it would appear that 44% of daily energy in this population is derived from dietary fats, with purified butter (ghee), animal fats and vegetable oils being major contributors. The animal source fats is also reflected in the amount of saturated fatty acid (57 g) in the diet. Protein intake is 146 g / day, in excess of the recommended 0.8 g / kg body weight for an average adult male of 70 kg body weight (56 g / day). The total daily energy content of the diet (2744 kcal / day) is also above the average recommended daily intake of 2550 kcal for men / day) and fibre content of the diet is 13.82 g, a value far below the estimated average requirement (UK EAR) of 18 g / day. This is far lower than the reference nutrient intake (RNI) of 24 g / day (UK) and 30 g / day (India) (NIN,2011).

These recipes although containing some vegetables, actually provide far less of the amounts recommended 400 g equivalent portions per day of fruits and vegetables. There is a distinct lack of fruits in the recipes and thus provides an opportunity to explore consumption of fruits and vegetables using either a 24-Hour Recall or Food Frequency Questionnaire (FFQ). These findings from the focus groups suggest a high fat, high protein, high energy, low fibre dietary pattern in this population, with low fruit and vegetable consumption. There is also a heavy reliance on animal source fats and proteins.

Table 4.2 Distribution of Food composition in daily diet according to most common sources of macro nutrients in each meal

Sources	Breakfast					Lunch					Dinner				
	CHO	PRO		FAT	Fibre	CHO	PRO		Fat	Fibre	CHO	PRO		Fat	Fibre
		Plant	Animal				Plant	Animal				Plant	Animal		
Cereals	Wheat (67.65%)/ Plain Flour (90%)				Wheat (46.61)%	Wheat (58%) Rice (29%)				Wheat 34.88%	Wheat (90%) / Corn flour (90%) Plain Flour (90%) /Rice (90%)				Wheat (48%) Corn flour (45%)
	Sugar (7.26%)														
Vegetable	Potato (17.44%)				Mixed Veg (54.20%)	Potato (25%)					Potato (25%)				
Meat / Poultry			Chicken (52.31%)	Chicken (15.12%)				Chicken (33%)	Chicken (11.53%)				Chicken (60.56%)	Chicken (10%)	
			Lamb (42.45%) Egg (34.27%)	Lamb (32.68%)				Lamb (27.42%)	Lamb (33.37%)				Lamb (54%)	Lamb (32%)	
Pulses / Legumes							Channa / Rajma (25.24%)			Chickpeas (47%)/ Rajma/ 57%		Chana / (5.80%) Rajma (3.16%)			Chickpeas (48%)/ Rajma/ 67%
							Masoor (35.03%)					Masoor (23%)			
Dairy Products															

Table 4.2 Distribution of Food composition in daily diet according to most common sources of macro nutrient content(cont.)

Sources	Breakfast					Lunch					Dinner				
	CHO	PRO		FAT	Fibre	CHO	PRO		Fat	Fibre	CHO	PRO		Fat	Fibre
		Plant	Animal				Plant	Animal				Plant	Animal		
			Milk (8.61%)												
FAT Sources				Ghee (Purified Butter) (12%)					Ghee (19%)					Ghee (14%)	
				Paneer (17%)					Paneer (24%)					Vegetable oil (58%)	
				Vegetable Oil (60.65%)					Vegetable oil (57%)					Paneer	

Table 4.3 Most Frequently Consumed Vegetables recipes during breakfast, lunch and dinner (Samples) (Appendix 4a)

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (mg)
1A. Punjabi mixed vegetable												
Total (100g)	2.24	9.40	10.68	136.26	612.13	5.40	4.78	5.69	2.16	4.14	3.10	0.00
1B. Low fat Punjabi mixed vegetable												
Total (100g)	1.91	9.40	11.79	139.40	430.33	8.26	3.16	5.15	2.16	4.14	3.10	0.00
2. Punjabi saag												
Total (100g)	2.62	2.20	6.28	55.39	247.49	4.49	1.68	1.80	0.51	0.97	0.73	5.22
3. Punjabi spinach and potato curry												
Total (100g)	2.47	8.45	7.15	114.55	388.06	6.06	1.09	1.63	1.94	3.72	2.79	0.00
4. Punjabi aubergine curry												
Total (100g)	0.94	7.50	3.11	83.68	242.25	0.41	2.44	2.70	1.73	3.30	2.48	11.96
5.Low fat punjabi aubergine curry												
Total (100g)	0.99	7.50	2.35	80.85	66.90	0.19	2.16	0.96	1.73	3.30	2.48	0.00
6. Punjabi Aubergine and Potato Curry												
Total (100g)	1.20	6.20	7.02	88.69	350.30	3.67	2.71	1.38	1.43	2.73	2.05	0.00
7. Low fat Punjabi Aubergine and Potato Curry												
Total (100g)	1.31	6.20	7.44	90.78	313.78	3.89	2.83	1.41	1.43	2.73	2.05	0.00
8. Punjabi Potato, Onion, Tomato curry												
Total (100g)	1.51	8.00	10.93	121.77	625.95	9.00	1.65	1.97	1.84	3.52	2.64	0.00
9. Low fat Punjabi Potato, Onion, Tomato curry												
Total (100g)	1.77	8.00	12.73	130.02	250.81	9.93	2.26	2.08	1.84	3.52	2.64	0.00
10. Fat Punjabi Potato and Green pepper Curry												
Total (100g)	2.04	8.50	4.75	103.67	534.19	3.28	1.31	0.82	1.96	3.74	2.81	0.00

Table: 4.4 Meat based commonly consumed recipes during breakfast, lunch and dinner (Appendix 4b)

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (mg)
1. Punjabi lamb curry Total (100g)	7.79	14.88	3.91	180.70	755.32	0.83	2.48	0.51	3.42	6.55	4.91	28.37
2. Low fat Punjabi lamb curry Total (100g)	14.30	10.71	1.14	158.10	660.88	0.04	0.93	0.26	2.46	4.71	3.53	59.60
3. Punjabi lamb and potato curry Total (100g)	12.98	8.63	5.27	150.62	629.61	4.13	0.89	0.80	1.98	3.80	2.85	49.38
4. Punjabi mutton curry Total (100g)	14.37	12.15	2.65	177.40	741.54	0.64	1.50	0.23	2.79	5.35	4.01	62.75
4. Low fat Punjabi mutton curry Total (100g)	11.94	17.02	2.23	209.83	877.08	0.00	1.58	0.31	3.91	7.49	5.62	71.49
5. Punjabi lamb chop Total (100g)	14.66	14.09	2.04	193.56	809.09	0.78	1.06	0.18	3.24	6.20	4.65	57.48
6. Low fat Punjabi lamb chop Total (100g)	12.61	10.76	1.63	153.83	643.02	0.08	1.31	0.33	2.48	4.74	3.55	55.46
7. Punjabi lamb keema (Minced) Total (100g)	13.27	15.13	2.92	200.89	839.71	0.86	1.55	0.24	3.48	6.66	4.99	51.11
8. Low fat Punjabi lamb keema (Minced) Total (100g)	9.44	13.05	3.45	168.98	706.36	0.64	2.09	1.03	3.00	5.74	4.31	34.59
9.Punjabi Low fat matar keema (100g) Total	11.17	8.81	3.79	139.12	581.50	0.96	1.95	2.12	2.03	3.88	2.91	45.31

Table 4.5 Pulse, Legume and Lentils based commonly consumed recipes during breakfast, lunch and dinner (Appendix 4c)

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (mg)
1 A. Punjabi masur dhal with masur and onion Total 100g	4.20	14.49	9.22	181.57	754.72	6.89	1.63	0.37	3.33	6.38	4.78	39.79
1 B. Punjabi masur dhal with masur and onion (low fat) Total 100g	3.62	2.78	8.52	64.67	273.03	5.43	2.41	0.56	0.64	1.22	0.92	0.00
2. Punjabi masur dhal (thick) Total 100g	7.18	5.56	14.34	129.88	547.91	13.21	0.48	0.01	1.28	2.45	1.83	13.86
3 A.Punjabi musar and mung dhal Total 100g	9.95	12.03	19.86	219.06	918.02	16.62	1.63	0.25	2.77	5.29	3.97	28.96
3 B. low fat Punjabi musar and mung dhal Total 100g	10.61	5.61	21.42	172.67	728.54	17.93	1.71	0.24	1.29	2.47	1.85	14.12
4 A. Punjabi Mixed dhal (Masur,Mung, Channa) Total 100g	8.96	7.35	18.76	166.85	701.85	15.26	1.95	0.29	1.69	3.23	2.42	17.00
4 B. low fat Punjabi Mixed dhal (Masur,Mung, Channa) Total 100g	8.19	5.16	16.55	129.77	547.63	13.44	1.89	0.35	1.19	2.27	1.70	9.15
5 A. Punjabi Channa dhal (thin) Total 100g	15.82	9.38	39.82	285.13	1204.61	34.33	2.74	0.12	2.16	4.13	3.10	11.13
5 B.low fat Punjabi Channa dhal (thin) Total 100g	12.36	4.60	32.30	198.78	842.35	26.00	3.58	0.36	1.06	2.03	1.52	0.00
6 A. Punjabi Channa dhal (thick) Total 100g	7.17	12.54	15.69	197.96	826.32	13.98	1.09	0.05	2.89	5.52	4.14	29.44

Table 4.6: Rice and cereal based commonly consumed recipes during breakfast, lunch and dinner (Appendix 4d)

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (mg)
1. Punjabi Meat Pilau Total (100g)	9.03	10.46	14.32	187.52	783.85	13.45	0.62	0.11	2.41	4.60	3.45	30.86
2. Punjabi Chicken Biryani Total (100g)	9.73	9.38	14.62	181.80	759.93	13.92	0.50	0.20	2.16	4.13	3.10	33.83
3.Low Fat Punjabi Chicken Biryani Total (100g)	14.43	5.00	9.50	140.74	588.30	9.17	0.33	0.20	1.15	2.20	1.65	54.93
4. Punjabi Peas Pilau Total (100g)	3.91	11.27	18.10	189.46	791.96	15.79	1.35	5.16	2.59	4.96	3.72	28.38
5.Low Fat Punjabi peas pilau Total (100g)	3.44	8.60	17.11	159.63	667.25	13.95	2.00	4.34	1.98	3.78	2.84	3.00
6. Punjabi mixed Vegetable Pulau Total (100g)	2.54	10.96	15.49	170.76	713.76	13.48	1.86	1.30	2.52	4.82	3.62	34.70
7. Low Fat Punjabi mixed vegetable Pilau Total (100g)	2.16	12.69	25.00	222.85	931.50	24.21	0.56	1.30	2.92	5.58	4.19	70.00
8. Punjabi Parathas Total (100g)	9.86	9.84	71.24	412.97	1726.20	69.96	1.28	1.30	2.26	4.33	3.25	24.28
9. Low fat Punjabi Parathas Total (100g)	10.18	6.22	73.27	389.78	1629.30	71.96	1.32	1.30	1.43	2.74	2.05	16.97
10. Punjabi methi parathas Total (100g)	10.98	5.28	47.87	282.87	1182.41	43.69	4.18	5.40	1.21	2.32	1.74	4.34

4.3 Distribution of commonly consumed Sample meals during breakfast, lunch and dinner

A complete list of commonly consumed meals and their components are presented in Appendix 4e,4f,4g,4h

Table: 4.7 Commonly consumed Breakfast meals from focus group study (Appendix 4e)

Recipes	Weight (g)	Protein (g)	Fat (g)	CHO (g)	Energy Kcal	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (mg)
1st													
Chapatti	60.00	5.88	0.30	46.56	212.46	11.07	87.66	1.27	1.32	0.07	0.13	0.10	0.00
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	100.00	0.00	0.69	1.32	0.99	8.40
Chicken curry with potato	150.00	21.00	13.20	6.60	229.20	36.65	11.52	51.83	1.05	3.04	5.81	4.36	2.55
Milk	250.00	8.00	9.75	12.00	167.75	19.08	28.61	52.31	0.00	2.24	4.29	3.22	35.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	468.00	34.88	26.24	70.16	656.36	21.26	42.76	35.99	2.37	6.04	11.55	8.66	45.95
2nd													
Chapatti	60.00	4.32	3.53	0.18	49.75	34.73	1.45	63.82	0.76	16.49	0.04	0.08	0.06
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	100.00	0.00	0.69	1.32	0.99	8.40
Lamb curry	150.00	11.69	22.32	5.86	271.05	17.25	8.65	74.10	0.76	5.13	9.82	7.36	42.56
(Tea)Milk	50.00	1.60	1.95	2.40	33.55	19.08	28.61	52.31	0.00	0.45	0.86	0.64	7.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	268.00	17.61	30.79	13.44	401.30	17.55	13.40	69.05	1.52	7.08	13.55	10.16	58.02
3rd													
Chapatti	60.00	4.32	3.53	0.18	49.75	34.73	1.45	63.82	0.76	16.49	0.04	0.08	0.06
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	100.00	0.00	0.69	1.32	0.99	8.40
Cauliflower Potato Curry	150.00	4.04	6.53	12.97	126.77	12.76	40.92	46.32	1.83	1.50	2.87	2.15	16.18
Tea (MILK)	50.00	1.60	1.95	2.40	33.55	19.08	28.61	52.31	0.00	0.45	0.86	0.64	7.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	268.00	9.96	15.00	20.55	257.02	15.51	31.98	52.51	2.58	3.45	6.60	4.95	31.64

Table 4.8 Commonly consumed Lunch meals from focus group study (Appendix 4f)

Recipes	Weight (g)	Protein (g)	Fat (g)	CHO (g)	Energy (Kcal)	Energy (KJ)	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (mg)
Lunch														
1st														
Chapatti	120	11.76	0.60	93.12	424.92	1776.17	11.07	1.27	87.66	2.64	0.14	0.26	0.20	0.00
Ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
rice	150	3.90	1.95	46.35	218.55	880.50	7.14	8.03	84.83	0.00	0.45	0.86	0.64	0.00
Mix veg curry	80	1.79	7.52	8.54	109.01	489.71	6.58	62.09	31.34	4.55	1.73	3.31	2.48	0.00
chicken curry	150	14.44	22.61	7.49	291.21	1217.26	19.83	69.88	10.28	0.58	5.20	9.95	7.46	52.42
Masoor-moong dal	150	14.93	18.05	29.78	341.28	1377.03	17.50	47.60	34.91	0.37	4.15	7.94	5.96	43.43
Papadum	20	2.30	7.76	5.66	101.68	416.80	9.05	68.69	22.27	0.00	1.78	3.41	2.56	0.38
Total	680	49.12	68.47	190.94	1576.47	6526.76	12.46	39.09	48.45	8.14	15.75	30.13	22.60	124.23
2nd														
Chapatti	180	17.64	0.90	139.68	637.38	2664.25	11.07	1.27	87.66	3.96	0.21	0.40	0.30	0.00
Ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
Rice	100	2.60	1.30	30.90	145.70	587.00	7.14	8.03	84.83	0.00	0.30	0.57	0.43	0.00
potato cabbage curry	80	1.44	2.50	6.42	53.90	209.24	10.68	41.68	47.64	0.59	0.57	1.10	0.82	4.96
lamb curry	150	11.69	22.32	5.86	271.05	1132.99	17.25	74.10	8.65	0.76	5.13	9.82	7.36	42.56
masoor dal (thick)	150	10.77	8.34	21.51	204.19	821.86	21.10	36.76	42.14	0.01	1.92	3.67	2.75	20.79
papadum	20	2.30	7.76	5.66	101.68	416.80	9.05	68.69	22.27	0.00	1.78	3.41	2.56	0.38
Total	690	46.44	53.09	210.03	1503.72	6201.44	12.35	31.78	55.87	5.32	12.21	23.36	17.52	96.69
3rd														
Chapatti	180	17.64	0.90	139.68	637.38	2664.25	11.07	1.27	87.66	3.96	0.21	0.40	0.30	0.00
Ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
Rice	150	3.90	1.95	46.35	218.55	880.50	7.14	8.03	84.83	0.00	0.45	0.86	0.64	0.00
spinach potato saag	50	1.24	4.23	3.58	57.28	194.03	8.64	66.39	24.97	0.81	0.97	1.86	1.39	0.00
channa dal	150	10.76	18.82	23.53	306.50	1239.49	14.04	55.25	30.71	0.07	4.33	8.28	6.21	44.16
mutton curry	150	21.55	18.22	3.97	266.10	1112.30	32.39	61.64	5.97	0.34	4.19	8.02	6.01	94.12
Total	690	55.08	54.10	217.11	1575.63	6459.87	13.98	30.90	55.12	5.18	12.44	23.80	17.85	166.29

Table 4.9 Commonly consumed dinner meals from focus group study (Appendix 4g)

Recipes	Weight(g)	Protein (g)	Fat (g)	CHO (g)	Energy Kcal	Energy KJ	%PRO	%CHO	%FAT	FIBRE(g)	PUFA(g)	MUFA(g)	SFA(g)	Cholesterol(mg)
Dinner														
1st														
Paratha	180.00	17.75	17.71	128.23	743.33	3107.16	9.55	69.00	21.45	2.34	4.07	7.79	5.84	43.70
Ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
chicken curry	150.00	14.44	22.61	7.49	291.21	1217.26	19.83	10.28	69.88	0.58	5.20	9.95	7.46	52.42
lamb chops	200.00	29.33	28.17	4.07	387.12	1618.18	30.30	4.21	65.49	0.37	6.48	12.40	9.30	114.95
Total	690.00	61.51	78.48	139.79	1511.48	6311.90	16.28	36.99	46.73	3.29	18.05	34.53	25.90	239.08
2nd														
Chapatti	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
Ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
spinach saag	100.00	2.62	2.20	6.28	55.39	247.49	18.93	45.33	35.75	1.80	0.51	0.97	0.73	5.22
mutton curry	100.00	28.73	24.30	5.30	354.80	1483.07	32.39	5.97	61.64	0.45	5.59	10.69	8.02	125.50
Pokada	100.00	15.40	24.76	43.61	458.91	1839.47	13.42	38.01	48.57	2.23	5.70	10.90	8.17	3.44
Total	100.00	46.75	61.24	55.19	958.93	3939.33	19.50	23.02	57.48	4.48	14.09	26.95	20.21	162.16
3rd														
Rotli	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
Ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
lamb curry	200.00	15.58	29.76	7.82	361.40	1510.65	17.25	8.65	74.10	1.01	6.84	13.09	9.82	56.74
mixed veg curry	150.00	3.36	14.10	16.01	204.40	918.20	6.58	31.34	62.09	8.54	3.24	6.20	4.65	0.00
Punjabi mix dhal(mung, masoor and channa)	150.00	13.43	11.02	28.15	265.49	1052.77	20.24	42.40	37.36	0.43	2.53	4.85	3.64	25.49
Total	660.00	32.38	64.86	51.97	921.11	3850.92	14.06	22.57	63.37	9.98	14.92	28.54	21.40	110.24

4.4 Results of Individual Dietary Analysis of Focus Group Members

The data from 24h diet recall interviews were collated and analysed to assertain food choice and dietary intake among focus group members. The results were summarized below:

Table 4.10 Mean (SD) and percentage energy contribution by macronutrients to daily intake among 40 healthy adult Punjabi males in a focus group in Medway, Kent

Macro-nutrient	Average Amount (g) /day	SD	% Energy Contribution	AMDR* % Energy
Carbohydrate	307.52	49.39	41.83	45-65
Total Fat	142.61	21.91	43.65	20-35
Saturated Fatty Acids (SFA)	46.2	7.16	14.14	N/A
Protein	106.77	15.01	14.52	10-35

***AMDR= Acceptable maconutrient distribution range**

The contribution of total carbohydrate to energy was just below 42% compared to total fat (43.65%) the former constituting less than the recommended ratio (55%) and the latter exceeding recommendations (33-35% of dietary energy). The protein share of the daily intake was 14.52% however the magnitude of intake (106.77 g) was much higher than recommended intakes for protein (60 g / day). The percentage contribution of saturated fats (14.14%) a major portion of which was from animal fat, exceeded the recommended levels (10% of total energy) for intake. The actual average intake of saturated fatty acids (SFA) was 46.2g (±4.3) (Table 4.11). The average fibre intake among the focus group was 15.35 (±0.92) g / day. This reported intake of fibre falls short of the estimated average requirement, (EAR =18 g / d) which would meet the needs of 50% of the UK population, and the reference nutrient intake (RNI =24 g / day) which would meet the needs of 97.5% of the population. The average energy intake (Table 4.11) was 2940.57 (±214.75) kcal / day which is also in excess of the UK EAR of 2550 kcal / day thus suggesting that this population is consuming more energy, more protein, higher amounts of fats and SFAs and low fibre. This finding among individuals in the focus group corroborates the estimates computed from the typical meal recipes provide by the group (Tables 4.7 – 4.9).

Table 4.11 Daily average macronutrient and energy intake by meal type (Breakfast, Lunch and Supper)

Variables	Protein g	Fat (g)	Carbohydrate (g)	Energy (Kcal)	Energy (KJ)	FIBRE(g)
Breakfast	18.35(1.62)	23.74(1.71)	68.82(4.50)	562.31(27.44)	2233.39(121.01)	3.69(0.67)
% Energy	13.05%	38%	48.96%			
Lunch	42.62(2.18)	52.00(3.37)	159.21(8.46)	1275.31(52.95)	5270.24(227.25)	6.86(0.87)
% Energy	13.37%	36.7%	49.94%			
Supper	45.79(3.16)	66.87(3.14)	79.49(10.47)	1102.95(72.18)	4540.65(299.51)	4.79(0.73)
% Energy	16.61%	54.57%	28.83%			
Total	106.77(8.66)	142.61(12.64)	307.52(28.51)	2940.57(214.75)	12044.29(915.24)	15.35(0.92)
RNI / EAR / AI	0.8g/kg/day		55% of total Energy	2500 Kcal/ Day		18g /day

In table 4.11 above, a breakdown of the relative contributions of different meals to the macronutrient components of the diet is presented. The protein, fat and carbohydrate contributions to breakfast meals were 18.35g (1.62) [13.05%], 23.74g (1.71), [38%] and 68.82g (4.50) [48.96%] respectively contributing a total of 562.31 (27.44) Kcal to daily intake. Overall dietary non-starch polysaccharide (NSP, fibre) intake during breakfast was 3.69g (0.67). At Lunch, protein, fat and carbohydrate contributed 42.62g (2.18), [13.37%]; 52.00g (3.37), [36.7%] and 159.21g (8.46) [49.94%] respectively i.e. an energy equivalent of 1275.31(52.95) Kcal. The average fibre intake during lunch was 6.86g (0.87).

During supper, protein, fat and carbohydrate intake were 45.79g(3.16), [16.61%]; 66.87g(3.14) [54.57%]; and 79.49g(10.47) [28.83%] respectively contributing a total of 1102.95 (72.18)Kcal to the daily intake. Overall fibre intake during supper was 4.79 g (0.73).

This pattern of intake suggests that overall high fat intake is common in this group, the bulk of which is consumed in the evening (54.57% of energy) when physical activity is usually at the lowest. The total fibre content of the diet as previously stated above was rather low 15.35g (0.92), below the UK estimated average requirement (EAR) of 18 g per day and only enough to meet 63.96 % of the reference nutrient intake (RNI) value. In this group, the bulk of fibre was obtained in the lunch meal with little coming from breakfast and the evening meal.

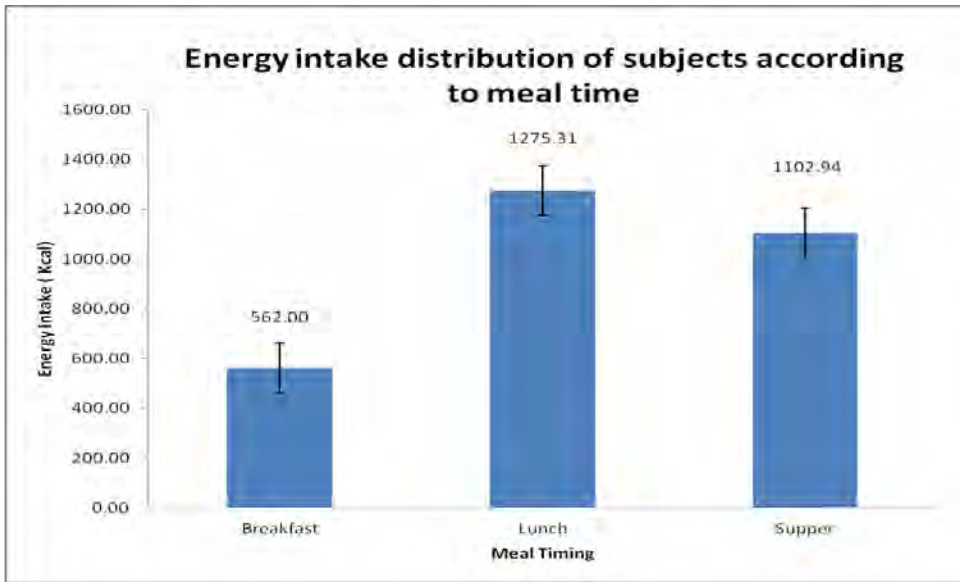

Figure 4.1 Energy intake distribution of subjects according to meal time

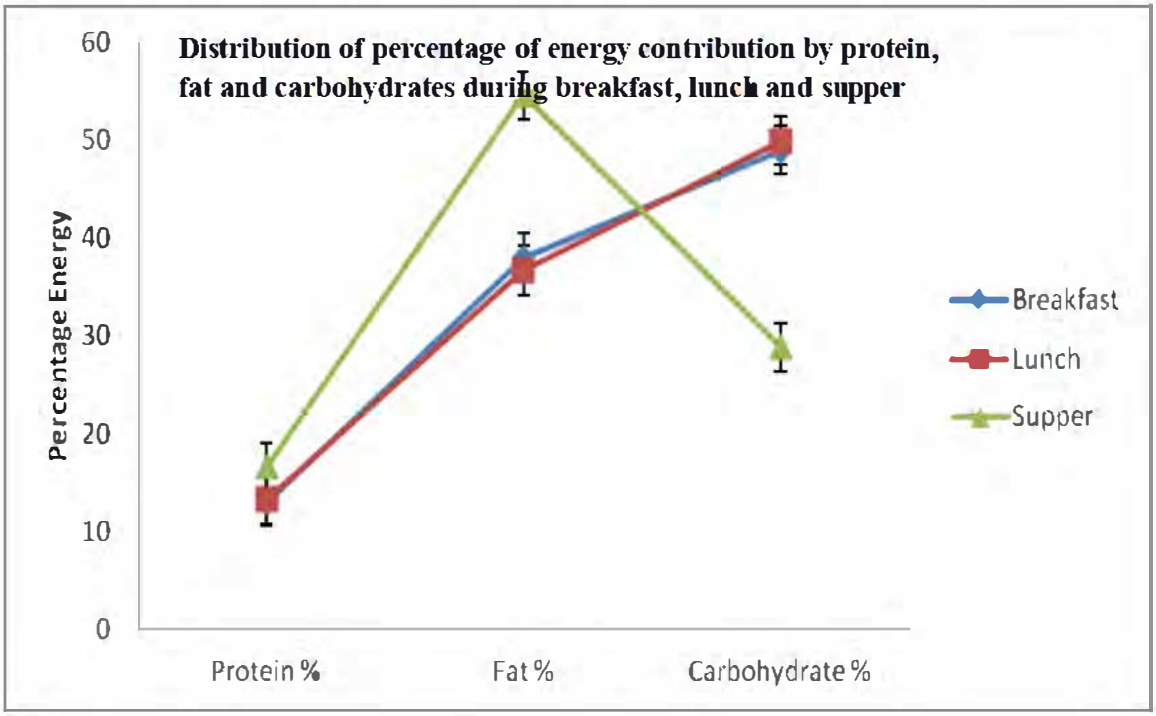

Figure 4.2 Distribution of percentage of energy contribution by protein, fat and carbohydrates during breakfast, lunch and supper

Table 4.12 Distribution of type of dietary fat intake during each meal in the Focus Group (24-hr Recall data) (n=40)

Variables	PUFA (g) (SD)	MUFA (g)(SD)	SFA (g)(SD)	Cholesterol(mg)(SD)
Breakfast	5.46 (0.39)	10.44(0.75)	7.83(0.56)	46.67(6.57)
Lunch	11.36(0.96)	21.74(1.84)	18.90(1.38)	106.51(5.45)
Supper	15.38(0.72)	29.42(1.38)	22.07(1.04)	147.83(4.75)
Total	32.20(2.88)	61.60(5.51)	48.80(4.1)	301.01(29.36)

Total fat intake at breakfast was 23.74 (1.71) g of which PUFA constituted 5.46 (0.39) g, MUFA was 10.44 (0.75) g and SFA was 7.83 (0.56) g. Total cholesterol intake at breakfast was 46.67 (6.57) mg. During lunch total fat intake was 52.00 (3.37) g of which PUFA contributed 11.36 (0.96) g; MUFA was 21.74 (1.84) g and SFA was 18.90 (1.38) g. Total cholesterol intake during lunch was 106.51 (5.45) mg. Total fat intake at the evening meal (supper) was 66.87 (3.14) g of which PUFA was 15.38 (0.72) g; MUFA was 29.42 (1.38) g and SFA contributed 22.07 (1.04) g. Total cholesterol intake during supper was 147.83 (4.75) mg. Total PUFA, MUFA, SFA and cholesterol intake throughout the day were 32.20 (2.88) mg, 61.60 (5.51) mg, 48.80 (4.1) mg and 301.01 (29.36) mg respectively.

Table 4.13 Percentage distribution of fat constituents - SFA, MUFA & PUFA

Meals	%PUFA	%MUFA	%SFA
Breakfast	22.99	43.97	32.98
Lunch	24.84	41.80	33.34
Supper	22.99	43.99	33.00

Table 4.14 Average Intrinsic Mineral Intake per day in Focus Group (n =40)

	Na(mg)	K(mg)	Ca(mg)	Mg(mg)	Fe(mg)	Cu(mg)	Zn(mg)	Se (µg)	I(µg)
Breakfast	188.53(58.41)	625.81(39.55)	183.22(15.69)	69.02(5.88)	4.88(0.62)	0.37(0.05)	2.42(0.30)	6.55(0.97)	29.19(4.65)
Lunch	261.41(31.96)	1413.48(56.21)	225.41(12.09)	170.02(8.55)	9.83(0.71)	0.91(0.05)	6.23(0.41)	20.07(1.45)	20.89(2.21)
Supper	555.84(68.2)	1528.93(86.96)	185.20(21.04)	143.08(10.70)	11.58(1.01)	2.87(0.55)	8.68(0.77)	18.04(1.85)	22.62(1.96)
Total	1005.78(112.28)	3568.21(283.76)	593.83(13.74)	382.12(30.19)	26.29(2)	4.15(0.75)	17.33(3.15)	44.66(7.2)	72.70(4.3)
%RNI	62.86	101.95	74.23	109.18	438.23	592.45	184.38	99.25	76.53

As shown in table 4.14, daily Sodium intake was 1005.78 (112.28) mg that is equivalent to 62.86% of the RNI (1600mg/day). However, in this focus group study only intrinsic sodium intake was reported and the value does not include salt added at table, which could not be quantified because the information was too subjective, thus total intake may be higher than reported here. Calcium intake of 593 (13.74) mg was 74.23% of the RNI value. Overall iron and copper intake were excessive, providing the equivalent of 438.23% and 592.45% of their RNI values respectively. Such high levels of these minerals merit further investigation, especially in the case of iron which can serve as a pro-oxidant in large amounts.

Table 4.15 Daily Vitamin Intake among individuals in Focus Group from 24-hour recall data (n=40)

	A (µg)	D (µg)	B1 (mg)	B2 (mg)	B3 (mg)	B6 (mg)	B12 (mg)	Folate (µg)	C (mg)
Breakfast	1183.49(535.16)	0.38(0.11)	0.37(0.03)	0.26(0.03)	4.50(0.52)	0.53(0.05)	0.48(0.14)	53.34(5.98)	23.07(7.35)
Lunch	948.01(286.40)	0.66(0.11)	0.81(0.06)	0.31(0.02)	11.33(0.89)	1.01(0.06)	0.85(0.25)	126.04(6.99)	29.35(5.41)
Supper	2318.08(757.30)	3.76(0.57)	3.53(0.65)	3.36(0.66)	14.48(1.14)	4.19(0.72)	4.96(0.69)	154.15(19.28)	37.22(5.98)
Total	4449.58(422.94)	4.80(1.87)	4.72(1.71)	3.92(1.02)	30.32(2.94)	5.73(1.1)	6.30(1.4)	333.54(30.03)	89.64(4.09)
%RNI	635.65	48.00	471.60	356.76	252.66	5221.32	419.67	166.77	224.11

Table 4.15 displays a summary of vitamin intake among the focus group. It appears that there is high intake of all the vitamins far exceeding the RNI values except for vitamin D. Vitamin D intake is very low 4.80 (1.87) µg meeting only 48 % of RNI values for this particular group.

Chapter Five: Focus Group Results: Discussion

5.0 Discussion of Findings from Focus Group Study

In this study, the primary focus was to see the types of food consumed as well as the overall quality of various food recipes. This was set in the context of a Punjabi South Asian socio-demographic group in Medway, Kent whose average household income was between £15,000 and £20,999 of which 47.5% earn below £20,000. The earnings are below the average household income in Medway which averages £31,400 (Medway council, 2012). The next band of earnings in the focus group were those between £21,000 and £25,000 who were about 25% of the focus group. In this focus group 27% were first generation migrants and 72.5% were from the second generation. A large proportion of subjects (82.5%) were either overweight (BMI >25; ≤29.99 kgm^{-2}) or obese (BMI >30 kgm^{-2}).

Although overall dietary intake appeared to be adequate, the balance of nutrient was poor especially in respect of macronutrients. The type of food consumed by this community makes a difference in terms of total energy content during the day and depending on the time of day. This is particularly true because of diurnal variations in intake and meal composition with the bulk of intake occurring at lunch time and in the evenings compared to morning. Energy intake during breakfast was much lower than during lunch and dinner. To provide an objective assessment of energy consumption, macronutrient content as well as salt and other micronutrients were estimated and the findings used to help inform the Phase II of the study.

A look at the food choices and patterns of consumption suggest that this population consumes very little fruit and vegetables except vegetable curry which forms part of meals. Fruit intake has largely been unreported and the group appears to consume far less than the 400 g of fruit and

vegetables recommended (Five-A-Day concept), and probably even less than the European average consumption of 100 g / day. This low intake of fruits and vegetables appears to reflect the rather low intake of dietary fibre (less than 18 g / day, the amount required to meet the needs of up to 50% of the UK population.

5.1 Overall dietary quality from focus group study

5.1.1 Distribution of food composition in daily diet and most common sources of macronutrients

The pattern of consumption suggests that the Punjabi population living in Medway mostly take three meals i.e. breakfast, lunch and dinner and nothing is reported of between-meal snacks. Of these, breakfast consists of traditionally consumed meals with a mainly carbohydrate base, the major carbohydrate source being wheat, plain and highly refined flour from which chapattis and rotlis are either home-made or bought from the local bakeries. Almost all the meals have at-least one recipe made from potato. The meals often contain animal foods and the main protein sources from the breakfast are: chicken, egg, lamb, and dairy sources such as milk prepared in a variety of ways. The main fat sources are purified butter (Ghee) and vegetable oils. Margarine and bread are hardly used as part of the meal nor are other spreads such as marmalade.

Lunch forms the largest meal of the day contributing the highest amount of energy intake (**Figure 4.3**), followed by dinner (supper). The main carbohydrate sources in lunch and dinner are wheat, rice and potatoes, the latter mainly peeled, chopped into small pieces as part of e.g. vegetable, chicken or lamb curry. Protein sources in lunch and dinner are - chicken, lamb, mutton and minced meat (animals source); and chick peas, kidney beans (Rajma) and red lentils (dhal) (plant source). Fat sources are mainly contributed by ghee, vegetable oils, chicken and lamb.

Overall fibre intake was low throughout the day. And the main fibre source of breakfast was wheat, for lunch and dinner it was chick peas, wheat and other lentils. It is noteworthy that none of the participating five focus groups reported fruit intake as part of their meal.

5.1.2 Carbohydrate intake from individuals in the focus group study

The recommended range of carbohydrate intake suggested is 45 - 60% of total energy but this is meaningless and can be misleading unless it is linked to the actual amount of each macronutrient and the total energy intake. Thus, total energy intake may be excessive whilst the ratios for the three macronutrients remain within the recommended range. On average carbohydrate content of breakfast, lunch and dinner were- 68.82g (±4.50), 159.21g (±52.95), 79.49g (±10.47) which contributed 48.95%, 49.94% and 28.83% respectively with an average total daily energy contribution of 41.83% from carbohydrate. Traditionally adopted South Asian vegetable diets have been shown to be promising for diabetic patients.

Daily eating habits might appear healthy on their own but in actual fact the overall macro nutrient content needs further investigation in terms of quality of the food consumed. Moreover, studies have suggested that high-carbohydrate diets compared with high—monounsaturated-fat diets may cause persistent deterioration of glycaemic control and accentuation of hyperinsulinemia, and will increase plasma triglyceride and very-low-density lipoprotein cholesterol levels (Parillo, et.al., 1992; Rasmussen, et.al., 1993;Archer, et.al.,2003).

5.1.3 Protein intake from the focus group study

The protein recommendation for an average adult is 0.8 g/kg body weight (WHO 2002). On average protein intake during breakfast, lunch and dinner were- 18.35g (±1.62), 42.62g (±2.81),

45.79g (±3.16) which contributes to 13.06%, 13.37% and 16.61% respectively to total energy per meal and daily average energy contribution of 14.52% from protein sources. It is important to consider the quality of the protein as well. Proteins from plant sources may have low biological value compared to animal protein (Liu and Chou, 2010). For example: maize protein is limiting in tryptophan and wheat protein is limiting in lysine. However animal source proteins, particularly red meat has also been associated with a high risk of chronic disease, particularly bowel cancer and gouty arthritis (Pattison, et al., 2004; Long, et al., 2010) both of which appear to be increasing in prevalence among the general population.

5.1.4 Fat intake from focus group study

In this focus group, the main sources of the fat were ghee, corn oil, sunflower oil, ground nut oil, butter and margarine (to a very small extent). On average fat content during breakfast, lunch and dinner were- 23.74g (±1.71), 52.00g (±3.37), 66.87g (±3.16) which contributes 37.99%, 36.70% and 54.56% of energy content per meal. The fat contribution to total daily energy was 43.65%%, much higher than the recommendations of 33 – 35% (DOH, 2010).

Fat intake was higher during dinner time as the most energy-dense food was consumed during the evening meal after returning from work. Oils from nuts and seeds used are high in monounsaturated fats (MUFAs) which have lower atherogenic potential (Astrup et al., 2011; Albuquerque et al., 2006). High intakes of cholesterol and saturated fats increase cardio-vascular disease risk (Siri-Tarino et al., 2010). Diabetic patients are therefore advised to replace saturated fat with MUFAs and should preferably use complex carbohydrate in their diets. Fats from pure butter and ghee are high in LDL-cholesterol and vegetable recipes that are prepared with these are best taken in small quantities or avoided altogether. Fat intake was high due to extrinsic usage of traditional ghee in the recipes formulation.

5.1.5 Fibre intake from focus group study

Reported group fibre intakes and total fibre content of the diet among individuals in the focus groups was found to be low. The UK adult RNI is 24g/day but the average UK adult consumes about 18 g of fibre daily (EAR) (Cust et.al.,2009; Crowe et.al., 2012). The fibre intake of 15.34 g/day in this study does not meet the fibre requirements and such low consumption over time is bound to have negative health consequences. On average fibre content during breakfast, lunch and dinner were- 3.69 g (±0.67), 6.86 g (±0.87), 4.79 g (±0.73) which together is less than the estimated average requirement (EAR) of 18 g/day (which would meet the needs of up to 50% of the population). This value amounts to 61.38% of the RNI value for fibre.

This was rather surprising, given the range and mixture of food sources consumed by this community. It appears relatively small quantities of good fibre sources were included as part of their daily intake. Thus inclusion of fibre in the Punjabi diet is a matter of some concern, given the added health benefits of fibre in the diet. For instance, insoluble fibre will help bowel motility and strength; and soluble fibre has been shown to improve glycaemic control, allow carbohydrate digestion and amount absorbed in the gastrointestinal tract to be slow.

The recommended fibre intake for diabetes patients is between 30 and 40g / day (Geekie et.al.,1986; Hindy et.al.,2012). The protective effect of fibre may include acting directly to reduce clotting factors and oxidized LDL-cholesterol levels in diabetes patients (Marckman et al, 1990, Anderson, 2000). On the other hand, very high intakes of fibre have been found to interfere significantly with the absorption of non-haem-iron and should be taken into account in making dietary recommendations (Harvie, 1987, Brune, et.al., 1992, Prynne, et.al., 2012;).

5.1.6 Energy intake (EI) from focus group study

The recommended energy intake in the UK is 2550 kcal/day for men and 2000 kcal/day for women (SACN 2011). Energy content of breakfast, lunch and dinner were - 562.31 (±27.44), 1275.31(±52.95) and 1102.95(±72.18) respectively with a total EI of 2940.5 Kcal per day. This energy intake is in excess of the recommended intakes, especially for a largely sedentary population whose major occupation is non-manual. It is worth noting that in this group, dinner may be eaten very late just before they go off to sleep late at night. Therefore most of the energy will be stored as fat due to inactivity of the body throughout the night.

5.1.7 Mineral Intake from the focus group study

Mineral intake measured in the focus group was generally satisfactory. However in some cases intake was found to be below the recommended levels.The average sodium intake as reported by the focus group members from a single 24-hour recall was low. This however does not include added salt during and after cooking and so may be misleading. The average Na intake reported in the group was 1005.78 mg/day (±112.28) which is less than the UK RNI value of 1600 mg/day. Some Food surveys indicate that UK South Asian populations have high salt intakes (Brito, et.al., 2009) and that makes this finding rather surprising. Due to the nature of the recipes and cooking methods it is advisable to reduce the extrinsic usage of salt while cooking by these communities due to a higher reported prevalence of hypertension in ethnic minority groups in the UK including South Asians (Tillin, 2010).

Various combinations of recipes in Punjabi diets do contain mainly non-heam form of iron from plant based sources with relatively low bioavailability. However, Punjabi fish and meat based recipes consumed during lunch and supper do contain heam-iron, which has higher bioavailability. The average iron intake of individuals in the focus group was 26.29 mg (±2.0) per day which is 438% of the RNI. It is worth noting however that protein in the diet e.g. soy

protein can promote the absorption of non-heam iron. Although some studies have associated higher heam iron intake with a significantly increased risk of type 2 diabetes, this is of no relevance to the present study.

Magnesium intake of 382.12 mg (±30.19) was found to be adequate and amounts to 109.18% of the RNI value among the focus group. Evidence suggests that hypomagnesaemia is common in diabetics due to unnecessary secretion and due to osmotic dieresis (Mane, 2012). Hypomagnesaemia is related to retinopathy and cardiovascular health (Sales and Pedrosa 2006; Mane, 2012). Magnesium supplementation has also been shown to improve glycaemic control and lipid profile in diabetes patients (Hadjistarvi et al., 2010). One study has also suggested that higher cereal fibre and magnesium intakes may decrease diabetes risk (Hadjistarvi et al., 2010). The high levels of magnesium present in the south Asian recipes are potentially beneficial.

The average zinc intake was also adequate. Populations in South East Asia and sub-Saharan Africa are at greatest risk of zinc deficiency and zinc intakes are inadequate for about a third of the population. Zinc has its own anti-oxidant properties and is thought to affect beta cell functions and insulin secretion. Excessive Zinc in the body however can interfere with iron and copper in the GI tract.

Calcium intake was good in the focus group. It is important for bone health and for muscle metabolism and haemostasis. In certain population groups such as diabetes patients, particularly post-menopausal women, considering traditionally consumed recipes should include calcium in their diet. Consumption of milk or milk products with the daily meals will increase calcium intake. Overall meals contained adequate amounts of copper. Good copper content of the recipes would prove beneficial as it will help iron absorption.

The average amount of potassium present in the recipes was considered to be adequate. The commonly consumed meals by this Punjabi community and the individual intake assessment also

show that the meals do contain adequate amounts of potassium. Potassium loss is common in diabetes patients (Metso et. al., 2012; Im et.al, 2010; Takagi et.al., 2009). Hypokalaemia can also occur in diabetics if the kidney is compromised by nephropathy. Moreover, diabetes patients with the complication of hypertension prescribed with loop diuretics may experience higher losses of potassium in the urine.

In this focus group iodine intake as reported was 0.14mg and in the country of origin this particular population do consume Iodine-fortified salt to meet the requirements which is not the same in England where 95% of salt sold on the market is non-iodised. Average daily iodine intake was 72.70 µg (±4.3) which meets 76.53% of RNI value of 140 µg/day. In the country of origin (India) a large percentage of the population suffers from iodine deficiency disease (NIN, 2010). Therefore it might be worth considering iodine requirements for this population while designing or planning any intervention or educational toolkit.

5.1.8 Vitamin intake from focus group study

Vitamins play an important role in metabolism and provide an antioxidant role in the management of protein glycation and insulin sensitivity and overall diabetes management.

Vitamin C is an important component of the daily diets due to its support for the absorption of other nutrients. This is present in high amount across most commonly consumed three meals. The average intake in the focus group was 89.64 mg /day (± 4.09) which was more than 200% of the RNI value.

Vitamin A content of the diet of the focus group was found to be very high with an average intake of 4449.58 µg/day (± 422.94) equivalent to 635% of the RNI value. The major sources of vitamin A and vitamin B12 in the diet of this group was liver and eggs which were consumed very frequently in this group. Even though adequate amounts are encouraging, excessive intakes

of vitamin A can also predispose to liver toxicity (Hathcock et al., 1990) which may be undesirable.

Vitamin D content of the diet of individuals in the focus groups was low. The average intake was 4.8 µg/day (± 1.87) i.e. 48% of RNI value. Studies have shown that vitamin D related deficiencies are more common among South Asians in the UK (Darling 2012, Patel et al, 2012; Alam et al., 2012). Therefore this finding needs to be looked at as a possible source of risk among this population group. A study has also suggested that vitamin D deficiency may be involved in the pathogenesis of diabetes (Yiu, et. al., 2011; Baz-Hecht, et.al., 2010; Michos, 2009). Vitamin D supplementation has been associated with reduced risk of diabetes (Harris, et. al., 2012; George, et. al., 2012; Vacek, et.al., 2012; Mitri, et.al., 2011) in some studies.

Overall Vitamin B12 intake was adequate. The average intake was 6.30 mg/day (± 1.4) i.e. 419% of the RNI value. It is necessary to ensure that B12 levels are met because B12 deficiency is associated with pernicious anaemia and has been implicated in hyperhomocysteinemia (Ahmed, et al., 2012). B12 is intrinsically linked to the methylation cycle and one-carbon transfer reactions. Hyperhomocysteinemia is also associated with an increased risk of CHD in diabetic patients (Sabanayagam and Shankar, 2011; Dominguez et.al., 2010).

As diabetes patients have an increased risk CHD as a complication, it will be appropriate to keep homocysteine levels low by ensuring adequate amount of vitamin B12 for the prevention of further complications (Rafnsson, et. al., 2011; Armitage, et.al., 2010 Song, et.al., 2009).

Folate intake was also adequate with average intake among the focus group of 333.54 µg/day (± 30.03) i.e. 167% of the RNI value. Vitamin B12 and folate are important for healthy red blood cells and cardiovascular health (Ahmed et al., 2012). Folate is advantageous for diabetics due to its benefits for reducing macrovascular complications of the diseases (Qin et al., 2012). Folate

deficiency, like B12, has been associated with hyperhomocysteinemia and in endothelial dysfunction, CHD and stroke risk (Rafnsson, et. al., 2011).

Carbohydrate, fat and protein metabolism requires thiamine, riboflavin and niacin as an essential micronutrient. This particular community consumes adequate quantities of all these vitamins. B vitamin intakes overall were found to be more than adequate in the focus group.

Chapter Six: Phase II Study Results

6.0 Introduction

The Phase II study was carried out to provide socio-demographic information, food habits, dietary practices and physiological and physical assessments of a randomly selected homogenous adult male Punjabi migrant population living in Medway, Kent. The results presented here are based on information obtained using a pre-validated demographic questionnaire, repeat 24-hour diet recall and physiological and physical measurements. Results are presented in tabular format, figures and graphs. Overall discussion of this chapter is presented in Chapter seven with major findings of exposure risk factors associated with socio-demographic, physical – physiological and dietary mediators of behaviour and risk of chronic disease.

6.1 Results of Socio-demographic Survey

The total sample size details of which have been described in chapter two, was 137 males aged between 21 and 55 years. A summary of the demographic profiles is shown in **Table 6.1** below. The age distribution shows lack of uniformity in the very young and the very old age groups, but some uniformity of the distribution between age groups 26 to 45 years, varying between 25 and 31 individuals in these age groups. The age groups with the least distribution were 21 – 25 years (n=6; 4.38%) and 51 – 55 years (n=4; 2.92%). There were 15 (10.95%) subjects in the age group 46 – 50 years. Of the total sample, 126 (91.97%) of the subjects were married with 11 (8.03%) never married. The majority of the latter were in the age group 21 – 25 years.

First generation Punjabis (n=43) accounted for 31.39% and second generation (n=94) made up 68.61% thus showing a much larger second generation group in the ratio 3:7. This is not

dissimilar to the focus group which had a 1:3 first to second generation ratio. Occupational groups varied from manual labour (n=7; 5.1%); building trade (n=29; 21.17%); administration (n=27; 19.71%) through to business (n=35; 25.55%) and professionals (n=37; 27.0%). If those in the building trade are categorised along with those undertaking manual labour as "labour-intensive" jobs, and those working in administration, the professions and business as "service industry", then the ratio between the two will be approximately 26:74. This ratio is the opposite of the distribution among males in the State of Punjab in India where national Demographic and Health Survey data show 70% of the population working in agriculture and other labour-intensive sectors and 30% of the male population in the service industries.

Incomes reflected the occupational classes with the median group being those earning between £15,500 and £24,999 (n=67; 48.91%). Just over 5 percent (n=7) of the subjects earned more than £50,000. Compared to the Medway median income of £20,000 per annum, 13.86% of subjects in this group earned up to the median value for Medway. Educational levels varied between those who had up to Senior High School qualifications (n=21; 15.33%); those with Vocational qualifications including NVQs, HNDs across a range of subjects (n=70; 51.09%) and college or University graduates (n=46; 33.58%).

Two major lifestyle factors: smoking and alcohol consumption were investigated. Sixty six (n=66; 48.18%) of the subjects were non-smokers and 71 (51.82%) of them, were smokers. Of those who smoked, 47 of them (34.31% of the whole sample population; 66.2% of smokers) were "chain smokers" consuming up to one packet of cigarettes per day, and 24 of them (17.52% of the total sample population; 33.8% of smokers) were "casual" smokers consuming less than 10 cigarettes a day (Saul, et al., 2012; Shane, et al. 2009) (**Table 6.1**).

The majority of subjects (n =121; 88.32%) consume alcohol to varying degrees, with only 16 subjects (11.68% abstaining from alcohol indulgence. Of those who consume alcoholic beverages, 41 (29.93% of the total sample population; 33.88% of those who drink) only drink

occasionally. Thirty one of them (n=31, 22.63% of the total sample; 25.62% of those who drink) are “infrequent and light” drinkers whereas another 29 (21.18% of total sample; 23.97% of drinkers) were “Frequent but light” drinkers. Thirteen subjects (n=13, 9.49% of total sample population; 10.74% of drinkers) were classified as “moderate drinkers” and only 7 of them (5.11% of total sample population; 5.79% of drinkers) were classified as “heavy drinkers” (McKeigue, et al., 1991; Simmons and Williams, 1997; Harding, et al., 2008) the latter being likely to be alcohol dependent (Table 6.1). Of those who drink and smoke, there were 53 subjects i.e. in total, 38.69% of the subjects in this study both smoke and consume alcoholic beverages.

Table 6.1 Socio-demographic characteristics-of 137 adult males of Punjabi origin in Medway, Kent

Variable	Subjects (n-137)	Variables	Subjects (n= 137)	Variable	Subjects (n- 137)	Variable	Subjects (n=137)	Variable	Subjects (n=137)	Variable	Subjects (n=137)
Age(yrs)		**Marital Status**		**Household income (£) per Month**		**BMI Kg/m^2**		**Generation**		**Occupation**	
21-25	6	Never married	11	<9,499	8	Normal (<25)	11	1st Generation	43	Retired/Not working	0
26-30	29	Married	126	9,500-15,499	23	Overweight (25-29.9)	84	2nd Generation	94	Business	35
31-35	30	Divorced	0	15,500-24,999	67	Obese (≥30)	42			Administrative	27
36-40	31	**Education**		25,000-39,999	19					Military/Police	2
41-45	23	SSC / O-Level	13	40,000-49,999	13	**Smoking**		**Alcohol**		Builder developed	29
46-50	15	HSC / A-Level	8	>50,000	7	Smoker	71	Occasional	41	Professional	37
51-55	4	Graduate / Post Graduate (i.e. BSc, MSc)	46	**Smoke and Alcohol**	53	Non-Smoker	66	Infrequent light	31	Manual labour	7
		Vocational (HND, HNC, BTEC, Electrician, Building, Plumbing)	70			Chain Smoker	47 (>10 cigarette)	Frequent Light	29		
						Casual Smoker	24 (< 9 cigarette)	Moderate	13		
								Heavier	7		
								No Alcohol	16		

6.2 Physical Characteristics of the Subjects

The mean weight of the whole group (n=137) irrespective of age was 86.34 (±9.21) kg; with an age distribution showing that the age group 21 – 25 had the highest mean weight 96.60 kg (± 7.53) and the group with the lowest mean weight was the 51 – 55 year group (82.65 kg; ± 5.14) (Table 6.2). These two groups however also had the smallest number of subjects in the groups and though interesting, these 'outlier' results need to be interpreted with caution.

The average height of the whole group (n=137) was 1.74; (± 0.07). There was very little variation in height, with a range from 1.71 metres (46 – 50 age group) to 1.77 metres (21 – 25 age group). Thus confirming that stunting was not a feature of this sample population.

Body mass index (BMI), a proxy measure of obesity in sedentary populations was calculated from the ratio of weight (kg) to the square of the height (m^2) i.e. kgm^{-2}. The mean BMI for the whole group was 28.44 (± 2.34) kgm^{-2} and the distribution across age groups show that the 21 – 25 age group has the highest BMI mean of 30.72 (± 1.41) kgm^{-2}. However all age groups had BMI mean values >25 kgm^{-2} thus indicating that all groups were at least overweight. Of the 137 subjects, only 11 (8.03%) had BMI values within the WHO normal range of 20 – 25 kgm^{-2}. Eighty four (n=84; 61.31%) of subjects were overweight and another 42 (30.66%) were obese, thus giving a combined overweight and obese (OW + OB) value of 91.93% of the sample population. This figure is far in excess of the national average of England based on Health Survey of England (HSE, 2009) prevalence data of 61.3% OW + OB across England (SACN, 2011). Over the period 1999 to 2009, the changing trends of overweight and obesity in England have shown a shift from 57.9% (1999) to 61.3% (2009). The figure of nearly 92% OW + OB reported in this present study of Punjabi adult males in Medway is >30% above the national average overweight and obesity rate in England.

Girth measurements taken included waist circumference (WC) and hip circumference (HC). The waist circumference ranged from 84.50 (± 0.59) cm (51 – 55 age group) to 96.0; ± 8.20 cm (21 – 25 age group) (Table 6.2). The whole group mean WC was 88.0 cm (±5.49). The normative values quoted by the All India Institute of Medical Sciences (WHO, 2008) are 80 – 84 cm. Thus this Punjabi group of adult males has a WC above the Indian national average as well as the WHO cut-off points.

The hip circumference (HC) varied between 91.00 cm (51 – 55 age group) and 104.24 cm (25 – 30 age group) with a whole group mean value of 101.0 (± 9.55) cm. This sample mean value exceeds the normative values (WHO cut-off of 85 cm for high risk group) for adult males.

The waist hip ratio (WHR) which is obtained by dividing the values of the WC and HC varied between 0.84 (26 – 30 age group) to 0.93 (21-25; 51-55 age groups) with an overall sample mean value of 0.87 (± 0.07). Waist to hip ratio (WHR) was highest among 21-25 years and lowest among 31-35 years. After the age of 35 years increasing trend of Waist to hip ratio is observed. BMI and WHR show similar patterns as the BMI decreases.

Table 6.2 Average BMI and W/H Ratio in 137 Punjabi male adults in Medway, Kent

Age (years)	**BMI (kg/m2)**	BMI[θ] Cut- offs	Nutritional Status	**W/H Ratio**	W/H Cut-offs[α]
Group 21-25	30.72	<18.5	Under weight	0.92	
Group 26-30	28.67	18.5-24.9	Normal weight	0.84	
Group31-35	27.67	25.29.9	Pre-obesity	0.83	>0.90 (High risk of Non communicable disease)
Group 36-40	28.46	30-34.9	Obesity Class I	0.86	
Group 41-45	28.78	35-39.9	Obesity Class II	0.88	
Group 46-50	28.37	40+	Obesity Class III	0.88	
Group 51-55	27.78			0.87	

[θ] WHO 2004 BMI Cut-off points (WHO, 2004); [α]WHO 2008, Waist Circumference and Waist-Hip Ratio (WHO, 2008)

Table 6.3 BMI - Waist Circumference according to BMI cut off ranges

BMI (kg/m^2)	**Waist Circumference(cm)**	**Waist Circumference(cm) Cut Offs[∞]**
18.5-24.99	83.82	
25-29.99	87	>85 High Risk of NCD[∞]
30-34.99	91.04	

[∞] WHO- Waist Circumference: Waist to Hip Ratio Cut off points (WHO, 2008

6.3 Physiological Measures: Systolic and Diastolic Blood Pressure

Mean systolic blood pressure (SBP) in the whole group was 135 (± 9.95) mm Hg in an otherwise apparently normal, healthy undiagnosed group of individuals. The age groups with higher SBP were the 21 – 25 group (142.5 ± 11.1 mm Hg); 40 – 45 age group (140.8; ± 9.37 mmHg); and the 46 – 50 age group (139.5 ± 9.23 mm Hg) (Table 6.4). With recent developments in relation to risk factors for chronic disease and using the WHO and ATP III (Takamiya, et al. 2004) definition criteria for the metabolic syndrome, a systolic BP of 135 mm Hg in a sedentary population with characteristics e.g. OW + OB; high WC and WHR such as has been described in this study is regarded appropriately as *"pre-hypertensive"*. Most age groups in this study are therefore in that 'borderline category' for elevated systolic blood pressure.

Similarly diastolic blood pressure (DBP) values varied between 84.5 (± 5.48) mm Hg in the 30 – 35 age group to 90 (±5.48) mm Hg in the 21 – 25 age group. The whole group mean DBP was 86.25 (± 5.17). These values of DBP lie on the upper end of the normal range for DBP.

Table 6.4 Physical and Physiological Measurements of adult males of Punjabi origin in Medway, Kent (n=137)

Age Groups		Wt (KG)	Height (m)	BMI (kg/m2)	Waist (CM)	Hip (CM)	W/H Ratio	BP Di mm/Hg	BP Sys mm/Hg
	Mean	96.60	1.77	30.72	96.00	103.67	0.93	90.00	142.50
Group 21-25	SD	7.53	0.04	1.41	8.20	7.50	0.03	5.48	11.10
	SEM	3.07	0.02	0.58	3.35	3.06	0.01	2.24	4.53
	Mean	87.74	1.75	28.67	86.93	104.24	0.84	85.24	133.52
Group 26-30	SD	9.28	0.07	2.96	4.83	8.88	0.09	5.05	8.54
	SEM	1.72	0.01	0.55	0.90	1.65	0.02	0.94	1.59
	Mean	83.29	1.74	27.67	86.67	100.67	0.87	84.53	132.67
Group 31-35	SD	8.07	0.06	2.08	4.48	10.08	0.07	5.48	9.41
	SEM	1.47	0.01	0.38	0.82	1.84	0.01	1.00	1.72
	Mean	87.50	1.75	28.45	88.45	103.32	0.86	85.39	134.42
Group 36-40	SD	10.76	0.06	2.43	5.07	10.92	0.06	4.88	10.51
	SEM	1.93	0.01	0.44	0.91	1.96	0.01	0.88	1.89
	Mean	84.10	1.71	28.78	87.57	98.57	0.89	88.04	140.78
Group 41-45	SD	7.65	0.06	2.42	6.36	7.31	0.04	4.87	9.37
	SEM	1.60	0.01	0.51	1.33	1.52	0.01	1.01	1.95
	Mean	87.67	1.76	28.36	87.60	99.20	0.89	88.67	139.47
Group 46-50	SD	8.40	0.09	0.64	5.11	9.38	0.05	4.29	9.23
	SEM	2.17	0.02	0.16	1.32	2.42	0.01	1.11	2.38
	Mean	82.65	1.73	27.78	84.50	91.00	0.93	88.25	133.25
Group 51-55	SD	5.14	0.08	0.69	0.58	0.00	0.01	2.87	10.53
	SEM	2.57	0.04	0.34	0.29	0.00	0.00	1.44	5.27
Total	**Mean**	**86.34**	**1.74**	**28.44**	**88**	**101**	**0.87**	**86.25**	**135.78**
	Median	**87.20**	**1.74**	**28.22**	**86.50**	**100.00**	**0.88**	**86.00**	**135.00**
	SD	**9.21**	**0.07**	**2.34**	**5.49**	**9.55**	**0.07**	**5.17**	**9.95**
	SEM	**0.78**	**0.01**	**0.20**	**0.47**	**0.81**	**0.01**	**0.44**	**0.85**

The co-efficient of determination (r^2) comparisons between body weight, systolic and diastolic blood pressure showed weak positive relationships (R^2=0.0535 and 0.0645 respectively) suggesting a 5.35% and 6.45% possible impact of body weight on SBP and DBP in this sample population. On the other hand taken independently, although these were apparently normal healthy subjects, they showed a mildly elevated blood pressure both systolic and diastolic, which could be regarded as pre-hypertensive.

Similarly comparing average BMI values with SBP and DBP, the co-efficient of determination r^2 were 0.1007 and 0.1091 respectively suggesting a potential 10 – 11% influence of BMI on SBP and DBP in this population (**Table 6.4**).

The waist to hip ratio (WHR) showed a much stronger co-efficient of determination with systolic blood pressure (R^2 = 0.7124 or 71.24% influence) and a moderate co-efficient of determination with diastolic blood pressure (R^2 = 0.2286 or 22.86% influence) but the waist circumference on its own only showed a 2.25% and 5.07% impact on SBP and DBP respectively.

6.4 Correlations between Variables

There were significant correlations between age and WHR (r=-0.229; p=0.033); diastolic BP (r=0.184; p=0.03); systolic BP (r=0.171; p=0.044). Similarly, significant but negative correlations were observed between age and energy intake (r= -0.198; p=0.02); protein intake (r=-0.207; p=0.015) and total fat intake (r=-0.208; p=0.014). Significant negative correlations were also observed between age and MUFA (r=-0.207; p=0.015); PUFA (r=-0.290; p=0.001) and the P/S ration (r= -0.230; p=0.007). However no particular associations were observed between age and the WC, SFA intake, total cholesterol intake, sugar and fibre intakes.

Weight also correlated significantly with BMI (r=0.703; p<0.001); WC (r=0.748; p<0.001); HC (r=0.561; p<0.001); diastolic BP (r=0.254; p=0.003); systolic BP (r=0.231; p=0.006) and the P/S ration (r=0.198; p=0.02) but not the WHR, total energy intake, fat intake or total cholesterol intake, total sugar and fibre intake.

Body mass index (BMI) correlated significantly with the WC (r=0.469; p<0.001); HC (r=0.224; p=0.008); diastolic BP (r=0.330; p<0.001)); and systolic BP (r=0.318; p<0.001) but not total energy intake, total fat, SFA, total cholesterol or dietary fibre intake. The WHR correlated with the P/S ratio (r=0.189; p=0.026) but not with other variables.

Similarly, significant but negative correlations were observed between age and energy intake (r=0.198; p=0.02); protein intake (r=-0.207; p=0.015) and total fat intake (r=-0.208; p=0.014). Significant negative correlations were also observed between age and MUFA (r=-0.207; p=0.015); PUFA (r=-0.290; p=0.001) and the P/S ration (r= -0.230; p=0.007) however no particular associations were observed between age and the WC, SFA intake, total cholesterol intake, sugar and fibre intakes.

6.5 Intergenerational Comparisons of Physical Characteristics and Blood Pressure

Comparisons between subjects of first (n=43) and second generation (n=94) showed that to a large extent the magnitude of the variables of interest were much higher among the second generation as demonstrated by the differences in means calculated e.g. in **Table 6.5** below however the differences were not always significant.

The mean age (SD) of the first generation was 40 (6.1) years compared to the second generation's age of 29 (6.1) years with differences in mean age (95% confidence interval) of 10.89 (8.95, 12.84) years (p= 0.001). Mean weight (SD) showed that the second generation with weights of 88.73 (9.53) kg were heavier than the first generation with weights of 85.3 (8.9) kg

(p= 0.047). A difference in mean (95% CI) was -3.46 (-6.887, -0.051). Similarly the mean (SD) values for height were 1.76 (0.06) m compared to 1.7 (0.1) m (p=0.038) between the second and first generation respectively with differences in mean (95% CI) of 0.023 (-0.046, -0.001) **(Table 6.5).**

For the body mass index, mean BMI (SD) were 28.3 (2.2) and 28.69 (2.63) kgm^{-2} respectively between first and second generation with a difference in means (95% CI) of -0.368 (-1.287, 0.550) however these differences were not statistically significant (p=0.475) suggesting that BMI was similar in the two groups. Similarly the waist circumference (WC) was 87.2 (5.1) cm in the 1^{st} generation and 88.95 (6.12) cm in the 2^{nd} generation with a difference in means (95% CI) of -1.795 (-3.930, 0.339) (p=0.098) and hip circumferences of 100.6 (9.5) cm v. 103.12 (9.46) cm and a difference in means of -2.558 (-6.027, 0.910) (p=0.146).

Table 6.5 Physical and Physiological Measurements of adult males of Punjabi origin in Medway, Kent(Iutergeneration Data)

Generation		Age (Years)	Wt (KG)	Height (m)	BMI (kg/m2)	Waist (CM)	Hip (CM)	W/H Ratio	BP Di mm/Hg	BP Sys mm/Hg
1st Generation	Mean	40.0	85.3	1.70	28.3	87.2	100.6	0.9	86.7	136.7
	Median	39.0	86.2	1.70	28.1	86.0	99.0	0.9	86.0	136.0
	SD	6.1	8.9	0.10	2.2	5.1	9.5	0.1	5.0	10.0
	CI 95% Upper	41.2	87.1	1.70	28.8	88.2	102.5	0.9	87.6	138.8
	CI 95% Lower	38.7	83.5	1.70	27.9	86.1	98.6	0.9	85.7	134.7
2nd Generation	Mean	29	88.73	1.76	28.69	88.95	103.12	0.87	85.37	133.63
	Median	29	89.50	1.78	29.04	88.00	103.00	0.90	85.00	135.00
	SD	3	9.53	0.06	2.63	6.12	9.46	0.08	5.57	9.53
	CI 95% Upper	29.9	91.6	1.80	29.5	90.8	105.9	0.9	87.0	136.5
	CI 95% Lower	28.2	85.9	1.70	27.9	87.1	100.3	0.8	83.7	130.8
	Differences in Mean	**10.89**	**-3.46**	**0.023**	**-0.368**	**-1.795**	**-2.558**	**0.004**	**1.280**	**3.119**
	CI 95% Upper	**12.84**	**-0.051**	**0.100**	**0.550**	**0.3389**	**0.910**	**0.030**	**3.252**	**6.711**
	CI 95% Lower	**8.95**	**-6.887**	**-0.046**	**-1.287**	**-3.930**	**-6.027**	**-0.022**	**-0.691**	**-0.4222**
	p-value	**0.0001**	**0.047**	**0.038**	**0.475**	**0.098**	**0.146**	**0.758**	**0.200**	**0.084**

The mean (SD) waist-hip-ratio (WHR) were 0.9 (0.1) and 0.87 (0.08) respectively between first and second generation with a difference in means (95% CI) of -0.004 (-0.022, 0.030) (p=0. 758); systolic blood pressure (SBP) was 136.7 (10.0) and 133.63 (9.53) mm Hg in the 1st and 2nd generations respectively with a difference in means (95% CI) of 3.119 (-0.422, 6.711) (p=0.084) and diastolic blood pressure (DBP) of 86.7 (5.0) v. 85.37 (5.57) mm Hg and a difference in means of -1.280 (-0.691, 3.252) (p=0.200).

6.6 Energy and Macronutrient Intakes

Analysis of data on energy and macronutrient intake is displayed in **Table 6.6** below. Mean (SD) energy intake among the whole group (n=137) was 3201.79 (1219.14) kcal/ i.e. 13.41(5.10) MJ/day. The UK estimated average intake (EAR) for energy was sufficient to meet the needs of

50% of the population intake for males is 2550 kcal/day (SACN, 2011). This shows that there is an excess intake of 651 kcal/day in this sample population. The highest energy intake of 3573.83Kcal (932.19) was observed in the age group 21 to 25 years and the lowest energy intake of 2551.69 Kcal (1420.31) recorded in those 46 to 50 years. The correlation between age and energy intake in this study was r= -0.198 (p=0.020).

Mean (SD) intake of fat was 119.25 (61.24) g/day **(Table 6.6)**. The total fat intake appears to decrease with age; with the percentage contribution of energy from fat being highest among 21-25 age group and contributing to a total calorific intake of 36.11%. The lowest percentage of energy from fat is however observed in the age group of 41-45 years. In terms of magnitude, the actual amounts of fat intake varied between 98 g (98.09 g; ± 73.32 and 99.31 g; ± 78.14) in the 46 – 50 and 51 – 55 age groups respectively; with higher intakes among younger groups, up to as high as 144 g and 143 g in the 21 – 30 age group. As a proportion of total daily energy intake, this amount of fat is higher than would be expected especially in a largely sedentary population. The large standard deviation values indicate very wide variation in intake within and between the groups.

The distribution of fat intake **(Table 6.6)** shows that total fat, MUFA, PUFA and the P/S ratio show significant negative correlations with age, but SFA intake does not show significant age-related correlation. Pearson's correlation coefficient shows correlations between age and total fat (r= -0.208; p=0.014); MUFA (r= -0.207; p=0.015); PUFA (r= - 0.290; p=0.001) and P/S ratio (r= -0.230; p=0.007). Although no significant correlation was found between age and SFA, overall, the intake of SFA was high, with a group mean (SD) of 37.38 (21.17) g/d. United Kingdom recommended intakes stipulate that the contribution of SFA as a percentage of total fat intake should not exceed 11% (BDA, 2009) and 10% of total energy. In this study, all age groups without exception had mean SFA intake contributing between 32 and 41% of dietary energy from fats.

Similarly, the recommendation for MUFA is not to exceed 15% of energy from fat but in this sample population, MUFA intake was 44.41 (24.94) g/day, contributing between 12.70 (1.19)% of total daily energy **(Table 6.6)** thus exceeding the recommendations. Highest intake of MUFA was observed in the 36-40 age group and lowest in the 31-35 group. Polyunsaturated fatty acids (PUFA) should contribute up to 7% of total energy. However these percentage values can be misleading especially if the total fat intake as a whole is in excess of recommendations. In this study, the PUFA intake was 29.08 (17.02) g/day contributing about 8.15% of total energy on average. A breakdown of the data into *cis*- and trans-fatty acids has not been included in the interpretation of findings here.

Total mean (SD) cholesterol intake in the whole group was 402 (248.33) mg /day with a very wide variation within and between groups. The highest intakes of 507 mg/day and 493 mg/day were observed in the 25 – 30 and 46 – 50 age groups respectively **(Table 6.6)**. The WHO recommendation (WHO, 2002) and UK Dietary Reference Value (RNI) for total cholesterol intake is <300 mg /day in normal healthy individuals with no high risk of cardiovascular disease or diabetes and <200 mg/day for those at high risk.

Table 6.6 Energy and Macro-nutrient intake among 137 adult males of Punjabi origin in Medway, Kent

		Energy (Kcal)	Energy (MJ)	Protein (g)	Total Fat (g)	SFA (g)	MUFA (g)	PUFA (g)	P/S Ratio	Cholesterol (mg)	CHO (g)	Intrinsic Sugar(g)	Extrinsic Sugar(g)	Dietary Fibre (g)
Group 21-25														
	Mean	3573.86	15.36	108.08	143.37	46.87	52.95	43.54	1.09	317.54	462.80	121.91	124.89	14.53
	SD	932.19	3.90	14.10	47.06	19.44	13.67	15.35	0.31	112.38	140.21	24.77	66.65	9.33
	SEM	380.57	1.59	5.76	19.21	7.94	5.58	6.27	0.13	45.88	57.24	10.11	27.21	3.80
Group 26-30	**Mean**	3401.64	14.59	129.48	144.66	52.18	52.47	39.99	0.92	507.84	395.44	111.56	55.05	14.14
	SD	1418.40	5.94	66.35	74.84	27.30	32.96	21.91	0.57	270.19	155.26	41.80	29.82	12.07
	SEM	263.39	1.10	12.32	13.90	5.07	6.12	4.07	0.10	50.17	28.83	7.76	5.54	2.41
Group 31-35	**Mean**	3178.60	13.80	109.31	114.43	44.32	32.00	38.10	0.84	357.23	427.88	134.59	61.70	17.74
	SD	999.09	4.18	25.17	51.72	17.88	20.95	12.39	0.27	116.63	147.23	89.60	32.78	10.40
	SEM	182.41	0.76	4.60	9.44	3.26	3.83	2.26	0.05	21.29	26.88	16.36	5.98	1.89
Group 36-40	**Mean**	3078.05	13.23	105.72	117.02	41.47	45.14	30.40	0.80	389.20	400.50	103.49	70.21	11.93
	SD	1204.66	5.04	46.71	50.41	16.67	19.91	14.08	0.32	276.56	176.53	62.73	51.50	6.34
	SEM	216.36	0.91	8.39	9.05	2.99	3.58	2.53	0.06	49.67	31.71	11.27	9.25	1.38

Table 6.6 Energy and Macro-nutrient intake among n=137 adult males of Punjabi origin in Medway, Kent (Cont.)

		Energy (Kcal)	Energy (MJ)	Protein (g)	Total Fat (g)	SFA (g)	MUFA (g)	PUFA (g)	P/S Ratio	Cholesterol (mg)	CHO (g)	Intrinsic Sugar (g)	Extrinsic Sugar (g)	Dietary Fibre (g)
Group 41-45	Mean	3000.42	13.04	97.20	107.51	36.30	40.38	30.83	0.99	322.27	411.01	116.93	56.22	16.48
	SD	1115.13	4.67	41.03	53.91	19.07	20.50	14.84	0.46	186.10	134.21	26.49	32.13	5.87
	SEM	232.52	0.97	8.55	11.24	3.98	4.27	3.09	0.10	38.80	27.98	5.52	6.70	1.22
Group 46-50	Mean	2551.69	11.02	95.46	98.09	39.74	35.63	22.72	0.65	493.09	321.77	114.30	41.94	14.80
	SD	1420.31	5.95	63.53	73.32	22.37	28.73	19.25	0.17	380.30	129.00	49.35	24.10	8.17
	SEM	366.72	1.54	16.40	18.93	5.78	7.42	4.97	0.04	98.19	33.31	12.74	6.22	2.11
Group 51-55	Mean	2649.75	11.31	70.81	99.31	40.46	33.53	25.23	0.34	319.53	368.17	121.87	139.98	10.56
	SD	1246.94	5.22	53.47	78.14	31.75	31.58	10.09	0.01	212.18	71.80	22.42	62.25	8.22
	SEM	623.47	2.61	26.73	39.07	15.87	15.79	5.05	0.01	106.09	35.90	11.21	31.12	4.11
Total	**Mean**	3201.79	13.41	108.05	119.25	37.38	44.41	29.08	**0.8**	402.18	400.36	116.70	64.17	15.23
	Median	3279.64	13.73	105.36	108.96	33.68	40.44	23.88	**0.7**	349.15	395.58	107.41	56.55	14.42
	SD	1218.48	5.10	49.40	61.24	21.17	24.94	17.02	**0.4**	248.33	151.09	58.57	43.40	9.14
RNI / AI / EAR		2550		0.8g/kg (BW)		10g/day					55% of Total Energy			24g/day

Table 6.7 Comparing Age, energy intake and body mass index in n=137 adult males of Punjabi origin in Medway, Kent

	Age (yrs)	Energy (Kcal)	Energy (MJ)	BMI (Kg/m^2)	BMI[θ] Cut- offs	Nutritional Status	Adult Energy Intake (Kcal)
Group	21-25	3573.86(±932.19)	15.05(±3.90)	30.68(±1.41)	<18.5	Under weight	
Group	26-30	3401.64(±1418.40)	14.28(±5.94)	28.70(±2.96)	18.5-24.9	Normal weight	
Group	31-35	3178.60(±999.09)	13.51(±4.18)	27.66(±2.08)	25.29.9	Pre-obesity	2550[Ŧ]
Group	36-40	3078.05(±1204.66)	13.23(±5.04)	28.38(±2.43)	30-34.9	Obesity Class I	
Group	41-45	3000.42(±1115.13)	13.04(±4.67)	28.80(±2.42)	35-39.9	Obesity Class II	
Group	46-50	2632.12(±1420.31)	11.02(±5.95)	28.32(±0.64)	40+	Obesity Class III	
Group	51-55	2701.67(±1246.94)	11.31(±5.22)	27.78(±0.69)			

[θ] WHO 2002 BMI Cut-offs (WHO, 2002); [Ŧ] Recommended Adult Male Energy Intake (NHS, 2012)

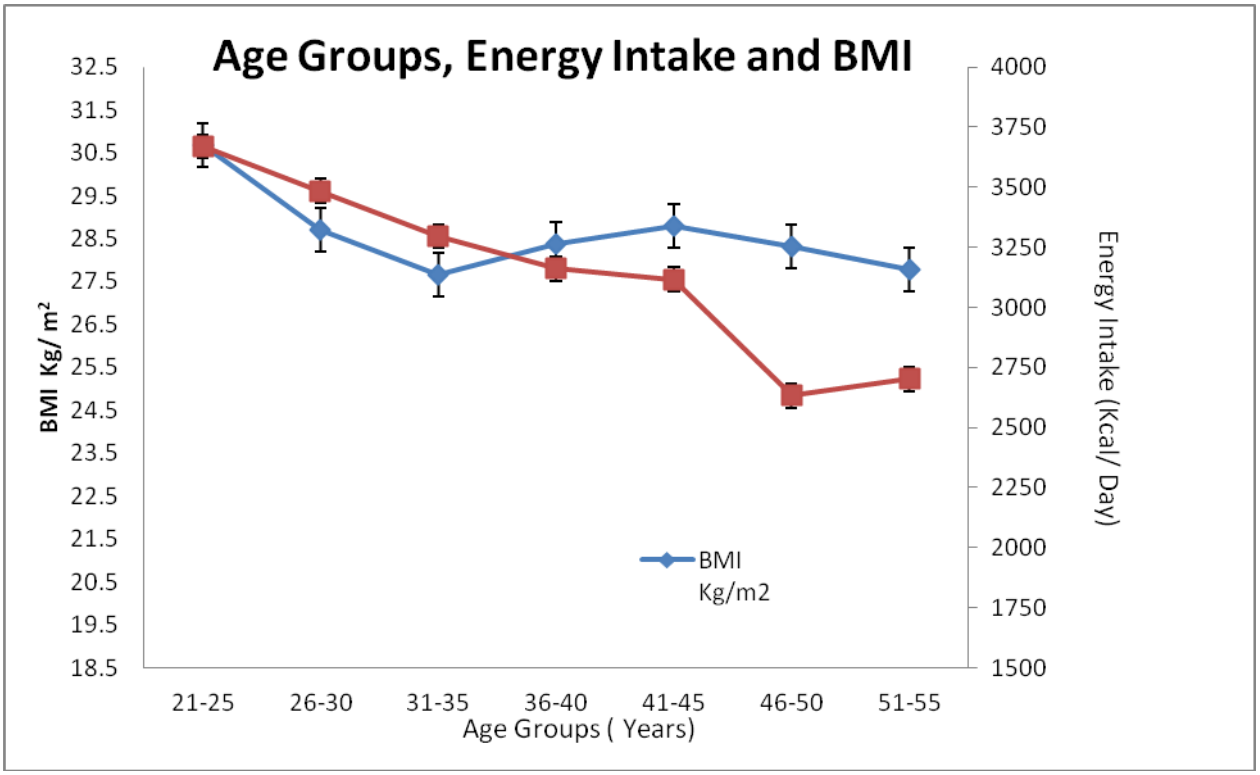

Figure 6.1 Age (X Axis) BMI (Y Axis) –Energy Intake (Z Axis) in 137 Punjabi male adults in Medway, Kent

Table 6.8 Percentage energy contribution from protein, fat and carbohydrate

Age groups	%Protein	%Fat	% CHO	%SFA
Group 21-25	12.10	36.11	51.80	11.80
Group 26-30	15.23	38.27	46.50	13.80
Group 31-35	13.76	32.40	53.85	12.54
Group 36-40	13.74	34.22	52.05	12.12
Group 41-45	12.96	32.25	54.79	10.88
Group 46-50	14.96	34.60	50.44	14.01
Group 51-55	10.69	33.73	55.58	13.74
Mean	13.35	34.51	52.14	12.70
Median	13.74	34.22	52.05	12.54
SD	1.59	2.12	3.07	1.19
CI 95% Upper	14.53	36.08	54.42	13.58
CI 95% Lower	12.17	32.94	49.87	11.82

The mean (SD) carbohydrate intake was 400.36 (151.09) g/day with intrinsic and extrinsic sugars contributing 116.70 (58.57) g/day and 64.17 (43.40) g/day respectively. The percentage contribution of carbohydrate to total energy was 52.14 (3.07) %. There appears to be an inverse relationship between age group and carbohydrate intake, the amount of carbohydrate intake increasing with age **(Table 6.6 and Table 6.8)** above. In the 26 to 30 age group, 46.50% of total energy came from carbohydrate. The age Group 51-55 were found to consume the highest percentage (55.58%) of energy from carbohydrate **(Table 6.6, Table 6.8 and Figure 6.2)** in relative terms. In real terms of magnitude, the total carbohydrate intake was high, ranging between 321 g and 462 g with the whole group mean of 400.36 (±151.09) g/day. This also shows very wide within-group and between-group variations in intake suggesting that among the subjects, there were habitual high carbohydrate/energy consumers.

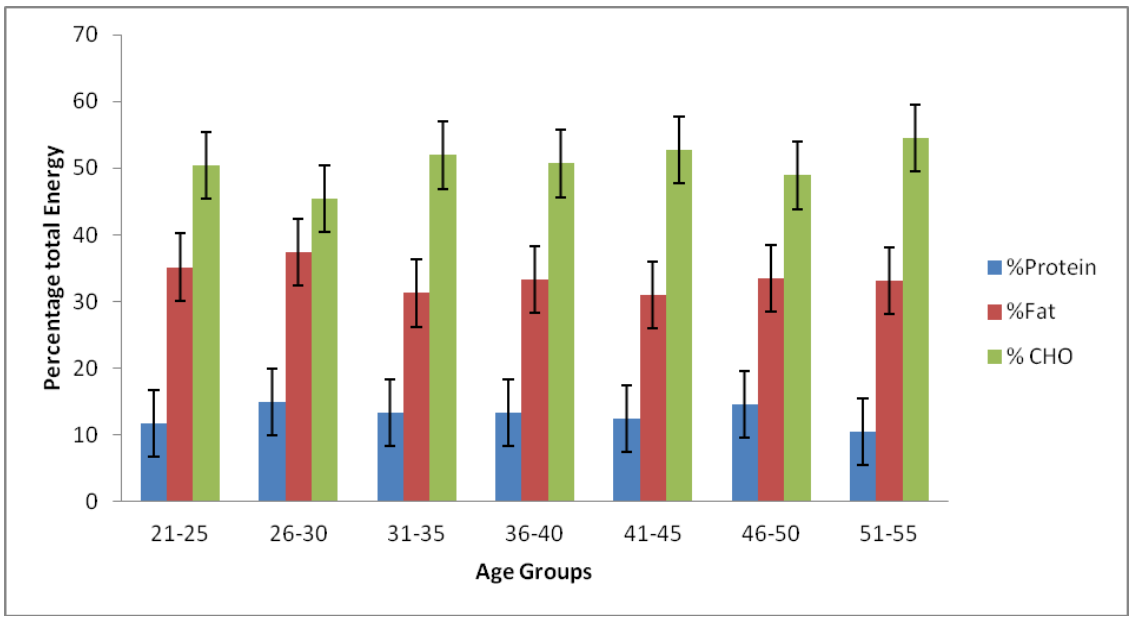

Figure 6.2 Percentage energy contribution from Macro nutrient in different age groups

Table 6.9 Percentage fat constituent - SFA, MUFA & PUFA as a percentage of total dietary fat intake per day from main study group

Age Group	SFA%	MUFA%	PUFA %
Group 21-25	32.69	36.96	30.36
Group 26-30	36.07	36.27	27.65
Group 31-35	38.73	27.97	33.29
Group 36-40	35.44	38.57	25.97
Group 41-45	33.76	37.55	28.67
Group 46-50	40.51	36.32	23.16
Group 51-55	40.74	33.76	25.50
Mean	**36.85**	**35.34**	**27.81**
Median	**36.08**	**36.33**	**27.65**
SD	**3.20**	**3.57**	**3.36**
95% CI Upper	**39.22**	**37.99**	**30.29**
95 % CI Lower	**34.48**	**32.70**	**25.31**

The mean (SD) protein intake for the whole group was 108.05 (49.40) g/day. The contribution of protein to daily total caloric intake ranges from 10.96 to 15.23%. This appears to be within the range of dietary recommendations except that the actual amount of protein consumed is much higher than the daily recommended values **(Table 6.10)**.

Table 6.10 Excess protein consumption per day according to body weight

Age Groups	Weight (kg)	Recommended† 0.8g/kg	Average Daily Intake (g)	Intake g/Kg BW	Excess Intake g/Kg BW	Excess g/day
Group 21-25	96.6(±7.52)	77.28(±6.01)	108.08(±14.10)	1.12(±0.21)	0.32(±0.21)	30.80(±18.90)
Group 26-30	87.74(±9.28)	70.19(±7.42)	129.48(±6.35)	1.48(±0.68)	0.68(±0.68)	59.28(±14.97)
Group 31-35	83.29(±8.07)	66.63(±6.51)	109.31(±15.02)	1.33(±0.37)	0.51(±0.37)	42.67(±28.24)
Group 36-40	87.50(±10.76)	70.00(±8.61)	105.72(±13.46)	1.24(±0.60)	0.41(±0.60)	35.71(±19.25)
Group 41-45	84.1(±7.65)	67.28(±6.12)	97.20(±14.03)	1.16(±0.48)	0.36(±0.48)	29.91(±17.29)
Group 46-50	87.67(±8.39)	70.13(±6.71)	95.46(±16.15)	1.09(±0.73)	0.29(±0.73)	25.31(±14.16)
Group 51-55	82.65(±5.1)	66.12(±4.11)	70.81(±15.43)	0.86(±0.0.1)	0.06(±0.01)	4.69(±1.63)
Mean	**87.08**	**69.66**	**102.29**	**1.17**	**0.37**	**32.63**
Median	**87.50**	**70.00**	**105.72**	**1.16**	**0.36**	**30.80**
SD	**4.73**	**3.79**	**17.78**	**0.19**	**0.19**	**16.66**
SEM	**1.79**	**1.43**	**6.72**	**0.07**	**0.07**	**6.30**
95% CI Upper	**90.59**	**72.47**	**115.47**	**1.33**	**0.52**	**44.97**
95% CI Lower	**83.57**	**66.86**	**89.12**	**1.04**	**0.23**	**20.28**

As shown in **Table 6.10**, protein intake has been broken down into consumption by different age groups and also per kg body weight per day (**Table 6.10**). Protein age distribution of intake showed a similar pattern to fat intake, with the younger age groups consuming much higher amounts of protein. The 51 – 55 age group had a mean intake of 70.81 g (± 53.47) compared to intakes of 108 g (± 14.1) and 129.48 g (± 66.35) in the 21 -25 and 26 – 30 age groups respectively. For the typical UK population, the recommendation for daily protein intake per kg body weight is 0.8 gram (SACN 2011) and in India, for a 70 kg man, the recommendation is 60 g of total protein per day which works out as 0.85 g/kg/dl ay (NIN 2010). In this study, apart from the age group of 51-55 years whose average protein intake was 70.81 g (± 15.43) close to

the recommendation of 66.12 g /d for the average weight of the group, all other age groups showed a marked increase in protein intake per day compared to recommendations. Overall, the whole group had a mean protein intake of 102.29 g/day (compared to the recommended 0.8 g/kg/day) which works out as a difference of 0.37 g/kg/day, and an excess of 32.63 g (± 16.66) of protein intake per day.

6.7 Sugar and Fibre intake

The mean (SD) sugar intake from intrinsic sources in foods was 116.70 g (± 58.57) per day with a range from 103 g (36 – 40 age group) to 134 g (31 – 35 age group) i.e. an energy equivalent of 412 to 536 kcal/day **(Table 6.6 above)**. In addition, added or extrinsic sugar content of the diet amounted to an average of 64.17 (± 43.40) g/day with a range from 41 g (46 – 50 age group) (equivalent to 84 kcal/d) to 139 g (51 – 55 age group) (equivalent to 556 kcal/d). This provides a total range of sugar intake from 496 kcal to 1096 kcal per day extra, i.e. suggesting that in this study group sugar alone could contribute to one-third of the total daily caloric intake. There was however a wide variation of intakes across the age groups. The 51 - 55 age group had the highest extrinsic (added) sugar intake although their intake of intrinsic sugar was not particularly high.

Mean (SD) dietary non-starch polysaccharides (NSP) or fibre intake in the whole group was 15.23 g /day (9.14) with a wide variation among subjects. The range of intakes among different age groups was from 10 g /day in the 51 – 55 age group to 18 g /day in the 31 – 35 age group. The fibre intakes are below levels recommended for the general UK and Indian population. The UK EAR for fibre, sufficient to meet the needs of 50% of the population is 18 g/day and the RNI sufficient to meet the needs of up to 97.5% per cent of the population is 24 g/day. In this study, fibre intakes across the group were below the EAR value, but with wide variations among individuals within and between groups, therefore, mean intake only provides up to 63.5% of the RNI value.

6.8 Intergenerational Comparisons of Energy Intake and Macronutrient Intakes

Energy Intake (EI) and macro nutrient comparisons between subjects of first (n=43) and second generation (n=94) showed intergenerational differences. Mean (SD) of EI in the first generation was 3060.8 (±1209.9) kcal/day compared to the second generation's 3513.24 (±1192.69) kcal/day with differences in mean (95% CI) of -452.43 (-890.46, -14.39) (p= 0.043). Mean (SD) protein intake of the second generation was 121.66 (±54.71) g/day compared to 101.9 (±45.8) g in the 1st generation and a difference in means (95% CI) of -19.77 (-38.87, -0.680) (p=0.043) **(Table 6.11).**

Mean total fat (SD) intakes were 114.0 (±58.3) and 130.91 (±66.55) g respectively between first and second generations with a difference in means (95% CI) of -16.92 (-40.40, 6.55) however these differences were not statistically significant (p=0.155) suggesting that total fat intake was similar in the two groups. The mean (SD) values for PUFA were 32.97 (±18.20) g v. 27.3 (±16.2) g (p=0.086) in 1st and 2nd generations respectively with a difference in means (95% CI) of -5.64 (-12.09, 0.809). Similarly the saturated fatty acid (SFA) intake was 36.0 (±19.8) g in the 1st generation compared to 40.40 (±23.95) g in the 2nd generation with a difference in means (95% CI) of -4.38 (-12.71, 3.953) (p=0.298) and MUFA was 42.30 (±23.0) g v. 48.99 (±28.59) g and a difference in means of -6.657 (-16.54, 3.233) (p=0.184).

Table 6.11 Intergenerational comparisons: Energy and macronutrient intake among n=137 adult males of Punjabi origin in Medway, Kent

Generation		Energy (Kcal)	Energy (MJ)	Protein (g)	Total Fat (g)	SFA (g)	MUFA (g)	PUFA (g)	P/S Ratio	Cholesterol (mg)	CHO (g)	Intrinsic Sugar(g)	Extrinsic Sugar(g)	Dietary Fibre (g)
1st Generation	Mean	3060.8	12.8	101.9	114.0	36.0	42.3	27.3	0.8	386.9	384.5	113.0	63.9	14.4
	Median	3181.0	13.3	100.2	110.3	31.5	40.5	23.9	0.7	342.7	393.8	104.2	53.8	12.1
	SD	1209.9	5.1	45.8	58.3	19.8	23.0	16.2	0.4	248.6	149.2	55.8	43.7	8.2
	95% CI Upper	3304.1	13.8	111.1	125.7	40.0	47.0	30.6	0.9	463.9	414.5	124.3	33.4	16.0
	95% CI Lower	2817.5	11.8	92.7	102.3	32.0	37.7	24.1	0.7	336.9	354.5	101.8	27.9	12.7
2nd Generation	Mean	3513.24	14.71	121.66	130.91	40.40	48.99	32.97	0.9	435.86	435.38	124.78	64.79	17.07
	Median	3696.22	15.48	116.25	105.11	35.85	40.35	24.05	0.7	354.66	431.78	112.88	56.55	16.38
	SD	1192.69	4.99	54.71	66.55	23.95	28.59	18.20	0.4	247.19	150.99	64.17	43.21	10.83
	95% CI Upper	3869.7	16.2	138.0	150.8	47.6	57.5	38.4	1.0	509.7	480.5	144.0	77.7	20.3
	95% CI Lower	3156.8	13.2	105.3	111.0	33.2	40.4	27.5	0.8	362.0	390.3	105.6	51.9	13.8
	Differences in Mean	-452.43	-1.894	-19.77	-16.92	-4.38	-6.657	-5.64	-0.066	-48.92	-50.88	-11.74	-0.897	-2.683
	95% CI Upper	-14.39	-0.060	-0.680	6.55	3.953	3.233	0.809	0.085	41.62	4.140	10.85	14.95	1.016
	95% CI Lower	-890.46	-3.729	-38.87	-40.40	-12.71	-16.54	-12.09	-0.218	-139.47	-105.91	-34.35	-16.75	-6.384
	p-values	0.043	0.043	0.043	0.155	0.298	0.184	0.086	0.386	0.286	0.069	0.304	0.911	0.152

Polyunsaturated to Saturated fatty acid ratio (P/S ratio) between first and second generations was 0.8 (±0.4) v. 0.9 (±0.4) with a difference in means (95% CI) of -0.066 (-0.218, 0.085) (p=0.386). Total cholesterol, carbohydrate, intrinsic sugar, extrinsic sugar and dietary fibre intake among first and second generation were, 386.9 (±248.6) v. 435.86 (±247.19) mg; difference of means of -48.92 (-139.47, 41.62); 384.4 (±149.2) v. 435.38 (±247.19) g (p=0.286), difference in means, -50.88 (-105.91, 4.14) (p=0.069); 113.0 (±55.8) v. 124.78(±64.17) difference in means, -11.74 (-34.35, 10.85) (p=0.304); 63.9 (±43.7) v. 64.79 (±43.21) g, difference in means, -0.897 (-16.75, 14.95) (p=0.911); and dietary fibre (NSP) 14.4 (±8.2) v. 17.07 (±10.83) g), difference in means, -2.683 (-6.384, 1.016) (p= 0.152) respectively between the 1st and 2nd generation respectively. Thus there was no statistical difference in intake of all the macronutrients except protein.

6.9 Mineral Intake for the study cohort

Intake of all minerals apart from iodine was higher than RNI values among this sample population. However, there was a gradual decrease in mineral intake as age increases. Those in the age group 51-55 years had the lowest intake of all minerals compared to other groups. Minerals of particular interest to this study include calcium, (Ca), iron (Fe), sodium (Na), potassium (K), magnesium (Mg), zinc (Zn), copper (Cu), Iodine (I) and selenium (Se).

Mean calcium (Ca) intake for the whole group was 829.25 mg/day (± 508.23) with little variation between the groups although within-group variations in intake was observed. The range of intakes of calcium were from 725 mg/d (in the 41 – 45 age group) to 966.33 mg/day (in the 26 – 30 age group). The intakes of calcium met the UK RNI value of 700 mg/day for adults.

The distribution of iron (Fe) intakes generally good with a mean intake of 17.73 mg/day (± 8.11) for the whole group, compared to the RNI value of 14.8 mg/day. The 46 – 50 age group and 51 – 55 age group however showed lower intakes of Fe.

Sodium (Na) intake was of particular interest because of its links to hypertension and oher forms of cardiovascular disease. In this group, the Na intake reported is solely from intrinsic Na from dietary analysis, and does not include extrinsic or extra Na e.g. added to meals at table. Therefore the intake reported may be an under-estimation of actual individual intake. The mean value for the whole group was 2575.63 mg/day (±1305) which is equivalent to intake of 6438 mg/day of salt with a range between 1616 mg/day in the 51 – 55 age group and 2790 mg/day in the 26 – 30 age group. There was also wide within and between-group variations in intake. The intakes as reported here exceed the upper limit of 6 g/day recommended by the Food Standards Agency (DOH, 1991; FSA; Department of Health, 2008;) by at least 400 mg per day despite the fact that these values do not take into account added salt and so may be an under-estimation of actual Na intake in this group.

Potassium (K) intake on average was 3824.44 mg/day (± 1305) with a range from 2882 mg/d (±1797.65) in the 46 – 50 age group to 4026.20 mg/d (±1824.06) in the 26 – 30 age group. Potassium intake is adequate (UK RNI is 3500 mg/day) to meet the metabolic requirements and in particular its role in the modulation of blood pressure and cardiovascular health (Mierlo et al., 2010; Kelly et al., 2012).

Magnesium (Mg) intake varied between 301 mg/day and 491 mg/day with the lower intake observed among the 51 – 55 age group. The overall sample mean intake was 437.80 mg/day (± 177.78). this compares favourably with the UK RNI value of 300 mg/day and is enough to meet individual needs. There was however individual variation within and between groups.

Zinc intake also varied within groups but the overall mean intake for the whole group was 14.55 mg/day (± 6.64) wih a range between the groups from 10.58 mg/day in the 51 – 55 age group to 15.70 mg/day in the 26 – 30 age group. The RNI value for Zn is 9.5 mg/day and the intakes in this group meet the requirements. Mean copper (Cu) intake for the whole group was 4.03 mg/day, ranging from 3.25 mg/day to 4.55 mg/day. These intakes of Cu are more than twice the RNI value of 1 – 1.2 mg/day for adult males in the UK. Copper is an antioxidant with known cardioprotective properties and this intake is not excessive but potentially benefitial to the subjects.

Selenium (Se) is an antioxidant mineral important in over 100 reactions involving metallo-enzymes such as glutathione peroxidase. Intake of selenium is however difficult to measure and the values reported are usually incomplete.

However in this study, values of Se intake observed are just under the RNI value of 60 µg/day. The whole group mean Se intake was 55.86 µg/day with a low range from 29.66 µg in the 21 – 25 age group to 60.96 µg in the 31 – 35 age group. Wide within and between-group variations were also observed thus suggesting that whereas some individuals consumed adequate or high amounts of Se, others were habitually consuming low amounts of this mineral.

Iodine intake showed a mean value for the whole group of 61.01 µg/day (± 32.84). This intake is far less than 50 per cent of recommended intakes of 140 µg/day in the UK. The range of intakes varied from 36.74 µg/day in the 21 – 25 age group to 71.70 µg in the 41 – 45 age group. This low iodine intake suggests that subjects are not consuming good sources of iodine such as sea food. Furthermore, it also suggests that the bulk of the salt they are consuming is not iodised are not common in the UK for this group.

Table 6.12 Daily mineral intake among adult male Punjabis in Medway, Kent (n=137)

		Ca (mg)	Fe (mg)	Mg (mg)	P (mg)	K (mg)	Na (mg)	Cl (mg)	Zn (mg)	Cu (mg)	Se (mcg)	Mn (mcg)	I (mcg)
Group 21-25	Mean	766.90	18.45	491.51	1663.09	3753.18	2576.89	1575.77	13.82	4.55	29.66	4288.10	36.74
	SD	286.11	2.19	98.45	450.29	1248.52	1210.02	825.16	2.59	0.62	4.50	1237.13	8.33
	SEM	116.80	0.89	40.19	183.83	509.70	493.99	336.87	1.06	0.25	1.84	505.06	3.40
Group 26-30	Mean	966.33	18.57	464.72	1859.20	4342.95	2790.79	2524.67	16.33	3.58	71.27	4202.19	84.66
	SD	454.64	8.60	178.71	744.98	1824.06	1208.29	1088.52	8.15	1.14	26.02	2106.51	28.31
	SEM	84.42	1.60	33.19	138.34	338.72	224.37	202.13	1.51	0.21	4.83	391.17	5.26
Group 31-35	Mean	834.10	18.29	478.55	1707.89	4026.20	2401.44	2030.12	15.70	4.35	47.16	4765.77	54.83
	SD	394.65	6.86	146.44	406.93	1485.47	954.64	1132.32	3.91	1.16	21.24	1640.81	24.99
	SEM	72.05	1.25	26.74	74.29	271.21	174.29	206.73	0.71	0.21	3.88	299.57	4.56
Group 36-40	Mean	785.37	18.41	416.08	1598.44	3474.17	2970.02	2434.82	14.11	4.37	60.95	3912.58	52.10
	SD	653.30	10.05	199.89	850.09	1594.39	1388.21	1291.08	7.26	4.90	35.23	1786.98	29.03
	SEM	117.34	1.81	35.90	152.68	286.36	249.33	231.88	1.30	0.88	6.33	320.95	5.21
Group 41-45	Mean	725.27	16.37	447.98	1546.45	3881.16	2354.13	1927.45	13.52	4.28	52.15	4395.35	53.53
	SD	405.10	6.98	171.84	683.25	1470.11	1362.94	1431.16	5.99	2.66	28.13	2022.06	25.34
	SEM	84.47	1.46	35.83	142.47	306.54	284.19	298.42	1.25	0.56	5.87	421.63	5.28
Group 46-50	Mean	851.05	17.07	348.36	1457.75	3335.12	2288.20	1902.70	12.65	3.25	55.92	2803.12	71.70
	SD	646.21	8.67	186.28	947.29	1797.65	1714.17	1667.61	7.91	1.49	44.14	1494.41	52.03
	SEM	166.85	2.24	48.10	244.59	464.15	442.60	430.58	2.04	0.38	11.40	385.86	13.43
Group 51-55	Mean	748.90	11.53	301.86	1297.96	2882.34	1616.49	1421.15	10.58	3.27	30.90	2837.37	44.41
	SD	707.83	7.08	210.26	891.99	1910.83	1390.38	1284.10	7.72	1.19	21.33	1179.55	27.02
	SEM	353.91	3.54	105.13	446.00	955.42	695.19	642.05	3.86	0.60	10.67	589.78	13.51
Total	**Mean**	**829.25**	**17.73**	**437.80**	**1647.17**	**3824.44**	**2575.66**	**2156.63**	**14.55**	**4.03**	**55.87**	**4103.94**	**61.01**
	Median	**767.99**	**16.38**	**418.74**	**1559.14**	**3817.63**	**2398.34**	**1950.71**	**13.56**	**3.72**	**51.86**	**3875.86**	**55.98**
	SD	**508.23**	**8.11**	**177.78**	**719.91**	**1632.29**	**1305.15**	**1284.05**	**6.64**	**2.72**	**31.07**	**1871.17**	**32.84**
	SEM	**43.26**	**0.69**	**15.13**	**61.28**	**138.95**	**111.10**	**109.31**	**0.56**	**0.23**	**2.64**	**159.28**	**2.79**
RNI (LRNI)		**700(400)**	**8.7(8)**	**300(150)**		**3500(2000)**	**2400**	**2500**	**9.5(4)**				**140(70)**

6.10 Vitamin Intake among main study cohort

Overall vitamin intake among the subjects was adequate except vitamin D and B12 which were below their RNI values. The mean intake of vitamin A (retinal equivalent, RE) was 1835.55 µg/day (±605.60) compared to the RNI value of 700 µg/day. Intakes ranged from 1088 to 2759 µg/d (**Table 6.8** below).

Vitamins B6, B12 and folate are important in the methylation cycle and one-carbon transfer reactions. The mean intake of vitamin B6 among the whole group was 2.31 mg/day (± 0.45) although intake among the 51 – 55 age group (1.38 mg/day; ± 0.78) was below the RNI value of 1.6 mg/day. The group with the highest intake of B6 were the 26 – 30 age group with a mean intake of 2.80 µg/day (±1.29). Vitamin B12 intake was below the RNI value of 1.5 mg/day (1500 µg/day). Folate intake for the whole group (342.73 µg/day; ± 92.58) exceeded the RNI value (200 µg/day) in all the groups except the 51 – 55 age group whose intake of 149.61 (±62.51) µg/day was low. The range of intakes varied from 149 to 435 µg observed in the 46 – 50 age group.

Vitamin C intake was also adequate wit a whole group mean value of 212.93 (± 56.13) mg/day. The RNI for vitamin C is 40 mg/day for adults. The group with the highest intake in this study was the 31 – 35 age group whose mean consumption was 304.93 mg (±245.5) / day but there was wide within group variation in intake among this particular age group.

Vitamin D intake was low in this population with an overall mean of 5.63µg/day compared to the RNI value of 10 µg/day. None of the groups achieved the RNI for vitamin D. The range of intakes varied between 3.72 µg/day (± 1.39) in the 41 – 45 age group and 7.74 µ g/day (± 4.30) among the 26 – 30 age group. The intake among the 51 – 55 age group was also very low (4.44 µg/day; ± 3.36) and also show wide variation within the group. However it is worth noting that

the dietary data from repeated 24-hour recalls were collected between the Spring and summer months when significant amounts of vitamin D are likely to be produced de-novo from ultraviolet light from natural sunlight exposure. The pattern of vitamin D intake is shown in **Figure 6.3** below.

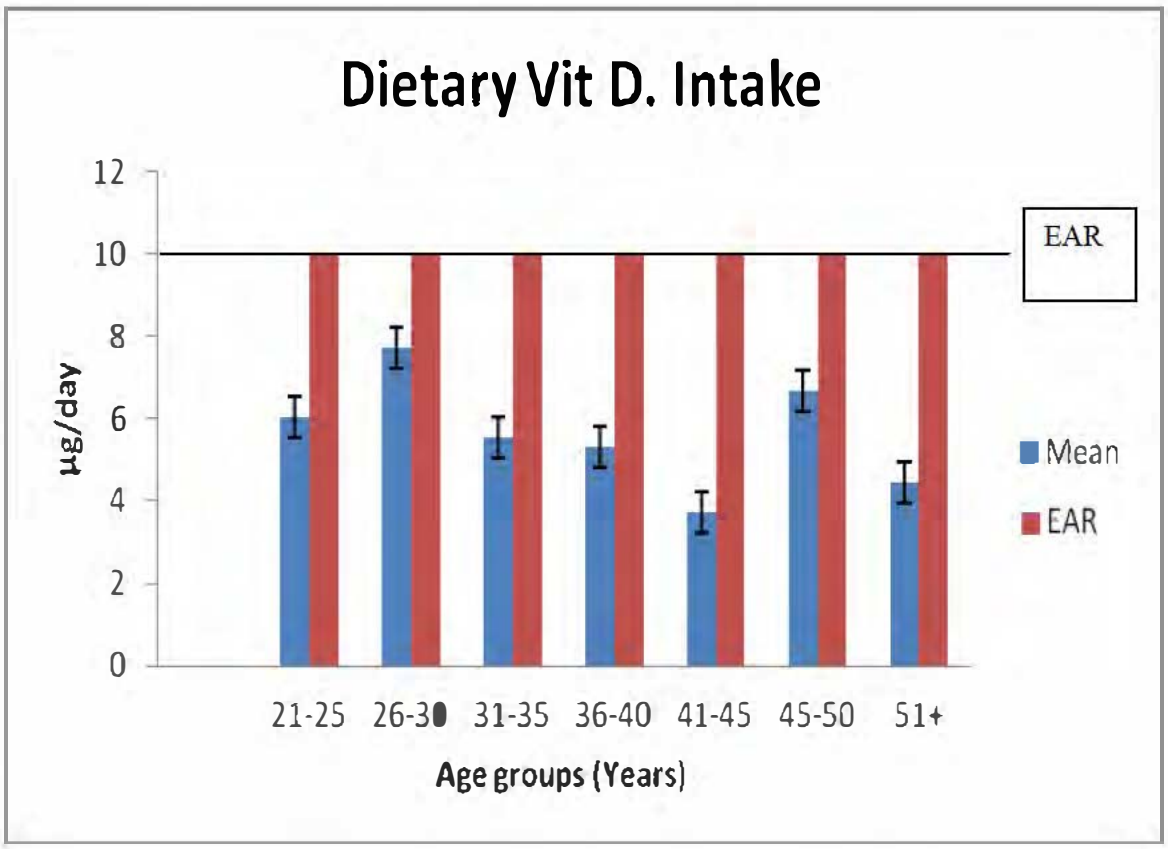

Figure 6.3 Vitamin D µg/day intake among adult male Punjabis in Medway, Kent (n=137)

Table 6.13 Daily Vitamin intake among adult male Punjabis in Medway, Kent (n=137)

		A (mcg)	B 1 (mg)	B2 (mg)	B3 (mg)	B6 (mg)	Folate (mcg)	B12 (mcg)	C (mg)	D (mcg)	E (mg)	K (mcg)
Group 21-25	Mean	1414.26	2.01	2.26	28.62	2.26	312.05	12.11	217.54	6.06	23.31	219.87
	SD	606.79	0.41	0.63	10.73	1.58	123.54	7.75	49.15	2.26	11.26	173.34
	SEM	247.72	0.17	0.26	4.38	0.64	50.44	3.17	20.06	0.92	4.60	70.77
Group 26-30	Mean	1389.62	1.89	2.56	29.63	2.80	361.42	8.36	171.40	7.74	18.91	363.85
	SD	859.67	0.94	1.53	18.24	1.29	115.62	4.34	135.82	4.30	10.59	124.38
	SEM	159.64	0.17	0.28	3.39	0.24	21.47	0.81	25.22	0.80	1.97	97.37
Group 31-35	Mean	2046.84	1.94	2.68	26.51	2.46	387.42	14.50	304.93	5.53	14.84	149.78
	SD	1092.17	0.65	1.38	6.59	1.20	91.47	11.40	245.50	3.32	6.85	74.84
	SEM	199.40	0.12	0.25	1.20	0.22	16.70	2.08	44.82	0.61	1.25	13.66
Group 36-40	Mean	1666.78	1.89	3.81	28.91	2.60	378.08	6.94	218.30	5.30	14.70	198.53
	SD	1244.48	0.97	3.58	15.41	1.53	221.98	4.42	173.09	3.05	7.19	79.30
	SEM	223.52	0.17	0.64	2.77	0.27	39.87	0.79	31.09	0.55	1.29	32.20
Group 41-45	Mean	1532.33	1.64	2.49	23.46	2.49	375.49	4.44	213.11	3.72	14.85	216.50
	SD	1333.96	0.60	2.23	10.04	1.32	256.04	2.51	144.89	1.39	5.76	115.13
	SEM	278.15	0.13	0.47	2.09	0.27	53.39	0.52	30.21	0.29	1.20	24.01
Group 46-50	Mean	1719.46	1.77	2.62	25.19	2.20	435.10	6.11	241.07	6.68	16.08	143.97
	SD	1249.69	0.90	1.43	17.08	1.09	227.89	3.49	135.57	6.40	10.17	90.28
	SEM	322.67	0.23	0.37	4.41	0.28	58.84	0.90	35.00	1.65	2.63	23.31
Group 51-55	Mean	1088.46	1.00	1.53	13.40	1.38	149.61	8.13	124.17	4.44	8.11	142.88
	SD	10.73	0.78	1.05	9.63	0.78	62.51	0.58	102.95	3.36	5.44	81.16
	SEM	5.36	0.39	0.53	4.82	0.39	31.26	0.29	51.48	1.68	2.72	40.58
Total	**Mean**	**1551.11**	**1.74**	**2.56**	**25.10**	**2.31**	**342.74**	**8.65**	**212.93**	**5.64**	**15.83**	**205.06**
	SD	**301.85**	**0.35**	**0.68**	**5.61**	**0.46**	**92.59**	**3.50**	**56.14**	**1.35**	**4.62**	**77.74**
	SEM	**114.09**	**0.13**	**0.26**	**2.12**	**0.17**	**35.00**	**1.32**	**21.22**	**0.51**	**1.75**	**29.38**
RNI(LRNI)		**700(250)**	**1(08)**	**1.3**	**17**	**1.4**	**200(100)**	**1.5(1)**	**40(10)**	**10**	**12**	

6.11 Intergenerational Comparisons of Micronutrient Intakes

Comparisons between subjects of first (n=43) and second generation (n=94) illustrated interesting results. Reported intakes were much higher among the second generation as

demonstrated by the differences in means calculated e.g. in **Table 6.14** below however the differences were not always statistically significant.

The mean magnesium intake (SD) of the first generation was 409.40 (±178.43) mg compared to the second generation's 500.55 (±161.20) mg with difference in means (95% CI) of -91.15 (-152.05,-30.251) (p= 0.005). Comparison of intake of Potassium showed that Mean (SD) the second generation was 4290.83 (±1520.22) and the first generation, 3613.33 (±1644.99) mg with a difference in means (95% CI) of -677.50 (-1247.43,-107.56) (p= 0.02). Similarly the mean (SD) values for Phosphorous were 1850.58 (±598.90) v. 1555.10 (±757.39) mg with differences in mean (95% CI) of -295.47 (-532.83,-58.10) (p=0.015).

Zinc, manganese and iodine intake were 16.38 (±6.78) v. 13.72 (±6.43) mg (p =0.03); 4762.32 (±1727.47) v. 3805.94 (±1865.88) mcg (p=0.004); and 69.98 (±32.92) v. 56.95 (±32.17) mcg (p=0.03) respectively with difference in means (95% CI) of -2.66 (-5.10,-0.219), -956.37(-1603.62,-309.13,), -13.03(,-24.99,-1.075) respectively (Table 6.14).

Mean (SD) of iron intake were 17.18 (±8.52) and 18.95 (±7.06) mg respectively between first and second generation with a difference in means (95% CI) of -1.771 (1.173, -4.71) mg (p=0.236). Similarly the Calcium was 792.87 (±559.78) mg in the first generation and 909.61 (±362.78) mg in the second generation with a difference in means (95% CI) of -116.74 (-274.64, 41.57) (p=0.146) and Sodium of 2550.48 (±1369.50) mg v. 2631.29 (±1163.66) mg and a difference in means of -80.81 (368.56, -579.58) (p=0.722). The mean (SD) copper intakes were 4.01 (±3.21) v. 4.09 (±1.00) mg respectively with a difference in mean (95% CI) of -0.074

(-0.794, 0.646), (p=0.839). Comparisons show no differences in iron, calcium and sodium intake between the generations **(Table 6.14)**.

The mean (SD) vitamin B1 and D intakes were 1.71 (±0.79), 2.06(±0.84) mg and 5.3 (±3.8), 6.6 (±3.9) mcg respectively between first and second generation with differences in means (95% CI) of -0.342(,-0.644,-0.040), (p=0. 027) and -1.33(-2.719, 0.051),(p= 0.059) (**Table 6.15**). The differences in B1 intake were statistically significant and that of vitamin D was tending towards significance.

Difference in intake between first and second generation of Vitamins A, B2, B3, B6, Folate, B12, C, E and K were not statistically significant. Mean (SD) of Vitamin A, B2, B3, B6, Folate, B12, C, E and K were 2229.6 (±663.61) v. 1566.02 (±969.51) mg, 2.9 (±2.6) v. 2.6 (±1.34) mg, 25.9 (±13.4) v. 28.62 (±14.84), 2.4 (±1.3) v. 2.66 (±1.33) mg; Folate 372.5 (±209.6) v. 373.81 (±110.52) mcg, 15.9 (±5.2) v. 10.25 (±6.86) mcg, 223.0 (±181.7) v. 233.01 (±165.12) mg, 15.3 (±7.8) v. 17.53 (±9.7), 207.84 (±242.46) v. 243.82(±334.89) mcg respectively between first and second generation with differences in means (95% CI) of 663.61 (,-93.73,1420.96) (p= 0.085), 0.307 (-966,-0.351) (p=0.358), -2.697 (-7.97,2.573) (p=0.311); -0.233 (-0.711,0.244) (p= 0.335) ; -1.347 (55.39, -52.69), (p= 0.961), 5.655 (-1.803,16.39,);(p = 0.136), -9.997 (-74.23, 54.23,); (p=0.759); -2.263 (-5.339,0.812); (p = 0.148), -35.97 (-135.6; 63.74); (p = 0.477) respectively (**Table 6.15**).

Table 6.14 Daily mineral intake according to generations from the main study group

		Ca (mg)	Fe (mg)	Mg (mg)	P (mg)	K (mg)	Na (mg)	Cl (mg)	Zn (mg)	Cu (mg)	Se (mcg)	Mn (mcg)	I (mcg)
1st Generation	Mean	792.87	17.18	409.40	1555.10	3613.33	2550.48	2117.74	13.72	4.01	55.79	3805.94	56.95
	Median	580.9	16.0	393.4	1472.0	3424.1	2384.5	1960.8	13.1	3.4	51.7	3548.4	52.4
	SD	559.78	8.52	178.43	753.39	1644.99	1369.50	1320.60	6.43	3.21	32.09	1865.88	32.171
	95% CI Upper	905.4	18.9	445.3	1706.6	3944.1	2825.9	2383.3	15.0	4.7	61.5	4181.2	63.4
	95% CI Lower	680.3	15.5	373.5	1403.6	3282.5	2275.1	1852.2	12.4	3.4	48.6	3430.7	50.5
2nd Generation	Mean	909.61	18.95	500.55	1850.58	4290.83	2631.29	2242.41	16.38	4.09	57.79	4762.32	69.98
	Median	908	19	490	1895	4066	2445	1759	16	4	53	4537	61
	SD	362.78	7.06	161.20	598.90	1520.22	1163.66	1209.92	6.78	1.00	28.96	1727.47	32.92
	95% CI Upper	1018.1	21.1	548.7	2029.6	4745.2	2979.1	2604.1	18.4	4.4	66.5	5278.7	79.8
	95% CI Lower	801.2	16.8	452.4	1671.6	3836.4	2283.5	1880.8	14.4	3.8	49.1	4246.0	60.1
	Differences in Mean	**-116.74**	**-1.771**	**-91.152**	**-295.47**	**-677.50**	**-80.81**	**-124.67**	**-2.66**	**-0.074**	**-2.789**	**-956.37**	**-13.03**
	95% CI Upper	**41.57**	**1.173**	**-30.251**	**-58.10**	**-107.56**	**368.56**	**330.24**	**-0.219**	**0.646**	**8.156**	**-309.13**	**-1.075**
	95% CI Lower	**-274.64**	**-4.71**	**-152.05**	**-532.83**	**-1247.43**	**-530.20**	**-579.58**	**-5.10**	**-0.794**	**-13.73**	**-1603.62**	**-24.99**
p-value		**0.146**	**0.236**	**0.005**	**0.015**	**0.020**	**0.722**	**0.587**	**0.033**	**0.839**	**0.614**	**0.004**	**0.033**

Table 6.15 Daily Vitamin intake among adult males of Punjabi intergenerational differences

		A (mcg)	B 1 (mg)	B2 (mg)	B3 (mg)	B6 (mg)	Folate(mcg)	B12 (mcg)	C (mg)	D (mcg)	E (mg)	K (mcg)
1st Generation	Mean	2229.6	1.71	2.9	25.9	2.4	372.5	15.9	223.●	5.3	15.3	207.84
	Median	1334.6	1.6	2.1	25.4	2.3	326.8	7.6	167.7	4.4	14.4	334.6
	SD	3439.●	0.79●	2.6	13.4	1.3	2●9.6	35.2	181.7	3.8	7.8	242.46
	95% CI Upper	2921.2	1.9	3.4	28.6	2.7	414.6	23.0	259.5	6.1	16.8	256.6
	95% CI Lower	1538.1	1.6	2.4	23.2	2.2	33●.3	8.8	186.5	4.6	13.7	159.1
2nd Generation	Mean	1566.●2	2.●6	2.61	28.62	2.66	373.81	1●.25	233.●1	6.67	17.53	243.82
	Median	1265.72	1.98	2.24	24.4●	2.36	345.●●	7.94	209.99	6.7●	14.86	160.21
	SD	969.51	0.84	1.34	14.84	1.33	11●.52	6.86	165.12	3.9●	9.73	334.89
	95% CI Upper	1855.8	2.3	3.●	33.1	3.1	4●6.8	12.3	282.4	7.8	20.4	343.9
	95% CI Lower	1276.2	1.8	2.2	24.2	2.3	34●.8	8.2	183.7	5.5	14.6	143.7
	Differences in Mean	**663.61**	**-0.342**	**0.307**	**-2.697**	**-0.233**	**-1.347**	**5.655**	**-9.997**	**-1.333**	**-2.263**	**-35.97**
	95% CI Upper	**1420.96**	**-0.040**	**0.966**	**2.573**	**0.244**	**52.69**	**16.39**	**54.23**	**0.051**	**0.812**	**63.74**
	95% CI Lower	**-93.73**	**-0.644**	**-0.351**	**-7.970**	**-0.711**	**-55.39**	**-1.803**	**-74.23**	**-2.719**	**-5.339**	**-135.6**
p-value		**0.085**	**0.027**	**0.358**	**0.311**	**0.335**	**0.961**	**0.136**	**0.759**	**0.059**	**0.148**	**0.477**

6.12 Correlations between mineral intake and blood pressure

Comparisons were made between current mineral intake and SBP and DBP. There was very weak correlation between SBP and DBP and potassium intake (r=0.044, p=0.613; and r=0.012, p=0.886 respectively). Similarly, a weak and non-significant correlation existed between DBP v. Sodium intake (r=-0.088; p=0.305) and no correlation between SBP v. Sodium (r= 0.001; p= 0.993). Other minerals e.g. magnesium and calcium did not also show any correlation with BP. Correlation between DBP v. Magnesium (r = -0.024; p= 0.779) and SBP v. Magnesium (r = 0.047; p = 0.583) were weak and /or not significant and so was DBP diastolic v. Calcium (r= 0.067; p = 0.440) and SBP v. Calcium (r= 0.132; p =0.124).

Chapter Seven: Physical Activity

7.0 Physical Activity among South Asian Male Punjabi Population

Results of self-reported physical activity among adult male Punjabi migrants (n=137) in Medway, Kent are reported here. Comparisons are made for the whole group, and between 1st and 2nd generations within the study sample population.

The metabolic equivalent of task (MET) is a physiological measure expressing energy cost of physical activity defined as the ratio of metabolic rate during a specific physical activity to a reference metabolic rate (i.e. 1 MET = 1kcal/kg/hr). Whilst the MET is used as a means of expressing the intensity and expenditure of activities in a way comparable among persons of different weight, other measures of physical activity can be used to express physical activity e.g. the METS-MINUTE. The concept of the METS-MINUTE has been applied to quantify the total amount of physical activity which allows comparisons to be made across persons and the different types of activities. The components of physical activity including work, transport and non-occupational (recreational) and their contributions to physical activity among the different age groups have thus been quantified in METS-Minutes per week **(Table 7.1)**. The data was collected via interviews conducted by the investigator using a pre-validated global physical activity questionnaire (GPAQ) (WHO, 2008). Results from the study are presented as Mean (± SD). Quantitative measures of physical activity level such as the total daily energy expenditure (TDEE) and physical activity level (PAL) are also compared with total daily energy intake (TDEI) derived from repeat 24-Hour recall data.

Table 7.1 Physical activity converted into **MET-minutes / week** according to activity type

Age Groups (years)	Activity at Work Vigorous (Mean ±SD)	Activity at work Moderate (Mean ±SD)	Travel to and from work (Mean ±SD)	Recreational Activity Vigorous (Mean ±SD)	Recreational Activity Moderate (Mean ±SD)	Total Met-minutes/ week
21-25	60.00(146.97)	30.00 (73.48)	230.00 (258.53)	220.0(244.95)	130(179.67)	670.0
26-30	70.3 (145.3)	72.4 (163.8)	122.80 (201.0)	66.2 (168.4)	266.9 (215.5)	598.6
31-35	48.00 (124.47)	94.00 (160.44)	68.67 (136.12)	84.00 (175.88)	228.00 (189.34)	522.67
36-40	38.71 (121.54)	44.52 (92.91)	112.26 (195.80)	77.42 (179.46)	303.87 (208.39)	576.78
41-45	15.65 (75.07)	112.17 (180.28)	120.00 (190.60)	41.74 (117.85)	260.09 (211.61)	549.65
46-50	16.0 (62.0)	36.0 (74.5)	138.7 (181.2)	72.0 (126.7)	236 (176.3)	498.7
51-55	0.00 (0.00)	90 (180.0)	295.0 (224.7)	0.00 (0.00)	120 (84.9)	505.00
Mean	**36 (25.87)**	**68 (32.01)**	**155 (78.57)**	**97 (58.93)**	**213 (67.70)**	**552**
95% CI Upper	**54.69**	**92.16**	**213.54**	**140.99**	**263.13**	**601.06**
95% CI Lower	**16.37**	**44.73**	**97.13**	**53.68**	**162.82**	**503.91**

7.1 Interpretation of Physical Activity across age groups: MET-minutes per week

Activities have been split into work-related vigorous or moderate forms; travel-related (considered to be moderate); and recreational vigorous and moderate forms based on the design of GPAQ. For purposes of clarity and comparison, brisk walking at 5 km per hr for 30 minutes is regarded as moderate activity equivalent e.g. to 4 METS, and can be translated into approximately 120 MET-Minutes (by multiplying by time in minutes). This is equivalent to running at 10 km per hr for 15 minutes i.e. vigorous intensity activity which generates 8 METS (8 X 15 = 120 METS-Minutes). Thus to establish a daily pattern of physical activity and the relative contributions of different sets of activities to daily PA, it is possible to accumulate the total effort expended in these different activities and to use this to make sound deductions about the sedentariness of the population, examine health benefits of PA and the relevant physical activity levels of the population vis-à-vis chronic disease risk.

In this present study, the age group with the highest MET-Minutes for vigorous activity at work were the 26 – 30 years group with a mean (SD) METS-Minutes per week of 70.3 (SD) and the 51 – 55 age group had no work-related vigorous activity recorded. The overall group mean (SD) was 36 (25.87) METS-Minutes per week for work-related vigorous physical activity with a 95% confidence interval (95% CI) of 16.37, 54.69.

For work-related moderate PA, the age group with the highest MET-Minutes were the 41 – 45 years group with a mean (SD) METS-Minutes per week of 112.26 (SD), followed by the 31 – 35 years group with mean (SD) values of 94.00 (SD) and the 51 – 55 age group with 90.0 (SD). The 21 – 25 age group had the lowest work-related moderate activity recorded i.e. 30.0 (SD)

METS-Minute per week. The overall group mean (SD) for work-related moderate PA was 68.0 (32.01) METS-Minutes per week with a 95% CI of 44.73, 92.16.

Travel-related vigorous activity data show that the 51 – 55 age group spent the most time travelling to and from work accruing the highest MET-Minutes with a mean (SD) METS-Minutes per week of 295.0 (SD), followed by the 21 – 25 age group with mean (SD) values of 230.00 (SD) and the 46 – 50 age group with 137.7 (SD). The age group with the lowest travel-related moderate activity recorded was the 31 – 35 age group with a mean (SD) of 68.67 (SD) METS-Minutes per week. The overall group mean (SD) for travel-related moderate PA was 155 (32.01) METS-Minutes per week with a 95% CI of 97.13, 213.54.

Vigorous recreational physical activity was highest in the 21 – 25 age group with a mean (SD) METS-Minutes per week of 220.0 (SD), followed by the 31 – 35 age group with mean (SD) values of 84.00 (SD) and the 36 – 40 age group with 77.427 (SD). The age group with the lowest travel-related moderate activity recorded was the 51 – 55 age group who did not have any recreational PA and this recorded zero METS-Minute per week. The overall group mean (SD) for recreational vigorous PA was 97 (SD) METS-Minutes per week with a 95% CI of 53.68, 140.99.

Moderate recreational physical activity was highest in the 36 – 40 age group with a mean (SD) METS-Minutes per week of 303.87 (SD), followed by the 26 – 30 age group with mean (SD) values of 266.9 (SD) and the 41 – 45 age group with 260.09 (SD) METS-Minute per week. The age group with the lowest recreational moderate activity recorded was the 51 – 55 age group who recorded a mean (SD) value of 120 (84.9) METS-Minute per week. The overall group mean (SD) for recreational moderate PA was 213 (SD) METS-Minutes per week with a 95% CI of 182.82, 263.13. When occupational, travel and recreational physical activity were put together,

the cumulative METS-Minute per week values showed that the 21 – 25 age group had the highest values of 670 followed by the 26 – 30 age group with 598.6 MET-Minutes per week. These values compare favourably with the lower cut-off for moderate physical activity (600 METS-Minutes per week) according to the WHO recommendations (WHO, 2013). Those aged between 31 – 55 years all had values below the 600 mark and would therefore be classified (based on the METS-Minutes per week classification alone) as engaging in low levels of physical activity. The overall group cumulative value was 552 METS-Minutes per week (sedentary/low level of PA) with a range from 503.91 – 601.06 METS-Minutes per week.

These results suggest a sample population with a low level of physical activity. However it would be useful to combine and compare these to the calculations of physical activity level (PAL) **(Table 7.4)** to aid classification in terms of sedentariness of the population.

7.2 Comparison of Total Daily Energy Expenditure due to different Activities across age groups

The quantification of energy costs of individual physical activities based on the conversion from METS to energy equivalents in kilocalories (i.e. 1 MET = 1kcal / kg /hr.) and age-group comparisons is presented in **Table 7.2**. Activities have been split into work-related vigorous or moderate forms; travel-related (considered to be moderate); and recreational vigorous and moderate forms based on the design of GPAQ. In addition, the energy costs of sitting quietly and sleeping have been added to provide a more complete picture of the total daily energy expenditure (TDEE) estimates for each age-group category and the whole group.

The age group with the highest work-related energy expenditure (EE) due to vigorous activity was the 26 – 30 age group with a mean (SD) of 87.50 204.11) kcal /d followed by the 21 – 25

age group with a mean value of 87.50 (214.33) kcal/d. The 51 – 55 age group had no work-related vigorous activity recorded. The overall group mean (SD) was 56.15 (159.45) kcal/day from work-related vigorous physical activity with a 95% CI of 29.54, 82.75.

Energy costs of work-related moderate PA, show that the age group with the highest energy expenditure was the 31 – 35 years group with a mean (SD) of 281.63 (454.00) kcal/day followed by the 41 – 45 years group with mean (SD) values of 274 (260.69) kcal/day. The 21 – 25 age group had the lowest work-related energy expenditure with a mean value of 43.75 (107.17) kcal/day. The whole group mean (SD) EE from work-related moderate activity was 173.76 (324.58) kcal/day. The very wide SD values observed throughout most of the groups reflect the lack of consistency in individual engagement in PA of any kind at work as captured in the GPAQ.

Table 7.2 Total Daily Energy expenditure (EE) Kcal/ day due to various types of activity according to activity type (n=137)

Age Groups (years)	Activity at Work Vigorous (Mean ±SD)	Activity at work Moderate (Mean ±SD)	Travel to and from work (Mean ±SD)	Recreational Activity Vigorous (Mean ±SD)	Recreational Activity Moderate (Mean ±SD)	Sitting (Mean ±SD)	Sleeping (Mean±SD)	TDEE (Kcal/ day) (Mean ±SD)
21-25	87.50(0.00)	43.75(0.00)	368.07(411.92)	342.97(388.18)	218.67(303.33)	1255.80(97.84)	691.35 (68.84)	3008.10(229.73)
26-30	98.31(204.11)	108.15(249.40)	258.57(385.21)	241.38(384.38)	532.78(341.76)	1140.64(120.66)	590.10(106.44)	2969.93(509.50)
31-35	61.56(159.73)	281.63(454.00)	132.92(265.49)	188.39(350.87)	478.22(321.37)	1082.81(104.94)	533.32(115.68)	2778.86(394.28)
36-40	55.66(175.63)	126.09(257.96)	231.56(473.52)	158.81(355.98)	610.11(342.88)	1137.54(139.94)	566.02(133.21)	2885.79(260.74)
41-45	18.21(87.33)	274(360.69)	169.05(274.35)	115.43(276.14)	516.74(389.73)	1093(99.48)	568.09(83.32)	2755.33(484.09)
46-50	25.41(98.43)	95.95(215.52)	274.38(329.71)	160.65(327.00)	512.85(445.07)	1139.75(109.16)	622.75(69.78)	2831.74(510.22)
51-55	0.00(0.00)	117.30(234.60)	649.49(253.71)	0.00(0.00)	156.40(312.80)	1074.45(66.80)	532.63(73.86)	2693.34(355.94)
Mean	**56.15(159.45)**	**173.76(324.58)**	**228.08(366.32)**	**183.50(342.99)**	**509.08(360.01)**	**1122.47(119.73)**	**579.31 (109.51)**	**2852.35(512.39)**
95% CI Upper	**82.75**	**227.91**	**289.19**	**240.73**	**569.14**	**597.58**	**597.58**	**2937.84**
95% CI Lower	**29.54**	**119.61**	**166.96**	**126.27**	**449.01**	**561.04**	**449.01**	**2766.86**
p-value	**0.001**	**0.012**	**0.017**	**0.014**	**0.001**	**0.128**	**0.147**	**0.023**

Energy costs of travel-related activity show that the age group with the highest EE was the 51 – 55 age group with a mean (SD) of 649.49 (253.71) kcal/day followed by the 21 – 25 age group with mean (SD) EE values of 368.07(411.92) kcal/day and the 45 – 50 age group with mean (SD) EE values of 274.38 (329.71) kcal/day. The 31 – 35 age group had the lowest travel-related energy expenditure with a mean value of 132.92 (265.49) kcal/day. The whole group mean (SD) EE from travel-related activity was 228.08 (366.32) kcal/day with a 95% CI of 166.96, 289.19. The very wide SD values observed throughout most of the groups reflect the lack of consistency in individual engagement in PA of any kind in relation to daily travel as captured in the GPAQ.

Energy costs of vigorous recreational activity was highest in the 21 – 25 age group with a mean (SD) of 342.97 (388.18) kcal/day followed by the 26 – 30 age group with mean (SD) EE values of 241.38(384.38) kcal/day. The group with the lowest EE due to vigorous recreational activity was the 51 – 55 age group who recorded no EE at all in this category. The whole group mean (SD) EE from recreational vigorous activity was 183.50 (342.99) kcal/day with a 95% CI of 126.27, 240.73. EE due to recreational moderate activity was highest in the 36 – 40 age group with a mean (SD) of 610.11 (342.88) kcal/day followed by the 26 – 30 age group with mean (SD) EE values of 532.78 (341.76) kcal/day and the 41 – 45 and 45 – 50 age groups with mean (SD) EE values of 516.74 (389.73) and 512.85 (445.07) kcal/day respectively. The 51 – 55 age group recorded the lowest recreation-related moderate energy expenditure with a mean value of 156.40 (312.80) kcal/day. The whole group mean (SD) EE from recreation-related moderate activity was 509.08 (360.01) kcal/day with a 95% CI of 449.01, 569.14.

The GPAQ is designed to capture different types and intensities of physical activity but does not capture sedentariness. Therefore to quantify total daily energy expenditure, it is imperative to include measures of the energy costs of sedentary behaviour, notably sitting (e.g. at a desk, on a sofa watching television) and sleeping, both of which contribute significantly to the use of a

person's time (within a 24-hour cycle) and involve some amount of energy expenditure. To estimate the energy costs of sleeping and sitting, the Schofield Equation (Schofield, 1985) can, and is often used. In this study, this equation was applied to help quantify (by estimation using the prediction equation and taking into account time spent per activity) EE due to sitting and sleeping.

The cumulative energy cost of sitting was highest in the 21 – 25, 26 – 30, 46 – 50 and the 36 - 40 age groups with mean values of 1255.80, 1140.64, 1139.75 and 1137.54 kcal / day. The contribution of sitting to the daily EE was also quite high in the age groups 41 – 45, 31 – 35 and 51 – 55 years. The whole group mean (SD) EE from sitting was 1122.47 (119.73) kcal/day with a 95% CI of 561.04, 597.58. The average cumulative sitting time for the whole per day was 13.56 hours. Sitting was thus by far the greatest contributor to daily energy expenditure apart from the resting metabolic rate.

The energy cost of sleeping was similar across all age groups, ranging from 532.63 (73.86) in the 51 – 55 age group to 691.35 (68.84) kcal / day in the 21 – 25 age group. The average sleeping time for the whole group was 7.46 hours per day. . The whole group mean (SD) EE from sleeping was 579.31 (109.51) kcal/day with a 95% CI of 449.01, 597.58.

The cumulative or sum total of daily energy expenditure energy varied between 2693.34 (355.94) kcal / day in the 51 – 55 age group to 3008 (229.73) kcal / day in the 21 – 25 age group with wide variations in the SD values across age groups. The whole group mean (SD) EE from sitting was 2852.35 (512.39) kcal/day with a 95% CI of 2766.86, 2937.84.

7.3 Estimation of Energy Balance and their Association with Physical Activity Level (PAL)

In Table 7.3, a summary of total daily energy intake (EI, kcal / day) data estimated from pooled means of three 24-hour dietary recall data are presented as well as total daily energy expenditure (TDEE, kcal / day) based on calculations from GPAQ data (for occupational, travel and recreational PA) and using Schofield's equation (for energy costs of sitting and sleeping) (Schofield, 1985). From these data, estimates of energy balance i.e. EI – TDEE have been calculated and the group comparisons are presented here to indicate whether the subjects were in positive (i.e. > +1kcal / day) or negative (i.e. < 0 kcal /day) energy balance (EB) based on intake over expenditure.

The data displayed show that except for the 46 – 50 age group which was in negative energy balance with a mean (SD) balance of -199.62 (1389.45) kcal / day but with a very large SD value showing wide intra-group variation, all the other age groups were in positive energy balance. The 51 – 55 age group with mean (SD) EB of +8.33 (1553.21) kcal / day, all other age groups had EB of at least 300 kcal per day representing excess energy intake over expenditure. The highest EB was recorded in the 21 – 25 age group with mean (SD) of 661.42 (956.92) kcal / day followed by the 31 – 35 and 26 – 30 age groups with mean (SD) values of 516.60 (1047.88) and 514.21 (1515.42) kcal / day respectively. The whole group mean (SD) EB was 363.93 (1307.99) kcal / day representing excess energy over expenditure with a 95% CI of 145.70, 582.17. Physical activity level (PAL) was calculated using WHO/FAO predictive equations based on physical activity ratios (PAR) of the various components of daily physical activity (methods previously described in detail in section 3.6.5 in chapter three). The results as displayed in **Table 7.3** suggest that this sample population was largely sedentary using reference PAL cut-offs. The

PAL values ranged from 1.53 (0.06) in the 41 – 45 age group to 1.64 (0.06) in the 51 – 55 age group. The reference cut-offs for classification of individuals (and population groups) as sedentary is PAL ranges from 140 – 169. All the age groups in this study population were within this category and reflect the general United Kingdom population status of sedentariness. The overall group mean (SD) PAL value of 1.54 (0.07) is confirmatory of a sedentary population with a 95% CI of 1.52 – 1.55. there was no significant variation in PAL among the groups (single factor ANOVA, p=0.783).

Table 7.3 Daily Energy Intake, Expenditure and Physical activity levels (PAL) of a Punjabi adult male population in Medway, Kent (n=137)

Age Groups (years)	EI (Kcal/ day) Mean (±SD)	Median	TDEE (Kcal/ day) (Mean ± SD)	Median	Energy Balance Kcal (Mean ± SD)	PAL Value (Mean±SD)	Median	PAL Level*
21-25	3669.53(932.19)	3703.99	3008.10(229.73)	3336.50	661.42(956.92)	1.56 (0.08)	1.55	Sedentary
26-30	3484.13(1418.40)	3696.22	2969.93(509.50)	3036.33	514.21(1515.42)	1.54 (0.08)	1.49	Sedentary
31-35	3295.45(999.09)	3389.11	2778.86(394.28)	2735.32	516.60(1047.88)	1.52 (0.06)	1.49	Sedentary
36-40	3225.16(1076.08)	3462.11	2885.79(260.74)	2830.24	339.37(1390.92)	1.54(0.09)	1.49	Sedentary
41-45	3115.54(1115.13)	3180.97	2755.33(484.09)	2818.10	360.21(1246.45)	1.53(0.06)	1.49	Sedentary
46-50	2632.12(1420.31)	2131.50	2831.74(510.22)	2908.97	-199.62(1389.45)	1.55(0.07)	1.50	Sedentary
51-55	2701.67(1246.94)	2701.67	2693.34(355.94)	2991.65	8.33(1553.21)	1.64(0.06)	1.63	Sedentary
Mean	**3216.28(1191.64)**	**3279.64**	**2852.35(512.39)**	**2904.21**	**363.93(1307.99)**	**1.54(0.07)**	**1.49**	**Sedentary**
95% CI Upper	**3405.08**		**2937.84**		**582.17**	**1.55**		
95% CI Lower	**2998.49**		**2766.86**		**145.70**	**1.52**		
p-value	**0.037**		**0.023**		**0.032**	**0.783**		

* PAL cut-offs 1.40-1.69 Sedentary or Sedentary or light activity lifestyle, 1.70-1.99; Active or moderately active lifestyle; 2.00-2.40 Vigorous or vigorously active lifestyle

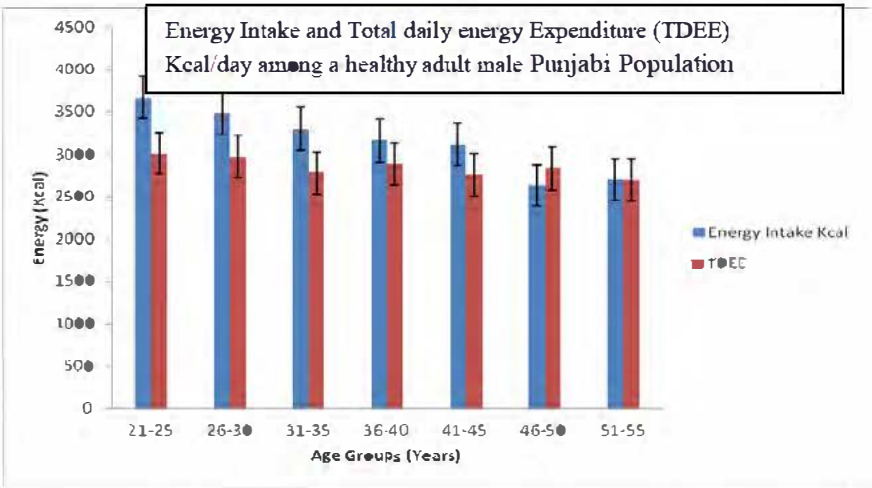

Figure 7.1: Energy Intake and Total daily energy Expenditure (TDEE) Kcal/day among a healthy adult male Punjabi Population

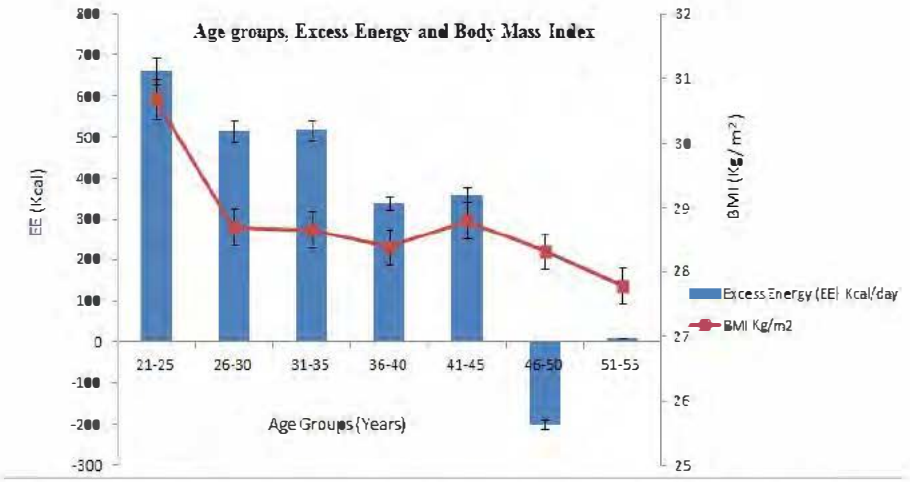

Figure 7.2: Energy Balance Kcal /day v Body Mass Index (BMI) Kg/m^2 across age groups in a healthy adult male Punjabi Population

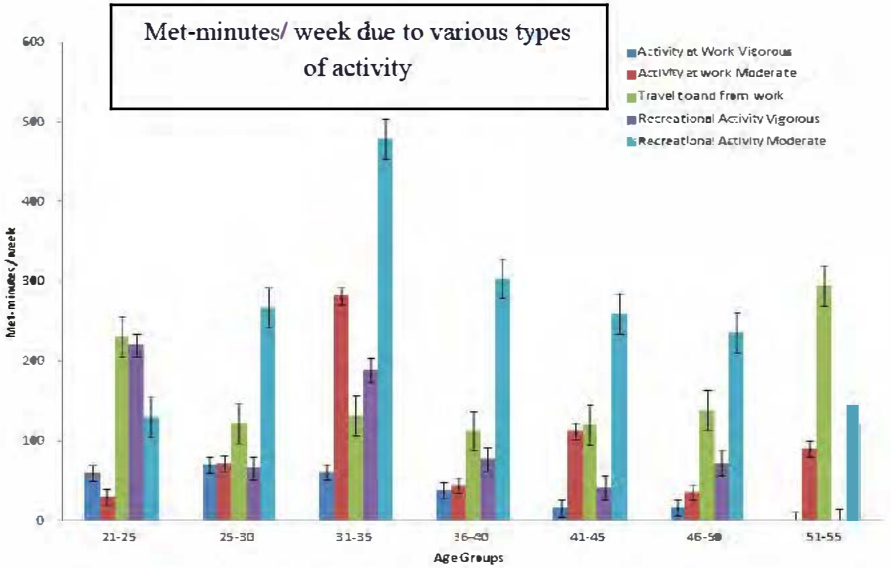

Figure 7.3: Met-minutes/ week due to various types of activity

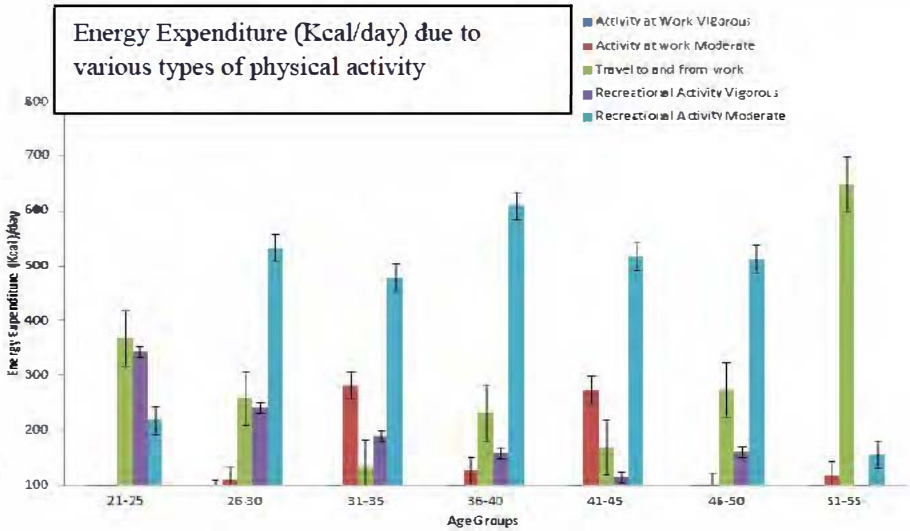

Figure 7.4: Energy Expenditure (Kcal/day) due to various types of physical activity

7.4 Intergenerational Comparisons of Energy Intake and Expenditure

The PAL values show that both first and second generations (**Table 7.4**) are sedentary with equal PAL of 1.54 (0.07). Total daily energy intake (EI) was significantly different between first and second generations. The mean (SD) EI was 3079.04 (1174.97) kcal/day in the 1st generation and 3517.95 (1186.08) kcal/day in the 2nd generation (p=0.045) with a difference in means (95% CI) of 438.21 (5.681, 870.74).

There were differences in the magnitude of total daily energy expenditure (TDEE) between the first and second generation. These differences tended towards statistical significant (p=0.085). TDEE in 1st generation and 2nd generation were 2803.59 (524.91) and 2960.05 (471.67) and the difference in means was 156.45 (-22.06, 334.98).

Energy balance (i.e. EI – TDEE) comparisons showed that 2nd generation had a higher EB of 557.89 (1253.07) than the 1st generation whose EB was 276.04 (1329.24). the difference in means (95% CI) was 281.75 (-184.96, 748.47). These differences suggest that though both groups expended energy to similar extents, the second generation's energy intake significantly exceeded that of the 2nd, and that is the main source of difference between these two largely sedentary groups in this male genetically and culturally homogenous population.

Table 7.4 Age and inter-generation differences in physical activity and energy balance

Variables*	Generations		Difference in Means	95%CI Lower	95% CI Upper	p-value	Group (n=137)	
	1st (n= 43) Mean (±SD)	2nd (n=94) Mean (±SD)					Mean (±SD)	Median
EI (Kcal/day)	3079.73(1174.97)	3517.95(1186.08)	438.21	5.681	870.74	0.045	3216.28(1191.64)	3279.64
Dietary Fibre								
EB (Kcal/day)	276.14(1329.24)	557.89(1253.07)	281.75	-184.96	748.47	0.256	363.93(1307.99)	333.04
TDEE (Kcal/day)	2803.59(524.91)	2960.05(471.67)	156.45	-22.06	334.98	0.085	2852.35(512.39)	2904.21
PAL	1.54(0.07)	1.54 (0.07)	0.0031	-0.024	0.0304	0.819	1.54(0.07)	1.49

***PAL = Physical Activity Level; * TDEE= Total Daily Energy Expenditure; * EI = Energy Expenditure; *EB = Energy Balance**

Chapter Eight: Physical Activity Discussion

8.1 Physical Activity Discussion

Physical inactivity (PI) is a major known risk factor for obesity, diabetes and cardiovascular disease among South Asian populations (McKeigue, et al., 1991; Zaman, et al., 2011; Jepson, et al. 2012). It has been postulated that moderate to high physical activity may reduce their risk of cardiovascular disease by half (Eapen, et al., 2009). The Department of Health in the UK recommend 150 minutes per week of moderate activity or 75 minutes per week of vigorous activity to attain the beneficial effect of physical activity (WHO, 2011, DOH, 2013).

Measurements of PA can be very difficult and the direct methods though more accurate, can be cumbersome, time-consuming with a high non-adherence rate. The indirect methods have therefore been developed and found to be quite effective in helping to estimate PA and daily energy expenditure. When combined with others measures of sedentary behaviour, the results of indirect measurement of PA are reliable. In the present study a pre-validated GPAQ questionnaire (Appendix 3) developed by WHO was used to measure the level of activity (or inactivity) among this homogeneous population of SA males of Punjabi origin and as the results show, the range of PAL is 1.45 – 1.60 which classifies the entire population sample as sedentary or involved in low levels of physical activity. Comparisons between first and second generations also showed that the two groups are equally culpable in not engaging in PA, be it work-related or recreational. The results of METS-Minutes per week estimations also give average values for the whole which falls short of 600 METS-Minutes per week, the threshold for sedentary activity.This low level of PA puts this population at a high risk of NCDs. Furthermore energy intake and expenditure comparisons also show clearly that this population is in positive energy

balance across age groups and generations. The second generation has a significantly higher energy intake (p=0.045) compared to the first generation; and have a higher body mass index (BMI) although the latter differences were not statistically significant. Both groups have BMI values above 28 kgm^{-2} and 91% of the subjects are at least overweight (using BMI cut-off criteria). These calculations of BMI and their use for risk categorisation in this sample population is based on UK and WHO reference normative cut-offs. However there is growing evidence to suggest that at lower BMI's people of Indian origin have a much higher cardiovascular and NCD risk compared to Caucasians (Joshi, et al., 2012; Jepson, et al., 2012). Thus it can be argued that using the WHO / UK BMI cut-offs to measure risk in this population may be under-estimating their risk. Therefore in order to develop an appropriate risk regression model for this group based on BMI cut-offs, it might be best to undertake a log transformation of BMI using the BMI cut-off of 23 kgm^{-2} (Indian reference for overweight) and the international classification of 25 kgm-2 to allow for a 'risk range' to be developed.

In assessing NCD risk for this population, it is better not to take the risk factors in isolation otherwise when results are computed and compared there may be a wrong impression of lower calculated risk when in fact the combination of risk factors in a multiple regression model might give a better picture of those factors that are particularly important e.g. for BMI, blood pressure and diabetes. On the other hand for purposes of mitigating risk, one could base an intervention plan on e.g. the very low level of physical activity currently practiced by this population. The plan any intervention successfully however the socio-cultural context of the barriers to PA in this population need to be pursued and understood as they are fundamental to both short and long term success of any planned interventions. Behaviour change is generally accepted to be a very difficult concept and the mediators of behaviour, and in particular PA-related behaviour can be difficult to fully grasp and address. Therefore understanding culture and working within that

culture to establish pathways for risk reduction would be the best option in public health interventions, including nutrition interventions.

This population of Punjabi males in the UK when compared to their age-matched cohorts in the Indian and Pakistani Punjab, are more engaged in 'sedentary' service type jobs (about 70% of the sample population) and only 30% (ANOVA $p<0.0001$) engage in manual labour or any degree of significance. On the contrary, those of a similar age range in the Indian Punjab are mostly engaged in agricultural type manual labour (70%) compared to Service industry type jobs (30%) (Headey, et al., 2012; Qureshi, et al., 2013). The Indian national statistics show that the Punjab Province has the highest rate of OW + OB (just over 30%) in the whole of India. This is an observation seen in a population in which 70% of the population is purported to be engaged in manual labour; and where physical activity due to transport (e.g. walking, cycling to and from work) is likely to be much higher than among their counterparts in the UK. That this UK based Punjabi male population in Medway, Kent has a rate of OW + OB as high as 91% among them is therefore not surprising because this migrant population has shown to have a higher energy intake, lower energy expenditure, lower PAL and are engaged in largely sedentary-type jobs. It is my opinion that the dynamics of the nutrition transition and the determination of risk factors in any genetically homogenous population cannot be properly explained without a clear understanding of the environmental mediators of physical activity behaviour, diet and other lifestyle factors. This is a fundamental principle in public health and public health nutrition is no exception.

Furthermore to ameliorate the major risk predictors described in pattern five of the nutrition transition by Barry Popkin et.al., (2000; 2003; 2004) (i.e. a sedentary population with excess energy intake, high fat (saturated fat) intake, OW + OB, low fibre intake, high refined sugar (and low complex sugar) intake, high cholesterol intake and status and signs of nutrition-related

(NCDs) it would require a complete examination of the underlying environmental contributors to risk in an otherwise homogenous population. The present study design scientific observational study lends itself to the principles of epidemiology necessary to understand and underscore risk within a population in order to plan to tackle it.

Physical inactivity (PI) a major role player for obesity among SA population. High incidence of obesity, diabetes and cardiovascular has been reported among south Asians living in UK and are growing concerns about low physical activity among this population (Health Improvement and Prevention, 2004; Butland, et. al., 2007). PA is one of the major independent risk factor for NCD's and it has been postulated that physically active, moderate to high physical activity may reduce risk of cardiovascular disease by half (Eapen, et al., 2009). WHO and DOH, UK suggested 150 minutes per week of moderate activity or 75 minutes per week of vigorous activity to attain beneficial effect of physical activity (WHO, 2011, DOH, 2013). In our study we have used pre-validated GPAQ questionnaire (Appendix 3) to measure the level of activity and inactivity among homogeneous population of SA origin, specifically Punjabi, males to quantify the level as well as the critical point to which we can plan an intervention trial to help promoting PA which is culturally accepted, occupationally adaptable and of interest to this particular group of SA community. In this study, 137 healthy adult male Punjabi were studied to explore the level of physical activity and inactivity, which player a major role in the disease progression of NCD's

8.2 Multiple Linear Regression Analyses

Risk factor analysis in order to predict risk is an important consideration in this present study. An attempt was therefore made to examine influential or predictor variables which had impact on a number of dependent variables. Single and multi-factorial analysis of variance (ANOVA) were

conducted to establish the strength of associations between predictor variables and co-variants and these results have been used elsewhere. Simple linear regression analysis was carried out and although this analysis is still on-going, initial results suggest strong links between the BMI and waist circumference Standardized coefficients (β) (0.437; $p<0.0001$); systolic blood pressure Standardized coefficients (β) (0.239; $p<0.001$); and dietary cholesterol Standardized coefficients (β) (0.165; $p<0.01$) (Table 8.1). The strongest influential factors for SBP were BMI Standardized coefficients (β) (0.328; $p<0.0001$); and age Standardized coefficients (β) (0.194; $p<0.018$); and DBP was similarly most influenced by BMI Standardized coefficients (β) (0.328; $p<0.0001$); and age Standardized coefficients (β) (0.197; $p<0.016$).

Further examination of the data including log transformation to standard data in a linear format for regression analysis is currently on-going and it is hoped that such analysis will shed further light on the dynamics of the risk factors and how they are interacting in this population of first and second generation migrants from the Punjab.

Regression Analysis

Table 8.1 Regression analysis Punjabi community living in Medway, Kent (n=137)

	Influential variables	**Standardized coefficients (β)**	**p-value (P<0.05)**
BMI	Waist Circumference	0.437	0.0001
	BP Systolic mm/Hg	0.239	0.001
	Carbohydrate	-0.193	0.01
	Cholesterol	0.165	0.028
Waist Circumference	Weight	0.762	0.0001
	Hip circumference	0.517	0.0001
	P/S ratio	0.229	0.002
BP Systolic	BMI	0.328	0.0001
	Age	0.194	0.018
BP Diastolic	BMI	0.328	0.0001
	Age	0.197	0.016

Table 8.2 Regression analysis Punjabi community living in Medway, Kent (n=30)

	Influential variables	**Standardized coefficients (β)**	**p-value (P<0.05)**
BMI	HDL	1.023	0.0001
	TC/HDL	0.501	0.04

Chapter Nine: Sub-group study results and discussion

Table 9.1 Physical and physiological measurements among subgroup (n=30) of migrant Punjabi Population

	Mean	Median	SD	95% CI Upper	95% CI Lower
Physical and Physiological					
Age (Years)	35.3	34.0	10.4	39.0	31.6
Weight (Kg)	82.6	83.8	6.5	84.9	80.2
Height (m)	1.7	1.7	0.0	1.7	1.7
BMI (Kg/m^2)	28.6	28.6	2.8	29.6	27.6
Waist (cm)	85.0	85.0	3.4	86.3	83.8
Hip(cm)	99.0	96.0	9.4	102.3	95.6
WHR	0.9	0.9	0.1	0.9	0.8
BP Diastolic(mm/Hg)	86.4	85.5	5.0	88.2	84.6
BP Systolic (mm/Hg)	136.0	136.5	9.0	139.2	132.8

Table 9.2 Biochemical measurements among subgroup (n=30) of migrant Punjabi Population

Biochemical analysis					
TC(mmol/L)	5.3	5.4	1.0	5.7	5.0
HDL(mmol/L)	1.9	2.0	0.7	2.2	1.7
TRG(mmol/L)	1.6	1.6	0.5	1.8	1.5
LDL(mmol/L)	1.7	1.6	0.5	1.8	1.5
Non-HDL(mmol/L)	3.3	3.2	1.1	3.6	2.9
TC/HDL	3.0	2.8	1.2	3.5	2.6
Glucose (mmol/L)	6.1	6.2	0.6	6.3	5.8

Table 9.3 Macro-nutrient among subgroup (n=30) of migrant Punjabi Population

Macro Nutrient					
	Mean	**Median**	**SD**	**95% CI Upper**	**95% CI Lower**
Protein (g)	100.9	89.2	31.1	112.1	89.8
Fat(g)	104.4	90.9	41.9	119.4	89.4
Carbohydrate (g)	352.2	325.3	134.3	400.3	304.2
SFA(g)	34.2	27.4	16.4	40.1	28.3
MUFA(g)	38.1	34.1	16.4	44.0	32.2
PUFA(g)	23.8	20.2	12.1	28.2	19.5
P/S Ratio	0.8	0.7	0.4	0.9	0.6
Dietary Cholesterol(mg)	423.4	445.6	125.6	468.3	378.4
Intrinsic Sugar(g)	352.2	325.3	134.3	400.3	304.2
Extrinsic Sugar (g)	112.0	86.0	73.4	138.3	85.8
Fibre (g)	12.5	10.2	7.9	15.4	9.7

Table 9.4 Physical Activity and Daily energy expenditure (n=30)

	Mean	**Median**	**SD**	**95% CI Upper**	**95 % CI Lower**
Total Physical Activity (Met-minutes/week)	671.59	675.70	114.48	733.46	609.73
Total Daily Energy Expenditure (TDEE) Kcal	2554.74	2734.46	601.95	2770.14	2339.33
PAL	1.53	1.49	0.07	1.56	1.51

Table 9.5 Intergeneration lipid profile among sub sample (n=30)

		TC mmol/l	HDL mmol/l	TRG mmol/l	LDL mmol/l	Non-HDL mmol/l	TC/HDL ratio	Glucose mmol/l
1st Generation	Mean	5.635	1.948	1.575	1.742	3.565	3.295	6.108
	Median	6.075	1.935	1.585	1.590	3.485	3.100	6.185
	SD	0.798	0.749	0.465	0.555	1.055	1.287	0.581
	95% CI Upper	6.008	2.298	1.793	2.001	4.058	3.897	6.380
	95% CI Lower	5.261	1.597	1.357	1.482	3.071	2.692	5.836
2nd Generation	Mean	4.857	1.978	1.617	1.460	2.789	2.550	5.958
	Median	4.985	2.050	1.705	1.295	3.090	2.600	5.940
	SD	0.897	0.402	0.600	0.374	0.797	0.683	0.705
	95% CI Upper	5.499	2.265	2.046	1.728	3.359	3.039	6.462
	95% CI Lower	4.214	1.690	1.187	1.192	2.218	2.061	5.453
	Differences in Means	**0.951**	**0.009**	**-0.161**	**0.233**	**0.910**	**0.785**	**0.157**
	95% CI Upper	**1.698**	**0.447**	**0.274**	**0.582**	**1.626**	**1.523**	**0.709**
	95% CI Lower	**0.203**	**-0.429**	**-0.596**	**-0.116**	**0.193**	**0.046**	**-0.394**
	p-value	**0.016**	**0.967**	**0.443**	**0.182**	**0.015**	**0.038**	**0.552**

9.1 Sub-group study discussion

The sub-sample (n=30) of subjects who agreed to undertake further investigations including biochemical analyses attended the Sports and Exercise Science laboratory on the Medway campus of the University of Greenwich after an overnight fast (12 hours following the last meal) where physical, physiological and biochemical measurements were taken. The mean (SD) age of the sub-group was 35.3 (10.4) years. The average height was 1.7 (0.0) metres and the weight was 82.6 (6.5) kg. The mean (SD) BMI was 28.6 (2.8) kgm^{-2}, the hip circumference was 99.0 (9.40) cm, waist circumference 85.0 (3.4) cm and the WHR was 0.90 (0.1). Mean (SD) systolic blood

pressure (SBP) .and diastolic blood pressure (DBP) were 136.0 (9.0); and 86.4 (5.0) mmHg respectively (Table 9.1)

Analysis of overall group energy and macronutrient intake showed a mean (SD) energy intake (EI) of 2829.41 (939.6) kcal/day. Comparisons between subjects of first (n=10) and second generation (n=20) showed significant intergenerational differences in energy intake. Mean (SD) of EI in the first generation was 3079.73 (±1174.97) kcal/day compared to the second generation's 3517.95 (±1186.08) kcal/day with a difference in means (95% CI) of -438.21 (-870.74, 5.681) (p= 0.045). These inter-generational differences were similar to the observation made in the larger study group (n=137).

Whole group mean (SD) protein intake was 100.9 (31.1) g/day. Mean (SD) total fat intake was 104.4 (41.9) g/day; carbohydrate was 354.2 (134.3); Lipid fractions in the diet were 34.2 (27.4); 38.1 (34.1) and 23.8 (12.1) g/day of saturated fatty acids (SFA), MUFA and PUFA respectively. The P/S ratio was 0.8 (0.4). Dietary cholesterol intake was 423.4 (125.6) mg/day; extrinsic sugar intake was 112.0 (73.4) g/day and the fibre intake was 12.5 (7.9) g/day. The fibre intake was thus far below the EAR value of 18.0 g/day for the UK population.

Biochemical data from fasting samples showed mean (SD) values of 5.3 (1.0) mmol/L of total cholesterol (TC) with a range from 5.0 – 5.5 mmol/L. Intergenerational comparisons showed that the first generation had a mean (SD) TC of 5.635 (0.798) mmol/L compared to the second generation's value of 4.857 (0.897) mmol/L with a difference of means (95% CI) of -0.951 (0.203, -1.698) (p=0.016). Serum HDL cholesterol was 1.9 (0.7) mg/day for the whole group. Intergenerational comparisons showed that the first generation had a mean (SD) HDL cholesterol of 1.948 (0.948) mmol/L compared to the second generation's value of 1.987 (0.402) mmol/L with a difference of means (95% CI) of -0.009 (-0.429, 0.447) (p=0.967). Triglycerides (TG)

level was 1.6 (0.5) mmol/L. The first generation had a mean (SD) TG of 1.575 (0.465) mmol/L compared to the 2nd generation's value of 1.617 (0.600) mmol/L with a difference of means (95% CI) of -0.161 (-1.596, 0.274) (p=0.443).

Serum LDL cholesterol level was 1.7 (0.5) mmol/L. Intergenerational comparisons showed that the first generation had a mean (SD) LDL cholesterol of 1.742(0.555) mmol/L compared to the 2nd generation's value of 1.460 (0.374) mmol/L with a difference of means (95% CI) of -0.233 (0.116, 0.582) (p=0.182).

The non-HDL cholesterol value was 3.3 (1.1) mmol/L. Intergenerational comparisons showed that the first generation had a mean (SD) non-HDL cholesterol of 3.565 (1.055) mmol/L compared to the second generation's value of 2.789 (0.797) mmol/L with a difference of means (95% CI) of 0.910 (0.193, 1.626) p=0.015 (Table 9.5).

The TC/HDL ratio was 3.0 (1.2). Intergenerational comparisons showed that the first generation had a mean (SD) TC/HDL ratio was 3.295 (1.287) compared to the second generation's value of 2.555 (0.683) with a difference of means (95% CI) of -0.785 (0.046, 1.523) (p=0.038).

The fasting blood glucose (FBG) value was 6.1 (0.6) mmol/L for the whole group. Intergenerational comparisons showed that the first generation had a mean (SD) FBG of 6.108 (0.581) mmol/L compared to the second generation's value of 5.985(0.705) mmol/L with a difference of means (95% CI) of 0.157 (-0.394, 0.709) (p=0.552).

9.2 Energy balance and physical activity levels Comparisons

Total daily energy intake (EI) was 2829.41 (939.61) kcal/day and the total daily energy expenditure (TDEE) was 1554.74 (601.95) kcal/day, giving a positive energy balance (excess

energy). Intergenerational comparisons showed that the first generation had a mean (SD) EI of 3079.73 (1174.97) kcal/day compared to the second generation's value of 3517.95 (1186.08) kcal/day with a difference of means (95% CI) of -438.21 (-870.74, 5.681) (p=0.045). Intergenerational comparisons of TDEE also showed that the first generation had a mean (SD) TDEE of 2803.51 (524.19) kcal/day compared to the second generation's value of 2960.05 (471.67) kcal/day with a difference of means (95% CI) of 156.45 (-22.06, 334.98) although this difference was not statistically significant p=0.085. Energy balance comparisons between first and second generation showed mean (SD) values of 276.04 v. 557.89 kcal/day of excess calorie in the first and second generation respectively with a mean difference (95% CI) of 281.75 (-184.96, 748.47) p=0.256. These groups were therefore in positive energy balance (Tables 9.5). The PAL for this group was 1.54 (0.07) thus establishing the group as a sedentary population. Intergenerational comparisons showed that the first generation had a mean (SD) PAL of 1.54 (0.07) compared to the 2nd generation's value of 1.54 (0.07) showing that physical activity levels between the generations were identical.

9.3 Overall Sub-study group discussion

In this part of the study, this sub-sample of the larger study population demonstrated a high energy intake exceeding UK EAR values of 2550 for sedentary populations with significant difference in EI between first and second generation (p=0.045). the second generation had a greater tendency to over-consume energy. The macronutrient components of energy were also found to be high across the board though intergenerational comparisons did not show any statistical differences in intakes. Total fat intake was high as well as the intake of SFAs, MUFA and PUFA. Total dietary cholesterol intake was in excess of 400 mg/day. This is particularly high as the excess daily energy intake already provides enough opportunity for de-novo synthesis

of serum cholesterol. Thus this sample population has the potential risk of developing chronic NCDs (Muskiet, 2010; Zhao, et al., 2011) if the present trends continue.

The polyunsaturated/saturated fatty acid (P/S) ratio of 0.8 though not very high, is on the borderline of cardiovascular risk (Schnabel, et al., 2012; Lee, et al., 2012;). The high intake of protein, most of which was red meat from lamb in addition to providing excess energy, is a cause for concern, given the strength of the evidence of cancer risk from red meat (WCRF, 2012). Excessive sugar intake, especially extrinsic sugar intake (mean 112 g/day) coupled inadequate consumption of vegetables and fruits and intake of dietary non-starch polysaccharides (NSP) or fibre in the region of the lower reference nutrient intake (12 g/day) means that this sample population is not benefiting from the health benefits of a high fibre intake. This fibre intake is also in contrast to the intake of fibre in the Indian Punjab region (Kaur, 2005; Sadana, et al., 1990).

The energy expenditure data also suggest a largely sedentary sample population with a low level of total daily physical activity. There were no significant intergenerational differences in energy balance ($p=0.256$) and PAL ($p=0.819$). Indeed members of the group had identical PAL values suggesting that their level of activity was broadly similar in type, intensity and frequency. For such a sedentary group, the high intake of energy, protein and fats (especially saturated fats) is rather unhealthy.

It is therefore not surprising to observe high BMI values in this group (mean > 28 kgm^{-2}) which puts them at increased risk of nutrition-related NCDs (Barouki, et al.,2012; Dhillon, et al., 2012; Khan, et al., 2013). Furthermore their waist circumference (WC) and hip circumference (HC) as well as the WHR are all within the margin of moderate to high risk for cardiovascular and other NCDs using the WHO reference cut-offs for these variables. Population-specific BMI cut-offs

also for people of Indian origin suggest that BMIs > 23 pose a significant increased health risk (Szuszkiewicz-Garcia, et al., 2012; Khanna, et al., 2013). Therefore the high BMI observations made in this sample population may well be 'the tip of the iceberg'.

Physiological measures of risk such as the systolic and diastolic blood pressure are important indicators of chronic disease co-morbidity. More recently greater emphasis is being placed on pre-hypertensive states (Datta and Rav, 2012; Celik, et al., 2012; Mungreiphy, et al., 2012;) and the old cut-offs for reference normative WHO values of BP of 140 / 90 mm of mercury for adults (Weisser, et al., 2000; Khunti, et al., 2010) has been debated and revised to reflect the evidence of early manifestations of signs of chronic disease in high risk groups with physical, dietary, lifestyle characteristics not-dissimilar to the population in this study. Thus cut-offs of SBP of 135 mmHg and DBP of 85 mmHg are being muted as the ideal target for establishing risk instead of the higher figures previously used. This sample therefore based on the 'new criteria' were all in the pre-hypertensive state irrespective of generation.

Examining biochemical risk factors in this sample population, there is also evidence of rising levels of serum lipids including total cholesterol >5.6 mmol/L with significant intergenerational differences ($p=0.016$) with the 1st generation at greater risk. HDL, LDL and total triglycerides (TG) levels were however similar in the two groups and within the normal ranges (Appendix 6).

The non-HDL which is the difference between TC and HDL (and includes other cholesterol fractions e.g. VLDL, IDL) has been shown to be a strong marker of cardiovascular risk (Ray, et al., 2009; Simprini, et al., 2011; Boekholdt, et al., 2012) and levels within certain cut-offs (Appendix 6) have been derived as reference points for risk classification. On the basis of such classification, this sample population falls within a moderate risk category for cardiovascular disease based solely on the TC and non-HDL cholesterol values alone. In addition, the TC/HDL

ratio is another marker of NCD risk and relevant cut-offs (Bhan, et al., 2010; Niranjan, et al., 2012; Elshazly, et al., 2013 Roy, et al., 2013). This sample population have demonstrated a moderate to high risk profile using TC/HDL cut-offs. There are however significant intergenerational differences in the TC/HDL ratio ($p=0.038$) with the 1st generation demonstrating higher values and hence greater NCD risk.

The second generation however exhibits increasing levels of sedentariness combined with high intakes of total energy, fats, cholesterol and low fibre intake. They also have higher average BMIs than the second generation. Therefore if the present observations and the trend continues, it is entirely predictable that the second generation Punjabi male migrant population in this study will experience symptoms and signs of NCDs at an earlier mean age than their first generation counterparts.

Chapter Ten : Overall Discussion

Socio-demographic, dietary, physical, physiological, physical activity and biochemical factors were examined and are summarized below:

10.1 Social characteristics and economic status of subjects

In this study, Phase II: 137 first and second generation Punjabi male migrants in Medway were specifically studied to shed light on a population sub-group in the United Kingdom with a disproportionate share of the burden of nutrition related chronic disease (DOH, 2012). Income levels are important factors for consideration in matters of health and disease and low income households have been found to display disproportionate levels of overweight and obesity in England (Mobley, et.al., 2006; Skelton, et.al., 2009; Seligman, et.al., 2010) and elsewhere. The median range of household income of this population (£15,500-£24,999) is below the average earning of the UK population of £29,000 (Household income, Medway council, 2012). Population dynamics showed that 69% of subjects were 2nd generation migrants and another 31% were 1st generation migrants. Nearly 70% of the subjects work in sedentary service sector jobs compared to 30% who are involved in manual labour.

10.2 Overall food choice

Among the major contributors to OW+OB is positive energy balance resulting from excessive dietary energy intake over energy expenditure (Cohen, 2008; Swinburn, et al., 2009; Hall et al., 2011 SACN, 2011). Thus as part of this enquiry, food frequency questionnaires were employed to obtain information about dietary habits and three repeated 24-hour recalls over a set period of

time was used to collect data about current dietary intakes from which total daily energy, macronutrient and micronutrient intakes were estimated and computed and except for a few notable ones, intake was generally adequate.

The results of the dietary assessments presented in Chapter six as pooled mean values show that the food habits and choices of the **Phase II** study group were markedly similar to that found in the **Phase I** focus group of 40 individuals from a similar cohort reported in chapters four of this thesis. Main carbohydrate sources were found to be refined wheat flours and polished rice of high glycaemic index and low fibre content. These are ingredients used to prepare Paratha and Chapatti, two popular dishes in the top ten for this population group. High levels of sugar intake as well as low fibre intake were also discussed in chapter seven. Protein sources were from plant and animal sources and animals protein sources were also contributory to the total saturated fat intake. Lamb and chicken were particularly common as well as eggs and liver which contributed to dietary cholesterol and vitamin B12 in this group. Plant protein sources included chick peas, kidney beans and lentils.

Most common fat sources were purified butter (Ghee) and vegetable oil. Sources of fibre in the diet were mainly wheat, pulses and lentils. Surprisingly very few reported fruit intake in the repeated 24-hour diet recalls and although vegetable sources were reported, these did not appear to contribute significantly to daily fibre intake. The deductions made from this study of dietary choices is that this population consumes little/no fruit and vegetables and therefore fall far short of the UK and EU recommendation of "Five portions of fruit and vegetables a day" equivalent to 400 g/day of a combination of fruits and vegetables of different colours and types. There also appears to be an inter-generational shift (first generation and second generation migrants) in food choice and energy intake in particular with a significantly higher EI among the second generation ($p=0.045$). Punjabi migrants who have their roots in the home country on the Indian

sub-continent seemed to follow and eat more 'traditional' food, their food choices and their EI did not reflect a low or moderate intake and though significantly lower than EI in the 2nd generation, was nonetheless still higher than the 2550 kcal/day EAR value for sedentary UK adult males (SACN, 2011). The differences in EI and food choice between the two generations who were either brought up (or lived most of their lives) in two different environments; one a traditional Indian State and the second, an "obesogenic" (Diabetes UK, 2010) UK environment suggests a possible demographic shift affecting food culture in an otherwise homogenous sample of the UK population.

10.2.1 Macronutrient intake and their energy equivalents

The distribution of daily intake of the components of energy i.e. the macronutrients carbohydrate, protein and fat were in the ratios 52.14%: 13.34%:34.51% (Table 6.6, Table 6.8) from an average 3150 Kcal/day is similar to the recommended distribution in the UK's dietary reference values for average intake of 2550 Kcal/day. In the present study, a closer examination of the contributions of the three components of dietary energy shows that in each case, the actual amount e.g. of fat, carbohydrate and protein consumed exceed RNI values even though the ratios appeared good. The energy equivalent of 1 g of fat is 9 kcal (irrespective of type of fat) and the results reported in this study show that that of the average 3150 kcal of daily energy consumed by the group as a whole, a bulk of the total daily energy is contributed from fat sources. Of this contribution of total fat to the diet, saturated fatty acid (SFA) intake average was as high as 37.38g per day. The contribution of SFA to the total fat was between 32 – 41%. This is far in excess of the recommendation of not more than 11% (DOH, 1991). Similarly, the contribution of MUFA to total fat between 27 – 39% far exceeded the recommended level of 15% of less. PUFA recommendation as a percentage of fat energy is 7% however as the results in this study show, the range was between 23 and 33%. High fat intake and in particular high levels of saturated fat

are known to contribute significantly to the prevalence of obesity as well as endothelial dysfunction, oxidative stress and chronic non-communicable diseases (NCDs) including ischaemic heart disease, cerebrovascular disease and hypertension (Mozaffarian, et.al., 2010; Katan, et.al., 2010; Phillips, et.al., 2012). Furthermore, components of the metabolic syndrome (Misra, et. al., 2010; Unger, et.al., 2010; Tierney, et.al., 2011) have been linked to dietary lipids including hyperglycaemia and type II diabetes. In this study, high levels of total fat in the diet and the different fractions are a cause for concern regarding chronic disease risk in this population. A large proportion of the fats come from animal fat sources such as chicken and lamb, as well as purified butter (ghee) which is traditionally used by South Asian communities in cooking.

Total fat intake and the contribution of components of fat i.e. SFA, MUFA and PUFA were in amounts two or three-fold higher than the recommended levels for adult males. Similarly the level of cholesterol intake among what we now know is a high risk group was more than 1½ times the level recommended for normal healthy low-risk individuals and 2 times the level recommended for high risk individuals such as was discovered in this sample population. These findings merit further examination and there is scope for nutrition education and other forms of intervention to mitigate the apparent dietary risk factors uncovered.

Further analysis to show relationships e.g. between age and SFA showed a coefficient of determination of R^2=0.45 suggesting a 45% influence of age on SFA. The younger age groups between 21 and 35 years consumed the highest amounts of saturated fats through what appears to be unhealthy food choices and thus laying the foundations for OW+OB and risk of chronic disease. The contribution of cholesterol to lipid intake further adds to the concerns raised above as follows: the UK (and international recommendations) for cholesterol in the diet (WHO, 2013) suggests that for normal, healthy adults with no particular chronic disease risk, total cholesterol

should not exceed 300 mg/day and for those with known risk of chronic disease or diabetes, intake should not exceed 200 mg/day. The range of cholesterol intake which varied between 318 and 507 mg/day was higher than recommended levels in all age groups studied and the whole group mean of 402 mg/day is excessive.

The implications of such high intakes of dietary cholesterol and their possible impact on chronic disease risk remains controversial. It has been argued by some that many countries in Asia and Europe have not provided a 'ceiling' for dietary cholesterol intake and in a recent review by Fernandez and Calle (2010), the authors argue that dietary cholesterol reduces circulating levels of small dense low density lipoprotein (LDL) cholesterol particles which are a major risk factor for cardiovascular disease. They cite clinical studies which show that even if dietary cholesterol may increase plasma LDL cholesterol in certain hyper responders, this scenario is always accompanied by increases in high density lipoprotein (HDL) cholesterol, thus maintaining the HDL/LDL ratio.

Although Fernandez and Calle (2010) discussed the merits (or de-merits) of having a ceiling such as the 300 mg/day limit for total cholesterol intake, it is my view that these issues need to be taken in perspective and contextualised. Apart from overloading the entero-hepatic circulation with extra cholesterol in the diet, in my view when dealing with a population such as this present one whose total dietary energy and the contribution of fat to that total energy is already high, and where that population shows significant evidence of OW+OB and has a known excess risk of chronic disease, having a ceiling on intake especially of components of the diet which can contribute to disease risk must be a good thing. It can further be argued that perhaps the reason some countries do not have their own cut-offs.The contribution of carbohydrate to the total daily energy intake is also worth noting. In this study, the main staple for this community was wheat and in Medway, Kent most of the community reported the use of ("Maida") which is plain wheat

flour (Table 4.2). This is highly refined and has a high glycaemic Index. Therefore, this ingredient can actually increase the overall glycaemic load. The second most common source of carbohydrate was Basmati Rice ("Chaul/Bhat"). Total carbohydrate intake is 400.36 g contributing on average 1200 kcal of energy per day. When the intrinsic and extrinsic sugar content of the diet are combined (Table 6.6) the range of energy intakes from sugars is from 496 – 1096 kcal/day. There is therefore the potential for sugars to contribute up to one-third of the total daily energy intake of 3150 kcal. This means that the glycaemic load (Pittas et.al., 2006;Liu and Chou, 2010) will be high and for those at risk of diabetes, this can be unhelpful and add to risk of other NCDs (Brown, et.al., 2011).

Furthermore, excess energy intake in the form of carbohydrates is likely to be converted into fats for storage. The mostly likely fats will be short chain fatty acids stored in the abdomen, in the omentum. This abdominal fat has been associated with high risk of chronic disease (Després, 1998; Thomas, et.al., 2004) including the metabolic syndrome (Aballay, et. al., 2013). Thus the excess sugar in the diets of this group which appears to be largely sedentary is not only unnecessary, it could potentially increase the risk of chronic disease among the population.

After the age group of 26- 30 years there was an increased trend of carbohydrate and sugars as a major source of energy contribution to the overall diet. Diet rich in refined carbohydrate is low in fibre content. Therefore, this may be one reason for which the overall dietary fibre was low among this community. The large amount of total energy comes from dinner and refined carbohydrate is digested quicker which increases total glucose available in the body for a shorter period of time. Considering that there is less physical activity after dinner for most individuals, most of the glucose will be stored as fat thus contributing to body weight and body fatness (including abdominal adiposity). It is particularly worth noting that this population is known to store fat in their abdomen. Abdominal obesity is associated with diabetes and cardiovascular

disease and this community suffers the most (Lapidus, 2012; Nakao 2012; Caballero, 2012; Okosun 2002). A closer examination of the protein content of the diet did not follow a particular set pattern although it initially appeared that as the age increased their overall protein intakes started to decrease. Based on UK RNI and international recommendations for protein intake of 0.8 g/kg/d, for the age group 21-25 years, expected protein intake should be 77.28 g (±6.01) per day (**Table 6.10: Chapter 6**). However in this group, their daily intake was 108.08 g (±14.10) which was rather high providing a daily protein intake excess of 0.32 g/kg body weight. This translates on average into 32.63 g (±16.66) excess protein consumed per day. For a largely sedentary population already consuming high amounts of total daily energy, the extra protein is most likely going to be converted into fat for storage and the likely storage sites include sub-cutaneous and abdominal sites, thus contributing to overweight and obesity. Abdominal fat stored in the omentum is also mostly made up of metabolically active short chain fatty acids which have been known to increase risk of cardiovascular disease (Glatz, 2010; Liu, 2012).

In this study, the protein intake per kilogram body weight was found to be 1.12 g/kg/day, compared to the recommended level of 0.8 g/kg/day. The ranges of individual intakes from 103 – 134 g/day with an overall mean of 102 g/day (**Table 6.10**) was rather excessive.

10.2.2 Fibre intake and its implications

The main source of dietary non-starch polysaccharides (NSP or dietary fibre) among this group was from staples and certain vegetables. Fruits were not a feature of the diet of this group and therefore was less likely to contribute significantly to fibre intake. Complex carbohydrates and fibre-rich diets have health benefits including reducing the rate of absorption of glucose from the gastrointestinal tract (low glycaemic index) (Jenkins, et al., 1987; Rizkalla et al., 2002; Brennan, et al., 2012; Denise, et al., 2012) and lipid-lowering effects (Bock et al., 2012) particularly

cholesterol (Satija and Hu, 2012). Soluble fibre in particular is effective in reducing serum cholesterol levels (Charlton et al., 2012) and increases the bulk of the stools thus reducing the risk of constipation (Nanji et al., 2012). Thus in population dietary intake studies, a look at dietary fibre intake can be informative in helping us ascertain, predict risk and take precautionary preventive measures for particular disease (Ho et al., 2012).

In the present study, the dietary habits and food choices suggested that fibre sources are limited. Findings which show an average fibre intake for this community of 15.23 g (±9.14) per day with a range of lowest amount of 10.56 g (±4.11) being consumed by the older age group of 51-55 years (Table 6.3, Chapter 6). The highest amount consumed was 17.74 g (±1.89) by the 31-35 age group and even this value is less than the estimated average requirement of 18 g/day which is thought to be sufficient to meet the needs of up to 50% of the UK population (DOH, 1991). The UK RNI value for fibre is 24 g /day and in India, the recommended intake is 30 g/day with a lower acceptable limit of 20g/day daily dietary intake (NIN, 2011). The low fibre intake among this population is rather surprising and worrying, given the fact that in India where the majority originate, plant-based diets rich in fibre are commonly consumed and the average fibre intakes are much higher. Overreliance on polished rice and highly refined wheat flour as was found in this group may be contributing significantly to this trend. This is not helped by the rather low levels of fruit and vegetable consumption observed both in the focus groups and in the study population.

10.2.3 Micronutrient mineral intake

Overall the mineral and vitamin intakes were more than adequate except for notable ones like iodine and vitamin D which were far below the recommended levels and need to be addressed. Low iodine intake in a population which has such a high salt intake is particularly worrying

though not surprising. More than 95% of the salt sold on the UK market is non-iodised salt and therefore unless the population is obtaining their iodine from other dietary sources, there is a risk of iodine insufficiency among certain population subgroups over time. This needs to be examined in some further detail and addressed. It is worth noting however that the RNI values are not a prescription of intake but statistically representative population intake values ensuring adequate intake for at least 97 per cent of the population.

The average calcium intake of 829.25 mg/d (± 508.23) was more than the RNI value of 700 mg/day for the UK, which would meet the needs of most people. Calcium is an important mineral not only required for bone metabolism, but also for muscle metabolism, nerve conduction and cardiovascular function (Burt et al., 2013). Ensuring adequate intakes of calcium is necessary for all age groups although in terms of bone mineralisation, the emphasis of dietary adequacy should particularly focus on infancy and early childhood. Peak bone mass is usually achieved between the ages of 15 and 20 years (NIN, 2011) thus implying that for optimum bone health through adulthood, investment in bone mineralisation must ideally take place in childhood. Iron intake was also adequate with the mean intake of 17.73 mg/day being enough to meet the needs of the subjects. Although the age 51 – 55 group had an average intake of 11.53 mg/day (± 7.08), this was still adequate for that age group whose requirements have been set at 8.7 mg/day (DOH, 1991).

Sodium intake of 2575.63 mg/day (±1305) was much higher than the recommended intake of 1600 mg/day for adults in the UK. The excess intake is greater than 900 mg per day. The Na intake reported here is equivalent to total salt consumption of 6438 mg/day, compared to the Food Standards Agency recommendation of not more than 6000 mg (6 g) of salt per day. The salt intake reported here is also only intrinsic salt contained in the diets analysed but does not include added salt at table. This means that the values reported may in fact be lower than actual

intakes among the group. Nonetheless these values are still high. Sodium is known to be associated with maintenance of membrane potential and is important in nerve and muscle conduction. Sodium also has numerous other functions and as the major extracellular cation, is essential for maintenance of fluid and electrolyte balance. However, higher Na levels in plasma have been associated with elevated blood pressure and risk of hypertension and other cardiovascular diseases (Graudal et al., 2011). It is estimated that over five million of the UK population has undiagnosed hypertension (BHF, 2013) and this means that particularly Na-sensitive individuals or population sub groups who are more susceptible to hypertension need to take the necessary preventive measures to reduce risk. One such measure is to monitor and reduce overall salt and Na intake through dietary modification. This is currently an important national (NICE, 2006) and global issue and focus by the international scientific community (Whitworth, 2003) on the reduction of mortality rates from hypertension and other NCDs. This high sodium intake found in this group raises serious questions about hypertension risk which need to be addressed. This study population has already shown signs of elevated blood pressure and a 'pre-hypertensive state' from the results obtained. Over 90% of the sample population is also OW+OB, meaning that they already have some other risk factors for the metabolic syndrome and NCDs. Therefore dietary factors which could enhance the risks need to be identified and tackled, including Na intake.

Potassium intake was adequate with an overall group average of 3824.44 mg/day, compared to the recommended intake of 3500 mg/day. Potassium is the predominant intracellular cation and acts in tandem with Na to maintain cell membrane potential, nerve and muscle conduction, maintenance of fluid, electrolyte and acid-base balance and cardiovascular function. Both hypo- and hyper-kalemia have implications for cardiac muscle function and affect both the heart rate and particularly T-wave function (Sweadner and Goldin, 1980; Garlid, 2003). Potassium at

physiological concentrations can be described as 'cardio-protective' just as sodium in excess can be described as 'promotive of cardiovascular dysfunction'.

Magnesium is an important mineral involved in many enzyme-led reactions, particularly involving energy metabolism in most biosynthetic pathways. For example Mg is associated with Na-K ATPase which is needed for phosphate transfer reactions e.g. in glycolysis, amino acid metabolism and haem biosynthesis. Mg is also essential for muscle metabolism, including cardiac muscle and deficiency though rare, has been associated with cardiovascular dysfunction (Antunes et al., 2013; Kupetsky-Rincon, and Uitto, 2012). In this study population, Mg intake ranged from 301 – 491 mg/day with a whole group average of 437.80 mg (± 177.78) mg/day. This exceeds the recommended intake of 300 mg/day and all age groups studied at least met the requirements. Similarly copper intake was adequate in all age groups with a range of intakes from 3.25 – 4.55 mg/day compared to the recommended intakes between 1 – 2 mg/day. Copper is a very important mineral associated with numerous metallo-enzymes including superoxide dismutase which is involved in essential anti-oxidant functions. Zinc distribution in the body is ubiquitous, underscoring its importance relative to its wider distribution. In groups at particular risk of oxidative stress and NCDs such as is being discovered in this study, adequate intake of anti-oxidant nutrients to help combat oxidative stress and NCD is particularly important. Although meeting requirements, excessive intakes of minerals such as copper can also have negative effects.

Zinc intake was adequate for most groups except the over 50s whose intake was (3.27 mg/day) below the RNI value of 9.5 mg/day. The overall mean intake was 14.55 (± 6.64) mg/day. Zinc also exhibits antioxidant functions and is also a component of insulin (Chimienti, 2013). Zinc is also associated with over 100 enzymes in the body and is therefore important for optimum health.

Selenium also has antioxidant functions and is associated with numerous enzymes including glutathione peroxidise involved in mopping up hydroxy free radicals in the body (Zeng et al., 2013). The average intake of Se in this study was 53.86 µg/day, which is below the RNI valueof 60 µg/day. The lowest intake was observed in the 21 – 25 age group who also had the highest average BMIs >30 kgm^{-2}. Selenium deficiency has also been associated with some forms of cardio-myopathy (Kershan's disease) but mostly seen in childhood in areas e.g. in some parts of Newzealand and China, following Coxsackie virus infection (Lee et al., 2013).

Iodine intake was also rather low, with a whole group average of 61.01 µg/day (± 32.84). this is less than 50% of the RNI value of 140 µg/day recommended. Very low intakes were particularly observed in the 21 – 25 age group whose average intake was 36.74 mg/day, although no group in the study had enough iodine in their diet. The sources of iodine in the diet were mainly iodised salt, but in the UK, less than 5% of salt sold on the market is iodised. Other good sources include sea food, but this study population ate very little sea food. Unless people specifically buy and use iodised salt regularly, though their overall salt intake may be high as has been reported in this study, they will still not meet their requirements for iodine. Therefore taking more salt may not be the answer for his population group since less than 95% of salt on the UK market is iodised. If they were to resort to increasing their salt intake, they also run the risk of NCDs. This finding provides scope for planning an intervention which would focus on nutrition and health education including providing information about food sources of iodine within their specific cultural context.

10.2.4 Micronutrient Vitamin Intake

In this report, discussion will be limited to only a few vitamins as overall, this study population met their vitamin requirements. Of particular note is vitamin B6 for which the whole group

average intake was 2.31 mg/day (± 0.45), above the RNI value of 1.6 mg/day. Folate intake also showed an overall average of 342.73 µg/day (± 92.58) which was far in excess of the RNI value of 200 mg/day. However again the 0ver 50s had a low average intake of 149.61 mg/day (± 62.51). It is worth noting that this group in addition to having a slightly reduced intake of total energy overall, appeared to be less inclined to consume fruits and although they took vegetables commonly consumed by this population group, the amounts consumed were not always high. Peculiar to this group was also their intake of total sugar which was very high compared to the other groups.

Vitamin D intakes were low. The average intake was 5.63 µg/day which was less than 60% of the RNI value of 10 µg/day. The lowest intakes were observed in the 41 – 45 age group (3.72 µg/day; ± 1.39) and the 51 – 55 age group (4.44 µg/day; ± 3.36). The data is based on three collections of 24-hour dietary recalls taken over the Spring and Summer months during which adequate daily sunlight and exposure would provide extra vitamin D through de-novo synthesis harnessing ultraviolet rays from the light spectrum. Previous studies in the UK have shown that the vitamin D intakes and status among South Asian females is generally lower than the average UK population (Darling et al., 2012) and follows a seasonal pattern with higher vitamin D status during the summer months and lower during the winter months (Al-Daghri et al., 2012). Some studies have also shown polymorphism in risk to vitamin D deficiency within the population (Casado-Díaza et al., 2012). If, as it appears in this study intake is habitually low, it reflects dietary sources of the vitamin and may be genetically related. This means that any planned intervention to increase vitamin D intake would require first addressing any genetic dimensions of the problem. These findings overall and the differences in food intake, food choices and levels of nutrient adequacy call for both a general but culturally specific intervention plan for this

population group, but also more specifically targeted and age-related interventions to help tackle the problems identified.

10.2.5 Total Energy Intake, Age and Body Mass Index Associations

Average energy intake by the study population was 3151.30 Kcal with the highest intake was observed in the age group of 21-25 years who also recorded the highest average BMI of 30.68 kg/m^2. It is worth noting however that the sample size in this particular age group was very small and therefore on its own, is not sufficient to draw any meaningful conclusions. However other aspects of the findings in respect of this age group suggest that it is not worth ignoring these findings either. There was a decreasing trend in energy intake (EI) with age which were strongly correlated (R^2=0.9374). A decreasing trend in BMI with age was also observed although this was not as strongly correlated (R^2=0.4075). Comparisons between EI and BMI showed an almost flat line with no demonstrable correlation between the two (R^2=0.0068). It was however observed that between the ages of 36-45 years, BMI increased despite a decrease in EI albeit that the EI was still higher than the estimated average requirements (EAR) of 2550 kcal/day for the UK population. This increase in BMI suggests that the underlying influences for energy balance need to be examined in some more detail. For example, what was the level of physical activity in these groups and in answering those questions, both occupational and non-occupational (recreational) physical activity would have to be examined. Similarly, a sharp drop in EI of at least 300 Kcal/day was observed in the age groups above 46 years which must be measured against their physical activity levels (PAL) and their BMI.

10.3 Physical and physiological status

In this study, 61.3% of subjects were overweight (BMI >25kgm^{-2}) and another 30% obese (BMI >30kgm^{-2}), thus giving a total overweight and obese (OW+OB) proportion of >91% of the

sample population. This prevalence of obesity in the Punjabi male population in Medway is 30% more than the average figures reported in the Health Survey of England (HSE, 2011), thus confirming that this group has an excess burden of OW+OB over and above the national average for England. Such high levels of obesity predispose to chronic diseases such as hypertension (and other forms of heart disease) and diabetes. Such a high rate of obesity in an otherwise normal population has implications for health care planning and policy. The waist-to-hip ratio (WHR) is a proxy measure of abdominal fatness and has been associated with NCD risk (Joyce et al, 2012; Cameron et al., 2012). There are normative cut-offs for the WHR reported by the world health organization (WHO, 2002; 2011) who suggest that values >0.90 are associated with high risk of NCDs. In this study, the overall group average WHR was 0.86 with a wide range from 0.83 to 0.92. The age group among both first and second generation had the highest WHR were the 21 – 25 group and can thus be characterised as being in a high risk category. Between 35 – 55 years, the range of WHR was 0.86 to 0.88 which is rounded up would amount also to 0.9. This high WHR is not surprising given that over 90% of the sample population is OW+OB. The high coefficient of determination (R^2= 0.7124) between WHR and systolic blood pressure (SBP) is indicative of a strong association between the WHR and SBP. This finding is supported by other previous studies (Ljung et al., 2000; Maffeis, et al., 2001; Faria et al., 2002) and puts the subjects in this study in a high risk category, given that the range of SBPs across all the age groups suggest a pre-hypertensive state. There was a less strong link of 22.86% between WHR and DBP (R^2= 0.2286). Multiple linear regression analyses showed that both systolic and diastolic are influenced by age (p=0.018; and p=0.018 respectively) and BMI (p<0.0001). Body mass index (BMI) and WHR also showed a very strong associations (R^2= 0.99; p<0.0001) and as the BMI increased so did the WHR. The significance of this link lies in the fact that each of these factors acts as an independent risk factor for chronic disease and if they occur together, the chances of a cumulative risk cannot be ruled out given the fact that they are components of the

defining characteristics of the so-called metabolic syndrome or syndrome X (Gustafsson and Hammarstorm, 2012; Salazar, et al., 2013). Thus in developing any risk regression model, both factors would have to be taken into account.

The waist circumference (WC) on its own has been used as a proxy measure of abdominal adiposity (Li et al., 2007) and some have argued that it is a better predictor of NCD risk than the WHR (Maffeis, et al., 2012). It is therefore increasingly being used as a NCD predictor in epidemiological studies worldwide. In this study, the average WC of 88 cm (± 5.49) with a range from 84 to 96 cm exceeds the WHO cut-off for high risk of NCDs i.e. WC >85 cm (WHO 2002; 2008; 2011). Data from the national institute of nutrition in Hyderabad, India suggest that WC between 80 and 84 cm is regarded as high risk for NCD (NIN, 2009).

The very high coefficient of determination (R^2= 0.9953) between BMI and WC reinforces the consistency of the findings in this study suggesting the presence of OW+OB and helping us to establish a chronic disease risk profile for this sample population.

10.3.1 Physical measurements and Blood Pressure

Overall blood pressure among the sample population shows an upward trend towards hypertension. This is rather not surprising due to their high BMI and other characteristics discussed above including abdominal obesity and dietary intake behaviour. The average SBP for the whole group 138.7 mm Hg (±9.95) for the whole group is by definition a pre-hypertensive state and the highest SBP was recorded among the 21-25 years group with an average of 142.50 mm Hg (±11.10). The diastolic BP average of 86.25 mm Hg (±5.17) was also trending towards diastolic hypertension and the highest DBP recorded of 90.00 mm Hg (±5.48) was in the 21-25 years group. Already in the young adult group we can see elevated blood pressure towards hypertension and this should alert us to consider preventive intervention measures. It has been

postulated in defining the metabolic syndrome that high BMI, elevated blood pressure and large waist circumference are important contributory risk factors for chronic disease for which South Asians in the UK are already known to be at higher risk including type two diabetes, CVD and CHD (Okosun, 2002; Caballero, 2003; Lapidus, 2012; Nakao, 2012).

10.4 Physical Activity Considerations

The average physical activity level (PAL) was 1.54 which by definition, reflects a sedentary population. This classification is further supported by their average METS-Minutes per week values based on the quantification of energy expenditure due to work, travel and recreation (Bull, et al., 2009). Their METS-Minutes per week was less than 600, the cut-off for sedentary behaviour (WHO, 2013). Measurements of PA can be very difficult and the direct methods though more accurate, can be cumbersome, time-consuming with a high non-adherence rate. The indirect methods have therefore been developed and found to be quite effective in helping to estimate PA and daily energy expenditure. When combined with others measures of sedentary behaviour, the results of indirect measurement of PA are reliable. In the present study a pre-validated GPAQ questionnaire (Appendix 3) developed by WHO was used to measure the level of activity (or inactivity) among this migrant population of SA males of Punjabi origin and as the results show, the range of PAL is 1.45 – 1.60 which classifies the entire population sample as sedentary or involved in low levels of physical activity. The results of METS-Minutes per week estimations also give average values for the whole which falls short of 600 METS-Minutes per week, the threshold for sedentary activity.

This low level of PA puts this population at a high risk of NCDs. Furthermore energy intake and expenditure comparisons also show clearly that this population is in positive energy balance

across age groups and generations. The second generation has a significantly higher energy intake (p=0.045) compared to the first generation; and hive a higher body mass index (BMI) although the latter differences were not statistically significant. Both groups have BMI values above 28 kgm^{-2} and 91% of the subjects are at least overweight (using BMI cut-of criteria). These calculations of BMI and their use for risk categorisation in this sample population is based on UK and WHO reference normative cut-offs. However there is growing evidence to suggest that at lower BMI's people of Indian origin have a much higher cardiovascular and NCD risk compared to Caucasians (Davies, et al., 2011; Joshi, et al., 2012; Pandit, et al., 2012). Thus it can be argued that using the WHO / UK BMI cut-offs to measure risk in this population may be under-estimating their risk. Therefore in order to develop an appropriate risk regression model for this group based on BMI cut-offs, it might be best to undertake a log transformation of BMI using the BMI cut-off of 23 kgm^{-2} (Indian reference for overweight) and the international classification of 25 kgm-2 to allow for a 'risk range' to be developed.

In assessing NR-NCD risk for this population, it is better not to take the risk factors in isolation otherwise when results are computed and compared there may be a wrong impression of lower calculated risk when in fact the combination of risk factors in a multiple regression model might give a better picture of those factors that are particularly important e.g. for BMI, blood pressure and diabetes.

On the other hand for purposes of mitigating risk, one could base an intervention plan on e.g. the very low level of physical activity currently practiced by this population. The plan any intervention successfully however the socio-cultural context of the barriers to PA in this population need to be pursued and understood as they are fundamental to both short and long term success of any planned interventions. Behaviour change is generally accepted to be a very difficult concept and the mediators of behaviour, and in particular PA-related behaviour can be

difficult to fully grasp and address. Therefore understanding culture and working within that culture to establish pathways for risk reduction would be the best option in public health interventions, including nutrition interventions.

This population of Punjabi males in the UK when compared to their age-matched cohorts in the Indian and Pakistani Punjab, are more engaged in 'sedentary' service type jobs (about 70% of the sample population) and only 30% (ANOVA $p<0.0001$) engage in manual labour or any degree of significance. On the contrary, those of a similar age range in the Indian Punjab are mostly engaged in agricultural type manual labour (70%) compared to Service industry type jobs (30%) (Headey, et al., 2012; Tsujita, et al., 2012). The Indian national statistics show that the Punjab Province has the highest rate of OW + OB (just over 30%) in the whole of India. This is an observation seen in a population in which 70% of the population is purported to be engaged in manual labour; and where physical activity due to transport (e.g. walking, cycling to and from work) is likely to be much higher than among their counterparts in the UK. That this UK based Punjabi male population in Medway, Kent has a rate of OW + OB as high as 91% among them is therefore not surprising because this migrant population has shown to have a higher energy intake, lower energy expenditure, lower PAL and are engaged in largely sedentary-type jobs. It is my opinion that the dynamics of the nutrition transition and the determination of risk factors in any genetically homogenous population cannot be properly explained without a clear understanding of the environmental mediators of physical activity behaviour, diet and other lifestyle factors. This is a fundamental principle in public health and public health nutrition is no exception.

Furthermore to ameliorate the major risk predictors described in pattern five of the nutrition transition by Barry Popkin et.al., (2000; 2003; 2004) (i.e. a sedentary population with excess energy intake, high fat (saturated fat) intake, OW + OB, low fibre intake, high refined sugar (and

low complex sugar) intake, high cholesterol intake and status and signs of nutrition-related NCDs) it would require a complete examination of the underlying environmental contributors to risk in an otherwise homogenous population. In my view the present study design scientific observational study lends itself to the principles of epidemiology necessary to understand and underscore risk within a population in order to plan to tackle it.

10.5 Comparison between Phase II and Phase III data

The sub-group Phase III of 30 participants for in-depth physical, physiological and biochemical measurements was self-selected in the sense that those already recruited who agreed to take part were included with a view to ensuring age-group balance. To test whether this sub-group (Phase III) had characteristics of similar variance to the lager study sample (n=137) (Phase II), differences in means were compared which showed that except for waist circumference (WC) with a difference of means (95% CI) of 2.684 (-1.170, 4.237) (p0.001) and the P/S ratio with a mean difference (95% CI) of -5.23 (-10.56, 0.054) (p0.052), all other diet, energy expenditure, PAL and energy balance comparisons did not show significant difference in the means thus indicating that the sub-group was indeed reflective of the bigger sample. Therefore findings from this group can be extrapolated to reflect the whole group. From the discussions in chapter 10, the study population demonstrated a high energy intake exceeding UK EAR values of 2550 for sedentary populations with significant difference in EI between first and second generation (p=0.045). The second generation had a greater tendency to over-consume energy. The macronutrient components of energy were also found to be high across the board though intergenerational comparisons did not show any statistical differences in intakes. Total fat intake was high as well as the intake of SFAs, MUFA and PUFA. Total dietary cholesterol intake was in excess of 400 mg/day. This is particularly high as the excess daily energy intake already

provides enough opportunity for de-novo synthesis of serum cholesterol. Thus this sample population has the potential risk of developing chronic NCDs (Khan, et al., 2013; Jayawardana, et al., 2013; Di Cesare, et al., 2013; Maharjan, et al., 2013; Anand, et al., 2013) if the present trends continue. The polyunsaturated/saturated fatty acid (P/S) ratio of 0.8 though not very high, is on the borderline of cardiovascular risk (Garimella, et al., 2013; Anton, et al., 2013; Lamping, et al., 2013; Sakata and Shimokawa, 2013; Gray, et al., 2013; Inoue, et al., 2013).

The high intake of protein, most of which was red meat from lamb in addition to providing excess energy, is a cause for concern, given the strength of the evidence of cancer risk from red meat (WCRF, 2007; Chan, et al., 2013; Egeberg, et al., 2013; Winkels, et al., 2013).

Excessive sugar intake, especially extrinsic sugar intake (mean 112 g/day) coupled little consumption of vegetables and fruits and intake of dietary non-starch polysaccharides (NSP) or fibre in the region of the lower reference nutrient intake (12 g/day) means that this sample population is not enjoying the health benefits of a high fibre intake. This fibre intake is also in contrast to the high intake of fibre in the Indian Punjab (Frentzel-Beyme and Chang-Claude, 1994; Grewal, et al., 1995; Kapoor, et al., 2011; Choudhary and Grover, 2012).

The energy expenditure data also suggest a largely sedentary sample population with a low level of total daily physical activity. There were no significant intergenerational differences in energy balance ($p=0.256$) and PAL ($p=0.819$). Indeed members of the group had identical PAL values suggesting that their level of activity was broadly similar in type, intensity and frequency (Table 7.3). For such a sedentary group, the high intake of energy, protein and fats (especially saturated fats) is rather unhealthy.

It is therefore not surprising to observe high BMI values in this group (mean > 28 kgm^{-2}) which puts them at increased risk of nutrition-related NCDs (Barouki, et al.,2012; Dhillon, et al., 2012;

Khan, et al., 2013). Furthermore their waist circumference (WC) and hip circumference (HC) was well as the WHR are all within the margin of moderate to high risk for cardiovascular and other NCDs using the WHO reference cut-offs for these variables. Population-specific BMI cut-offs also for people of Punjab Indian origin suggest that BMIs > 23 pose a significant increased health risk (Szuszkiewicz-Garcia, et al., 2012; Khanna, et al., 2013). Therefore the high BMI observations made in this sample population may well be 'the tip of the iceberg'.

Physiological measures of risk such as the systolic and diastolic blood pressure are important indicators of chronic disease co-morbidity. More recently greater emphasis is being placed on pre-hypertensive states (Datta and Rav, 2012; Celik, et al., 2012; Mungreiphy, et al., 2012) and the old cut-offs for reference normative WHO values of BP of 140 / 90 mm of mercury for adults (Weisser, et al., 2000; Khunti, et al., 2010) has been debated and revised to reflect the evidence of early manifestations of signs of chronic disease in high risk groups with physical, dietary, lifestyle characteristics not-dissimilar to the population in this study. Thus cut-offs of SBP of 135 mmHg and DBP of 85 mmHg are being muted as the ideal target for establishing risk instead of the higher figures previously used. This sample therefore based on the 'new criteria' were all in the pre-hypertensive state irrespective of generation.

Examining biochemical risk factors in this sample population, there is also evidence of rising levels of serum lipids including total cholesterol >5.6 mmol/L with significant intergenerational differences ($p=0.016$) with the first generation at greater risk. HDL, LDL and total triglyceride (TG) levels were however similar in the two groups and within the normal ranges (**Table 9.2**). The non-HDL which is the difference between TC and HDL (and includes other cholesterol fractions e.g. VLDL, IDL) has been shown to be a strong marker of cardiovascular risk (Ray, et al., 2009; Simprini, et al., 2011; Boekholdt, et al., 2012) and levels within certain cut-offs (**Appendix 6**) have been derived as reference points for risk classification. On the basis of such

classification, this sample population falls within a moderate risk category for cardiovascular disease based solely on the TC and non-HDL cholesterol values alone. In addition, the TC/HDL ratio is another marker of NCD risk and relevant cut-offs. This sample population have demonstrated a moderate to high risk profile using TC/HDL cut-offs. There are however significant intergenerational differences in the TC/HDL ratio ($p=0.038$) with the 1st generation demonstrating higher values and hence greater NCD risk. The second generation however exhibits increasing levels of sedentariness combined with high intakes of total energy, fats, cholesterol and low fibre intake. They also have higher average BMIs than the second generation. Therefore if the present observations and the trend continues, it is entirely predictable that the second generation Punjabi male migrant population in this study will experience symptoms and signs of NCDs at an earlier mean age than their first generation counterparts. Levels of serum lipids can tell us about NCD risk and especially risk of endothelial damage and oxidative stress (Rong et al., 2013; Ochoa-Avilés et al., 2012). Fasting glucose levels will also tell us about glycaemic control and may yet help us to uncover individuals and groups at risk of type two diabetes and other NCDs within the Punjabi male population in Medway.

A sub-sample of the study population has been chosen at random to undertake biochemical analysis and to enable matched comparisons between biochemical variables and BMI. WC, WHR, BP, EI, PAL and other aspects of the study. Furthermore comparisons between energy intake (EI) and energy expenditure (EE) as measured from the GPAQ will help shed more light on the energy balance dynamics in this population and help us quantify excess weight and body fatness accruing from positive energy balance where activity levels are found to be low. Thus by being able to objectively define the population physical activity level, it will be possible to identify lifestyle factors and behavioural issues to target for intervention, including cultural and psychological elements.

It is therefore hoped that following this stage of the study, evidence of the nutrition transition can be identified in this population group to enable us develop a chronic disease risk predictor model to guide future preventive interventions in this, and hopefully other population sub-groups in the UK and elsewhere.

10.6 Discussion of Methods and Study Limitations

Subject recruitment and sampling is an important component of research study design to ensure minimal bias in selection, measurements and results. In this study, a three stage approach was employed following ethical approval, first to identify the sample population of interest and to identify different geographical locations from which to recruit them. A sample size was calculated to allow us to determine what was minimally required to lend credibility to the types of analyses and conclusions which we might wish to make in respect of the population in question.

Applying random sampling approaches allowed us to select without bias the study group both for the Focus group discussions (n=40) and the main study (n=137) the latter of whom 30 were (self) selected (with age group adjustments) for in-depth studies including biochemical analyses. Those subjects who participated in the focus group were automatically eliminated from the main study. To test the hypothesis that this sub-group belonged to the original sample population (n=30 is a sub-set of n=137) differences in means of a number of variables were tested statistically and except for the waist circumference and P/S ratio, were all found to be statistically insignificant (Appendix 5).

Using the focus group approach enabled discussion among peers in a homogenous group under informal conditions that allowed individuals to express their opinions freely, and the group to

examine more closely common practices within their community. Splitting the group (n=40) into five smaller units of 8 people each was designed to reduce some of the disadvantages of large focus group members which can make it cumbersome to manage. However this also required having good facilitators and the group focusing on the tasks at hand. In this study, the facilitators ensured a good balance and steered the discussions well. Asking each participant to supply menus from their own home for wider discussion also allowed the group to share their practices and learn together.

Although part of the focus group data was qualitative, using the 24 hour recall to collect individual recent dietary intake data helped to establish personal dietary habits and food preferences, and to gauge energy intakes and other components of the diet, prior to the whole group study.

The use of standard socio-demographic questionnaires in establishing population dynamics is a common methodology used not only in the social sciences but increasingly in public health and nutritional epidemiology. Socio-demographic characteristics are an integral feature of a person's environment and contains potential mediators of food and nutrition-related behaviours (Bingham, et al., 2010; Blake, et al., 2011). Failure to recognise this in epidemiological study designs or observational (and indeed clinical experimental) studies weakens the study and one would regard as a missed opportunity. In the present study, the socio-demographic data helped o establish a baseline of subject characteristics, their homogeneity, education, income levels, types of occupation and how these in turn relate for instance to types and patterns of physical activity. The latter is an essential component of the energy balance equation, without which a full physiological assessment of PAL cannot be established.

Dietary assessment methodology has been criticised over decades. However they remain the main means of measuring population and individual dietary behaviour. Their use in this study

underlies their importance in nutritional epidemiology as well as our recognition that for purposes of comparison with other similar studies, they are the preferred choice.

The McCance and Widdowson's The Composition of Foods (FSA, 2002) in combination with Diet Plan 6 were employed to estimate the nutrient content of traditionally consumed recipes. This will not accurately represent the nutrient composition of food due to cooking style, spices usage as well as extrinsic salt or sugar usage. Although, participants were asked to provide with as accurate as possible recipes formulation, this could have been resolved with diet plate collection and therefore, analysis of the full diet plate as well as deduction of the wastage from the plate. However, this process is time consuming and expensive and virtually this study would have to take as a separate study to completely analyse the dietary intake and composition analysis. Traditionally consumed recipes ingredients can be from different sources, nature, biological variation and soil characteristic can make differences in the composition of the food (Southgate, 1998). Other limitations were toolkits that have been designed to gather dietary and social demographic data collection methods and administration techniques.

In assessing individual intakes, it has been shown that the 24-hour recall method does not give a true reflection of micronutrient especially mineral intakes which require a longer period of dietary assessment e.g. up to 36 days has been reported by some researchers (Johnson, 2002; Boffetta et al., 2012) and preferably by the food record method rather than 24-hour recall. However it is not unusual to employ repeat 24-hour recall techniques over a period of time to determine individual intakes. In this study, three repeat 24-hour recalls were done over a period of about two months and the pooled mean values of intake collated and used in reporting.

Measurement errors in dietary assessment are not to be taken lightly and relative validity tools have often been employed e.g. food frequency questionnaire (FFQ) versus 24-hour recall to help measure error mathematically and to factor these errors into analyses using regression modelling.

However, the FFQ, repeat 24-hour recall and focus group diet survey has provided a vast amount of information about food and food-related behaviour among a population in Medway who have traditionally shown a higher risk of chronic disease(Laar et al., 2012; Jayawardana et al., 2013).

Measurement techniques for blood pressure are well established and the mercury sphygmomanometer remains the standard tool for individual and population BP measurements. When utilised by trained individuals, the results are often accurate and reliable. In this study, the pooled mean of individual measurements of BP were recorded and used. It is however recognised that in order to make a firm diagnosis of hypertension, repeated measurements over a period of time e.g. 4 weeks at the same time in the same individual would be much preferred to confirm the level of the BP.

Anthropometric measurements have their individual limitations (Riboli, et al., 1997) and although these were borne in mind, the use of anthropometry as a proxy measure of body composition and overweight and obesity has been found to be accurate and reliable and is universally employed in population studies including the present one.

The use of the Global Physical Activity Questionnaire (GPAQ) (Bull, et al., 2009) has previously been explained in some detail (chapter 2). This WHO tool for measuring population physical activity has been validated against more direct methods such as the tri-axial accelerometer (Bull, et al., 2009) and found to be a reliable method of measuring population PA. A number of reviews on the subject have been published and in this study, the measurements, findings and their reporting take account of the limitations of the method..

The biochemical methods measured during fasting were single measurements taken in the morning (between 7 and 8 am). Although all subjects were instructed to ensure that measurements were being taken at least 12 hours after the last meal, the accuracy of

measurements can only be as reliable as the honesty of the individual being tested. I want to believe that all subjects in this study followed the protocol. The results could also be affected by a conscious effort on the part of the individual to modify their diet in anticipation of any test, but this will contribute to bias in the measurement. It is also worth noting that a single biochemical measurement is not conclusive although it may be indicative of biochemical risk. The results of this observational study are therefore interpreted with that degree of caution.

10.7 Conclusions

This study shows there are similarities and differences between daily dietary practices, food and recipes choices among Punjabi migrant population both at first and second generation, living in Medway, Kent. Components of the diet which may be detrimental to health e.g. total energy and fat content, particularly saturated fat and the P:S ratio will also need to be taken into account in health promotion and especially nutrition education and dietary interventions. High salt content was observed throughout. Matching a high salt intake with this high risk group is important in any future health promotion strategies, including designing risk predictor models aimed at reducing the primary and secondary prevalence of hypertension in this section of the UK population.Recipes are very high in animal protein, especially red meat which is known to be a major risk factor for e.g. bowel cancer. Again, mapping dietary intake, physical activity as well as biochemical test in this community with their chronic disease profile would help with future health promotion strategies and interventions. This community having a higher risk of diabetes and extrinsic sugar in the recipes was reported without giving the exact quantification. Daily dietary intake especially high protein, fat and salt sources also predispose to chronic disease risk and this needs to be taken into account in any plans to improve health in this community. Low intake of vitamin D was seen among various age groups. Although vitamin D deficiency should

not occur in populations where there is enough exposure of the skin to sunlight, in some communities, for cultural and religious reasons, certain groups especially women (and children) may not have enough daily sun exposure and would therefore benefit from vitamin D sources in the diet. Thus in the absence of such dietary sources, unless there are other supplementary sources, individuals are at increased risk of deficiency. Similarly vitamin B12 is obtained mainly from animal source foods e.g. liver and eggs. Although yeasts and some blue cheese provide adequate amounts of the vitamin, in a strictly vegetarian (vegan) community where no animal sources including milk are consumed, the risk of vitamin B12 deficiency is real. The observations in this study suggest that this community were normal with B12 unlike other communities from South East Asian community. What would be useful will be to undertake biochemical measurement for developing future nutritional guidance in respect of micro nutrient intake. These findings lend support to the possible underlying reasons for the previous observations of low vitamin C intake and status in these communities. This community is consuming adequate amount. Further confirmation could be done using biochemical test. That would form part of any future investigation following from the present study.

The research has shown that socio-demographic factors are very important in examining food choice and food-related behaviour in any community. This is particularly important with respect to how the wider society sometimes view BME groups and how conclusions are drawn about their needs. This study clearly demonstrates that health needs assessments need to take each individual separately. The study has also demonstrated wide dietary heterogeneity (i.e.maco and micro nutrient intake) between first and second generation migrants with various age groups and income level which both provide an insight into the richness of the diversity in food culture, food habit, profession and lifestyle as well as specific food-related risk factors which are not necessarily uniformly distributed across this community (Chapter 6).

The study revealed a number of important nutrition related health issues in this population group which need to be addressed. High BMI, elevated blood pressure, high waist circumference, higher intake of energy and SFA and lower intake of fibre. This is also a low to medium-income community which has a high level of OW+OB and are at increased risk of NCDs. Intergenerational changes in dietary intake patterns and changes to food consumed traditionally by the community as a whole also poses a risk to the progression of the chronic disease.

From these findings, we can postulate that an appropriate intervention model or disease risk prediction model can be developed to help define more objectively the disease profile and risk within this, and other South Asian communities with similar cultural and behavioural characteristics however the latter might require refinements of such a model to take into account specific individual and group differences in cultural, behavioural and lifestyle risk factors as well as their health belief systems.

10.7 Recommendations for Future Work

This study has revealed a number of things. It is clear that the Punjabi male adult population in Medway Kent has a higher than average problem of overweight and obesity compared with the median Figures for England (HSE, 2011). It has also been established from this observational study that the population is largely sedentary, and there is evidence of lack of vigorous physical activity across age ranges. The population has a very low fibre intake and consume very little fruit and vegetables. Physiological measurements describe a population in a pre-hypertensive state and the biochemical measurements suggest a risk of hyperlipidaemia and impaired glucose tolerance. Two major things that are common to this sample population is that they are all of Punjabi origin and a migrant population who have settled in Kent from Indian / Pakistani Punjab. There is also evidence that the second generation shows signs of increasing obesity, increased

energy intake (over expenditure) and high saturated fat intakes.The above findings suggest a population in nutritional transition. Future work should include:

A. Potential Studies / Projects

1. A larger study of the Punjabi community in other parts of the UK; and a study of the female population as well using a similar protocol;

2. A comparative study between subjects in the UK and people living in the Punjab in India and Pakistan using a similar protocol to test the findings.

3. An intervention study with a major focus on increasing fruit, vegetable and fibre consumption and decreasing total energy and SFA intakes in this cohort to examine impact.

4. A nutrition education intervention aimed at increasing awareness of the risk of chronic disease and diabetes and hypertension in this study population and introducing diet, lifestyle and behaviour modification that would help reduce risk.

5. Design, plan and carry out a physical activity intervention in the male Punjabi population in Medway, Kent.

All these studies would require the writing and submission of large grant proposals to research charities to enable the studies to be carried out with other UK and international partners.

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Appendices

Appendix 1a: Check List of Focus Group Questionnaire for recipes collection

Facilitator's Checklist:

a. What are the commonly consumed recipes during breakfast? Based on the following criteria:
   1. Cereal
   2. Pulses and legumes
   3. Fish
   4. Meat
   5. Dairy
   6. Vegetables

b. How are they prepared?

c. How much quantity normally consumed by an individual?

d. How many times were they consumed in a day, week or month?

Similarly (a-d) has to be reported for lunch and dinner recipes.

Instruction for the facilitators:

a) All recipes should have been collected by the participant from home before participating in the focus group study.

b) Each recipes presented by the participant should be agreed among the focus group member and recorded.

c) Any other recipes which are not traditionally consumed should not be discarded but should keep a mark "NT" on the recipe number.

d) After gathering the raw data, it should be collected in MS Excel pre-formatted data spread sheet.

Checklist	
1) Breakfast Recipes	
2) Lunch Recipes	
3) Dinner Recipes	
4) Data collected according to food groups	
5) Food preparation and cooking procedures	
6) Approximate consumption amount	
7) Finally agreed among the group members	
8) Data Entry on the pre-formatted Excel Spread sheet	

Appendices

Appendix 1b 24 hours recall completion procedure: Instruction

Is it a typical day? Yes / No				Participant No					
	24- Hours dietary recall and recipes collection sheet								
	Please enter today's date here 12/1/2013					DD	MM	YYYY	
Are you on a special diet?	Yes	No							
Which day of the week is it? (Please circle)	SAT	SUN		MON	TUE	WED	THU	FRI	
Time	Qty eaten (grams, cups, glass) Please Insert S/M/L*			Cup/ Mug/ Bowl Please Insert C/ M/B			Details of Food and drink	Where was it bought from or made	
7.30 am			L	C			Milk with sugar	Semi-Skim from Tesco	
7.30 am		M					3 Paratha	Home Made	
7.30 am		M		C			Channa Tomato curry	Home made	

Instructions for 24-Hour Recall Interviews detailed description of fields

	Description
Details of the Food:	• Detailed description (type, form, brand name) • Amount consumed • Any other foods eaten with it • Time • Occasion for eating (i.e. Breakfast, lunch, dinner) • Food source (where obtained) • Whether food was eaten at home
Information specific to the recall day:	• Day of the week (recall day) • Amount and type of water consumed, including total plain water, tap water, and plain carbonated water • Recall day's consumption amount compared to typical diet
Information specific to a participant's overall diet:	• Added salt: Frequency and type of salt added at the table and when preparing food • Whether on a special diet and type of diet • Recipes formulation information

Appendices

Appendix 1c Focus Group Study and 24 hours diet recall consent form

PARTICIPANT INFORMATION SHEET

INVITATION TO PARTICIPATION IN A RESEARCH

STUDY AT THE UNIVERSITY OF GREENWICH

Title: ***Time trends in meal composition, food choice, energy balance and their impact on non communicable disease and health in South Asian males in Kent***

Dear Participant,

You are being invited as a volunteer to participate in the above titled research study we are conducting as part of a MPhil/PhD study at the Medway Campus of the University of Greenwich (UoG). This letter provides you with the information you will need when considering whether to participate in our study. All evaluation and research studies carried out by UoG are governed and monitored by the University's Research Ethics Committee (UREC). If you decide to participate, you will be asked to sign the attached consent form after you have read and understood the purpose of the *Study*, and asked any questions you may have about the study and received satisfactory answers to help you decide about your agreement to participate. You will also be given a copy of this form to keep for your records.

PURPOSE OF THE STUDY

This study has been designed to help us obtain information about food recipes and food choices among South Asians in Kent. The dietary information will be collected in the form of a group discussion (focus group) where each member of the group will be able to explain the foods they consume and how they prepare it. Followed by an individual 24 hours diet recall For a small group of people, we will also be asking questions about your food intake and take some measurements (of body weight and height and waist circumference for example).

Appendices

You will be expected to stay with the study for a duration of 3 months: Activities during that period will include: 1) Initially filling out a focus group study questions, which will tell us about the different foods that you eat and how you prepare them 2) you will be asked to provide recipes that you cook commonly at home and how you prepare your meals (including ingredients, length of cooking etc.). Throughout you will be randomly selected for you to be interviewed (not more than 20 minutes per interview) about your diet on the previous day (called a 24 hour diet recall).

You have been approached as a possible participant in this evaluation: 1) Because of your country and / or ethnic origin (e.g. Punjabi for this study) and at least 18 years old adult and generally healthy.

STUDY PROCEDURES

If you decide to participate in the evaluation you will be asked to provide information from time to time.

Each of these surveys will be conducted in a focus group with 5 or 6 members (only) and will take approximately 60 minutes to fully complete.

To ensure confidentiality of all of your responses, you will be assigned a ***Participant number*** **and your name will not be used at any stage in the study.** This number is critical in enabling us to conduct relevant follow-up as well if we need to contact you for further information about your personal involvement in the study**.**

Following the focus group stage, some of you will be invited to take part in the individual part of the study where you will be asked personal questions about your diet, physical activity and some physical measurements taken.

Please note that this study is purely voluntary and if you do not wish to take part in any aspect of the study, you will be free not to take part. All you need to do is let the researchers know your intentions.

STUDY RISKS

Your participation in this survey involves no physical risks. We however recognise the potential inconvenience that we might cause you for asking you to participate as well as personal discomfort if you find some of our questions too personal (i.e. intrusive). If you do not feel like answering any particular questions, we will respect your wishes. We will also ensure that all information you provide is securely kept and not disclosed to any one. The reason for assigning you a Participant No. and using that number to code all of your answers is to reduce the risk that any answer you give can be tracked back to you. The master list of Participant No. numbers will be kept in a password-protected electronic file. Access to the protected file will be limited to a principal investigator of the research team in the school of science. The information you provide us will only be analysed for purposes of this research without disclosing your identity.

Appendices

STUDY BENEFITS

Benefits to you may include a better understanding of dietary intake, and first-hand experience with a focus group study. We hope to also design some simple to use toolkits to help people make healthy food choices in the future. If you are interested, after taking part in the study we will be happy to give you a complementary copy of the tool once we have designed it as appreciation for helping with the study.

Benefits to society may include a better understanding of commonly consumed foods and updating information about South Asian recipes in the United Kingdom.

COST FOR PARTICIPATION

You will not be expected to pay to take part in this study. we will not also be paying volunteers who take in the study.

COMPENSATION

For your participation in this survey, you will not receive any financial rewards.

CONFIDENTIALITY

As has already been mentioned under risks in this study, if you consent to participate, your personal information will be kept confidential throughout.

FUNDING

This study is self-funded by the by the principal investigator from the University of Greenwich. There are no commercial interests involved.

VOLUNTARY PARTICIPATION AND WITHDRAWAL FROM THE STUDY

We have already stated above that your participation is entirely voluntary. You are therefore free to withdraw from the study at any time if you do not wish to continue. However we hope that with the information we have provided and after any questions you ask us, you will be happy to help us with this study by taking part in all aspects. Your decision not to participate, or to withdraw from any part of the study at any time will not affect your relationship with the University of Greenwich or any other services, either now or in the future.

CONTACTS

If you have any questions or need more information about this study, please feel free to contact the principal research Mr Swrajit Sarkar (s.sarkar@gre.ac.uk; 0208 331 7570) or Dr Paul Amuna (ap10@gre.ac.uk; 0208 331 8514)

Appendices

STATEMENT OF CONSENT

NOTE: By signing below, you are indicating that this form has been explained to you, that you understand it, and any questions you have about the study have been answered. You are indicating that you understand the way the data may be used and how your privacy will be protected. By signing this form, you are agreeing to participate in the study.

I have read the information provided me about the above study. I have had opportunity to ask questions and understand what I am being asked to do. I also understand that my participation is purely voluntary and that I can withdraw from the study at any time without any obligation. Signing this form does not affect any of my legal rights.

I acknowledge that I have read the above explanation about this study and that all of my questions have been satisfactorily answered, and I agree to participate in this study of my own free will.

Signature of participant volunteer _____

Printed name of participant volunteer _____

Participant No. _____

Date _____

Appendices

I confirm that I have explained fully to the above subject the nature and purpose, procedures and the possible risk and potential benefits of this study.

_____

Signature of principal investigator

Date _____

Signature of witness

Date _____

Appendix 2: Food Frequency Questionnaire

Appendix 1d Socio-demographic data collection information sheet

Please provide us with as much accurate information as possible			
	Participants No.		
▪ How old are you?	Years		Months
▪ Your Weight	Kgs		
▪ How long have you being living in the United Kingdom?	Years		Months
▪ Please Tick your marital Status?	a) Married	b) Never Married	3)Divorced
▪ Annual Household Income?			
▪ Your occupational Status?			
▪ Your Education Status?			
▪ Do you have any Children? Number			
▪ How many people are there in your household?			

Appendix 2: Food Frequency Questionnaire

Official Use Only
Participants ID:
Date:
Data Entry: Y/N

Modified S-QFFQ developed for South Asian

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Punjabi Vegetable recipe													
Mixed veg. curry													
Spinach curry													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**										
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Spinach-potato curry													
Aubergine bhaji													
Aubergine-potato bhaji													
Potato, onion & tomato bhaji													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	Average use / intake											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Potato- green pepper bhaji													
Potato- courgette bhaji													
Bhindi bhaji													
Courgette bhaji													
Marrow bhaji													
Carrot, peas & potato bhaji													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Carrot – peas													
Carrot-potato bhaji													
Green chilli – carrot bhaji													
Cabbage bhaji													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	Average use / intake											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Cabbage-potato bhaji													
Cabbage, peas& potato bhaji													
Cauliflower bhaji													
Cauliflower–potato bhaji													
Cauliflower, potato & tomato bhaji													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Runner bean – potato bhaji													
Gourd bhaji													
Gourd- potato bhaji													
Tindora bhaji													
Karela bhaji													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	Average use / intake											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Punjabi Pulses & legume Dishes													
Peas- potato													
Masoor-tomato dhal													
Masoor dhal													
Masoor dhal thick													
Masoor – moong dhal													
Masoor, moon & channa dhal													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Channa dhal– thin													
Channa dhal- thick													
Channa - tomato													
Chickpeas													
Channa aloo													
Channa – urad dhal													
Mung dhal													
Whole mung dhal													
Whole mung													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Urad dhal													
Urad- tomato daal													
Mung- moth dhal													
Toor dhal													
Soya beans dhal													
Khadi													
Kichadi													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Punjabi Rice and cereal (staple) dishes													
Meat pilau													
Chicken biryani													
Peas pilau													
Mixed veg pilau													
Paratha													
Methi paratha													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Punjabi Meat & Chicken Dishes													
Lamb curry													
Lamb- potato curry													
Mutton curry													
Lamb chops													
Lamb keema													
Lamb Kebab													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Chicken curry													
Chicken curry with yogurt													
Roast chicken													
Matar paneer													
Matar paneer – potato curry													
Palak paneer													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Bread and Biscuits (one slice or 1 biscuit)													
White bread and rolls													
Brown bread and rolls													
Wholemeal bread and rolls													
Cream crackers, cheese biscuits													
Crispbread, eg Ryvita													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Breakfast Cereals (1 bowl)													
Porridge, Readybreak													
Breakfast cereals such as cornflakes, muesli etc.													
Oat porridge (dhuri)													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Potato salad													
White rice													
Brown rice													
White or green pasta, eg. spaghetti, macaroni, noodles													
Wholemeal pasta													
Lasagne, moussaka													
Dairy products and fats													
Single or sour cream (tablespoon)													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Double or clotted cream (tablespoon)													
Low fat yogurt, fromage frais (125g carton)													
Full fat or greek yogurt (125g carton)													
Cheese eg. cheddar, brie, edam (medium serving)													
Eggs													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Quiche (medium serving)													
Cottage cheese, low fat soft cheese (medium serving)													
Low calorie, low fat salad cream)													
Cottage cheese, low fat soft cheese (medium serving)													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Salad cream, mayonnaise tablespoon													
French dressing tablespoon													
Other salad dressing tablespoon													
Low calorie, low fat salad cream tablespoon													
Salad cream, mayonnaise tablespoon													
Foods and Amounts	**Average use / intake**												

Appendix 2: Food Frequency Questionnaire

	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
French dressing tablespoon													
Other salad dressing tablespoon													
Beverages													
Coffee, decaffeinatd (cup)													
Coffee whitener e.g. coffee mate (teaspoon)													
Cocoa, hot chocolate (cup)													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Horlicks, ovaltine													
Wine (glass)													
Masala Tea													
Tea with milk and sugar													
Alcoholic drinks													
Beer, lager or cider (half pint)													
Port, sherry, vermouth, liqueurs (glass)													
Spirits eg. gin, brandy, wisky, vodka													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Fizzy soft drink eg. coca cola, lemonade (glass)													
Pure fruit juice													
Fruit, squash or cordial (glass)													
Apples (1 fruit)													
Pears (1 fruit)													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Oranges, Satsuma's mandarins (1 fruit),													
Grapefruit (half)													
Bananas (1 fruit)													
Grapes													
Melon													
*peaches , plum, apricots (1 fruit)													
*strawberries , rasberries, kiwi fruit (medium serving)													
Foods and Amounts	**Average use / intake**												

Appendix 2: Food Frequency Questionnaire

	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Tinned fruit													
Dried fruit eg. raisins, prunes (medium serving)													
Vegetables (medium serving)													
Spinach													
Brussels sprouts													
Cabbage													
Peas													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Green beans, broad beans, runner beans													
Marrow, courgettes													
Cauliflower													
Parsnips, turnips, Swedes													
Leeks													
Onions													
Garlic													
Mushrooms													
Sweet peppers													
Beansprouts													

Appendix 2: Food Frequency Questionnaire

Foods and Amounts	**Average use / intake**											
	Portions or Amount consumed			Seldom	Once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	S	M	L										
Green salad, lettuce, cucumber, celery													
Watercress													
Tomatoes													
Sweetcorn													
Beetroot													
Coleslaw													
Avocado													
Baked beans													
Dried lentils, beans, peas													

Appendix 2: Food Frequency Questionnaire

2. Are there any other foods that you had more than once a week? Yes / No

Food	Usual Serving	Number of times eaten each week

3. What type of milk do you most often use?

4. How much milk do you drink each day?

5. Do you usually eat breakfast? What do you eat in your breakfast?

6. What type of cooking fat (Oil / Ghee) do you often use?

7. How often do you eat fried food that was prepared at home?

8. How often do you eat fried food away from home?

9. What do you do with visible fat on your meat?

10. How well cooked do you have your meat?

11. How often do you add salt to your food?

12. How often do you add salt to any food at the table?

Appendix 2: Food Frequency Questionnaire

13. Do you use any salt substitute?

14. On an average how many times a week did you eat the following foods?

Food type	Times per week	Portion size		
Vegetables (Not potatoes)		Large	Medium	Small
Salads				
Fruits & Fruit products				
Fish and fish products				
Meat and meat products				

15. Have you taken any vitamins, minerals, fish oil, fibre or other food supplements during the last one year?

a) Yes

b) No

c) Sometimes

Appendix 2: Food Frequency Questionnaire

d) Don't Know

if yes or sometimes please give details below

Supplements			Average frequency						
Brand	Name	Strength	Number of tablets or tea spoons taken in one day	Never of less than once a month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day

16. Are you on any special medication?

17. What medication are you taking?

Thank you

UNIVERSITY of GREENWICH

Office Use Only
Participants No.
Entry Date:

Global Physical Activity Questions

Physical Activity			
Next I am going to ask you about the time you spend doing different types of physical activity in a typical week. Please answer these questions even if you do not consider yourself to be a physically active person. There are various domains of activity which need to be included; work, activities in and around the home and garden, to get from place-to-place (transport-related) and recreation (discretionary or leisure-time) exercise or sports activities. This opening statement should not be omitted. "The respondent will have to think first about the time she/he spends doing work. Work includes things that he/she has to do such as paid or unpaid work, household chores, harvesting food, fishing or hunting for food, seeking employment." In answering the following questions 'vigorous-intensity activities' are activities that require hard physical effort and cause large increases in breathing or heart rate, 'moderate-intensity activities' are activities that require moderate physical effort and cause small increases in breathing or heart rate.			
Questions		**Response**	**Code**
Activity at work			
1.	Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like [carrying or lifting heavy loads, digging or construction work] for at least 10 minutes continuously?	Yes 1 No 2 if no go to P4	P1
2.	In a typical week, on how many days do you do vigorous intensity activities as part of your work?	Number of days ___	P2
3.	How much time do you spend doing vigorous-intensity activities at work on a typical day?	Hr:Min ____ : ____	P3 (a-b)
4.	Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking [or carrying light loads] for at least 10 minutes continuously?	Yes 1 No 2 if No, go to P7	P4
5.	In a typical week, on how many days do you do moderate intensity activities as part of your work?	Number of days _____	P5
6.	How much time do you spend doing moderate-intensity activities at work on a typical day?	Hr: Min : ____:____	P6 (a-b)
Travel to and from places			
The next questions exclude the physical activities at work that you have already mentioned. Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, to market, to place of Worship.			
7.	Do you walk or use a bicycle (pedal cycle) for at least 10 minutes continuously to get to and from places?	Yes 1 No 2 if No go to P10	P7
8.	In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?	Number of days _____	P8
9.	How much time do you spend walking or bicycling for travel on a typical day?	Hr: Min ____:_____	P9 (a-b)
Recreational Activities			
The next questions exclude the work and transport activities that you have already mentioned.			

Now I would like to ask you about sports, fitness and recreational activities (leisure),			
10.	Do you do any vigorous-intensity sports, fitness or recreational (leisure) activities that cause large increases in breathing or heart rate like [running or football,] for at least 10 minutes continuously?	Yes 1 No 2 if No go to P13	P10
11.	In a typical week, on how many days do you do vigorousintensity sports, fitness or recreational (leisure) activities?	Number of days _____	P11
12.	How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	Hr: Min _____:____	P12(a-b)
13.	Do you do any moderate-intensity sports, fitness or recreational (leisure) activities that causes a small increase in breathing or heart rate such as brisk walking,(cycling, swimming, volleyball)for at least 10 minutes continuously?	Yes 1 No 2 if No go to P16	P13
14.	In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational (leisure) activities?	Number of days ___	P14
15.	How much time do you spend doing moderate-intensity sports, fitness or recreational (leisure) activities on a typical day?	Hr:Min _____:_____	P15(a-b)
Sedentary behaviour			
The following question is about sitting or reclining at work, at home, getting to and from places, or with friends including time spent [sitting at a desk, sitting with friends, travelling in car, bus, train, reading, playing cards or watching television], but do not include time spent sleeping.			
16.	How much time do you usually spend sitting or reclining on a typical day?	Hr:Min: ____:_____	P16(a-b)

Appendix 4 a: Most Frequently Consumed Vegetables recipes during breakfast, lunch and dinner

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
11. Low Punjabi Potato and Green papper Curry												
Total (100g)	1.98	8.50	11.27	129.53	480.40	10.15	1.03	1.97	1.96	3.74	2.81	0.00
12.Punjabi potato and courgette curry												
Total (100g)	2.09	6.80	9.93	109.29	432.55	6.92	2.76	1.43	1.56	2.99	2.24	0.00
13.Low fat Punjabi potato and courgette curry												
Total (100g)	2.52	6.80	10.00	111.26	335.99	4.62	4.97	0.98	1.56	2.99	2.24	0.00
14.Punjabi Bhindi												
Total (100g)	2.02	10.00	5.00	118.11	513.89	1.18	3.29	2.29	2.30	4.40	3.30	0.00
15.Low fat Punjabi Bhindi												
Total (100g)	1.91	10.00	4.55	115.84	363.05	0.25	3.48	2.25	2.30	4.40	3.30	0.00
16.Punjabi Courgette curry												
Total (100g)	1.64	11.20	3.00	119.38	302.34	0.46	2.28	1.80	2.58	4.93	3.70	0.00
17.Low fat Punjabi Courgette curry												
Total (100g)	1.55	11.20	3.44	120.75	265.74	0.38	2.63	0.33	2.58	4.93	3.70	0.00
18.Punjabi Marrow curry												
Total (100g)	0.70	6.40	3.02	72.46	212.53	0.76	2.26	1.82	1.47	2.82	2.11	0.00
19.Punjabi Carrot, peas and potato curry												
Total (100g)	2.08	5.60	9.25	95.73	529.13	3.60	4.95	7.30	1.29	2.46	1.85	15.00
20.Low fat Punjabi Carrot, peas and potato curry												
Total (100g)	1.95	5.60	11.50	104.22	391.42	7.52	3.54	5.36	1.29	2.46	1.85	15.00
21. Punjabi carrots and peas curry												
Total (100g)	1.76	12.80	7.56	152.47	587.78	1.49	5.57	7.94	2.94	5.63	4.22	29.70
22. Lower fat Punjabi carrots and peas curry												
Total (100g)	0.98	12.80	7.25	148.11	416.24	0.77	6.22	7.07	2.94	5.63	4.22	0.00
23. Punjabi carrots and potato curry												
Total (100g)	1.35	11.60	8.70	144.60	379.28	2.65	5.35	4.32	2.67	5.10	3.83	0.00

Table 4 b: Most Frequently Consumed Vegetables recipes(c) during breakfast, lunch and dinner

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
24. Punjabi carrots and potato curry												
Total (100g)	1.12	11.60	9.15	145.50	348.41	3.57	5.08	4.55	2.67	5.10	3.83	12.33
25. Punjabi green chilli and carrots												
Total (100g)	0.68	7.40	6.95	97.14	403.01	0.26	6.51	7.05	1.70	3.26	2.44	0.00
26. Low fat Punjabi green chilli and carrots												
Total (100g)	0.68	7.40	7.18	98.07	317.24	0.27	6.73	7.29	1.70	3.26	2.44	0.00
27. Punjabi cabbage												
Total (100g)	1.73	2.25	6.83	54.48	247.20	1.38	4.82	0.29	0.52	0.99	0.74	0.00
28. Punjabi Cabbage and Potato curry												
Total (100g)	1.66	8.20	6.82	107.70	430.50	3.04	3.57	0.60	1.89	3.61	2.71	20.45
29. Punjabi Cabbage and Potato curry												
Total (100g)	1.80	3.12	8.02	67.37	261.56	3.89	3.76	0.74	0.72	1.37	1.03	6.19
30. Punjabi cabbage peas and potato curry												
Total (100g)	2.83	9.88	7.20	129.04	540.45	4.07	2.69	3.31	2.27	4.35	3.26	0.00
31. Punjabi cauliflower curry												
Total (100g)	2.92	7.05	3.62	89.61	398.33	0.30	2.85	0.19	1.62	3.10	2.33	0.00
32. Punjabi cauliflower curry												
Total (100g)	3.27	5.25	4.07	76.60	286.66	0.86	2.88	0.10	1.21	2.31	1.73	0.00
33. Punjabi Cauliflower and potato curry												
Total (100g)	2.70	4.35	8.65	84.52	366.23	6.52	1.91	1.22	1.00	1.91	1.44	10.79
34. Punjabi Cauliflower and potato curry												
Total (100g)	3.17	3.10	5.99	64.56	318.60	3.17	2.57	0.49	0.71	1.36	1.02	0.00
35. Punjabi cauliflower, tomatoes and potato curry												
Total (100g)	2.44	4.85	7.41	83.06	319.71	4.20	2.90	0.86	1.12	2.13	1.60	9.96
36. low fat Punjabi cauliflower, tomatoes and potato curry												
Total (100g)	2.38	3.16	7.85	69.34	297.36	5.93	1.87	1.25	0.73	1.39	1.04	0.00

Table 4.c Most Frequently Consumed Vegetables recipes(d) during breakfast, lunch and dinner

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
37. Punjabi Runner Beans and Potatoes Curry												
Total (100g)	0.92	1.23	7.05	42.96	137.88	6.37	0.68	1.45	0.28	0.54	0.41	0.00
38. Punjabi Gourd (Kaddu) curry												
Total (100g)	1.61	0.89	5.28	35.59	124.32	2.29	2.95	0.62	0.20	0.39	0.29	0.00
39. Punjabi Gourd and Potato curry												
Total (100g)	1.12	10.61	5.90	123.58	514.55	3.71	2.19	0.66	2.44	4.67	3.50	0.00
40.low fat Punjabi Gourd and Potato curry												
Total (100g)	1.32	6.11	6.55	86.45	296.67	4.30	2.25	0.97	1.41	2.69	2.02	0.07
41. Punjabi Tindora												
Total (100g)	1.19	14.59	3.02	148.14	691.13	0.67	2.36	0.20	3.36	6.42	4.81	0.00
42. low fat Punjabi Tindora												
Total (100g)	1.30	8.09	3.15	90.60	408.91	0.66	2.49	0.37	1.86	3.56	2.67	0.00
43. Punjabi Karela												
Total (100g)	1.37	12.51	4.02	134.15	458.06	3.42	0.61	1.01	2.88	5.50	4.13	0.00
44. low fat Punjabi Karela												
Total (100g)	1.10	0.67	1.61	16.86	51.93	0.44	1.17	0.81	0.15	0.29	0.22	0.00
45. Punjabi Pea and Potato Curry												
Total (100g)	3.48	1.26	8.56	59.48	257.25	5.96	1.81	6.09	0.29	0.55	0.42	0.00
46. low fat Punjabi Pea and Potato Curry												
Total (100g)	2.67	8.55	10.91	106.02	443.18	9.06	1.44	4.43	1.97	3.76	2.82	0.00

Appendix 4 d: Meat based commonly consumed recipes during breakfast, lunch and dinner (a)

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
1. Punjabi lamb curry Total (100g)	7.79	14.88	3.91	180.70	755.32	0.83	2.48	0.51	3.42	6.55	4.91	28.37
2. Low fat Punjabi lamb curry Total (100g)	14.30	10.71	1.14	158.10	660.88	0.04	0.93	0.26	2.46	4.71	3.53	59.60
3. Punjabi lamb and potato curry Total (100g)	12.98	8.63	5.27	150.62	629.61	4.13	0.89	0.80	1.98	3.80	2.85	49.38
4. Punjabi mutton curry Total (100g)	14.37	12.15	2.65	177.40	741.54	0.64	1.50	0.23	2.79	5.35	4.01	62.75
4. Low fat Punjabi mutton curry Total (100g)	11.94	17.02	2.23	209.83	877.08	0.00	1.58	0.31	3.91	7.49	5.62	71.49
5. Punjabi lamb chop Total (100g)	14.66	14.09	2.04	193.56	809.09	0.78	1.06	0.18	3.24	6.20	4.65	57.48
6. Low fat Punjabi lamb chop Total (100g)	12.61	10.76	1.63	153.83	643.02	0.08	1.31	0.33	2.48	4.74	3.55	55.46
7. Punjabi lamb keema (Minced) Total (100g)	13.27	15.13	2.92	200.89	839.71	0.86	1.55	0.24	3.48	6.66	4.99	51.11
8. Low fat Punjabi lamb keema (Minced) Total (100g)	9.44	13.05	3.45	168.98	706.36	0.64	2.09	1.03	3.00	5.74	4.31	34.59
9.Punjabi Low fat matar keema (100g) Total	11.17	8.81	3.79	139.12	581.50	0.96	1.95	2.12	2.03	3.88	2.91	45.31

Appendix 4d: Meat based commonly consumed recipes during breakfast, lunch and dinner(cont.)

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
10. Punjabi lamb kebab Total (100g)	13.26	8.94	2.37	142.93	597.46	0.19	1.58	0.28	2.06	3.93	2.95	51.18
11. Punjabi chicken curry Total (100g)	9.63	15.07	4.99	194.14	811.51	2.18	2.47	0.39	3.47	6.63	4.97	34.95
12. low fat Punjabi chicken curry Total (100g)	17.28	4.02	1.76	112.35	469.63	0.21	1.14	0.20	0.92	1.77	1.33	75.19
13. Punjabi chicken curry with yogurt Total (100g)	13.03	10.99	1.79	158.13	661.00	0.22	1.39	0.31	2.53	4.83	3.63	50.96
14. low fat Punjabi chicken curry with yogurt Total (100g)	17.41	6.59	1.35	134.35	561.59	0.36	0.89	0.14	1.52	2.90	2.17	69.55
15. Punjabi chicken and potato curry Total (100g)	14.00	8.80	4.40	153.20	640.50	3.20	1.00	0.70	2.02	3.87	2.90	1.70

Appendix 4e Pulse, Legume and Lentils based commonly consumed recipes during breakfast, lunch and dinner

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
1 A. Punjabi masur dhal with masur and onion												
Total 100g	4.20	14.49	9.22	181.57	754.72	6.89	1.63	0.37	3.33	6.38	4.78	39.79
1 B. Punjabi masur dhal with masur and onion (low fat)												
Total 100g	3.62	2.78	8.52	64.67	273.03	5.43	2.41	0.56	0.64	1.22	0.92	0.00
2. Punjabi masur dhal (thick)												
Total 100g	7.18	5.56	14.34	129.88	547.91	13.21	0.48	0.01	1.28	2.45	1.83	13.86
3 A.Punjabi musar and mung dhal												
Total 100g	9.95	12.03	19.86	219.06	918.02	16.62	1.63	0.25	2.77	5.29	3.97	28.96
3 B. low fat Punjabi musar and mung dhal												
Total 100g	10.61	5.61	21.42	172.67	728.54	17.93	1.71	0.24	1.29	2.47	1.85	14.12
4 A. Punjabi Mixed dhal (Masur,Mung, Channa)												
Total 100g	8.96	7.35	18.76	166.85	701.85	15.26	1.95	0.29	1.69	3.23	2.42	17.00
4 B. low fat Punjabi Mixed dhal (Masur,Mung, Channa)												
Total 100g	8.19	5.16	16.55	129.77	547.63	13.44	1.89	0.35	1.19	2.27	1.70	9.15
5 A. Punjabi Channa dhal (thin)												
Total 100g	15.82	9.38	39.82	285.13	1204.61	34.33	2.74	0.12	2.16	4.13	3.10	11.13
5 B.low fat Punjabi Channa dhal (thin)												
Total	12.36	4.60	32.30	198.78	842.35	26.00	3.58	0.36	1.06	2.03	1.52	0.00
6 A. Punjabi Channa dhal (thick)												
Total 100g	7.17	12.54	15.69	197.96	826.32	13.98	1.09	0.05	2.89	5.52	4.14	29.44

Appendix 4e: Pulse, Legume and Lentils based commonly consumed recipes during breakfast, lunch and dinner (cont.)

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
6 B.low fat Punjabi Channa dhal (thick)												
Total												
100g	4.88	8.75	11.77	129.77	541.19	8.08	2.58	0.41	2.01	3.85	2.89	0.00
7 A. Punjabi channa Dhal with tomatoes												
Total												
100g	3.81	11.03	9.40	139.83	581.52	6.14	2.49	0.51	2.54	4.85	3.64	0.00
7 B. Low fat Punjabi channa Dhal with tomatoes												
Total												
100g	4.83	13.40	10.82	164.37	684.47	8.46	1.76	0.31	3.08	5.90	4.42	29.89
8 A. Punjabi whole Chickpeas												
Total												
100g	5.95	5.45	14.08	121.91	511.57	11.05	2.16	0.23	1.25	2.40	1.80	0.00
8 B. low fat Punjabi whole Chickpeas												
Total												
100g	6.05	3.96	14.16	113.04	475.30	11.29	2.03	0.30	0.91	1.74	1.31	0.00
9 A. Punhabi channa aloo												
Total												
100g	3.32	2.20	10.66	57.87	244.55	7.76	2.26	1.08	0.51	0.97	0.73	0.00
9 B.Low fat punjabi channa aloo												
Total												
100g	3.02	1.59	10.35	55.39	234.46	7.40	2.37	1.20	0.37	0.70	0.53	0.00
10. Punjabi channa and urad dhal												
Total												
100g	12.78	11.25	23.36	244.11	1022.14	20.24	1.84	0.19	2.59	4.95	3.71	28.00
11 A. Punjabi mung dhal												
Total												
100g	16.75	8.66	30.49	259.38	1091.98	25.06	2.51	0.27	1.99	3.81	2.86	22.22
11 B. Low punjabi whole mung dhal												
Total												
100g	15.76	1.87	28.35	186.27	790.21	23.43	2.39	0.42	0.43	0.82	0.62	0.00

Appendix 4e Pulse, Legume and Lentils based commonly consumed recipes during breakfast, lunch and dinner (cont.)

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
12 A.Punjabi whole mung dhal Total 100g	15.58	17.29	27.61	307.81	1288.82	23.06	2.00	0.20	3.98	7.61	5.70	42.58
12 B. Low fat Punjabi Mung dhal Total 100g	19.64	9.33	34.74	288.14	1214.32	29.48	2.05	0.19	2.15	4.10	3.08	22.43
13 A.Punjabi whole Mung curry Total 100g	8.81	19.90	16.42	269.04	1119.79	12.63	2.28	0.45	4.58	8.76	6.57	0.00
13 B. Low Fat Punjabi mung dhal Total 100g	10.61	2.98	19.80	137.15	580.39	15.21	2.75	0.55	0.68	1.31	0.98	0.00
14. Punjabi Mung and masur dhal Total 100g	13.03	22.93	30.54	373.03	1557.80	18.90	9.46	0.24	5.27	10.09	7.57	28.24
15. Punjabi Urad Dhal Total 100g	3.71	13.13	11.02	159.35	662.77	4.61	0.11	0.02	3.02	5.78	4.33	31.40
16A.Punjabi urad tomato dhal Total 100g	4.67	15.10	9.32	169.23	703.60	6.81	0.66	0.20	3.47	6.64	4.98	35.26
17B. Low fat punjabi urad dhal Total	6.47	13.14	12.09	181.74	758.47	11.10	0.39	0.06	3.02	5.78	4.34	0.00
18.Punjabi toor dhal Total 100g	11.25	1.09	32.84	178.01	756.92	29.71	1.99	0.33	0.25	0.48	0.36	0.00
19 A.Punjabi soya bean dhal Total 100g	7.78	16.59	5.24	193.05	799.85	1.17	2.83	0.34	3.82	7.30	5.47	33.83

Appendix 4e Pulse, Legume and Lentils based commonly consumed recipes during breakfast, lunch and dinner (cont.)

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
19 B.Punjabi soya bean dhal low fat Total 100g	7.72	10.22	5.17	142.28	591.41	1.34	2.80	0.41	2.35	4.50	3.37	0.00
20 A. Punjabi khadi Total 100g	3.22	18.27	5.15	191.56	792.43	1.46	3.63	0.01	4.20	8.04	6.03	51.47
20 B.Punjabi khadi low fat Total 100g	5.79	4.14	10.96	88.76	373.96	7.96	2.73	0.02	0.95	1.82	1.37	6.48
21 A. Punjabi Kitchadi(Rice and Lentils Total 100g	4.70	8.02	21.07	169.88	714.01	20.52	0.23	0.00	1.85	3.53	2.65	24.59
22 B. Low fat Punjabi Kitchadi(Rice and Lentils Total 100g	5.85	0.72	20.77	107.49	458.47	19.99	0.32	0.00	0.16	0.31	0.24	0.00

Appendix 4f: Rice and cereal based commonly consumed recipes during breakfast, lunch and dinner

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
1. Punjabi Meat Pilau Total (100g)	9.03	10.46	14.32	187.52	783.85	13.45	0.62	0.11	2.41	4.60	3.45	30.86
2. Punjabi Chicken Biryani Total (100g)	9.73	9.38	14.62	181.80	759.93	13.92	0.50	0.20	2.16	4.13	3.10	33.83
3.Low Fat Punjabi Chicken Biryani Total (100g)	14.43	5.00	9.50	140.74	588.30	9.17	0.33	0.20	1.15	2.20	1.65	54.93
4. Punjabi Peas Pilau Total (100g)	3.91	11.27	18.10	189.46	791.96	15.79	1.35	5.16	2.59	4.96	3.72	28.38
5.Low Fat Punjabi peas pilau Total (100g)	3.44	8.60	17.11	159.63	667.25	13.95	2.00	4.34	1.98	3.78	2.84	3.00
6. Punjabi mixed Vegetable Pulau Total (100g)	2.54	10.96	15.49	170.76	713.76	13.48	1.86	1.30	2.52	4.82	3.62	34.70
7. Low Fat Punjabi mixed vegetable Pulau Total (100g)	2.16	12.69	25.00	222.85	931.50	24.21	0.56	1.30	2.92	5.58	4.19	70.00
8. Punjabi Parathas Total (100g)	9.86	9.84	71.24	412.97	1726.20	69.96	1.28	1.30	2.26	4.33	3.25	24.28
9. Low fat Punjabi Parathas Total (100g)	10.18	6.22	73.27	389.78	1629.30	71.96	1.32	1.30	1.43	2.74	2.05	16.97
10. Punjabi methi parathas Total (100g)	10.98	5.28	47.87	282.87	1182.41	43.69	4.18	5.40	1.21	2.32	1.74	4.34

Appendix 4f: Rice and cereal based commonly consumed recipes during breakfast, lunch and dinner (cont.)

Recipes	Protein (g)	Fat (g)	Carbohydrate (g)	Energy Kcal	Energy KJ	Starch (g)	Total Sugar(g)	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
11. Low fat Punjabi methi parathas Total (100g)	10.22	1.66	48.09	248.19	1037.42	45.01	1.98	0.08	0.38	0.73	0.55	0.00
12. Punjabi Chapati Total (100g)	9.80	0.50	77.60	354.10	1480.14	75.50	2.10	2.20	0.12	0.22	0.17	0.00
13. Punjabi Roti Total (100g)	11.50	1.20	73.70	351.60	1469.69	70.50	3.20	4.50	0.28	0.53	0.40	0.00

Appendix 4g: Commonly consumed Breakfast meals from focus group study

Recipes	Weight (g)	Protein (g)	Fat (g)	CHO (g)	Energy Kcal	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
1st													
Chapati	60.00	5.88	0.30	46.56	212.46	11.07	87.66	1.27	1.32	0.07	0.13	0.10	0.00
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	100.00	0.00	0.69	1.32	0.99	8.40
Chicken curry with potato	150.00	21.00	13.20	6.60	229.20	36.65	11.52	51.83	1.05	3.04	5.81	4.36	2.55
Milk	250.00	8.00	9.75	12.00	167.75	19.08	28.61	52.31	0.00	2.24	4.29	3.22	35.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	468.00	34.88	26.24	70.16	656.36	21.26	42.76	35.99	2.37	6.04	11.55	8.66	45.95
2nd													
Chapati	60.00	4.32	3.53	0.18	49.75	34.73	1.45	63.82	0.76	16.49	0.04	0.08	0.06
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	100.00	0.00	0.69	1.32	0.99	8.40
Lamb curry	150.00	11.69	22.32	5.86	271.05	17.25	8.65	74.10	0.76	5.13	9.82	7.36	42.56
(Tea)Milk	50.00	1.60	1.95	2.40	33.55	19.08	28.61	52.31	0.00	0.45	0.86	0.64	7.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	268.00	17.61	30.79	13.44	401.30	17.55	13.40	69.05	1.52	7.08	13.55	10.16	58.02
3rd													
Chapati	60.00	4.32	3.53	0.18	49.75	34.73	1.45	63.82	0.76	16.49	0.04	0.08	0.06
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	100.00	0.00	0.69	1.32	0.99	8.40
Cauliflower Potato Curry	150.00	4.04	6.53	12.97	126.77	12.76	40.92	46.32	1.83	1.50	2.87	2.15	16.18
Tea (MILK)	50.00	1.60	1.95	2.40	33.55	19.08	28.61	52.31	0.00	0.45	0.86	0.64	7.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	268.00	9.96	15.00	20.55	257.02	15.51	31.98	52.51	2.58	3.45	6.60	4.95	31.64
4th													
Paratha	90.00	8.87	8.86	64.12	371.66	9.55	69.00	21.45	1.17	2.04	3.90	2.92	21.85
Ghee	5.00	0.00	4.99	0.00	44.91	0.00	0.00	100.00	0.00	1.15	2.20	1.65	14.00
Punjabi Channa Aloo	100.00	3.32	2.20	10.66	75.69	17.52	56.32	26.16	1.08	0.51	0.97	0.73	0.00

Appendix 4 g: Commonly consumed Breakfast meals from focus group study(cont.)

Recipes	Weight (g)	Protein (g)	Fat (g)	CHO (g)	Energy Kcal	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
(Tea)Milk	50.00	1.60	1.95	2.40	33.55	19.08	28.61	52.31	0.00	0.45	0.86	0.64	7.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	370.00	13.79	18.00	82.17	545.82	10.11	60.22	29.67	2.25	4.14	7.92	5.94	42.85
5th													
Roti	90.00	10.35	1.08	66.33	316.44	13.08	83.85	3.07	4.05	0.25	0.48	0.36	0.00
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	100.00	0.00	0.69	1.32	0.99	8.40
Punjabi Mixed veg curry	150.00	3.36	14.10	16.01	204.40	6.58	31.34	62.09	8.54	3.24	6.20	4.65	0.00
Tea(Milk)	50.00	1.60	1.95	2.40	33.55	19.08	28.61	52.31	0.00	0.45	0.86	0.64	7.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	298.00	15.31	20.12	89.74	601.33	10.19	59.70	30.12	12.59	4.63	8.85	6.64	15.40
6th													
Roti	90.00	10.35	1.08	66.33	316.44	13.08	83.85	3.07	4.05	0.25	0.48	0.36	0.00
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	100.00	0.00	0.69	1.32	0.99	8.40
Punjabi Matur Keema	150.00	14.17	19.57	5.17	253.48	22.35	8.16	69.48	1.55	4.50	8.61	6.46	51.89
Tea (Milk)	50.00	1.60	1.95	2.40	33.55	19.08	28.61	52.31	0.00	0.45	0.86	0.64	7.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	298.00	26.12	25.59	78.90	650.41	16.06	48.52	35.42	5.60	5.89	11.26	8.45	67.29
7th													
Chapati	60.00	5.88	0.30	46.56	212.46	11.07	87.66	1.27	1.32	0.07	0.13	0.10	0.00
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	100.00	0.00	0.69	1.32	0.99	8.40
Punjabi Spinach and potato curry	150.00	3.71	12.68	10.73	171.83	8.64	24.97	66.39	2.44	2.92	5.58	4.18	0.00
Tea (Milk)	50.00	1.60	1.95	2.40	33.55	19.08	28.61	52.31	0.00	0.45	0.86	0.64	7.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	388.00	11.19	17.92	64.69	464.78	9.63	55.67	34.70	3.76	4.12	7.88	5.91	15.40

Appendix 4g: Commonly consumed Breakfast meals from focus group study(cont.)

Recipes	Weight (g)	Protein (g)	Fat (g)	CHO (g)	Energy Kcal	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
8th													
Paratha	90.00	8.87	8.86	64.12	371.66	9.55	69.00	21.45	1.17	2.04	3.90	2.92	21.85
Ghee	5.00	0.00	4.99	0.00	44.91	0.00	0.00	100.00	0.00	1.15	2.20	1.65	14.00
Chicken curry	150.00	14.44	22.61	7.49	291.21	19.83	10.28	69.88	0.58	5.20	9.95	7.46	52.42
Tea(MILK)	50.00	1.60	1.95	2.40	33.55	19.08	28.61	52.31	0.00	0.45	0.86	0.64	7.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	300.00	24.91	38.41	79.00	761.33	13.09	41.51	45.40	1.75	8.83	16.90	12.67	95.27
9th													
Punjabi Methi paratha	90.00	9.88	4.75	43.08	254.63	15.52	67.68	16.80	4.86	1.09	2.09	1.57	3.91
Ghee	5.00	0.00	4.99	0.00	44.91	0.00	0.00	100.00	0.00	1.15	2.20	1.65	14.00
Punjabi Mutton curry	150.00	21.55	18.22	3.97	266.10	32.39	5.97	61.64	0.34	4.19	8.02	6.01	94.12
Tea (MILK)	50.00	1.60	1.95	2.40	33.55	19.08	28.61	52.31	0.00	0.45	0.86	0.64	7.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	300.00	33.03	29.92	54.46	619.19	21.34	35.18	43.48	5.20	6.88	13.16	9.87	119.03
10th													
Roti	90.00	10.35	1.08	66.33	316.44	13.08	83.85	3.07	4.05	0.25	0.48	0.36	0.00
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	100.00	0.00	0.69	1.32	0.99	8.40
whole mung curry	100.00	8.81	19.90	16.42	280.00	12.58	23.46	63.96	0.45	4.58	8.76	6.57	0.00
Tea(Milk)	50.00	1.60	1.95	2.40	33.55	19.08	28.61	52.31	0.00	0.45	0.86	0.64	7.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	248.00	20.76	25.92	90.15	676.94	12.26	53.27	34.46	4.50	5.96	11.41	8.55	15.40
11th													
Paratha	90.00	8.87	8.86	64.12	371.66	9.55	69.00	21.45	1.17	2.04	3.90	2.92	21.85
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	100.00	0.00	0.69	1.32	0.99	8.40
lamb curry	100.00	7.79	14.88	3.91	180.70	17.25	8.65	74.10	0.51	3.42	6.55	4.91	28.37
tea(Milk)	50.00	1.60	1.95	2.40	33.55	19.08	28.61	52.31	0.00	0.45	0.86	0.64	7.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	248.00	18.27	28.68	75.42	632.86	11.55	47.67	40.78	1.68	6.60	12.62	9.46	65.62

Appendix 4 g: Commonly consumed Breakfast meals from focus group study(cont.)

Recipes	Weight (g)	Protein (g)	Fat (g)	CHO (g)	Energy Kcal	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
12th													
Meethi Paratha	90.00	9.88	4.75	43.08	254.63	15.52	67.68	16.80	4.86	1.09	2.09	1.57	3.91
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	100.00	0.00	0.69	1.32	0.99	8.40
Punjabi Potato, onion and tomato curry	100.00	1.51	8.00	10.93	121.77	4.95	35.92	59.13	1.97	1.84	3.52	2.64	0.00
Milk	250.00	8.00	9.75	12.00	167.75	19.08	28.61	52.31	0.00	2.24	4.29	3.22	35.00
Sugar	10.00	0.00	0.00	10.00	40.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	453.00	19.39	25.50	76.02	611.09	12.69	49.76	37.55	6.83	5.86	11.22	8.41	47.31
13th													
Roti	90.00	10.35	1.08	66.33	316.44	13.08	83.85	3.07	4.05	0.25	0.48	0.36	0.00
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	100.00	0.00	0.69	1.32	0.99	8.40
Punjabi Aubergin Curry	150.00	1.41	11.25	4.66	125.52	4.49	14.84	80.67	4.05	2.59	4.95	3.71	17.95
Tea(Milk)	50.00	1.60	1.95	2.40	33.55	19.08	28.61	52.31	0.00	0.45	0.86	0.64	7.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
total	418.00	13.36	17.27	78.39	522.45	10.23	60.02	29.76	8.10	3.97	7.60	5.70	33.35
14th													
Paratha	90.00	8.87	8.86	64.12	371.66	9.55	69.00	21.45	1.17	2.04	3.90	2.92	21.85
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	100.00	0.00	0.69	1.32	0.99	8.40
Punjabi Bhindi Bhaji	100.00	2.02	10.00	5.00	118.11	6.85	16.95	76.20	2.29	2.30	4.40	3.30	0.00
Milk	75.00	2.40	2.93	3.60	50.33	19.08	28.61	52.31	0.00	0.67	1.29	0.97	10.50
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	273.00	13.30	24.78	77.72	587.04	9.06	52.96	37.98	3.46	5.70	10.90	8.18	40.75
15th													
Chapati	90.00	8.82	0.45	69.84	318.69	9.96	1.14	78.89	1.98	0.10	0.20	0.15	0.00
Ghee	3.00	0.00	2.99	0.00	26.95	0.00	0.00	3.00	0.00	0.69	1.32	0.99	8.40
Punjabi Potato, cabbage curry	100.00	1.66	8.20	6.82	107.70	6.43	26.48	67.08	0.60	1.89	3.61	2.71	20.45
Tea milk	50.00	1.60	1.95	2.40	33.55	9.70	14.55	26.59	0.00	0.45	0.86	0.64	7.00

Appendix4g: Commonly consumed Breakfast meals from focus group study(Cont.)

Recipes	Weight (g)	Protein (g)	Fat (g)	CHO (g)	Energy Kcal	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
sugar	5.00	0.00	0.00	5.00	20.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
Egg	120.00				0.00								
Total	368.00	12.08	13.59	84.06	506.89	9.53	66.33	24.14	2.58	3.13	5.98	4.49	35.85
16th													
Rice	150.00	3.90	1.95	46.35	218.55	11.30	134.35	12.72	0.00	0.45	0.86	0.64	0.00
chicken curry	150.00	14.44	22.61	7.49	291.21	29.75	104.83	15.43	0.58	5.20	9.95	7.46	52.42
Tea (Milk)	75.00	2.40	2.93	3.60	50.33	14.55	21.82	39.89	0.00	0.67	1.29	0.97	10.50
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	380.00	20.74	27.49	62.44	580.09	14.30	43.05	42.65	0.58	6.32	12.09	9.07	62.92
17th													
Rice	150.00	3.90	1.95	46.35	218.55	11.30	134.35	12.72	0.00	0.45	0.86	0.64	0.00
whole chickpeas	150.00	8.92	8.17	21.12	193.73	29.28	69.29	60.34	0.35	1.88	3.60	2.70	0.00
tea (Milk)	50.00	1.60	1.95	2.40	33.55	9.70	14.55	26.59	0.00	0.45	0.86	0.64	7.00
sugar	5.00	0.00	0.00	5.00	20.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
total	355.00	14.42	12.07	74.87	465.83	12.39	64.29	23.33	0.35	2.78	5.31	3.98	7.00
18th													
rice	150.00	3.90	1.95	46.35	218.55	11.30	134.35	12.72	0.00	0.45	0.86	0.64	0.00
mixed veg curry	100.00	2.24	9.40	10.68	136.26	6.12	29.16	64.72	5.69	2.16	4.14	3.10	0.00
tea- milk	50.00	1.60	1.95	2.40	33.55	9.70	14.55	26.59	0.00	0.45	0.86	0.64	7.00
Sugar	5.00	0.00	0.00	5.00	20.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
total	305.00	7.74	13.30	64.43	408.36	7.58	63.11	29.31	5.69	3.06	5.85	4.39	7.00
19th													
Rice	150.00	3.90	1.95	46.35	218.55	11.30	134.35	12.72	0.00	0.45	0.86	0.64	0.00
Lamb curry	150.00	11.69	22.32	5.86	271.05	25.87	111.15	12.98	0.76	5.13	9.82	7.36	42.56
tea-milk	50.00	1.60	1.95	2.40	33.55	9.70	14.55	26.59	0.00	0.45	0.86	0.64	7.00
sugar	5.00	0.00	0.00	5.00	20.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	355.00	17.19	26.22	59.61	543.15	12.66	43.90	43.44	0.76	6.03	11.54	8.65	49.56

Appendix 4g Commonly consumed Breakfast meals from focus group study(Cont.)

Recipes	Weight (g)	Protein (g)	Fat (g)	CHO (g)	Energy Kcal	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
20th													
Paratha	90.00	8.87	8.86	64.12	371.66	8.60	19.31	62.10	1.17	2.04	3.90	2.92	21.85
ghee	5.00	0.00	4.99	0.00	44.91	0.00	0.00	5.00	0.00	1.15	2.20	1.65	14.00
chicken curry	100.00	9.63	15.07	4.99	194.14	19.83	69.88	10.28	0.39	3.47	6.63	4.97	34.95
cauliflower bhaji	100.00	2.92	7.05	3.62	89.61	12.27	15.19	72.55	0.19	1.62	3.10	2.33	0.00
tea-milk	50.00	1.60	1.95	2.40	33.55	9.70	14.55	26.59	0.00	0.45	0.86	0.64	7.00
sugar	5.00	0.00	0.00	5.00	20.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
total	350.00	23.02	37.92	80.13	753.88	12.21	42.51	45.27	1.74	8.72	16.69	12.51	77.80

Appendix 4h: Commonly consumed Lunch meals from focus group study

Recipes	Weight (g)	Protein (g)	Fat (g)	CHO (g)	Energy (Kcal)	Energy (KJ)	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
Lunch														
1st														
Chapati	120	11.76	0.60	93.12	424.92	1776.17	11.07	1.27	87.66	2.64	0.14	0.26	0.20	0.00
ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
rice	150	3.90	1.95	46.35	218.55	880.50	7.14	8.03	84.83	0.00	0.45	0.86	0.64	0.00
Mix veg curry	80	1.79	7.52	8.54	109.01	489.71	6.58	62.09	31.34	4.55	1.73	3.31	2.48	0.00
chicken curry	150	14.44	22.61	7.49	291.21	1217.26	19.83	69.88	10.28	0.58	5.20	9.95	7.46	52.42
Masoor-moong dal	150	14.93	18.05	29.78	341.28	1377.03	17.50	47.60	34.91	0.37	4.15	7.94	5.96	43.43
Papadum	20	2.30	7.76	5.66	101.68	416.80	9.05	68.69	22.27	0.00	1.78	3.41	2.56	0.38
Total	680	49.12	68.47	190.94	1576.47	6526.76	12.46	39.09	48.45	8.14	15.75	30.13	22.60	124.23
2nd														
Chapati	180	17.64	0.90	139.68	637.38	2664.25	11.07	1.27	87.66	3.96	0.21	0.40	0.30	0.00
ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
Rice	100	2.60	1.30	30.90	145.70	587.00	7.14	8.03	84.83	0.00	0.30	0.57	0.43	0.00
potato cabbage curry	80	1.44	2.50	6.42	53.90	209.24	10.68	41.68	47.64	0.59	0.57	1.10	0.82	4.96
lamb curry	150	11.69	22.32	5.86	271.05	1132.99	17.25	74.10	8.65	0.76	5.13	9.82	7.36	42.56
masoor dal (thick)	150	10.77	8.34	21.51	204.19	821.86	21.10	36.76	42.14	0.01	1.92	3.67	2.75	20.79
papadum	20	2.30	7.76	5.66	101.68	416.80	9.05	68.69	22.27	0.00	1.78	3.41	2.56	0.38
Total	690	46.44	53.09	210.03	1503.72	6201.44	12.35	31.78	55.87	5.32	12.21	23.36	17.52	96.69
3rd														
Chapati	180	17.64	0.90	139.68	637.38	2664.25	11.07	1.27	87.66	3.96	0.21	0.40	0.30	0.00
ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
rice	150	3.90	1.95	46.35	218.55	880.50	7.14	8.03	84.83	0.00	0.45	0.86	0.64	0.00
spinach potato saag	50	1.24	4.23	3.58	57.28	194.03	8.64	66.39	24.97	0.81	0.97	1.86	1.39	0.00
channa dal	150	10.76	18.82	23.53	306.50	1239.49	14.04	55.25	30.71	0.07	4.33	8.28	6.21	44.16
mutton curry	150	21.55	18.22	3.97	266.10	1112.30	32.39	61.64	5.97	0.34	4.19	8.02	6.01	94.12
Total	690	55.08	54.10	217.11	1575.63	6459.87	13.98	30.90	55.12	5.18	12.44	23.80	17.85	166.29
4th														
Chapati	120	11.76	0.60	93.12	424.92	1776.17	11.07	1.27	87.66	2.64	0.14	0.26	0.20	0.00
ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
rice	125	3.25	1.63	38.63	182.13	733.75	7.14	8.03	84.83	0.00	0.37	0.72	0.54	0.00
lamb, potato curry	150	19.47	12.94	7.91	225.93	944.41	34.46	51.54	14.00	1.20	2.98	5.69	4.27	74.07
Bhindi bhaji	100	2.02	10.00	5.00	118.11	513.89	6.85	76.20	16.95	2.29	2.30	4.40	3.30	0.00
Soya bean dhal (Thick)	150	11.68	24.88	7.86	302.11	1199.78	15.46	74.13	10.41	0.50	5.72	10.95	8.21	50.74
Total	655	48.17	60.03	152.52	1343.01	5537.29	14.35	40.23	45.43	6.64	13.81	26.41	19.81	152.81

Appendix 4h: Commonly consumed Lunch meals from focus group study(Cont.)

Recipes	Weight (g)	Protein (g)	Fat (g)	CHO (g)	Energy (Kcal)	Energy (KJ)	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
5th														
Roti	120	13.80	1.44	88.44	421.92	1763.63	13.08	3.07	83.85	5.40	0.33	0.63	0.48	0.00
Ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
Rice	200	5.20	2.60	61.80	291.40	1174.00	7.14	8.03	84.83	0.00	0.60	1.14	0.86	0.00
Whole moon curry	150	13.21	29.85	24.63	420.00	1679.69	12.58	63.96	23.46	0.68	6.87	13.13	9.85	0.00
Potato, onion, tomato Curry	150	2.26	12.00	16.40	182.65	938.93	4.95	59.13	35.92	2.95	2.76	5.28	3.96	0.00
Total	630	34.47	55.87	191.27	1405.79	5925.54	9.81	35.77	54.42	9.03	12.85	24.58	18.44	28.00
6th														
Roti	180	20.70	2.16	132.66	632.88	2645.44	13.08	3.07	83.85	8.10	0.50	0.95	0.71	0.00
Ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
Rice	150	3.90	1.95	46.35	218.55	880.50	7.14	8.03	84.83	0.00	0.45	0.86	0.64	0.00
Punjabi gourd	80	1.29	0.71	4.22	28.47	99.45	18.14	22.51	59.35	0.50	0.16	0.31	0.23	0.00
Chicken potato curry	150	21.00	13.20	6.60	229.20	960.75	36.65	51.83	11.52	1.05	3.04	5.81	4.36	2.55
Total	570	46.89	28.00	189.83	1198.92	4955.44	15.64	21.02	63.34	9.65	6.44	12.32	9.24	30.55
7th														
Roti	150	17.25	1.80	110.55	527.40	2204.53	13.08	3.07	83.85	6.75	0.41	0.79	0.59	0.00
Ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
Lamb curry	250	19.48	37.19	9.77	451.75	1888.31	17.25	74.10	8.65	1.27	8.55	16.37	12.27	70.93
Rice	200	5.20	2.60	61.80	291.40	1174.00	7.14	8.03	84.83	0.00	0.60	1.14	0.86	0.00
Papadum	20	2.30	7.76	5.66	101.68	416.80	9.05	68.69	22.27	0.00	1.78	3.41	2.56	0.38
Total	630	44.23	59.33	187.78	1462.05	6052.94	12.10	36.52	51.37	8.02	13.65	26.11	19.58	99.31
8th														
Roti	150	17.25	1.80	110.55	527.40	2204.53	13.08	3.07	83.85	6.75	0.41	0.79	0.59	0.00
Ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
Chicken curry	200	19.25	30.15	9.98	388.28	1623.01	19.83	69.88	10.28	0.78	6.93	13.27	9.95	69.89
Peas & potato curry	100	3.48	1.26	8.56	59.48	257.25	23.40	19.06	57.54	6.09	0.29	0.55	0.42	0.00
Rice	150	3.90	1.95	46.35	218.55	880.50	7.14	8.03	84.83	0.00	0.45	0.86	0.64	0.00
Papadum	20	2.30	7.76	5.66	101.68	416.80	9.05	68.69	22.27	0.00	1.78	3.41	2.56	0.38
Total	630	46.18	52.90	181.10	1385.21	5751.39	13.33	34.37	52.29	13.62	12.17	23.28	17.46	98.27
9th														
Paratha	180	17.75	17.71	128.23	743.33	3107.16	9.55	21.45	69.00	2.34	4.07	7.79	5.84	43.70
Ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
Cabbage potato curry	100	1.66	8.20	6.82	107.70	430.50	6.15	68.52	25.32	0.60	1.89	3.61	2.71	20.45
Chicken curry	200	19.25	30.15	9.98	388.28	1623.01	19.83	69.88	10.28	0.78	6.93	13.27	9.95	69.89
Papadum	20	2.30	7.76	5.66	101.68	416.80	9.05	68.69	22.27	0.00	1.78	3.41	2.56	0.38
Total	510	40.95	73.80	150.69	1430.81	5946.77	11.45	46.42	42.13	3.72	16.97	32.47	24.35	162.43

Appendix 4h: Commonly consumed Lunch meals from focus group study(Cont.)

Recipes	Weight (g)	Protein (g)	Fat (g)	CHO (g)	Energy (Kcal)	Energy (KJ)	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
10th														
Paratha	180	17.75	17.71	128.23	743.33	3107.16	9.55	21.45	69.00	2.34	4.07	7.79	5.84	43.70
Lamb potato curry	250	32.44	21.56	13.18	376.56	1574.01	34.46	51.54	14.00	2.01	4.96	9.49	7.12	123.45
Ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
Karela curry	100	1.37	12.51	4.02	134.15	458.06	4.08	83.93	12.00	1.01	2.88	5.50	4.13	0.00
Papadum	20	2.30	7.76	5.66	101.68	416.80	9.05	68.69	22.27	0.00	1.78	3.41	2.56	0.38
Total	560	53.86	69.52	151.10	1445.54	5925.33	14.90	43.29	41.81	5.35	15.99	30.59	22.94	195.54
11th														
Rice	250	6.50	3.25	77.25	364.25	1467.50	7.14	8.03	84.83	0.00	0.75	1.43	1.07	0.00
Chicken curry	250	24.06	37.69	12.48	485.35	2028.76	19.83	69.88	10.28	0.97	8.67	16.58	12.44	87.37
Spinach saag	50	1.31	1.10	3.14	27.70	123.75	18.93	35.75	45.33	0.90	0.25	0.48	0.36	2.61
Urad tomato dhal	150	7.01	22.65	13.98	287.81	1055.40	9.74	70.84	19.42	0.31	5.21	9.97	7.48	52.89
Total	700	38.88	64.69	106.84	1165.10	4675.41	13.35	49.97	36.68	2.18	14.88	28.46	21.35	142.87
12th														
Rice	250	6.50	3.25	77.25	364.25	1467.50	7.14	8.03	84.83	0.00	0.75	1.43	1.07	0.00
Lamb curry	150	11.69	22.32	5.86	271.05	1132.99	17.25	74.10	8.65	0.76	5.13	9.82	7.36	42.56
Channa Dhal	100	3.81	11.03	9.40	152.10	581.52	10.02	65.25	24.73	0.51	2.54	4.85	3.64	0.00
Potato and courgette	100	2.09	6.80	9.93	109.29	432.55	7.65	56.00	36.35	1.43	1.56	2.99	2.24	0.00
Total	600	24.09	43.39	102.45	896.69	3614.55	10.75	43.55	45.70	2.71	9.98	19.09	14.32	42.56
13th														
Aubergine and Potato	150	1.81	9.30	10.53	133.03	525.45	5.43	62.92	31.65	2.07	2.14	4.09	3.07	0.00
Lamb chops	200	29.33	28.17	4.07	387.12	1618.18	30.30	65.49	4.21	0.37	6.48	12.40	9.30	114.95
Roti	180	20.70	2.16	132.66	632.88	2645.44	13.08	3.07	83.85	8.10	0.50	0.95	0.71	0.00
Ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
Total	540	51.83	49.61	147.26	1242.85	5158.37	16.68	35.93	47.39	10.54	11.41	21.83	16.37	142.95
15th														
Rice	300	7.80	3.90	92.70	437.10	1761.00	7.14	8.03	84.83	0.00	0.90	1.72	1.29	0.00
Mixed dhal (Masur,Mung,Channa)	200	17.91	14.69	37.53	353.99	1403.70	20.24	37.36	42.40	0.58	3.38	6.47	4.85	33.99
Papadum	20	2.30	7.76	5.66	101.68	416.80	9.05	68.69	22.27	0.00	1.78	3.41	2.56	0.38
Total	520	28.01	26.35	135.89	892.77	3581.50	12.55	26.57	60.88	0.58	6.06	11.60	8.70	34.37
16th														
Roti	180	20.70	2.16	132.66	632.88	2645.44	13.08	3.07	83.85	8.10	0.50	0.95	0.71	0.00
Chicken curry	250	24.06	37.69	12.48	485.35	2028.76	19.83	69.88	10.28	0.97	8.67	16.58	12.44	87.37
Boiled eggs	120										0.00	0.00	0.00	
Total	550	44.76	39.85	145.14	1118.23	4674.20	16.01	32.07	51.92	9.07	9.16	17.53	13.15	87.37

Appendix4h: Commonly consumed Lunch meals from focus group study(Cont.)

Recipes	Weight (g)	Protein (g)	Fat (g)	CHO (g)	Energy (Kcal)	Energy (KJ)	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (g)
17th														
Rice	250	6.50	3.25	77.25	364.25	1467.50	7.14	8.03	84.83	0.00	0.75	1.43	1.07	0.00
Toor dhal	150	16.87	1.63	49.26	279.17	1135.37	24.17	5.25	70.58	0.49	0.37	0.72	0.54	0.00
Low fat Matar Kheema	150	16.75	13.21	5.69	208.67	872.25	32.11	56.99	10.91	3.18	3.04	5.81	4.36	67.97
Total	550	40.12	18.09	132.20	852.09	3475.13	18.83	19.11	62.06	3.67	4.16	7.96	5.97	67.97
18th														
Roti	210	24.15	2.52	154.77	738.36	3086.34	13.08	3.07	83.85	9.45	0.58	1.11	0.83	0.00
Thick soya bean dal	200	15.57	33.18	10.49	402.81	1599.70	15.46	74.13	10.41	0.67	7.63	14.60	10.95	67.65
Potato, Onion, Tomato curry	200	3.02	16.00	21.87	243.53	1251.91	4.95	59.13	35.92	3.94	3.68	7.04	5.28	0.00
Total	610	42.73	51.70	187.12	1384.70	5937.96	12.34	33.60	54.05	14.06	11.89	22.75	17.06	67.65
19th														
Roti	210	24.15	2.52	154.77	738.36	3086.34	13.08	3.07	83.85	9.45	0.58	1.11	0.83	0.00
Chicken curry	300	28.88	45.22	14.97	582.42	2434.52	19.83	69.88	10.28	1.16	10.40	19.90	14.92	104.84
Ghee	10	0.00	9.98	0.00	89.82	369.30	0.00	100.00	0.00	0.00	2.30	4.39	3.29	28.00
Total	520	53.03	57.72	169.74	1410.60	5890.16	15.04	36.83	48.13	10.61	13.28	25.40	19.05	132.84
20th														
Khichdi	300	14.09	24.07	63.21	525.80	2142.02	10.72	41.19	48.09	0.00	5.54	10.59	7.94	73.78
Bhindi bhaji	100	2.02	10.00	5.00	118.11	513.89	6.85	76.20	16.95	2.29	2.30	4.40	3.30	0.00
Kadhi	150	4.83	27.41	7.72	296.88	1188.64	6.51	83.09	10.40	0.02	6.30	12.06	9.04	77.21
Total	550	20.94	61.47	75.94	940.78	3844.55	8.90	58.81	32.29	2.31	14.14	27.05	20.29	150.99

Appendix 4i: Commonly consumed dinner meals from focus group study

Recipes	Weight(g)	Protein (g)	Fat (g)	CHO (g)	Energy Kcal	Energy KJ	%PRO	%CHO	%FAT	FIBRE	PUFA	MUFA	SFA	Cholesterol
Dinner														
1st														
Paratha	180.00	17.75	17.71	128.23	743.33	3107.16	9.55	69.00	21.45	2.34	4.07	7.79	5.84	43.70
ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
chicken curry	150.00	14.44	22.61	7.49	291.21	1217.26	19.83	10.28	69.88	0.58	5.20	9.95	7.46	52.42
lamb chops	200.00	29.33	28.17	4.07	387.12	1618.18	30.30	4.21	65.49	0.37	6.48	12.40	9.30	114.95
Total	690.00	61.51	78.48	139.79	1511.48	6311.90	16.28	36.99	46.73	3.29	18.05	34.53	25.90	239.08
2nd														
Chapati	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
spinach saag	100.00	2.62	2.20	6.28	55.39	247.49	18.93	45.33	35.75	1.80	0.51	0.97	0.73	5.22
mutton curry	100.00	28.73	24.30	5.30	354.80	1483.07	32.39	5.97	61.64	0.45	5.59	10.69	8.02	125.50
pokada	100.00	15.40	24.76	43.61	458.91	1839.47	13.42	38.01	48.57	2.23	5.70	10.90	8.17	3.44
Total	100.00	46.75	61.24	55.19	958.93	3939.33	19.50	23.02	57.48	4.48	14.09	26.95	20.21	162.16
3rd														
Rotli	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
lamb curry	200.00	15.58	29.76	7.82	361.40	1510.65	17.25	8.65	74.10	1.01	6.84	13.09	9.82	56.74
mixed veg curry	150.00	3.36	14.10	16.01	204.40	918.20	6.58	31.34	62.09	8.54	3.24	6.20	4.65	0.00
Punjabi mix dal(mung, masoor and channa)	150.00	13.43	11.02	28.15	265.49	1052.77	20.24	42.40	37.36	0.43	2.53	4.85	3.64	25.49
Total	660.00	32.38	64.86	51.97	921.11	3850.92	14.06	22.57	63.37	9.98	14.92	28.54	21.40	110.24
4th														
Naan	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
chicken potato curry	150.00	21.00	13.20	6.60	229.20	960.75	36.65	11.52	51.83	1.05	3.04	5.81	4.36	2.55

Appendix 4i: Commonly consumed dinner meals from focus group study(Cont.)

Recipes	Weight(g)	Protein (g)	Fat (g)	CHO (g)	Energy Kcal	Energy KJ	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (mg)
lamb kabab	200.00	26.51	17.87	4.75	285.87	1194.92	37.09	6.64	56.27	0.56	4.11	7.86	5.90	102.36
Punjabi masur dhal with masur and onion	150.00	6.30	21.74	13.84	276.18	1132.08	9.12	20.04	70.84	0.55	5.00	9.56	7.17	59.68
Total	640.00	53.81	62.79	25.18	881.06	3657.06	24.43	11.43	64.14	2.16	14.44	27.63	20.72	192.59
5th														
paratha	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
mutton curry	200.00	28.73	24.30	5.30	354.80	1483.07	32.39	5.97	61.64	0.45	5.59	10.69	8.02	125.50
bhindi bhaji	80.00	1.62	8.00	4.00	94.48	411.11	6.85	16.95	76.20	1.83	1.84	3.52	2.64	0.00
pokada	100.00	10.26	16.51	29.08	305.94	1226.31	13.42	38.01	48.57	1.48	3.80	7.26	5.45	2.29
Total	540.00	40.61	58.79	38.37	845.05	3489.79	19.22	18.16	62.61	3.77	13.52	25.87	19.40	155.79
6th														
Chapati	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
chicken curry	200.00	19.25	30.15	9.98	388.28	1623.01	19.83	10.28	69.88	0.78	6.93	13.27	9.95	69.89
pokada	100.00	10.26	16.51	29.08	305.94	1226.31	13.42	38.01	48.57	1.48	3.80	7.26	5.45	2.29
Pea and Potato Curry	100.00	3.48	1.26	8.56	59.48	257.25	23.40	57.54	19.06	6.09	0.29	0.55	0.42	0.00
papadum	20.00	2.30	7.76	5.66	101.68	416.80	9.05	22.27	68.69	0.00	1.78	3.41	2.56	0.38
Total	580.00	35.29	65.66	53.27	945.21	3892.67	14.94	22.55	62.52	8.35	15.10	28.89	21.67	100.57
7th														
Thick Naan	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
lamb khima	150.00	19.90	22.69	4.38	301.33	1259.56	26.42	5.81	67.77	0.36	5.22	9.98	7.49	76.66
cauliflower, tomatoes and potato curry	100.00	2.44	4.85	7.41	83.06	319.71	11.77	35.68	52.55	0.86	1.12	2.13	1.60	9.96
papadum	20.00	2.30	7.76	5.66	101.68	416.80	9.05	22.27	68.69	0.00	1.78	3.41	2.56	0.38
chicken potato	150.00	21.00	13.20	6.60	229.20	960.75	36.65	11.52	51.83	1.05	3.04	5.81	4.36	2.55
Total	570.00	45.64	48.50	24.05	715.27	2956.83	25.53	13.45	61.03	2.27	11.16	21.34	16.01	89.54

Appendix4i: Commonly consumed dinner meals from focus group study(Cont.)

Recipes	Weight(g)	Protein (g)	Fat (g)	CHO (g)	Energy Kcal	Energy KJ	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (mg)
8th														
parathaChapati	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
chicken curry	150.00	14.44	22.61	7.49	291.21	1217.26	19.83	10.28	69.88	0.58	5.20	9.95	7.46	52.42
Punjabi aubergine curry	100.00	0.94	7.50	3.11	83.68	242.25	4.49	14.84	80.67	2.70	1.73	3.30	2.48	11.96
Pokada	150.00	15.40	24.76	43.61	458.91	1839.47	13.42	38.01	48.57	2.23	5.70	10.90	8.17	3.44
Total	540.00	30.77	64.86	54.21	923.62	3668.28	13.33	23.48	63.20	5.51	14.92	28.54	21.40	95.82
9th														
Rotli	180.00	17.75	17.71	128.23	743.33	3107.16	9.55	69.00	21.45	2.34	4.07	7.79	5.84	43.70
ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
lamb curry	200.00	15.58	29.76	7.82	361.40	1510.65	17.25	8.65	74.10	1.01	6.84	13.09	9.82	56.74
pokoda	150.00	15.40	24.76	43.61	458.91	1839.47	13.42	38.01	48.57	2.23	5.70	10.90	8.17	3.44
Total	540.00	48.73	82.21	179.66	1653.46	6826.58	11.79	43.46	44.75	5.58	18.91	36.17	27.13	131.89
10th														
Rotli	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
Punjabi chicken potato curry	250.00	35.00	22.00	11.00	382.00	1601.25	36.65	11.52	51.83	1.75	5.06	9.68	7.26	4.25
Papadum	20.00	2.30	7.76	5.66	101.68	416.80	9.05	22.27	68.69	0.00	1.78	3.41	2.56	0.38
Total	420.00	37.30	29.76	16.66	483.68	2018.05	30.85	13.78	55.38	1.75	6.84	13.09	9.82	4.63
11th														
paratha	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
Ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
Mutton curry	200.00	28.73	24.30	5.30	354.80	1483.07	32.39	5.97	61.64	0.45	5.59	10.69	8.02	125.50
Cauliflower and potato curry	100.00	2.70	4.35	8.65	84.52	366.23	12.76	40.92	46.32	1.22	1.00	1.91	1.44	10.79
papadum	30.00	3.45	11.64	8.49	152.52	625.20	9.05	22.27	68.69	0.00	2.68	5.12	3.84	0.57
Total	490.00	34.88	50.27	22.43	681.66	2843.81	20.47	13.16	66.37	1.67	11.56	22.12	16.59	164.86

Appendix4i: Commonly consumed dinner meals from focus group study(Cont.)

Recipes	Weight(g)	Protein (g)	Fat (g)	CHO (g)	Energy Kcal	Energy KJ	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (mg)
12th														
paratha	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
mixed veg curry	150.00	3.36	14.10	16.01	204.40	918.20	6.58	31.34	62.09	8.54	3.24	6.20	4.65	0.00
whole mung dhal	200.00	31.15	34.57	55.23	656.66	2577.64	18.98	33.64	47.38	0.40	7.95	15.21	11.41	85.16
pokada	100.00	10.26	16.51	29.08	305.94	1226.31	13.42	38.01	48.57	1.48	3.80	7.26	5.45	2.29
Total	640.00	44.78	75.16	100.31	1256.82	5091.45	14.25	31.93	53.82	10.42	17.29	33.07	24.80	115.46
13th														
paratha	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
mixed vegetable pulau	400.00	10.16	43.84	61.96	683.04	2855.04	5.95	36.28	57.77	5.20	10.08	19.29	14.47	138.80
Papadum	20.00	2.30	7.76	5.66	101.68	416.80	9.05	22.27	68.69	0.00	1.78	3.41	2.56	0.38
pokada	200.00	20.53	33.02	58.15	611.88	2452.63	13.42	38.01	48.57	2.97	7.59	14.53	10.90	4.59
Total	620.00	32.99	84.62	125.77	1396.60	5724.47	9.45	36.02	54.53	8.17	19.46	37.23	27.92	143.77
14th														
Chicken biriyani	400.00	38.92	37.52	58.48	727.28	3039.72	21.41	32.16	46.43	0.80	8.63	16.51	12.38	135.32
Pakoda	150.00	15.40	24.76	43.61	458.91	1839.47	13.42	38.01	48.57	2.23	5.70	10.90	8.17	3.44
lamb chops	150.00	21.99	21.13	3.05	290.34	1213.63	30.30	4.21	65.49	0.28	4.86	9.30	6.97	86.22
Total	700.00	76.31	83.41	105.15	1476.54	6092.82	20.67	28.48	50.84	3.30	19.18	36.70	27.53	224.98
15th														
Paratha	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
Punjabi meat pilau	400.00	36.12	41.84	57.28	750.16	3135.40	19.26	30.54	50.20	0.44	9.62	18.41	13.81	123.44
Pakoda	150.00	15.40	24.76	43.61	458.91	1839.47	13.42	38.01	48.57	2.23	5.70	10.90	8.17	3.44
Papdum	20.00	2.30	7.76	5.66	101.68	416.80	9.05	22.27	68.69	0.00	1.78	3.41	2.56	0.38
Total	570.00	53.82	74.36	106.55	1310.75	5391.67	16.42	32.52	51.06	2.67	17.10	32.72	24.54	127.26

Appendix4i : Commonly consumed dinner meals from focus group study(Cont.)

Recipes	Weight(g)	Protein (g)	Fat (g)	CHO (g)	Energy Kcal	Energy KJ	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (mg)
16th														
paratha	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
mixed veg curry	150.00	3.36	14.10	16.01	204.40	918.20	6.58	31.34	62.09	8.54	3.24	6.20	4.65	0.00
chicken curry	150.00	14.44	22.61	7.49	291.21	1217.26	19.83	10.28	69.88	0.58	5.20	9.95	7.46	52.42
lamb kabab	100.00	13.26	8.94	2.37	142.93	597.46	37.09	6.64	56.27	0.28	2.06	3.93	2.95	51.18
pulav veg	200.00	5.08	21.92	30.98	341.52	1427.52	5.95	36.28	57.77	2.60	5.04	9.64	7.23	69.40
Total	740.00	36.13	77.55	56.85	1069.88	4529.74	13.51	21.26	65.23	12.00	17.84	34.12	25.59	201.00
17th														
Paratha	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
lamb khima	100.00	13.27	15.13	2.92	200.89	839.71	26.42	5.81	67.77	0.24	3.48	6.66	4.99	51.11
mutton curry	150.00	21.55	18.22	3.97	266.10	1112.30	32.39	5.97	61.64	0.34	4.19	8.02	6.01	94.12
rice	200.00	5.20	2.60	61.80	291.40	1174.00	7.14	84.83	8.03	0.00	0.60	1.14	0.86	0.00
Urad Dhal	100.00	3.71	13.13	11.02	177.05	662.77	8.37	24.89	66.73	0.02	3.02	5.78	4.33	31.40
Total	690.00	43.72	59.06	79.71	1025.26	4158.08	17.06	31.10	51.84	0.60	13.58	25.99	19.49	204.63
18th														
paratha	130.00	12.82	12.79	92.61	536.85	2244.06	9.55	69.00	21.45	1.69	2.94	5.63	4.22	31.56
ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
chicken curry	200.00	19.25	30.15	9.98	388.28	1623.01	19.83	10.28	69.88	0.78	6.93	13.27	9.95	69.89
Meat pulav	300.00	27.09	31.38	42.96	562.62	2351.55	19.26	30.54	50.20	0.33	7.22	13.81	10.36	92.58
Total	640.00	59.16	84.30	145.55	1577.57	6587.92	15.00	36.91	48.09	2.80	19.39	37.09	27.82	222.04
19th														
chicken birayani	400.00	38.92	37.52	58.48	727.28	3039.72	21.41	32.16	46.43	0.80	8.63	16.51	12.38	135.32
lamb kabab	200.00	26.51	17.87	4.75	285.87	1194.92	37.09	6.64	56.27	0.56	4.11	7.86	5.90	102.36
pokoda	100.00	10.26	16.51	29.08	305.94	1226.31	13.42	38.01	48.57	1.48	3.80	7.26	5.45	2.29
Total	700.00	75.69	71.90	92.30	1319.09	5460.96	22.95	27.99	49.06	2.84	16.54	31.64	23.73	239.98

Appendix4i: Commonly consumed dinner meals from focus group study(Cont.)

Recipes	Weight(g)	Protein (g)	Fat (g)	CHO (g)	Energy Kcal	Energy KJ	%PRO	%CHO	%FAT	FIBRE (g)	PUFA (g)	MUFA (g)	SFA (g)	Cholesterol (mg)
20th														
rice	200.00	5.20	2.60	61.80	291.40	1174.00	7.14	84.83	8.03	0.00	0.60	1.14	0.86	0.00
channa Dhal with tomatoes	200.00	7.62	22.06	18.81	304.20	1163.03	10.02	24.73	65.25	1.02	5.07	9.70	7.28	0.00
spinach and potato curry	100.00	2.47	8.45	7.15	114.55	388.06	8.64	24.97	66.39	1.63	1.94	3.72	2.79	0.00
Pakoda	100.00	10.26	16.51	29.08	305.94	1226.31	13.42	38.01	48.57	1.48	3.80	7.26	5.45	2.29
Ghee	10.00	0.00	9.98	0.00	89.82	369.30	0.00	0.00	100.00	0.00	2.30	4.39	3.29	28.00
Total	700.00	25.55	59.59	116.84	1105.91	4320.70	9.24	42.26	48.50	4.14	13.71	26.22	19.67	30.29

Appendix 5: Mean differences between main study and sup sample group and significant differences

	Wt (KG)	BMI (kg/m2)	Waist (CM)	Hip (CM)	W/H Ratio	BP Di mm/Hg	BP Sys mm/Hg
Differences in Mean	-1.42	-0.171	2.684	2.388	0.003	-0.146	-0.224
CI 95% Upper	2.372	0.926	4.237	6.216	0.035	1.896	3.510
CI 95% Lower	-5.223	-1.270	-1.130	-1.436	-0.027	-2.189	-3.959
p-value	0.453	0.753	0.001	0.215	0.799	0.886	0.904

Mean difference between main study and subgroup population, macro nutrient intake

	Energy (Kcal)	Protein (g)	Total Fat (g)	SFA (g)	MUFA (g)	PUFA (g)	P/S Ratio	Cholesterol (mg)	CHO (g)	Intrinsic Sugar(g)	Extrinsic Sugar(g)	Dietary Fibre (g)
Differences in Mean	-368.76	-6.97	-14.68	-3.10	-6.24	-5.23	-0.077	21.74	-47.74	-4.38	-3.59	-2.684
95% CI Upper	34.06	7.17	3.88	3.92	1.11	0.054	0.069	83.94	8.06	24.59	13.81	0.614
95% CI Lower	-771.58	-21.13	-33.24	-10.14	-13.60	-10.56	-0.224	-40.44	-103.54	-33.37	-21.01	-5.98
p-values	0.072	0.328	0.119	0.380	0.095	0.052	0.294	0.489	0.92	0.761	0.0.679	0.109

Mean difference between main study and subgroup population, mineral intake

	Ca (mg)	Fe (mg)	Mg (mg)	P (mg)	K (mg)	Na (mg)	Cl (mg)	Zn (mg)	Cu (mg)	Se (mcg)	Mn (mcg)	I (mcg)
Differences in Mean	-0.222	-1.016	-55.73	-107.19	-444.75	-201.36	-158.54	-0.449	-0.327	-2.77	-2.77	-3.852
95% CI Upper	250.07	1.461	3.61	159.00	174.68	225.88	337.80	1.655	0.319	7.06	-38.11	5.68
95% CI Lower	-250.53	-3.494	-115.09	-307.38	-1064.19	-628.60	-654.90	-2.555	-0.974	-12.61	-1320.43	-13.38
p-value	0.999	0.415	0.065	0.422	0.155	0.349	0.523	0.670	0.318	0.574	0.423	0.423

Mean difference between main study and subgroup population, vitamin intake

	A (mcg)	B 1 (mg)	B2 (mg)	B3 (mg)	B6 (mg)	Folate (mcg)	B12 (mcg)	C (mg)	D (mcg)	E (mg)	K (mcg)
Differences in Mean	92.56	-0.143	-0.320	-2.73	0.2833	4.201	2.50	-49.86	0.885	-1.17	-42.24
95% CI Upper	764.99	-0.108	0.199	0.766	0.1164	82.39	9.26	14.56	1.37	2.45	12.42
95% CI Lower	-579.85	-0.396	-0.840	-6.243	-0.683	-73.99	-4.25	-114.3	-1.18	-4.79	-96.90
p-value	0.785	0.259	0.224	0.124	0.161	0.914	0.464	0.126	0.092	0.519	0.129

Appendix 6: Lipid and Glucose Cut-offs

Components of Lipid	Normal	Borderline	High	Very High
Triglycerides (TG) (mmol/L)	≤1.69	1.70-2.24	2.58-5.63	≥5.64
Low Density Lipoprotein (LDL) (mmol/L)	≤3.33	3.34-4.11	4.13-4.88	>4.91
High Density Lipoprotein (HDL) (mmol/L)	Men: 1.03-1.29			
Total Cholesterol (TC) (mmol/L)	< 5.17	5.17 - 6.18	> 6.19	
non-HDL (mmol/L)	<3.36	3.37-4.11	4.13-4.88	≥4.91
TC/HDL ratio	<4.5			

Fasting Blood Glucose	Cut offs
Normal (non- diabetic)	3.9-5.5mmols/l
Pre-diabetic	5.6-6.9mmols/l
Diagnosed with diabetes	>7.0mmols/l