Exploration of diet quality and physical activity level among British Bangladeshi Population living in the United Kingdom

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Abstract

The diet quality and unhealthy lifestyle depends on the availability, affordability and accessibility of foods and lifestyle choices based on social, cultural and working norms. British Bangladeshi have an increased intake of fat, protein, refined carbohydrates and highly processed food and sedentary lifestyle (Popkin et al., 2001, Monteiro 2010, Misra et al., 2009). These, such pattern of food intake and lifestyle are key to increased risk of non-communicable diseases.

The aim of this research was to evaluate the diet quality and physical activity level of British Bangladeshi people living in the United Kingdom and explore the association between physical activity and diet quality.

A total number of (n=137) British Bangladeshis males and females were randomly selected to take part in this study. Participating involved completing a repeated 24 hours dietary recall to assess diet quality in terms of Healthy Eating Index (HEI) Score and the Global Physical Activity Questionnaire (GPAQ) to assess physical activity level among this population. Overall, study involved in recruitment of participant, collect data, and collate data and data analysis. Demographic, anthropometric, nutrient, and physical activity level were reported as descriptive statistics (Mean, ±SD). Inferential statistics, independent sample t-test were performed to report significant differences between male and female. Further analysis was performed between reported intake and recommendation using one sample t-test. Linear regression was used to ascertain the association between PAL and HEI.

British Bangladeshi male and female population have high Body mass Index (BMI) of 24.82 kg/m^2 (±2.35) and 25.64 kg/m^2 (±3.27) respectively based on South Asian BMI cut-offs (Choo, 2002; (Shaikh et al,. 2019). A low diet quality score was observed among both gender with a HEI scores of 38.31 points (±8.34) and 37.57 points (±7.33) respectively. Low physical activity level (PAL) 1.32 (±0.21) and 1.24 (±0.11) was observed between male and females respectively. The overall fat intake among male and female (94.58 g/day) was above the UK government dietary recommendation of 70g/day. Overall fibre intake between male and female 20.80g/day (±2.10) was below the recommendation for UK population (30g/day) for healthy living. Protein intake exceeded by 49.95g/day in male and 45.23g/day in female. Iron intake from food was observed relatively low in females 12.98 mg/day (±2.75) below the RNI in the UK (14.8mg/day) ($p<0.001$). Sodium intake exceeded by >1600mg/day in males 2564mg/day (±776) and females 2301.84 (±568 mg/day). Positive association between PAL and HEI of $R^2 = 0.38$ was observed.

Thus, British Bangladeshi population is at risk of nutrition related diseases associated with low fibre, high sodium, low vitamin D and sedentary lifestyle. This information can be used to tailor culturally acceptable, adaptable and affordable -future public health initiatives related to fruits and vegetable intake, salt reduction campaign and engage this population with moderate or vigorous physical activity.

Keywords:
British-Bangladeshi, Healthy eating index, GPAQ, Physical Activity Level

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Abbreviations

ABBREVIATION	MEANING
BMI	Body mass index
BNF	British Nutritional Foundation
BP	Blood Pressure
CI	Confidence Interval
CVD	Cardiovascular Disease
DM	Diabetes Mellitus
EI	Energy Intake
GPAQ	Global Physical Activity Questionnaire
HEI	Healthy Eating Index
HDL	High density lipoprotein
LDL	Low density lipoprotein
MUFA	Monounsaturated fatty acids
NCD	Non-communicable diseases
NR-NCD	Nutrition related non-communicable diseases
NHS	National Health Service
PA	Physical Activity
PAL	Physical Activity Level
PUFA	Poly unsaturated fatty acids
RNI	Reference nutrient intake
SD	Standard Deviation
ST	Sedentary time
WHO	World health organization

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DECLARATION

I declare that this thesis is presented solely for the consideration

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University and has not been presented elsewhere in any form.

Chapter One: Introduction

1.0 Introduction

The increase prevalence of non-communicable diseases (NCD) and mortality has been associated with unhealthy diet, lack of physical activity and obesity. These are modifiable risk factors for south Asian British Bangladeshi population (Rezende et al., 2014; Furbish and Chowdhury, 2016). The Office of National Statistic (2011) have documented that Bangladeshi form 0.7% (451,529 residents) of the total population in the United Kingdom (Office for National Statistics, Census, 2011).

NCD are a medical condition that are not transmissible from one person to another (Islam et al., 2014; Kim and Oh, 2013). NDCs includes diabetes type 2, cancer, obesity, Alzheimer and stroke. Genetical aspects can also contribute to increase the risk of developing these illnesses (Chowdhury et al., 2014; Misra and Khurana, 2010).

Diet quality depends on the availability, affordability and accessibility of foods and lifestyle choices available based on their social, cultural and working norms (Abdelaal et al., 2017; Flegal et al., 2012; Holmboe-Ottesen and Wandel, 2012). One way of improving the overall quality of life is dependent upon the level of support system readily available within the host country (Osei-Kwasi et al., 2016; Liu et al., 2012). Thus, providing a better chance of reducing illnesses and improves overall quality of life among aforementioned population (Alipanah et al., 2009; Forrest et al., 2006; Rautiainen et al., 2016). Therefore, this research was aimed at exploring overall socio-demographic, diet quality and physical activity level to ascertain overall healthy living in the United Kingdom.

British Bangladeshi are the people originally from Bangladesh, who have acquired British citizenship and settled in the UK. Over 92% of British Bangladeshi living in the UK are Muslim, about 49.7% of this ethnic minority live in London borough council, UK. 11.09% of this population lives in the West Midlands, 5.43% in South east England and 1.70% in South west, majority in Bournemouth (Griffiths et al.,2008). British Bangladeshi are mainly working in the restaurant and hotel industries, new generations are aspiring to professional career such as teachers and doctors. Based on the Ofsted reports data from secondary schools it have been suggested that British Bangladeshi pupils are making progress in studies compare to other ethnic minority (Asthana, 2016; Wigmore, 2017). In 2013 the achievement rate at GCSE had increased significantly to 61%, compared to 56% for White British pupils (Chowdhury and Ahmed, 2018).

British Bangladeshi have 5-folds higher risks of NCD's than caucasian counterpart living in the United Kingdom (Cruickshank et al. 1980, 1991; Sevak et al. 1994; Landman & Cruickshank, 2001). One of the many contributory factors is the amount of sub-cutaneous adipocyte deposition in the body, this is higher compared to the caucasian population (3491 μm2 vs 1648 μm2, respectively).

The excessive intake of saturated fat can increase the build-up of cholesterol in the arteries and subsequently increase the risk of heart disease and stroke (Nettleton and Hornstra, 2017; Liu et al., 2017). Moderate intake of poly-unsaturated fatty acids is also important, excess intake can suppress thyroids hormones in the boy and reduce its functionality (Souza et al., 2010; Cordeiro et al., 2011). Imbalance intake of Omega 6 can increase the risk of chronic inflammatory disease and autoimmune diseases (Patterson et al., 2012; Innes and Calder, 2018).

Leading to a high glucose disposal in blood plasma and consequently increasing the risk of developing diabetes mellitus (DM) type 2. The main cause behind this scenario is the excess intake of unsaturated fat, refined carbohydrate intake and lack of physical exercise (Chandalia et al. 2007; Khazrai and Pozzilli, 2014; Algoblan et al., 2014).

Cross sectional study by Pardhan et al., 2004 observed high prevalence of diabetic type 2 among south Asian population including British Bangladeshi compared to caucasian population living in the United Kingdom (45% vs 37%; respectively). This point was further explored by Ajjan et al., 2007 that South Asian population including British Bangladeshi have a 19% higher prevalence of developing metabolic syndrome compared to white Caucasians. The raised prevalence of diabetes has been associated with excessive intake of refined carbohydrate and lack of physical activity (Chambers et al., 1999; Rippe and Angelopoulos, 2016; DiNicolantonio et al., 2016).

Coronary heart disease (CHD) was reported to be 15% higher among British Bangladeshi living in the United Kingdom (Figure 1). Obesity is one of the most common type of NCDs among British Bangladeshis (Taylor et al., 2005; Sengupta et al., 2013). WHO definition for obesity is “abnormal or excessive fat accumulation that presents a risk to health” based on anthropometric definition, it is categorized as the body mass index (BMI). Established on epidemiological study, 24.3% of British Bangladeshi living in the United Kingdom are obese with a cohort mean of 25.81 kg/m^2 based on south Asian BMI cut-offs (Garcia et al., 2017). Among this cohort adults with 23+ BMI have a greater risk of developing chronic diseases. Previously reported epidemiology and health statistics suggested key micro and macro nutrient are off key concern among this population (Sunyer, 2009; Kearns et al., 2014; Tobias and Hu, 2018). Recommendations based in daily intake of added sugar are not to exceed 10% of the total EI. This is far exceeded by this population with an overall consumption of 19.8% of the total energy (Leung and Stanner 2011). However, our current study didn’t suggest that added sugar exceed this requirement and reported on results section (*Chapter 3*).

The UK nutritional guideline suggested that fat intake should not exceed 70g per day; epidemiological research integrating male and female suggested an average intake of 122g per day (Ellahi B. 2014; Kassam-Khamis et al., 1999). The recommended amount of salt is 6g per day; public health research among British Bangladeshi suggested that the mean intake is 10g salt/day (Brito-Ashurst et al., 2010). Relationship among the increasing intake of refined carbohydrate, fat and salt along with physical inactivity and risk of NCD's have been reported in previous researches. Currently, there are no recommendations specific to the British Bangladeshi community in the UK (Patel et al., 2016; Lirussi, 2010). The intake of fruits and vegetables among South Asians in the UK is predominantly low (Talegawkar et al., 2015; LeCroy and Stevens, 2017).

Dietary intake using food diary, food frequency and repeated recall conducted among British Bangladeshi population is suggestive an average intake of 3 fruits and vegetables a day (Bishwajit et al., 2017; Gaal et al., 2018). Research suggested the longer migrants lived in the host country it increases the intake of fruits and vegetables (Kandola and Tang, 2016). No significant changes were observed among South Asian living in the United Kingdom (Garduño-Diaz and Khokhar, 2012).

The lack of fibre, antioxidants, phenols and flavonoids intake, makes this population highly likely to develop diseases. Such as, cardiovascular disease, cancer and diabetes at an earlier age in comparison to other ethnicity's (Sharma et al., 2005; Minges et al., 2013). British Bangladeshis living in the United Kingdom do not meet the recommended nutritional guidelines (*Appendices 5, Figure 1*) (Jennings et al., 2014; Vaughan 2011; Emadian et al., 2017).

There is insufficient research based particularly on British Bangladeshi men and women living in the United Kingdom. The study of the dietary intake of a population is crucial and thus allowing nutritionist, public health practitioners and health professional's alike to better address dietary and physical activity related future interventions. Nutritional intake study can also help to find the genetic causes of diseases and investigate the exposure of illness in ethnic minorities and general population.

1.1 Aim of the research

Aims: The primary main aim is to evaluate the diet quality and physical activity level of British Bangladeshi living in the United Kingdom**.** A secondary aim is to explore the association between physical activity and diet quality.

Objectives:

To achieve primary aim of this research a repeated self-reported 24-hour dietary recall diary to compute HEI have been used to explore diet quality of British Bangladeshi living in the United Kingdom. To achieve secondary aim Global Physical Activity Questionnaire (GPAQ) version 2 has been used to explore the physical activity of British Bangladeshi living in the United Kingdom and correlating it with diet quality.

1.2 Research question

Do participant's engaging with high level of physical activity level had high Healthy Eating Index score and high diet quality?

Chapter Two: Literature review

2.0 Narrative Literature review

This section includes information regarding background research relevant to this study that explores diet quality, physical activity, nutrient intake pattern and overall health and well-being of the study population. Additionally, this chapter provides an overview of the methods assessed during the research procedure. This chapter gathered studies focusing on diet intake and physical activity of British Bangladeshis and identified gaps in the research.

2.1 Diet Quality and Healthy Eating Index Among south Asian population

The World Health Organization (1946) has stated that health is: "A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 1946, International Health Conference Report). A balanced and high-quality diet is required to improve health and prevent diseases. Diet quality is a term widely used in nutritional epidemiology field to examine the eating habits of a population (Weaver et al., 2005; Patterson and Popkin, 1994). This term has been characterized as: The choice of food made by an individual. Diet alone cannot prevent illness and decrease prevalence of NCDs. Nonetheless, healthy diet combined with regular exercise can influence the BMI values that improves cardio-metabolic profiles (Larson et al., 2009; Shalitin et al., 2009).

The most commonly consumed meal among British Bangladeshi are "dal vaat" (white rice and lentil), "mangsho" (meat) and "shutki mach" (dried fish). While the consumption of lentils and meat are beneficial to the body by providing energy and essential nutrients , daily and excessive consumption of dried fish and white rice that exceed nutritional guidelines is not favourable for the body by increasing the risk of obesity and chronic diseases (Podder et al., 2018; Jennings et al., 2014). The preparation of mach is predominantly made by marinating clean mach (fish) flesh in saltwater brine. The preparation continues by soaking the fishes in salty water for few hours and later draining the mach with running water. Pieces of mach are dried under direct sunlight for few days and lastly conserved in jars for consumptions (Rana and Chakraborty, 2016). The daily intake of white rice can increase the risk of metabolism syndromes and increase glucose level and fasting insulin responses in blood (Krittanawong et al., 2017; Mohan et al., 2014). Elevate consumption of dried/salty fish can increase sodium level in the body. Drying the shutki mach under direct sunlight can introduce fungal contaminations and increase risk of nasopharyngeal cancer and fungal infections (Atapattu and Samarajeewa, 1990; Ning et al., 1990; Anihouvi et al., 2019).

Quantitative and qualitative research on diet quality among British Bangladeshi have been completed over the years. It has been estimated that British Bangladeshi women have significantly poor diet quality compared to men. Nutrition related culturally accepted interventions have been identifies one of the many ways to improve this scenario (Han et al., 2015; Khan et al., 2016). UK based research regarding British Bangladeshi's diet quality revealed the high intake of fat, particularly saturated, salt and non-starch polysaccharides (B. Ellahi 2014). Nutritional research concerning British Bangladeshis diet is vital to improve and interpret correctly the diet quality of this population.

Therefore, in this study the overall diet quality and healthy eating index score (HEI) of British Bangladeshi population living in the United Kingdom are explored via following process developed by the United States Department of Agriculture (USDA) (Guo et al.,2004; Schwingshackl et al.,2015). This is a procedure to quantify and assess the dietary quality based on 24-hour dietary recalls intake. High diet quality has been referred to the consumption of lean meat, fruits, vegetable, skimmed milk and whole grain. Low diet quality has been associated with the excessive consumption of saturated fat, red meat, and sugar (A. Albert, et al., 2012; Fransen and Ocke, 2008; Arvaniti and Panagiotakos, 2008; M.B. Schulze et al., 2003). This index has been standardized and used in epidemiological research, nutritional assessments, and nutritional interventions. This tool was developed based on density approach indicating 1000 calories. The component used in the HEI 2015 are: whole fruits, total fruit (juice included), total vegetables (include legumes), greens and beans (no legumes) , whole grains, dairy, total protein foods, seafood and plant protein, fatty acids, refined grains, sodium, added sugar, saturated fat. Each component has specific scores that sum up to the maximum value of 100. A score of 80 or higher represent healthy eating and high diet quality, a score between 50 to 80 represent a diet that requires improvements and a score below 50 represent a low diet quality (Folsom and Nagraj, 2017; Schwingshackl and Hoffmann, 2015; Guo et al., 2004). Nutritional monitoring assessments suggest that low index score represent unhealthy diet indicating obese and overweight individuals. Epidemiological research concluded that individuals required to improve their diet quality to diminish non-communicable diseases risks. Life course analysis also show consistently high association between the consumption of whole grains, fruits and vegetables and high HEI scores. HEI is the optimal choice to achieve an accurate view on dietary intake and diet quality (Guo et al., 2004; McCullough et al., 2000; Drewnowski and Rehm 2014). Therefore, analysing the diet quality of British Bangladeshi can provide a overview of their dietary intake.

2.2 Physical activity among South Asian Bangladeshi population

Physical activity is defined as ‘bodily movement that is produced by the contraction of skeletal muscle and that substantially increases energy expenditure’ (US Department of Health and Human Services 1996). Previous studies have demonstrated that mortality and cardiovascular abnormalities can be decreased when physical activities are performed on a regular basis (Ortega et al., 2008; Blair et al., 2004). It has been analysed that physical activity improves endothelial function that works as a barrier to control the passageway of white blood cell, therefore preventing the expansion of sub-clinical atherosclerotic and vascular diseases

(Pahkala et al., 2011; Watts et al., 2004; Pate et al., 1995). Communicating physical activity awareness to ethnic minority is difficult. Research carried out by Bhugra and Beena (1999) concluded that language difficulty is a major barrier faced by this ethic minority; six out of ten families do not speak the English language at home and nine out of ten children are not fluent in English until they begin Secondary school (Ulmer and Nerenz, 2009; Zabar et al., 2006). Research based on self-reported physical activity survey suggested that exercise did improve health condition among British Bangladeshi population nevertheless culturally appropriate interventions are favorable and required to increase awareness (Chapman and Qureshi 2013).

Based on National Health Service (NHS) guidelines adults should perform at least 30 minutes of moderate intensity activity at least 5 days a week. According to the Food-based dietary guidelines-Bangladesh developed by the Food and Agriculture Organization (FAO) a minimum of 30 to 45 minutes of exercise including walking, running, cycling and household work is required for healthy living (Food and Agriculture Organization, 2019). However, there are no set guidelines available here in the United Kingdom for British Bangladeshis which is culturally acceptable and adaptable (Rathod et al., 2018; Truong, and Paradies, 2014). Research survey carried out among British Bangladeshi using the Global Physical Activity Questionnaire (GPAQ) version 2 suggested the overall country's prevalence of low physical activity was 34.5% (95% confidence interval, 33.5-35.5) (Moniruzzaman et al. 2016).

Clinical and biochemical research postulated that regular physical activity changes lipolysis sensitivity in subcutaneous and visceral adipose tissue thus aiding in obesity management (Kangeun et al., 2018; Johnson JL. et al., 2007; Kemmler et al., 2009). Epidemiological review has been completed assessing the physical activity (PA) and sedentary time (ST) of British Bangladeshis women. Data suggested that 70% of the participants did perform low physical activity (walking, cooking, and cleaning) and an average of 50% women were sedentary for more than 3 hours per day. Results suggested a predominantly low level of physical activity among females compared to male (Babakus and Thompson, 2012). Similar trends have been observed by Bhatnagar et al., (2015) and team, assessing the physical activity level among British Bangladeshis living in the UK. Results suggested that younger generation British Bangladeshis perform higher level of physical activity with 7 sessions of exercise events lasting 30 minutes or more for 4 weeks. Compared to the older generation British Bangladeshis with 4 sessions of exercise events lasting 30 minutes or more for 4 weeks. Both generations perform subordinate amount of physical activity level than the British Caucasian population. The research concluded suggesting that South Asian appears to portray enthusiasm toward physical activity (Bhatnagar et al., 2015).

There is significant literature gap relating the perceptions, behaviours and approaches of south Asians regarding physical activity level. Further research and interventions are needed to promote active lifestyles among this population. This study did not focus on to this aspect.

2.3 24-Hour Dietary Recall Among south Asian and British Bangladeshi population

Overall, reported dietary information regarding this population have been discussed from various study in section *2.7* and *2.8* of this chapter. The 24-hour dietary recall is a nutritional assessment method aimed to capture nutritive information among a population group. The 24-hour dietary recall method can be used to analyse relationship between dietary intake and health stability (Johnson RK et al., 1996). This method has the advantage to assess the total energy intake, dietary pattern, frequency of food consumption and nutrient composition. Single 24 recall does not represent the habitual diet of a population Multiple days recall are necessary to increase the accuracy and precision of the data. The capacity to practice this method on a large scale without facing any logistical complication in one of the many strengths of this assessment. High level of literacy is not required to complete this form and participants can effortlessly complete the assessment in their own time (Holmes et al., 2008; Bhakta et al., 2005).

Data received from the participants includes: the time of foods consumption, portions size, source of the products and where possible a model or picture of the meal. Generally, it does not take more than 15 minutes to complete the survey (Jackson et al., 2008; Yunsheng et al., 2009). Past research by Sevak et al., (2004) has adopted a 24-hours dietary recall method to assess macro- and micro-nutrient intake among the south Asian population living in the United Kingdom. The study concluded that the 24-hours dietary recall is a reliable and efficient tool to assess diet quality and the detection of chronic disease is high fat and refine carbohydrates are excessively consumed. This tool has also the capacity to identify the intake of traditional meals and foods from the heterogeneous population. Consequently, the dietary framework of a population can be observed using this tool and capture the picture of a British Bangladeshi dietary habits (Bhakta et al., 2005).

2.4 Global Physical Activity Questionnaire (GPAQ) Among south Asian and British Bangladeshi population

Measuring the physical activity level (PAL) of an individual is important to determine the degree of physical inactivity and detect their physical fitness level. Validated studies have found that Self-reported physical activity questionnaires are reliable and applicable to assess PAL in populations (Wanner et al., 2017; Mumu et al., 2017).

A common and validated tool used is the Global Physical Activity Questionnaire (GPAQ) (Mumu et al., 2017; Sallis and Saelens, 2000). The GPAQ was introduced by the World Health Organization (WHO) in 2002 to observe the trends of physical activity over time as part of the demographic and health survey (DHS). This questionnaire is available, and it has been translated in nine different language (Bull et al., 2009). The latest version of this questionnaire has been updated by Dr. Swrajit Sarkar from 1.5 to 2.0. The GPAQ acquire information in three forms: travel, work and sedentary behaviour in PAL points. The scores are given by minutes per day to increase the level of accuracy. Data accumulated from the GPAQ can allow researchers to observe the trend of physical activity among populations in developing countries (Armstrong and Bull, 2006; Hoos et al., 2012). Where residents do not have access to fitness infrastructures and facilities. Therefore, the purpose of this research is to assess immigrants migrating from Bangladesh living in the United Kingdom (Mumu et al., 2017).

The GPAQ has been utilized among British Bangladeshi population living in the UK by Ranasinghe et al., (2013). Results suggested the prevalence of physical inactivity among adults in the aforementioned population (Ranasinghe et al. 2013). It has been observed that only 26% of Bangladeshis men and 11% of women meet the daily recommended levels of physical activity (Hayes et al., 2002). Public health research completed by M. Baldew et al (2015). Examined the physical activity level among South Asian adult in UK using the GPAQ. Results demonstrate women and elderly do not meet the daily recommended physical activity level criteria and further interventions are needed focusing this population.

2.5 Origin of British-Bangladeshi in United Kingdom

Bangladesh is a country located in the Southern Asian. Based on the World population review Bangladesh is one of the most densely populated country in the world with over 160 million people (Development Report, 2018). The capital city of this country is Dhaka, other major cities are Sylhet and Chittagong. Over 70% of the Bangladeshi population lives in poverty and its economy is principally based on agricultures and textile industries (Khuda and Helali, 1991). The population of Bangladesh face malnutrition as an enormous challenge. In 2005 it has been estimated that over 40% of Bangladeshi mothers were malnourished (Benoist et al. 2005; Milton et al., 2004). After gaining independence from Pakistan in 1971 many Bangladeshi migrated to the United Kingdom (Chowdhury et al., 1998; Britannica, 2001; Brammer, 1990).

2.6 Acculturation of British Bangladeshis living in the United Kingdom

Changes in diet quality and palatability after migration has been describe as a nutrition transition. This phenomenon has been observed in migrants as income and high caloric food access increases. This scenario has been associated with obesity and lack of exercise (Popkin et al., 2001; Drewnowski and Popkin, 2009). This process has affected the lifestyles and diet of migrants travelling to the UK and round the world to developed counties. After migrating to the UK, British Bangladeshis increased the purchase of nutrients containing elevate amount of fat, refined carbohydrates and highly processed food. Due to the high cost and unavailability of traditional and fresh foods such as shutki and daal (Popkin et al., 2001, Monteiro 2010, Misra et al., 2009). The continuous exposure of unhealthy foods by advertisement companies and fast food chains is a factor indulging British Bangladeshi into an unhealthy lifestyle (Chopra et al., 2002; Lang et al., 2001). Traditionally consume products are not always available and affordable for Bangladeshis living in the UK. Therefore, alterations are made to cultural dishes, such as the use of white flour instead of Atta the traditional wholemeal wheat flour alterations increase the risk of nutrition related non-communicable diseases and chronic illnesses (Gilbert and Khokhar, 2008, Kumar et al., 2004).

Research has been carried out among British Bangladeshi living in England, and results revealed a high intake of protein and saturated fat compared to saturate fat and fibre after migrating from Bangladesh (Donin et al., 2010; Lip et al., 1995). Therefore, further research and analyses are required to understand the dietary eating pattern of British Bangladeshi to develop culturally acceptable interventions.

2.7 Macronutrient intake

There are three principal type of macronutrients fundamental to provide energy. These are protein, fat and carbohydrate. They are required in large amount by the body; each nutrient contains a unique functionality to provide energy to the body and maintain energy balance (Smolin & Grosvenor, 2013; Liu et al., 2003).

2.7.1 Protein intake

Protein is a crucial component that provides energy to the body helping the replacement, repair and growth of tissues. Protein contains nitrogen component that are formed by amino acids. Protein is crucial to produce hormones, haemoglobin, enzymes and function anabolic progression in the body (Lemon et al., 1992; Pedersen and Børsheim, 2013). The current UK Reference Nutrient Intake (RNI) for protein is 55g per day based on the Committee on Medical Aspects of Food and Nutrition Policy (COMAF,1991) report. Foods containing high proteins are meat, fish, poultry, legumes, nuts, eggs and dairy products (Kathryn E. et al., 2017; Wu G 2017). Excessive intake of protein can interfere with the liver's functioning and raise the risk of coronary artery diseases. Individuals with high intake of protein developed hyperalbuminemia, raised transaminases and abdominal pain (Mutlu and Keshavarzian.,2006; Fleming and Boyd., 2000). It is known by epidemiological assessment that up-to 80% of bowel, prostate and breast cancer are associated with high protein such as red meat and process meat intake (Bingham, 2006; Delimaris 2013). Contrarily, inadequate intake of protein can increase body fat and consequently increase body weight via sarcopenic obesity among this population (Zengin et al., 2017). Protein deficiency can decrease plasma concentration in amino acids leading to instability in the loss of muscle protein, decrease the rate of protein synthesis resulting imbalance in skeletal muscle mass (Santesso et al., 2012; Pezeshki et al., 2016).

Based on public health research, British Bangladeshi population living in the UK have a positive association between diabetes type 2 and high protein intake diets (Wang E. et al., 2010). Dietary survey among British Bangladeshi population living in the UK suggests an excessive intake of protein compared to the white Caucasian population (Leung and Stanner, 2011). Therefore, further research is required to understand this scenario to develop suitable interventions and create awareness among British Bangladeshis living in the UK.

2.7.2 Fat intake

Dietary fat is a macronutrient that helps the absorption of food and provide energy to the body. Dietary fats mainly consist of triglycerides, these particles contain a glycerol backbone and three fatty acids component (Liu et al., 2017; Wang and Hu, 2017). There are four main type of dietary fats: (1) Saturated fat differentiated into high-density lipoprotein (HDL) and low-density lipoprotein (LDL), (2) Trans-fat, (3) Monounsaturated fatty acids (MUFA) and (4) Polyunsaturated fatty acids (PUFA) including Omega-3 fatty acids and Omega-6 fatty acids (Forouhi et al., 2018; Dam et al., 2002). Fats with no double bonds are identified as saturated, for one or more bonds fats are recognised as MUFA or PUFA depending on the type of bonding. Same side bonds (cis) or opposite side bond (trans). Saturated fats are commonly found in red meat, poultry and full-fat dairy products. This lipid has been associated with cardio-vascular diseases (Svendsen and Retterstøl, 2017).

Fatty acids have the function to regulate intra cellular signalling, supervise the membrane's functions and monitor the production procedure of bioactive lipid mediators (Calder P., 2015; Schmid, 2010; Forouhi et al., 2018). Trans-fat are lipids found in oils and assist nutritional processing method known as hydrogenation. This fat has the capacity to increase blood cholesterol level and blood coagulation. This has been associated with high risk of stroke, cardiovascular diseases and inflammation (Dam et al., 2002; Briggs and Kris-Etherton, 2017). MUFA are formed by single bond; they are found in vegetable oils, nuts and avocados. This fat has the ability to reduce LDL, heart, stroke and decrease risk of breast cancer in women (Schwingshackl and Hoffmann, 2014). Polyunsaturated fatty acids are formed by two or more double bonds. This is found in seeds, fishes and oyster. Primary types of polyunsaturated fatty acids are omega-3 fatty acids and omega-6 fatty acids. The intake of omega-3 can reduce arrhythmia, reduce the accumulation of plaque in the arteries and maintain healthy blood pressure (BP) level (Wang, 2018; Michalak and Fichna, 2016). Previous dietary survey suggests that omega-3 polyunsaturated fatty acids includes alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). They are also responsible to maintain cell membrane fluidity and the structure of the cell and bran function (Swanson and Mousa, 2012). The excessive intake of omega-6 polyunsaturated fatty acids promote pathogenesis and increase inflammation in the body (Gammone et al., 2018; Chalupka, 2009)

A public health study in east London concluded that on average British Bangladeshi men consumed around 300g of fat per day, this data is twice the intake of the heterogeneous population (Silman et al., 1985). Therefore, it is crucial to investigate the current dietary habits of British Bangladeshis regarding fat and based upon that develop culturally accepted interventions to reduce the intake of red meat.

2.7.3 Cholesterol intake and epidemiological evidences

Cholesterol is a saturated fat consisting of four hydrocarbon rings found in every cell of the body. The molecular structure is $C_{27}H_{46}O$, it does not have the capacity to travel across the body alone. Therefore, for this reason, it bonds with phospholipid forming lipoprotein and decrease fluidity in the outer area of cell membranes. Conventionally there are two type of cholesterol known as: (1) LDL or “bad cholesterol” and (2) HDL or “good cholesterol” HDL can transport excess cholesterol away from the arteries to deliver it into the liver to be removed through the intestines. LDL can accumulate in the artery blocking the passage of red blood cell therefore increasing the risk of cardiovascular diseases (Kanter et al., 2012; Elshourbagy et al., 2013)

Dietary guidelines recommend an intake of less than 300mg per day for healthy and individuals and 200mg for CVD patients. Cholesterol is found in eggs, shellfish, full fat yogurt and cheese (Njike et al., 2010; Sacks et al., 2017; Fernandez and Calle, 2010). Disproportionate consumption of cholesterol can cause hypercholesterolemia and effect the liver functioning. This condition promote coagulation therefore damaging the endothelial system. This condition can be triggered by unhealthy die, elevate BMI and lack of exercise (Cheeseman, 2008; Bruckert and Rosenbaum, 2011).

In Wales and England, analysis from 2001 census on mortality caused by CHD, British Bangladeshi population indicated the highest rate. Public health studies have also observed that British Bangladeshis are more likely to develop CVD and due to excessive consumption of LDL compared to the general population. Increasing evidence based on nutritional assessments suggest HDL deficiency in British Bangladeshi population to other south Asians population (Herron et al., 2004; Greene et al., 2005; Esrey et al., 1996; Falaschetti & Chaudhury 2006; Mindell & Zaninotto 2006; Bhopal et al., 1999). Consequently, based on evidences it is crucial to investigate the excessive intake of cholesterol among this population and develop culturally appropriate awareness to disease CVDs.

2.7.4 Carbohydrate intake (refined and wholegrain)

Carbohydrates is a macronutrient and a main source of energy supply to the metabolism. The digestive system breaks down this macronutrient into glucose to use it as energy (Slavin and Carlson, 2014; Ludwig et al., 2018). Functions of this macronutrient are: control BP, regulate insulin metabolism in the body, contribute in triglyceride and cholesterol metabolism and support the fermentation procedure Therefore Carbohydrates plays an important role in aerobic and anaerobic health conditions. (Whistler, 1981; Ludwig et al., 2018). Monosaccharides are simple sugars, most commonly known as fructose, glucose and galactose. Other simple type of carbohydrates are disaccharides; they consist into two monosaccharides without the water particle. They are most commonly known as sucrose (table sugar) formed by glucose and fructose, lactose formed by glucose and galactose and maltose formed by two glucose molecules. Complex carbohydrates are oligosaccharides formed by three to ten monosaccharides and polysaccharide formed by long chain of monosaccharides joined by the glycosidic bonds (Cummings and Stephen 2007; Guezennec et al., 1993).

Population analysis have suggested that high intake of carbohydrates such as refined grains and high sugar drinks increase the risks of chronic disease (38% and 50% respectively). Contrary high intake of legumes and whole fruits decrease the risks of chronic disease by 11%. The current Reference Nutrient intake (RNI) for adults is about 200g to 300g daily. Excessive intake of carbohydrates can cause dyslipidaemia, diabetes type 2 and insulin resistance complications (Stanhope, 2015, SACN 2015, Khan and Sievenpiper, 2016). The consumption of carbohydrates and sugars have been increasing among ethnic minorities in Europe compared to the host country population. According to Health Survey for England 2004, general practitioners have diagnosed diabetes four times higher in British Bangladeshi men, and three times higher in women compared to the white Caucasian population (The Information Centre 2006. Health Survey for England 2004; Snijder et al., 2017, Meeks et al., 2015, De Boer et al., 2015). Hence, it is fundamental to decrease the excessive intake of sugars by expanding culturally accepted interventions and tool-kits to increase awareness.

2.7.4.1 Fibre intake (Non starch polysaccharides)

Dietary fibre is a carbohydrate and cannot be broken into sugar molecules by the body. It passes through the gastro-intestinal system and regulates the usage of sugar and manage appetite. Fibres has been categorized into two groups, as soluble (viscous or non-viscous) and non-soluble. These can be found in fruits, legumes, broccoli, and beans. The health benefits of dietary fibres are: lower hypertension, controls serum cholesterol level and increase insulin sensitivity (Anderson et al., 2009; Carlson et al., 2018). Soluble fibre can restrict the absorption of excessive cholesterol by passing through the small intestine and binding with the bile. Daily recommendation for fibre is 30g per day by the British Nutrition Foundation (BNF). Inadequate intake of fibre can lead to fibre deficiency, this condition can interfere with the correct functioning of the metabolism, causing colon and gastrointestinal disorders (Whitton et al., 2011; Williamson, 2006; Wood, 2011; Rimm et al., 1996).

Fibre intake among British Bangladeshi has been recorded low; epidemiological research suggests a regular intake of 12g among this ethnicity (Wyke & Landman 1997; Leung and Stanner, 2011). It is essential to increase awareness regarding the importance of dietary fibres by creating interventions accepted by ethnic minorities.

2.8 Micronutrients intake among south Asian and British Bangladeshi population

Micronutrients are divided into two groups described as vitamins and minerals**.** Vitamins are fundamental for the correct functioning of the immune system, blood coagulation and energy production. Minerals are crucial for bone growth, maintain fluid balance and assist enzyme reaction (Shenkin, 2006; Maggini et al., 2018).

Vitamins are divided into water soluble and fat soluble. Water soluble vitamins are not stored in the body excessive amount is secreted in the urine. Fat soluble vitamins cannot dissolve in water and excessive amount is stored by the body as dietary fat (Hamishehkar et al., 2016; Maggini et al., 2018; Hill et al., 2004). Minerals are divided into macro-minerals and trace-minerals. Macro-minerals nutrients are required in larger amount in the body. They assist body fluidity balance and muscle contraction. Traced minerals are less required in the body. They promote iron metabolism and helps the prevention of bone and teeth decay (Agnusdei and Civitelli, 1996; Williams, 2005).

2.8.1 Calcium intake

Calcium (Ca) is a macro- mineral it is found in most tissues of the body. Calcium is part of the alkaline family having pH greater than 7. Calcium promotes skeletal system's health, regulate calcium blood level and controls conductions in the central nervous system. The daily dietary reference intakes for calcium for adults 700 mg/day (Ross et al., 2011; Suitor and Meyers, 2007). Calcium deficiency can increase risk of bone fractures and lower bone's mineral density. Low calcium intake has been associated with rickets development (Sahay and Sahay, 2012; Fawzi et al., 2016). Epidemiological review committee suggested that calcium deficiency can to osteopenia and if untreated it can develop into osteoporosis (Rodriguez et al., 2009; DRI Review committee 2012).

Contradictory studies suggest excessive intake of calcium has been associated with increasing risk of cardiovascular diseases and higher rates of death (Daly and Ebeling, 2010; Michaelsson et al., 2013; Xiao et al., 2013). Calcium consumption is relevantly low among British Bangladeshi. Epidemiological studies among this ethnicity have suggested a low intake of calcium in both men and women. A mean value of 340.8mg of calcium is consumed daily (Karageorgou et al., 2018). On the other hand, conflicting to evidences have suggested that adequate calcium intake has the ability reduce the risk of colorectal cancer and increase bone density (Huncharek at al., 2009; Ishihara et al., 2008).

There is significant literature gap regarding calcium intake among British Bangladeshi population. Further research is needed to promote adequate intake of calcium in this population. We, therefore, looked at overall dietary reported calcium intake per day basis and reported on *chapter 3 table 10.*

2.8.2 Iron intake

Iron is a trace-mineral, the atomic symbol is Fe. 25% of the iron in the blood is known as ferritin, and 70% of the iron is found in red blood cells and in muscles (Lieu et al., 2001; Murray-Kolb, 2013). Functionality of iron includes: regulate gene expression, bind and transport oxygen, control cell development and regulate electro transfer reaction (Theil, 1987; Kohgo et al., 2008; Finnamore et al., 2014). Iron is divided into: heme and non-heme. Heme iron are found in fish, meat and poultry; Non-heme are found in legumes, cereal, fruits and vegetables. Iron recommended daily intake for men and women is 8.7mg and 14.8mg respectively. Heme synthesis in the body procedure haemoglobin, a protein in red blood cells. Haemoglobin transport oxygen to the body' tissue from the lungs in the blood. The body also requires iron to convert biochemical energy from food into ATP (Adenosine Triphosphate), this procedure is described as cellular respiration (West and Oates, 2008; Carpenter and Mahoney, 1992; Abbaspour at al.,2014).

Epidemiological studies have associated high iron intake with chronically high heme increasing risk of Type 2 DM and decrease muscle strength (Bao et al., 2012; Lönnerdal, 2017). Based on WHO reviews, iron deficiency is known to be the most common type of nutrient deficiency in the world. Aetiological research based on the Bangladeshi population suggest that an average of 70% of women are anaemic. Insufficient intake of iron can weaken immune responses and affect pregnancy (Haas JD, 2001; Allen, 2000; Ronnenberg et al, 2004; Ahmed 2000). The Scientific Advisory Committee on Nutrition (SACN) observed the incident of iron deficiency among British Bangladeshi women followed by Indian and Pakistani. Validates studies suggest that more than 20% women do not meet recommendation (SANC 2010; Chapple, 1998).

2.8.3 Vitamin D intake

Vitamin D is a fat-soluble vitamin it plays an important role in the regulation of phosphorus and calcium mineral in the metabolism. Vitamin D is produced when sun light energy is absorbed by the skin. Dietary sources that contain vitamin D are egg yolk, fish oil, cheese and soymilk. Functionality of vitamin D includes control skeletal calcium balance and prevent excessive release of parathyroid hormone, (Norman et al., 2006; Gordon et al., 2004; DeLuca 2004). The Recommended Nutrient Intake (RNI) of vitamin D is 10ug per day (Aggarwal et al., 2010; Wang et al., 2008; SANC 2016).

Epidemiological analysis observed that elevate intake of vitamin D also known as vitamin D toxicity is linked with bone pain, irregular heartbeat, and stones development in kidneys. High vitamin D consumption increase the concentrations of 25(OH)D. These exceed the binding capacity and cause release of 1-alpha 25(OH)2D, which enters and target the metabolism and alter balance (Marcinowska-Suchowierska et al., 2018; Koul et al., 2011; Alshahrani and Aljohani 2013). The inadequate intake of vitamin D can decrease in bone density and increase the risks of osteoporosis and osteopenia (Takiishi et al., 2010; Holick et al., 2005, 2007).

The consumption of calcium is relevantly low among British Bangladeshi; Nearly 70% to 82% of south Asian have been reported to have low plasma 25(OH)D. Nutritional assessment suggest that 20% of Bangladeshi do not meet the daily recommended dietary intake. This rate is two times higher than the general population (Dunnigan et al., 1979; Lawson and Thomas 1999; Karageorgou 2018).

Public health research focusing on British Bangladeshi suggest 17.1% women were vitamin D deficient in summer season and 58% in winter season, while Caucasian women did not have any vitamin D deficiency during the year. This occurs due to the lack of exposure of sunlight to the skin (Falaschetti & Chaudhury 2006; Lanham-New et al., 2011).

2.8.4 Sodium intake

The atomic symbol of sodium is Na, the atomic number is 11 and the atomic weight is 22.9u. Sodium is part of the alkali metal group this group have Ph is greater than 7 (Strazzullo and Leclercq, 2014; McGuire, 2013). Sodium regulate balance between minerals and water in the metabolism, conduction of nerve impulses and relaxation and contraction of muscles. Sodium is found in table salt and in unprocessed meats and fresh fruits and vegetables (Jackson et al., 2018; Wang et al., 2015). Once into the system sodium acts as body's electrolytes and carry electric charges where necessary. Kidneys plays an important role in the maintenance of sodium in the body, by regulating sodium concentration and excreting the excess amount in the urine (Munteanu and Iliuta, 2011; Strazzullo and Leclercq, 2014; Farquhar et all., 2016).

Based on nutritional assessments elevate consumption of sodium has been associated with of heart failure and water retention in the body. It has been proven by nutritional expertise that restricting dietary sodium can restrict cardiovascular disease (CVD) and stoke prevalence (Larsen et al., 2014; Doukky et al., 2016). Consuming a small amount of sodium can increase the risk of hyponatremia, high cholesterol and irregularities in triglycerides (Doukky et al. 2016; Drake-Holland and Noble, 2016; Graudal et al., 2017).

Based on the SACN analysis and Public Health England Government Recommendations for Food Energy and Nutrients for Males and Females the daily dietary reference intakes for salt for adults is ≤6 g which is approximately 2300mg of sodium intake (SACN 2016; Public Health England 2016; Levy and Tedstone, 2017). Excessive dietary salt intake among British Bangladeshis population has been emphasized in many epidemiological research (Jensen et al., 2018, Johnson et al., 2017, Brito-Ashurst et al., 2013). It has been reported that usually two meals consumed in a Bangladeshi household contain 10g of salt, this equivalent to 3,875.8 mg of sodium. There is substantial literature gap regarding salt intake among British Bangladeshis population. Further research and culturally appropriate interventions are required to promote balanced diet and healthy lifestyle. *Chapter 3 Table 10* have the reported dietary sodium intake level for this study population.

Chapter Three: Methodology

3.0 Methodology

This chapter provides detailed methods including process, steps, techniques and software usages with valid peer reviewed evidences for reducing overall study bias and statistical analysis process were described.

3.1 Study Design

This study consisted into a cross-sectional observational design focusing on British Bangladeshis living in the United Kingdom. The research was carried out as a cross sectional study and data were collected between May 2019 and June 2019. This study received approval from the Research Ethics Committee in Bournemouth University preceding the beginning of data collection. Participants were asked to complete three days repeated 24 hours dietary recall and Global Physical Activity Questionnaire (GPAQ). Nutritional data was analysed using Nutritics and R statistical software and scoring was completed using Healthy Eating Index scoring procedure (Khan et al., 2016; Buyuktuncer et al., 2018). Physical activity levels data were collected using Global Physical Activity Questionnaire and scoring was completed based upon this assessment. An inclusion and exclusion criteria were set before beginning the project, these can be found in *section 3.3* (Trinh et al., 2009; Bauman et al., 2009). To invite the participants to take part in this project leaflets (Appendices 5, Figure 3) were provided, and cultural association and organization such as mosques and temples were contacted to advertise the recruitment procedure. Word of mouth was also used to publicize the initiation of this study. Participants interested to take part in the project were given Participants Information Sheet (PIS) and Participants Consent Form (PCF). (*Appendices, 11 and 12*) After a written consent was received a basic instructions manual was given including portion size guide and how to complete the survey. (*Appendices, 5 Figure 3*)

3.2 Participants Recruitment

To analyse the diet quality and physical activity level of British Bangladeshis age between 18 to 60 years participants were recruited based on the inclusion and exclusion criteria, these can be found in *section 3.3*. Data collection begin succeeding the informed consent and the ethical approval. Participants for the study were recruited from East London, Dorset and Birmingham where there is a vast majority of British Bangladeshi population. British Bangladeshi associations, organisations, mosque and temples were given a leaflet and were informed about the study. A total of 137 participants both male and female were requited between 18 and 60 years of age and met the eligibility criteria set for the research. Participants were asked to complete a self-reported: (1) 24- hours repeated dietary recall (to analyse daily dietary intake), (2) GPAQ (to explore physical activity), (3) Anthropometric measurements (height, weight and BMI) and provide (4) Sociodemographic information's (gender, age, marital status and highest level of education. The survey was created using Survey Monkey, this is an online tool that allow its users to create webpages and surveys free of cost. The web link provided by this platform is easily accessible via any devise connected to the internet (Waclawski. 2012; Knussen and McFadyen. 2010).

3.3 Inclusion and exclusion criteria

The following table contains inclusions and exclusion criteria for the research project:

Table 3.1: Study inclusion and exclusion criteria

Variable	Inclusion	Exclusion	Rationale
Age	18-60	0-18, 60+	Infant, young adults and elderly might have specific diet and medications (Wang et al., 2017, Bayer, 2000; Leslies and Hankey 2015)
Sex	Male/Female	NA	Both sexes can provide (Holdcroft, 2007, Labots et al., 2018)
Marital status	Married, Divorced, Single	NA	Marital status does not affect diet quality (Manzoli et al., 2007)
Disease condition	Healthy individuals with no disease	Diagnosed Participates	Might face diet restriction due to illness (special diets) (Simpson and Doig, 2010)
Use of supplementation	Not consuming supplement	Currently consuming supplements	Supplement can interfere with daily intake (Babbs, 2014, Weaver and Miller, 2017)
Use of medication	Not under medication	Currently undergoing medication for NCD	Diet can interfere with medication procedure (Martínez-Mesa et al., 2016, Garg, 2016, Cohen et al., 2015)
Migration status	Permanently resident	Visitors, temporary stay	Participants living 8 or more years in the UK. Cut off due to the time-related lifestyles and adjustment to the culture of the UK (Trost et al., 2018, Sarkar et al., 2013)
Language	Must have achieve B1 level English	Not able to speak in English	To acquire English Citizenship must pass a Secure English Language Test (SELT) in at least CEFR level B1.

3.4 Study procedure

An online survey was created to facilitate the receptiveness of the participants. (https://www.surveymonkey.com/r/D92VJ3N) The survey was created by following the instruction provided in the online tool for the creation of survey. The participant's information sheet, agreement form and inclusion/exclusion criteria were given. A "I agree" handle was added in order to receive consent.

Various data were collected from each participants, for example:

- Physical measurements (Anthropometry)
- Dietary intake data (repeated 24-hour recall)
- Socio-demographic information's
- Self-reported physical activity measurements (GPAQ Questionnaire)

3.4.1 Sociodemographic data collection

In order to detect and examine differences among the Participants (n=137) it is important to collect socio-demographic data (Kirst et al., 2013).

Key information collected:

1- Date of birth
2- Marital status
3- Highest level of education

Using the 24-hour dietary recall and a form attached information about the age, marital status, and highest level of education were collected. Information regarding the family (spouse and children) was not included into the research.

3.3.2 Anthropometric data collection

To carry out further detailed analysis and understand the risk of nutrition related non-communicable diseases in British Bangladeshis living in the United Kingdom, participants were asked to provide anthropometric measurements such as weight and height. This data was collected to calculate and compute the BMI, Body mass index is a ratio that estimates a person's weight (kg) by height (m) squared.

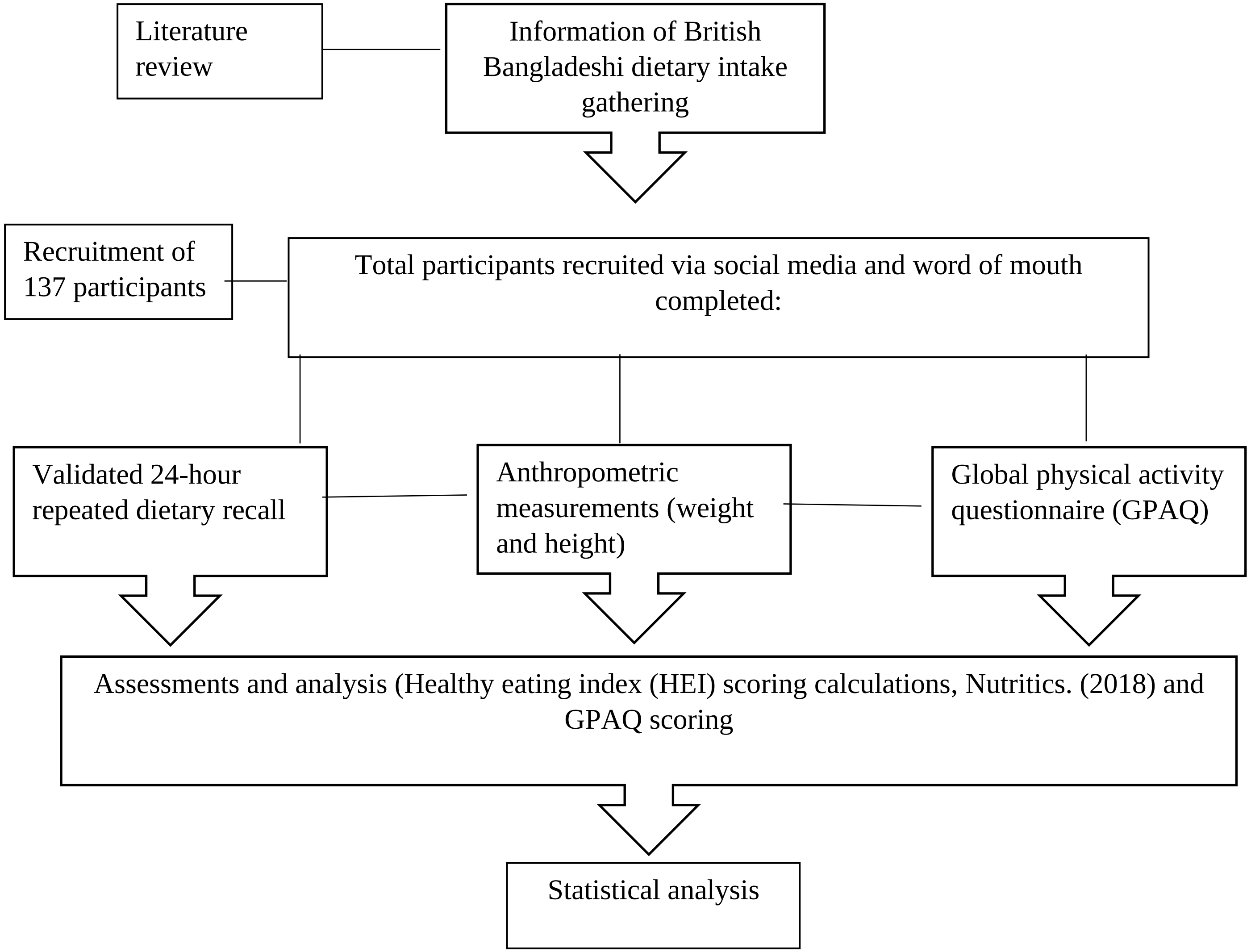


Figure 3.1: Schematic diagram of the phases involved in the main study

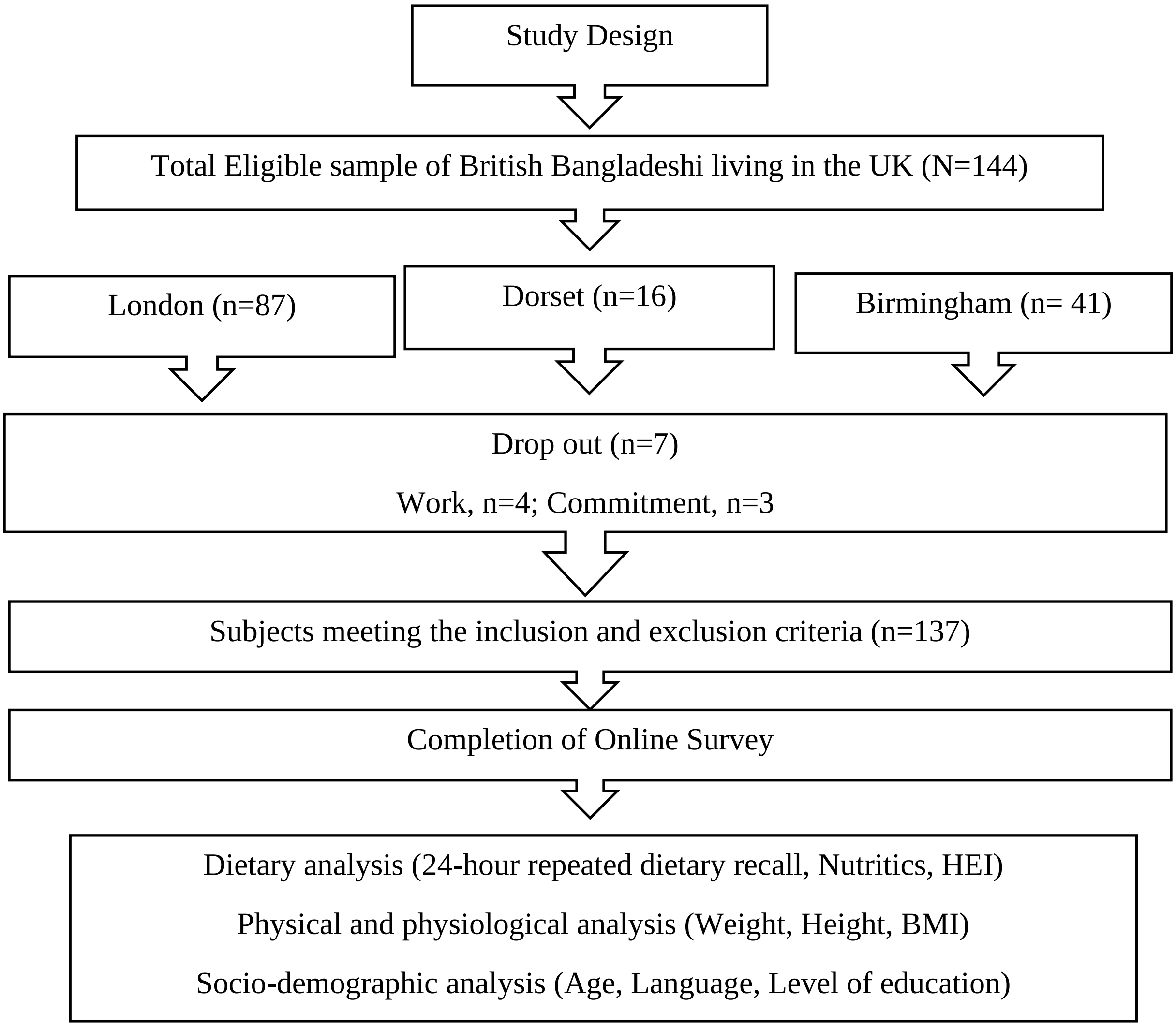


Figure 3.2: Schematic diagram for study design and recruitment stages

3.5 Data Collection

3.5.1 Assessment of Food intake, 24-hour repeated Dietary Recall

Participants were requested to provide detailed information about all food and beverages (also dietary supplements) consumed by the respondent in the past 24 hours (Johnson RK et al.,1996). A recall assessment requires 20 to 30 minutes to complete, but it may take considerably longer if many different foods were consumed. A portion size guide was also given to each participant interested and eligible in the study. This standardized and validated method was previously used in numerous studies among British Bangladeshi population to collect data on their dietary intake (Bromage and Mostofa, 2017; Karageorgou et al., 2018; Mohammadifard et al.,2015).

This section of the methodology can allow us to understand the eating habits, meal preparation procedure and food choice of the Participants. The 24-hour repeated dietary recall survey (Table 14) was collected in English language. Instructions to complete the survey was also provided. Each survey was provided with an ID number; this prevent to disclosure of their identity.

Key information collected:

1- The amount of food consumed
2- Was sugar and salt added to the food
3- What time of food was consumed?
4- Method of cooking

Participants were asked to complete a validated repeated 24 hours dietary recalls for three (3) days (two working days and one weekend day). This was allowing understanding the variation in intake over a period of time, analysing any repeatability and increasing accuracy in data analysis. Data collected was analysed using Nutritics. (2018) Research Edition (v5.02) R statistical software. This software is able to identify the energy in food and drinks and estimate the various type of nutritional components such as energy, protein, monosaccharides and cholesterol.

3.5.2 Physical activity assessment using Global physical activity questionnaire (GPAQ)

To calculate the level of physical activity performed by the participants an indirect measurement procedure was selected. The Global physical activity questionnaire (GPAQ) was developed by the World Health Organization (WHO) in 2002 to detect the tendencies of physical activity over a specific time space. This tool was validated by F. Bull and colleagues to gather information regarding individual's physical activity level to permit regional and global scale comparison (Bull et al., 2009). One of the domains of physical activity in the GPAQ survey includes: transportations (from and to) recreational activity and occupational activity. The questionnaire was formed by 16 questions considering these three sections (Appendices 9, Table 18). Participants were asked 16 questions from the GPAQ, information's were collected and examined to identify the daily energy cost of an individual's physical activity and exercise in kcal/day. Data provided were divided into three main groups: high, moderate and low. Where activity, exercise and in-activity were respectively given a code; For example, activity in the workplace have been coded as P1-P6, travelling activity from one place another have been coded as P7-P9 and leisure time or recreational activities have been coded as P10-P15.

The total amount of exercise was calculated using MET (Metabolic Equivalents) to indicate the intensity or effort given during an activity. One MET is equivalent to the caloric consumption of 1kcal/kg per hour. Each code will be computed using Epi Info™ software tool. The final data was represented based on scores. Participants scoring between 1.0 and 1.39

points have been categorized as sedentary, scores between 1.4 and 1.59 have been categorized as low active, scores between 1.6 and 1.89 have been categorized as active and participants scoring above 1.9 have been categorized as very active.

3.5.3 Healthy Eating Index Score (HEI-Score) calculation from dietary data

The Healthy Eating Index was used to determine the diet quality of participants. The standard of nutritional intakes was articulated per 1,000 calories. Each component provided scoring points that adds up to 100.

Primarily the total calories consumed was divided by 1000; the value achieved was known as the “calorie factor” this figure was crucial for the continuation of the scoring procedure. Scores based on the HEI are present in the *Appendices 3, Table 13*. The total intake of each category was divided by the calorie factor value; This was based on the number of cups consumed equivalent per 1000 calories. This diet quality index has been previously validated and researched among South Asians including Bangladeshi men living in the UK (Jackson and Momen, 2016; Buyuktuncer et al.,2018).

The scores of each nutritional category has been calculated as following:

Participants consuming more than 0.4 cups equivalent per 1000 calories of total fruits (juices excluded) 5 scoring points was given. If the results showed that participants consumed more than 0.8 cup equivalent per 1000 calories of 5 total fruits (including juices) scoring points was provided. The participants consuming ≥1.1 cups equivalent of total vegetables (including legumes) were provided with 5 points. The participants consuming ≥0.2 cups of greens and beans (excluding legumes) were given 5 points. Participants consuming more or equivalent of 1.5 oz cups per 1,000 calories of grains were provided with 10 points. Participants that have consumed more or equivalent of ≥1.3 oz cups per 1000 calories of dairy including all milk products such as cheese and fortified soy drinks were given 10 points. Participants intaking above or equivalent of 2.5 oz cups per 1000 calories of protein were given 5 points. Participants consuming above or equivalent of ≥0.8 oz equivalents per 1000 calories of Seafood & Plant Proteins were provided with 5 points. Participants consuming ≥2.5 of fatty acids were provided with 10 points and participants consuming than ≤1.2 equivalent per 1000 calories did not receive any points. Participants consuming ≤1.8 oz cups equivalents 1000 calorie of Refined Grains were given 10 points. Participants consuming ≤1.1 gram of sodium received 10 points; those intaking ≥2.0 grams were given 0 points. Participants consuming ≤8% of saturated fat (based on total energy) were given 10 points; those who consumed more than ≥16% of total energy were not provided with points. Participants consuming ≤6.5% of added sugar (based on total energy) were given 10 points; no points were provided if the intake was above 26% of the total energy.

As mentioned forehand each nutrient group has specific scores that sum up to the maximum value of 100; a score equivalent to 80 or higher represent healthy eating and high diet quality, a score between 50 to 80 represent a moderate diet quality that requires improvements and a score below 50 represent a low diet quality and requires immediate action to improve the scenario (Folsom and Nagraj, 2017; Schwingshackl and Hoffmann, 2015; Guo et al., 2004).

3.6 Sampling, Sample Size and subject recruitment

To complete the study, apparently healthy British Bangladeshi were recruited (aged 18-60) who met the criteria beforehand mentioned.

Sample size was calculated based on the use of the following provisions: a statistical power of 90 per cent ($1 - \beta = 0.9$) was sought with a medium effect size $\rho = 0.30$ and Type I error ($\alpha = 0.05$) with no centrality parameter δ of 3.28; using a point bi-serial model to allow for t-tests and correlation (two-tailed).

The sample size computed = 109 (Cohen, 1988). Allowing for recruitment and retention difficulties for ethnic minorities previously reported (Samsudeen & Bhopal, 2011) and assuming an attrition rate of 25 per cent, based on experience from our pilot study, the total sample size calculated was n = 136.3. A total of 137 subjects were therefore recruited to participate in the study (Sarkar et al., 2017).

Calculation method:

Point biserial: a Priori: Samples size calculation

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

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

The statistical difference is identical test for a difference in means $\mu 1$ the independent group. The alternative hypothesis is that the correlation coefficient has non-zero value r.

3.7 Analysis of nutritional data using Nutritics (2018) Research Edition (v5.02)

Nutritional information was collected from the 24-hour dietary recall and was be examined using Nutritics (2018) Research Edition (v5.02). This is web-based software can be accessed using any type of web browser with a stable internet connection. This software analyses portion sizes, type of food and method of cooking to examine each nutrient and offer detailed information regarding the daily intake.

Participants nutritional intake was encrypted with high level security known as 256-bit SSL; data was only visible to the researcher.

The Dietary Reference Values (DRV) used by the United Kingdom Department of Health and the European Union's European Food Safety Authority is available in Nutritics to analyse adequate recommendations and intake. A new feature added to Nutrtitics is Libro, this is a smartphone application to input data for the participants.

3.8 Ethical Consideration

This study was granted ethical approval by Bournemouth University's Research Ethics Committee in association with Bournemouth University's Research Ethics Code of Practice. All participants provided informed consent prior to data collection.

Informing the participant about the procedures and aim of the study is an ethical and legal requirement for projects involving human participants. The Participants Agreement Form (PAF) is a type of voluntary agreement between the researcher and the participant. Acquiring the consent from the subject involves providing information regarding their role in the study, their rights, purpose and method of the study and any possible risk or hazards. The Nuremberg Code and the Belmont Report have indicated that obtaining a written or verbal consent is necessary to administer a project involving human participant. The Nuremberg Code concluded that a consent is not only essential for safety and risks but also the crucial for the integrity of the project and respect the participant choice.

This procedure is fundamental to provide the participant individual autonomousness, also known as the action or liberty of an individual to take their own decision. The ethics process was completed following the instruction provided by the Bournemouth University Research Ethics Code of Practice: Policy and Procedure approved by the University Research Ethics Committee.

The Participants Agreement Form (PAF) and Participants Information Sheet (PIS) provided during this project included vital and valuable information including: the purpose of the study and the beneficial aspect of the project for the society, the duration of the study, confidentiality and rights to withdraw any time without any consequences. Each participant had the opportunity to ask questions and emails of both the researcher and supervisors were provided if further enquiries are needed. The language used for both participants forms was English.

A gate keeper was not be necessary in this project because the invitation has been presented to the British Bangladeshi community and to join voluntarily without pressurising or compelling. The role of Gatekeepers in a research is to allow or deny participants the access to the researcher or research (Holloway and Wheeler, 2002). Volunteer filled the survey presenting the type of food consumed and the time of consumption, no personal information will be present on it. An online survey link has been provided for subject willing to participate on a web platform (Polit et al, 2001).

3.9 Statistical Analysis

Data collected were computed using the Statistical Package for the Social Sciences (SPSS) latest Version 26 and Microsoft Excel software were used for further and in-depth analysis. Specific type of statistical analyses was performed.

A normality test was completed to differentiate between parametric and non-parametric data and statistical test were performed. Statistical analysis such as, independent sample t-test for normally distributed data was performed to report significant differences between male and female. Linear regression was used to determine the association between PAL and HEI and calculate the correlation between these two components. The calculation of 95% Confidence Interval was computed alongside with the comparison of the mean using Z-test, were measured to be statistically significant value of $p \leq 0.05$. Male and Female nutritional data mean intake was also calculated separately due to the difference in Nutritional recommendations.

Chapter Four: Results

4.0 Results

This chapter of the research includes detailed information regarding the findings of the project. This includes socio-demographic data were presented as means (±SD), anthropometrics results means (±SD) , nutritional intake means (±SD) with 95% CI and p-values were reported were significance were below 0.05 between and among the group, physical activity level reported as means (±SD) and compared with low, moderate and vigorous PAL and healthy eating index score were reported as score. These analyses were completed to collect data and complete the objectives of the research and calculate any association between the PAL score and HEI points; to achieve the aim.

4.1 Reported Sociodemographic and Anthropometrics results

The mean (SD) age was 29 (±10.61) years old for this study population, most participants were young between 18 to 20 years of age. The mean age for male and females was 34 (±15.38) and 28 (9.38) years of age respectively. Participants age distribution has been represented in *Table 4.1* (Appendices 1).

Participants were also required to provide anthropometrics measurements. Data collected includes: weight and height to calculate the Body Mass Index (BMI). The BMI mean (SD) for this research group was 25.51 (±4.59). The mean BMI for male and female was 24.82 (±2.35) and 25.64 (±3.27) respectively. It is possible to observe that only 16% of male falls into the normal BMI range, 41% into the overweight cut offs and a vast majority of 43% of male falls into the obese category. Simultaneously, only 21% of female had a normal BMI range, 32% of female into the overweight cut offs and 47% into the obese category.

Table 4.2: Demographic data for male and female of British Bangladeshi Living in the United Kingdom (n=137)

Area of origin	London (n=80) Dorset (n=16) Birmingham (n= 41)	
Education Level	Basic education (School and College) = n 66 Higher education (University) = n 71	
Marital status	Married= n 77 Not married = 60	
Habits	Smoke = 0 Alcohol consumer = 0	
	Male (SD)	Female (SD)
Age (Years)	34 (±15.38)	28.5 (±9.38)
Height (Meters)	1.66 (±0.07)	1.59 (±0.05)
Weight (Kg)	68.09 (±7.55)	64.94 (±8.08)
BMI (Kg/m^2)	24.82 (±2.35)	25.64 (±3.27)

4.2 Reported Healthy eating index (HEI) results

Nutritional data collected from the 24-hour dietary recall were analysed and scored using the Healthy eating index. The component taken in consideration in the HEI 2015 are: whole fruits, total fruit (juice included), total vegetables (include legumes), greens and beans (no legumes), whole grains, dairy, total protein foods, seafood and plant protein, fatty acids, refined grains, sodium, added sugar, saturated fat.

Table 4.3: Healthy Eating Index overall scores

	Population (n=137)	*Male (n=22)*	*Female (n=115)*
Mean (SD)	37.69 (±13.41)	38.31 (±8.34)	37.57 (±7.33)
95%CI	2.27	3.70	1.35
95% Upper CI	39.96	42.01	38.93

95% Lower CI	11.15	34.61	36.22
p value of the differences	0.160		
Cut-offs	<50 (low diet quality)	<50 (low diet quality)	<50 (low diet quality)

The mean (SD) score for this research group was 37.69 (±13.41). The average score for male and female was 38.31 (±8.34) and 37.57 (±7.33) respectively with a p value of (0.160) is suggestive of no significance differences between male and female participants. A score of 80 or higher describes healthy eating and high diet quality, a score between 50 to 80 describes a moderate diet quality and a score below 50 represent a low diet quality. Based on these results it is possible to deduce the low diet quality among British Bangladeshis. This research population has been identified in the low diet quality HEI cut-off.

Table 4.4: Scores of Healthy Eating Index components of British Bangladeshi population

Healthy Eating Index component	*Maximum points*	*Minimum points*	*Population scores*	*Male population points*	*Female population points*
Whole Fruits	5	0	3.82	3.64	3.99
Total fruits	5	0	3.97	3.70	4.23
Total vegetables	5	0	4.29	4.36	4.21
Greens and beans	5	0	4.19	4.11	4.26
Whole grain	10	0	0.65	0.59	0.70
Dairy	10	0	6.92	7.59	6.24
Sea Food	5	0	1.37	1.25	1.49
Refined Grains	10	0	0.93	1.05	0.80
Total Protein	5	0	3.95	3.67	4.22
Sodium	10	0	1.32	1.18	1.45
Added Sugar	10	0	1.39	1.82	0.96
Saturated fat	10	0	0.19	0	0.37
Fat	10	0	6.49	6.27	6.70

The score for Whole Fruits (no juice) for this study population was 3.82 points. The score for total fruits (including juice) for this research population was 3.97 points. The score for Total vegetables (including legumes) for this study population was 4.29 points. The score for green and beans (not including legumes) for this research population was 4.19 points. The score for whole grains for this study population was 0.65 points. Compared to the maximum score obtainable of 10 points. The score for dairy for this research was 6.92 points. The score for Sea food for this research population was 1.37 points. Compared to the maximum score obtainable of 10 points. The score for Refined grains for this population was 0.93 points. Compared to the maximum score obtainable of 10 points. The score for total Protein for this research population was 3.67 points. The score for Sodium for this research population was 1.32 points. Compared to the maximum score obtainable of 10 points. The score for added Sugar for this population was 1.39 points. Compared to the maximum score of 10 points. The score for Saturated fat for this research population was 0.19 points. Compared to the maximum score of 10 points. The score for Fat for this research population was 6.49 points. Detailed scoring of male and female have been displayed in *Table 4.4*.

The HEI scoring suggested that overall diet quality of British Bangladeshi male and female is low. This statement has been affirmed by observing the low points acquired in each HEI category. Highest points obtained by males was 7.59 in the Dairy category and the lowest points obtained was 0 in the fat category. Based on female intake, the highest points achieved was 6.70 in the fat category and the lowest point achieved was 0.37 in the fat category. By this scoring technique it is possible to observe the high intake of protein, fat, refined grains and sugar. A low intake was been observed among fruits and vegetables categories.

4.3 Reported Global Physical Activity Questionnaire (GPAQ) results

The total amount of exercise was calculated using MET (Metabolic Equivalents) one MET is equivalent to the caloric consumption of 1kcal/kg per hour.

Participants scoring between 1.0 and 1.39 have been categorized as sedentary, scores between 1.4 and 1.59 have been categorized as low active, scores between 1.6 and 1.89 have been categorized as active and participants scoring above 1.9 have been categorized as very active (Armstrong and Bull, 2006; Hoos et al., 2012).

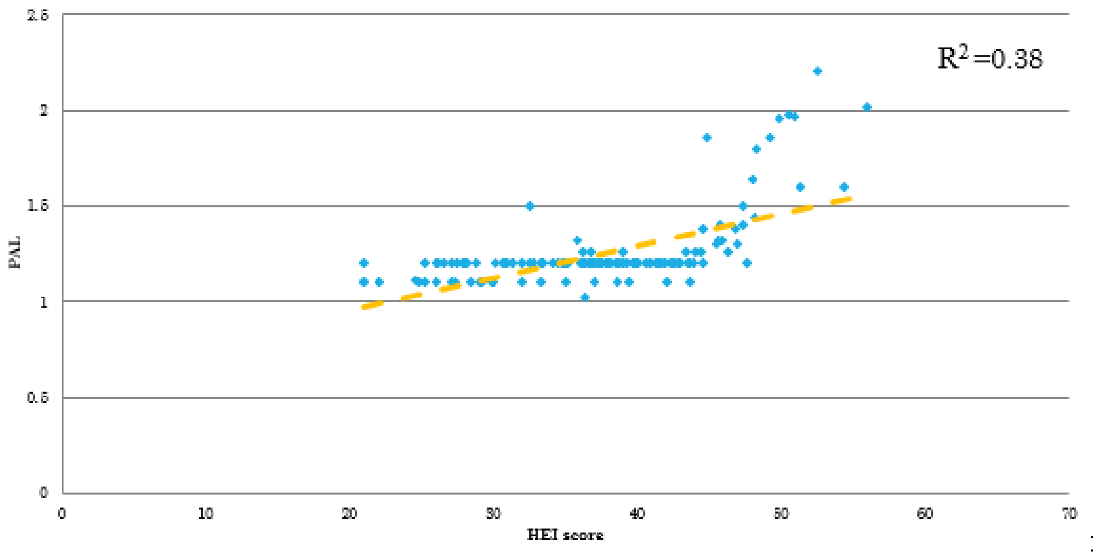
The mean (SD) intake for Physical activity is 1.25PAL (±0.04) for the study population. The average intake for men was 1.32PAL (±0.21) and 1.24PAL (±0.11) for females respectively. There is no significant difference between male and female PAL score (p value of 0.935).

Table 4.5: Reported Physical Activity Level Scores

Physical Activity Level	Population points	Male population points	Female population points
Mean (SD)	1.25 (±0.04)	1.32 (±0.21)	1.24 (±0.11)
95%CI	0.01	0.09	0.02
95% Upper CI	1.26	1.42	1.26
95% Lower CI	0.03	1.23	1.22
p value of the differences/ p value	0.935		

Results from statistical analysis have suggested that low HEI scores are positively associated with low PAL scores. This have been also proven with a positive association between these two variables, with a value of 0.38 R^2

Figure 3.3: Graph representing association between HEI and PAL scores



4.4 Reported macronutrients Intake

The comprehensive discussion of this chapter regarding macronutrients, are present in *Chapter five*, including the main findings and investigating association between diet quality, physical activity, socio-demographic variables and non-communicable diseases. The daily average macronutrient and energy intake among British Bangladeshi population can be found in *Table 4.6, 4.7* and *4.8* of this chapter. The assessment of both male and female nutritional intake has been examined due to the difference in recommended nutritional guidelines (Leblanc et al., 2015; SACN 2016).

4.4.1 Reported Carbohydrates Intake

The optimal amount of carbohydrates consumption based on Government Dietary Recommendations is >333g/day for men and >267g/day for women (SACN 2016; Public

Health England 2016; Levy and Tedstone, 2017). The actual mean (±SD) intake of carbohydrate was 262.54g per day (±41.73) for both male and female. Average intake for male was 282.05g/day (±43.50) and female 258.80g/day (±60.30) respectively. This is suggestive of %RNI values of 85.49 for the male research group and 88.37 for female research group respectively. There was no significant difference between the male and female population intake (p value 0.076).

4.4.1.1 Reported added Sugar, Salt and Fibre Intake

Nutritional Recommendations of added sugar consumption is 33g/day for men and 27g/day for women (SACN 2016; Public Health England 2016). The mean intake for this population was 32.03g/day (±8.02). Intake for male was 33.03g/day (±15.19) and 31.84g/day (±11.40) for female respectively. There was no significant difference between the male and female population intake of added sugar (p value 0.292). Dietary Recommendations suggest a daily intake of 30g/day fibre for both male and female (SACN 2016; Public Health England 2016). The average intake for this research population was 20.80g/day (±2.10). Male intake was 20.43g/day (±5.60) and 20.87g/day (±5.89) for female respectively. There was no significant difference between the male and female population intake of fibre (p value 0.882). Nutritional Recommendations salt suggest a daily intake of 6g/day for both male and female (SACN 2016; Public Health England 2016). The mean intake for this research population was 5.86g/day (±0.12). Mean intake for men and women was 6.41g/day (±1.92) and 5.75g/day (±1.42) respectively. There was no significant difference between the male and female population intake of salt (p value 0.120).

4.4.2 Reported Protein Intake

The optimal amount of protein to consume for a healthy living is 55g for males and 45g for females daily (SACN 2016; Public Health England 2016; Levy and Tedstone, 2017).

The mean (SD) protein intake in this research group was 100.98g/day (±16.65). Average daily intake for male was 104.95g/day (±19.46) and 100.23g/day (±20.98) for female respectively. There was a borderline conventional significance (p=0.056) between male and female intake of protein.

4.4.3 Reported fat Intake

The optimal amount of fat to consume for a healthy living is >97g/day for men and >78g/day for women (SACN 2016; Public Health England 2016).

The actual mean (SD) intake of fat was 93.95g/day (±31.98). Daily average intake for male was 95.49g/day (±21.62) and 93.66g/day (±22.12) for female respectively. Statistically, there is no significant difference between the intake of male and female population (p value 0.778). The intake of fat has been divided into MUFA, PUFA and saturated fatty acids (SFA). The recommendations for these nutrients are: SFA recommended intake is >31g/day for men and >24g/day. PUFA recommended intake is 18g/day for men, 24g/day for women. MUFA recommended intake is 36g/day for men and 29g/day for women (SACN 2016; Public Health England 2016). The average SFA intake in this research group was 28.20g/day (±14.30).

Daily SFA intake for male was 30.34g/day (±7.62) and 27.79/day (±8.89) for female respectively. There was no significant difference between the male and female population intake (p value 0.691). The mean (SD) PUFA intake for this population was 16.70g/day (±16.70). Intake for male was 17.37g/day (±6.76) and 16.58g/day (±4.47) for female respectively. There was no significant difference between the male and female population intake of PUFA (p value 0.493). The average MUFA intake in this research group was

34.84g/day (±14.51). Average for male was 36.63g/day (±11.19) and 34.50g/day (±8.81) for female respectively. Statistically, there was no significant difference between the male and female population intake (p value0.996).

4.4.3.1 Reported Cholesterol intake

Dietary guidelines based on cholesterol suggest an optimal intake of 300mg for both men and women (SACN 2016; Public Health England 2016). Reported mean (SD) intake of cholesterol was 345.61mg/day (±52.66) for this research group. Mean (SD) intake for men and women was 386.96 mg/day (±135.88) and 337.70 mg/day (±119.48) respectively. Based on statistical analysis, there is a strong correlation between total fat intake **and total PAL** NO with cholesterol (p value of 0.001). There was no significant difference between the male and female population intake (p value 0.361).

4.4.4 Reported Energy intake (EI) Intake

The recommended amount of energy intake (EI) in the UK is 2500 (kcal/day) for men and 2000 (kcal/day) for women (SACN 2016; Public Health England 2016). Average (SD) intake for this research group was 2264.37kcal/day (±218.47). Mean value for male suggested an intake of 2407.21g/day (±364.69) and 2237.04g/day (±376.40) for female respectively. Statistically, there was no significant difference between the male and female population energy intake (p value 0.202).

Table 4.6: Daily average macronutrient and energy intake among British Bangladeshi population (n=137) RNI/EAR from SACN Dietary Reference Values for Energy (2011).

	Energy (Kcal)	*Protein g*	*CHOg*	*FATg*	*SFAg*	*MUFAg*	*PUFAg*	*Chol g*	*Added Sugar g*	*Fibre g*	*Salt g*
RNI/EAR	2500	55	333	97	31	36g	18g	0.3	33	30	6
Mean (SD)	2264.37 (±218.47)	100.98 (±16.65)	262.54 (±41.73)	93.95 (±31.98)	28.20 (±14.30)	34.84 (±14.51)	16.70 (±5.97)	0.35 (±0.53)	32.03 (±8.02)	20.80 (±2.10)	5.86 (±0.12)
95%CI	36.91	2.81	7.05	5.40	2.42	2.45	1.01	0.008	1.36	0.35	0.02
95% Upper CI	2301.28	103.80	269.59	99.36	30.62	37.30	17.71	0.35	33.38	21.16	5.88
95% Lower CI	1810.56	13.84	34.68	26.58	11.88	12.06	4.96	0.04	6.67	1.74	0.10
p value of the differences	0.202	0.056	0.076	0.778	0.691	0.996	0.493	0.361	0.292	0.882	0.120

Table 4.7: Daily average macronutrient and energy intake among British Bangladeshi female (n=115)
RNI/EAR from SACN Dietary Reference Values for Energy (2011).

	Energy (Kcal)	*Protein g*	*CHOg*	*FATg*	*SFAg*	*MUFAg*	*PUFAg*	*Chol g*	*Added Sugar g*	*Fibre g*	*Salt g*
RNI/EAR	2000	45	267	78	24	29	14	0.3	27	30	6
Mean (SD)	2237.04 (±376.40)	100.23 (±20.98)	258.80 (±60.30)	93.66 (±22.12)	27.79 (±8.89)	34.50 (±8.81)	16.58 (±4.47)	0.34 (±0.12)	31.84 (±11.40)	20.87 (±5.89)	5.75 (±1.42)
95%CI	69.53	3.88	11.14	4.09	1.64	1.63	0.83	0.02	2.11	1.09	0.26
95% Upper CI	2306.58	104.10	269.94	97.75	29.44	36.13	17.40	0.36	33.94	21.96	6.02
95% Lower CI	2167.51	96.35	247.66	89.57	26.15	32.87	15.75	0.32	29.73	19.79	5.49

Table 4.8: Daily average macronutrient and energy intake among British Bangladeshi male (n=22)
RNI/EAR from SACN Dietary Reference Values for Energy (2011).

	Energy (Kcal)	*Protein (g)*	*CHO(g)*	*FATg*	*SFAg*	*MUFAg*	*PUFAg*	*Chol g*	*Added Sugar g*	*Fibre g*	*Salt g*
RNI/EAR	2500	55	333	97	31	36	18	0.3	33	30	6
Mean (SD)	2407.21 (±364.69)	104.95 (±19.46)	282.05 (±43.50)	95.49 (±21.62)	30.34 (±7.62)	36.63 (±11.19)	17.37 (±6.67)	0.39 (±0.13)	33.03 (±15.19)	20.43 (±5.65)	6.41 (±1.92)
95%CI	161.70	8.63	19.29	9.58	3.38	4.96	3.00	0.06	6.74	2.48	0.85
95% Upper CI	2568.91	113.58	301.33	105.07	33.71	41.59	20.37	0.447	39.76	22.91	7.26
95% Lower CI	2245.52	96.32	262.76	85.90	26.96	31.67	14.37	0.327	26.29	17.94	5.56

4.5 Reported Micronutrient Intake

Results presented in this section of the study, include vitamin and mineral intake of British Bangladeshi. Data have been analysed and computed using Nutritics (2018) Research Edition (v5.02) software. The complete discussion of this chapter regarding micronutrients, are present in Chapter Five, including the main findings and investigating association between diet quality, physical activity, socio-demographic variables and non-communicable diseases. Daily average micronutrients intake among British Bangladeshi population is present in *Table 4.9* and *Table 4.10* of this chapter.

4.5.1 Reported Mineral Intake

Dietary Recommendation for sodium is 2400mg/day for both men and women (SACN 2016; Public Health England 2016). The average intake for this research study was 2344.07mg/day (±46.62). Mean intake for men was 2564.81mg/day (±766.48) and 2301.84mg/day (±568.54) for female respectively. There was no significant difference between the male and female sodium intake (p value 0.119).

The mean (SD) intake for phosphorus was 1368.93 (±353.09). Average intake for men was 1410.89mg/day (±296.37) and 1360.90mg/day (±256.42) for female respectively. Dietary recommendations suggest an intake of 550mg/day (SACN 2016; Public Health England 2016). There was no significant difference between the male and female population intake (p value 0.265).

The mean (SD) intake for copper was 1.69mg/day (±0.39). Average intake for men was 1.57mg/day (±0.36) and 1.71mg/day (±0.39) for female respectively. Dietary recommendations suggest an intake of 1.2mg/day for both male and female (SACN 2016; Public Health England 2016). Statistically, there was no significant difference between the male and female intake of copper (p value 0.894).

The mean (SD) intake for zinc was 12.04mg/day (±4.61). Average intake for men was 11.05mg/day (±2.54) and 12.23mg/day (±2.96) for female respectively. Dietary guidelines suggest an intake of 9.5mg/day for both male and females (SACN 2016; Public Health England 2016). There was no significant difference between the male and female population intake (p value 0.313).

The mean (SD) intake for chloride was 3554.82mg/day (±106.41). Average intake for men was 3581.79mg/day (±1124.51) and 3549.66 (±877.03) for female respectively. Dietary guidelines suggest an intake of 2500mg/day for both male and females (SACN 2016; Public Health England 2016). Male and female intake was not statistically significant (p value 0.342).

The mean (SD) intake for selenium was 56.78ug/day (±10.15). Average intake for men was 63.89ug/day (±36.82) and 55.42ug/day (±12.91) for female respectively. Dietary guidelines suggest an intake of 75ug/day for both male and females (SACN 2016; Public Health England 2016). There was a statistically significant difference between the male and female population intake (p value 0.021).

The mean (SD) intake for iodine was 142.37ug/day (±47.13). Average intake for men was 127.69ug/day (±52.72) and 145.18ug/day (±81.51) for female respectively. Dietary guidelines suggest an intake of 140ug/day for both male and females (SACN 2016; Public Health England 2016). There was no significant difference between the male and female population intake (p value 0.843).

The mean (SD) intake for potassium was 2656.92mg/day (±680.15). Average intake for men was 2986.81mg/day (±593.88) and 2593.81 (±709.36) for female respectively. Dietary guidelines suggest an intake of 3500mg/day for both male and females (SACN 2016; Public Health England 2016). Male and female intake did not have a significant difference (p value 0.309).

The mean (SD) intake for calcium was 669.72mg/day (±356.08). Average intake for men was 728.60mg/day (±191.69) and 658.45mg/day (±154.36) for female respectively. Dietary guidelines suggest an intake of 700mg/day for both male and females (SACN 2016; Public Health England 2016). There was no significant difference between the male and female population intake (p value 0.835).

The mean (SD) intake for magnesium was 324.06mg/day (±7.74) for the entire population. The mean intake for men was 315.56mg/day (±61.18) and 325.69mg/day (±75.93) for female respectively. Dietary guidelines suggest an intake of 270mg/day for both male and female for healthy living (SACN 2016; Public Health England 2016). Significant difference between male and female intake was not observed (p value 0.312).

Dietary guidelines suggest an intake of 8.7mg/day for men and 14.8mg/day of iron (SACN 2016; Public Health England 2016). The mean (SD) intake for the population was 13.33mg/day (±0.70). Average intake for men was 15.16mg/day (±3.44) and 12.98mg/day (±2.75) for women respectively (SACN 2016; Public Health England 2016). There was a statistically difference between male and female iron intake (p value 0.049).

4.5.2 Reported Vitamin Intake of British Bangladeshi Living in the United Kingdom

Dietary Recommendations for Vitamin A is 700ug/day for male and 600ug/day for females. The mean (SD) intake for the population was 692.88ug/day (±105.08). The mean intake for men was 713.96ug/day (±287.73) and 688.85ug/day (±287.36) for women respectively (SACN 2016; Public Health England 2016). There was no significant difference between the male and female population intake (p value 0.565).

The mean (SD) intake for Vitamin D was 2.78ug/day (±0.44) for the population. The average intake for men was 3.96ug/day (±3.09) and 2.56ug/day (±1.31) for women respectively. Dietary Recommendations for Vitamin D is 10ug/day for male and female (SACN 2016; Public Health England 2016). Statistically, there was no significant difference observed between the male and female population intake (p value 0.104).

Dietary Recommendations for Vitamin E is 15mg/day for both male and females (SACN 2016; Public Health England 2016). The mean (SD) intake for the population was 10.24mg/day (±4.04). The average intake for men was 11.15mg/day (±3.57) and 10.07mg/day (±3.26) for women respectively. There was no significant difference between the male and female population intake (p value 0.596).

The mean (SD) intake for Vitamin K (Phylloquinone) is 17.61ug/day (±2.64) for both male and female in this research population. The average intake for men was 16.19ug/day (±22.43) and 17.88ug/day (±15.52) for women respectively. Dietary Recommendations for Vitamin K is 25ug/day for both men and women (SACN 2016; Public Health England 2016). Significant difference between male and female intake was not observed (p value 0.637).

The mean (SD) intake for Vitamin B6 (Pyridoxine) was 1.83mg/day (±0.35) for the subjects in this research. The average intake for men was 2.13mg/day (±0.64) and 1.78mg/day (±0.49) for women respectively. Dietary Recommendations for Vitamin B6 is 1.4mg/day for male and

1.2mg/day for females (SACN 2016; Public Health England 2016). There was a borderline conventional significance (p=0.062) between male and female intake of Vitamin B6.

Dietary Recommendations for Vitamin Thiamine (B1) is 1mg/day for male and 0.8mg/day for females (SACN 2016; Public Health England 2016). The mean (SD) intake for the population was 1.52mg/day (±0.09). The average intake for men was 1.48mg/day (±0.36) and 1.52mg/day (±0.43) for women respectively. There was no observed significant difference between male and female population intake (p value 0.142).

The mean (SD) intake for Riboflavin (B2) was 1.32mg/day (±0.10) (SACN 2016; Public Health England 2016). The average intake for men was 1.55mg/day (±0.54) and 1.28mg/day (±0.32) for women respectively. Dietary Recommendations for Vitamin B2 is 1.3mg/day for male and 1.1mg/day for females respectively. There was no significant difference between male and female intake (p value 0.217). Dietary Recommendations for Folates (B9) is 200ug/day for both male and females (SACN 2016; Public Health England 2016). The mean (SD) intake for the population was 214.09ug/day (±26.61). The average intake for men was 251.39ug/day (±77.21) and 206.95ug/day (±55.50) for females respectively. There was a statistically difference between male and female intake (p value 0.49). Dietary Recommendations for Vitamin B12 (Cobalamin) is 1.5ug/day for both male and females (SACN 2016; Public Health England 2016). The mean (SD) intake for the population was 5.00ug/day (±0.41) for the population study. The average intake for men was 5.61ug/day (±2.82) and 4.88ug/day (±2.20) for females respectively (SACN 2016; Public Health England 2016). There was no observed significant difference between male and female intake (p value 0.858).

The mean (SD) intake for Vitamin C was 64.16mg/day (±14.95) for the study population. The average intake for men was 55.38mg/day (±42.17) and 65.84mg/day (±33.90) for females respectively. Dietary Recommendations for Vitamin C is 40mg/day for both males and females

(SACN 2016; Public Health England 2016). There was no significant difference between male and female intake (p value 0.668).

The mean (SD) intake for Omega 6 is 4.66g/day (±7.18) for the study population. Dietary Recommendations for Omega 6 is 10g per day for both males and females (SACN 2016; Public Health England 2016). Dietary Recommendations for Omega 3 is 2g per day for both males and females (SACN 2016; Public Health England 2016). The mean (SD) intake for Omega 3 is 0.97g/day for this study population. Dietary recommendation for omega 3 alpha-linolenic acid (ALA) is 2.00g/day for female and 1.60g/day for male (SACN 2016; Public Health England 2016). The mean intake for male was 0.35g/day (±0.25) and 0.37g/day (±0.35) for females respectively. The mean (SD) intake for omega 3 eicosapentaenoic acid (EPA) for this study population was 0.03g/day (±0.02). Recommended dietary intake suggests a minimum intake of 0.25g/day for both male and female (SACN 2016; Public Health England 2016). The mean (SD) for docosahexaenoic acid (DHA) for this study population was 0.04g/day (±0.01). Nutritional recommendations suggest a minimum intake of 0.2gday for both male and female (SACN 2016; Public Health England 2016).

Table 4.9: Daily average Mineral intake among British Bangladeshi male and female (n=137)

	Iron mg		*Calcium mg*		*Potassium mg*		*Zinc mg*		*Copper mg*		*Selenium*		*Phosphorus mg*		*Chloride mg*		*Sodium mg*		*Iodine ug*		*Magnesium*	
	Male	Femal	Male	Female	Male	Female	Male	Femal	Male	Femal	Male	Femal	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
RNI/EAR	8.70	14.80	700.00	700.00	3500.00	3500.00	9.50	7.00	1.20	1.20	75.00	60.00	550.00	550.00	2500.00	2500.00	2400.00	2400.00	140.00	140.00	300.00	300.00
Mean	15.16	12.98	728.60	658.45	2986.81	2593.81	11.05	12.23	1.57	1.71	63.89	55.42	1410.89	1360.90	3581.79	3549.66	2564.81	2301.84	127.69	145.18	315.6	325.7
±SD	3.44	2.75	191.69	154.36	593.88	709.36	2.54	2.96	0.36	0.39	36.82	12.91	296.37	256.42	1124.51	877.03	766.48	568.54	52.72	81.51	61.18	75.93
95%CI	1.52	13.48	84.99	28.51	263.31	131.04	1.13	0.55	0.16	0.07	16.32	2.38	131.40	47.37	498.58	162.01	339.84	105.03	23.37	15.06	27.13	14.03
95%CI Upper	16.69	12.47	813.59	686.97	3250.12	2724.85	12.18	12.78	1.73	1.78	80.21	57.81	1542.29	1408.27	4080.36	3711.67	2904.65	2406.86	151.06	160.24	342.7	339.7
95%CI Lower	13.64	87.68	643.61	629.94	2723.50	2462.77	9.92	11.69	1.41	1.64	47.56	53.04	1279.48	1313.54	3083.21	3387.65	2224.97	2196.81	104.31	130.13	288.4	311.7
P value of the differences	0.049		0.835		0.309		0.313		0.894		0.021		0.265		0.342		0.119		0.843		0.000	

Table 4.10: Daily average vitamin intake among British Bangladeshi male and female (n=137)

	Vitamin A ug		*Thiamine B1 mg*		*Pyridoxine B6 mg*		*Riboflavin B2 mg*		*Cobalamin B12 ug*		*Folate B9 ug*		*Vitamin C mg*		*Vitamin D ug*		*Vitamin K1 ug*		*Vitamin E mg*	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
RNI/EAR	700	600	1	0.8	1.4	1.2	1.3	1.1	1.5	1.5	200	200	40	40	10	10	25	25	15	15
Mean	713.96	688.85	1.48	1.52	2.13	1.78	1.55	1.28	5.61	4.88	251.39	206.95	55.38	65.84	3.96	2.56	16.19	17.88	11.15	10.07
±SD	287.73	287.36	0.36	0.43	0.64	0.49	0.54	0.32	2.82	2.20	77.21	55.50	42.17	33.90	3.09	1.31	22.43	15.52	3.57	3.26
95%CI	127.57	53.08	0.16	0.08	0.28	0.09	0.24	0.06	1.25	0.41	34.23	10.25	18.70	6.26	1.37	0.24	9.95	2.87	1.58	0.60
95%CI Upper	841.53	741.93	1.64	1.60	2.41	1.87	1.79	1.34	6.86	5.29	285.62	217.21	74.07	72.10	5.33	2.80	26.13	20.75	12.73	10.67
95%CI Lower	586.39	635.76	1.32	1.44	1.84	1.69	1.31	1.22	4.36	4.47	217.15	196.70	36.68	59.57	2.59	2.31	6.24	15.02	9.56	9.47
P value of the differences	0.565		0.142		0.062		0.217		0.858		0.049		0.668		0.104		0.637		0.596	

Chapter five

In this chapter, findings from the results were critically discussed by comparing with literatures and key research question for this study was explored.

5.0 Discussion

The primary aim of this research was the exploration of diet quality and physical activity level among British Bangladeshi Population living in the United Kingdom. Results from the research projects suggest a positive association between diet quality and physical activity 0.38 R^2. Previous studies have also exploring the association between diet and exercise among men in this ethnic minority, these have reported that participants engaging with elevate amount of physical activity level have high Healthy Eating Index score and high diet quality (Jeong et al., 2019; Burd et al., 2019; Pedersen and Saltin, 2015). Past epidemiological studies also suggested that subjects engaging with minimum or no level of physical activity and sedentary lifestyles have low Healthy Eating Index score and low diet quality (Ghosh-Dastidar and Dubowitz, 2017; Loong et al., 2018).

5.1 Discussion of Anthropometrics and Sociodemographic status

The Health Survey for England has estimated that there are over 6,6 million obese men and 5.9 million obese women (Agha et al.,2017; Government Office for Science, 2007). The mean (SD) BMI for men and women was 24.82 (±2.35) and 25.64 (±3.27) respectively. Merely 20% of the population was within the normal BMI range. WHO cut-offs for south Asians BMI are: <18.5 (underweight) >18.5 to 22.9 (healthy) >23 to 24.9 (overweight) ⩾25 (obesity) (WHO, 2011; Nuttall, 2015; Tam K et al., 2019). Based on public health studies, British Bangladeshis living in the United Kingdom have a mean BMI of 25.81 (Garcia et al., 2017). The raised level of BMI is also visible by the result of this research where men are overweight, and women are suffering from obesity. Increased BMI has been linked with the development of potentially deadly health conditions such as atherosclerosis, stroke, and diabetes type 2. This is a major public health concern and the prevalence continue to rise (Sutaria et al., 2019). High BMI has not only been observed among British Bangladeshi but also among other South Asian population. Vyas et al. (2003) observed the BMI of British Pakistani, results suggested a high BMI in both male and female (27.2 and 30.2 respectively). Analysis carried out by McKeigue et al. (1992) observe a high BMI among Indian British in both male and female (25.3 and 26.8 respectively). Currently there are many interventions presented by the UK government to reduce obesity. All Our Health e-learning sessions and NHS weight loss plans are an interactive day-to-day practice intervention for health care professionals and the general population to reduce the prevalence of obesity and promote healthy living lifestyles (Salisbury et al., 2011; Grosios and Burbidge, 2010; Martin et al., 2018). Making every contact count (MECC) is an intervention to promote health and wellbeing across the country (Chisholm et al., 2018; Nelson et al., 2013).

There are insufficient interventions involving British Bangladeshi men and women living in the United Kingdom. Analysing the BMI of British Bangladeshi population is important to allow health professionals to better address culturally accepted interventions related to physical activity and healthy eating.

This research result indicates that 84% of the study population is female (n=115) and 16% of the study population is male (n=22). Various epidemiological literatures have emphasized concerning the difficulty of recruiting South Asian men for health research (Newington and Metcalfe, 2014; Ryan et al., 2019). Often this situation is faced by the researchers due to commitments, dropouts and low level of interest from this ethnicity (Khambhaita et al., 2017; Finer et al., 2019). This was a limitation in this research. The disproportion in this study has been caused due to language and cultural barriers. Muslim mosques are segregated, and men and women pray in separate area in the building (King et al., 2017; Padela and Zaidi 2018). The unavailability to access into the male section of the mosque decreased the chances of recruiting men. Also, male population was less likely to participate in public health research study compared to women (Ryan et al., 2019).

The mean (±SD) age was 29 (±10.61) years for this research group. The mean age for male and females was 34 (±15.38) and 28 (9.38) years of age respectively. Population dynamics showed that 68% of the participants were below the age of 30. Based on epidemiological and clinical trials engaging young adults in health research has not been express as a concern. Previous studies have suggested that recruiting young generation British Bangladeshi has been easier. Simultaneously, the inclusion of elderly generation has been defined as complex to reach due to working hours and time consuming (Akter 2013, Rooney et al., 2011, Hussain-Gambles et al., 2004).

Results obtained from this study revealed that 56% of the research population was married and 44% was not married during the data collection procedure. Based on the sociodemographic information accumulated, 52% of the population have or are completing higher education and 48% have completed basic educational level such as school and college. British Bangladeshi's academical achievements are considerable above the national average. This has been also discussed by the Department of Education and Ofsted (Kalra, 2006; Ofsted 2004; Department of education 2015). Despite the high academic accomplishments, increasing nutritional knowledge among this population is necessary to diminish the development of nutrition related diseases.

5.2 Discussion of Participants' Healthy Eating index status

Based on the results of the dietary assessment present in Chapter four, mean (SD) values shows that this research group scored a value of 37.69 (±13.41). Based on the statistical analysis performed for this result, it has been concluded that there are no significant differences in the p values, with the p value of the differences was 0.160. Results from men and women statistical analysis suggested both a p value of ≤ 0.05 indicating a strong evidence against the null hypothesis. This score has been associated with low diet quality and the elevate intake of saturated fat, added sugar and red meats. A low score on the HEI has been related with risk of developing nutrition related non-communicable diseases. Academical research have instigated that healthy eating and a high diet quality had a beneficial effect on the reduction of chronic and heart diseases (Becker et al., 2004; Wirt and Collins 2009; Lee at al. 2001). Epidemiological cross-sectional studies have suggested that low diet quality is associated with low BMI level and obesity. Based on the results of this research it is possible to observe that both variables are predominantly lower than the recommended guidelines. British Bangladeshi population living in the United Kingdom have a major health concern regarding poor diet and unhealthy lifestyles (Sundararajan et al., 2014; Choudhury and Furbish 2016). High BMI and low diet quality have been associated with mortality and morbidity risks. According to dietary studies and systematic reviews British Bangladeshi individuals with elevate BMI and poor diet are more likely to suffer from diabetes type 2 and NR-CHD (Bhopal et al., 1999; Leung and Stanner 2011). Research based on the diet quality of British Bangladeshi can help nutritionist and dieticians address this topic and the current dietary and health condition of this ethnic minority. Therefore, proving culturally accepted interventions and treatments.

5.3 Discussion of Participants' physical activity level status

To measure the level of physical activity among British Bangladeshi the GPAQ was used (Appendices 9, Table 18). The GPAQ was developed by the World Health Organization (WHO) in 2002 to monitor physical activity, this was part of the demographic and health survey (DHS). Assessing the physical activity level (PAL) of an individual is essential to define the degree of physical inactivity and identify their physical fitness. PAL data has been divided into three categories: high, moderate and low level. Each category represents work related activities, travel related activities and leisure time. The sum of exercise will be calculated using MET (Metabolic Equivalents) one MET is equivalent to the caloric consumption of 1kcal/kg per hour. Participants achieving scores between 1.0 and 1.39 have been classified as sedentary, scores between 1.4 and 1.59 have been classified as low active, scores between 1.6 and 1.89 have been classified as active and participants scoring above 1.9 have been characterized as very active.

The mean (SD) physical activity level in this population was 1.25 PAL (±0.04). PAL level for men and women was 1.32 (±0.21) and 1.24 (±0.11) respectively. These values reflect a sedentary lifestyle. The accurate acquisition of PAL can be challenging due to human error and cumbersome. Low level of PA in British Bangladeshi population increased their risk of chronic and non-communicable diseases. The p value of the differences between male and female PAL was 0.935 showing a weak evidence against the null hypothesis. Based on past public health research British Bangladeshi living in the United Kingdom have been shown a low level of PA compared to the general population (Grace et al., 2007; Khatoon, J. 2006). Obesity and high BMI has also been associated with low PAL in this ethnicity. Based on previous epidemiological research British Bangladeshis are the least active ethnicity compare to other south Asian subgroups living in the UK. Only 5% of men and 3% of women in this research group met the current PAL recommendation of conducing active lifestyles. It is clearly visible that there is not a difference among PAL between British Bangladeshi men and women. Both values indicate a sedentary lifestyle routine.

Absence of motivation, unavailability of women/men only exercise facilities, lack of time and socio-cultural impediments have been identified as main barriers preventing an active lifestyle (Kearney et al., 1999; Booth et al., 2013). Paucity of motivation has been a major element causing low level of PA between both British Bangladeshi men and women. It has been discussed by previous cross-sectional epidemiological studies that the scenario of women exercising among men is a negative perception among British Bangladeshi and cause of apathy between female members of this community. Culturally accepted interventions addressed by female health professionals for British Bangladeshi women in Bengali language would increase motivation and awareness regarding physical activity. The availability of low-cost facilities open during weekday and weekends can also increase PAL among British Bangladeshi living in the UK (Emadian et al., 2017; Sohal et al., 2015; Lawton et al., 2006; Leung and Stanner 2011).

5.5 Discussion of Participants' macronutrient intake

The patterns of nutrient consumption suggested that most British Bangladeshi living in the United Kingdom consumes three meals per day (i.e. breakfast, lunch and dinner). A minority of this ethnicity does consume a mid-day or between meal snack. Lunch and Dinner meals principally consist of carbohydrates loads, high intake of refined grain and protein.

Dietary recommendations suggest a daily energy intake (EI) of 2500 (kcal/day) for men and 2000 (kcal/day) for women (SACN 2016; Public Health England 2016). The Average (SD) intake for this research group was 2264.37g/day (±218.47). Intake for male and female was 2407.21g/day (±364.69) and 2237.04g/day (±376.40) respectively. It is possible to observe an excessive intake of energy per day in this population group. The sample size for this research is not sufficient to deduce a significant conclusion. Nevertheless, data accumulated in this study does suggest an unhealthy and unbalanced dietary habit is present among British Bangladeshis.

Despite the mean values corresponding to a healthy population. The highest and lowest value (450.55g/day and 131.12g/day) of carbohydrates intake suggest an imbalance in nutritional intake is present among this population. High intake of carbohydrates is linked with the increase of LDL and cholesterol level causing complications in the metabolism. Furthermore, research have suggested that an inadequate or undistributed intake of carbohydras intake can lead to high risk of developing non-communicable diseases such as obesity, DM type 2 and hypertension leading to obesity and cardiovascular diseases (Slavin and Carlson, 2014; Ludwig et al., 2018). Disproportionate amount of fat in the lesser and greater omentum has been associated with metabolic syndrome (Aballay et al., 2013; Despres, 1998; Thomas et al., 2004). Hence exaggerate intake of sugar can increase risk of diabetes type 2 and insulin resistance metabolic impediments. The mean (SD) value of sugar 32.03g/day (±8.02) in the research population suggest a healthy intake in both male and female groups. Despite this optimistic circumstance it has been possible to detect excessive intake in both men and women by recognising the highest value of intake. Male and female highest intake was 58.17g/day and 76.40g/day respectively. Action on Sugar is a UK organization formed in 2014, their main aim is to reduce the amount of added sugar from processed food by working with nutrition specialist and food industries. This organization increases awareness regarding the excess use of sugar by food manufactures by publishing reports on journals with peer reviewed evidences (Macdonald, 2016; Khan and Sievenpiper, 2016). Excessive sugar intake combined with sedentary lifestyles has been associated with high risk of increase in DM type 2 and obesity among British Bangladeshi population (Sharma et al. 2005; Minges et al. 2013). Past interventions particularly aiming on ethnic minorities reported positive lifestyles changes. "Apnee Sehan" project was developed by Coe and Boardman (2008) aimed to promote healthy eating and balanced lifestyles and reduce DM type 2 among Sikh community in London. A culturally appropriate toolkit was developed aimed for this population. Participants recorded positive lifestyles changes after the intervention and increase level of awareness regarding DM type 2. Contractionary, systematic review carried by Muilwijk et al. (2018) identified eighteen intervention studies and four dietary guidelines developed for South Asian populations to decrease DM type 2 across Europe. Dietary and PAL guidelines were compared to recommendation for the general population. Evaluations suggested that these interventions were not adaptable for South Asians and it is necessary to formulate culturally specifit interventions and toolkits to reduce the prevalence of DM type 2.

Conversely, systematic review carried out by Bhurji et al. (2016) analysed the effectiveness of DM type 1 and 2 management interventions targeted at Pakistani, Bangladeshi and Indian populations. Minor improvements were observed in interventions carried out in Europe; significant improvements of blood sugar level were observed among participants in India. Interventions included yoga, meditation session and cooking exercise in the local (hindi) language to reduce blood sugar levels. Based on successful and unsuccessful interventions we can replicate these to initiate culturally accepted interventions and encourage British Bangladeshis to reduce the intake of refined carbohydrates and increase intake of healthy foods.

The mean (SD) intake of dietary fibre was 20.80g/day (±2.10) for the research group. Mean intake for men and women was 20.43g/day (±5.60) and 20.87g/day (±5.89) respectively. Insufficient intake of fibre prevents the reduction of serum cholesterol level this, inhibit the production of stools hence increasing risk of constipation, colon and gastrointestinal disorders risk (Charlton et al., 2012; Nanji et al., 2012; Williamson, 2006; Wood, 2011; Rimm et al., 1996). The low dietary fibre intake indicates a mediocre intake of fruits and vegetables among British Bangladeshi population. The means (SD) value for fat intake was 93.95g/day (±31.98) for both men and women. Daily average intake for male was 95.49g/day (±21.62) and 93.66g/day (±22.12) for female respectively. Dietary recommendations suggest an optimal intake of >97g/day for men and >78g/day for women (SACN 2016; Public Health England 2016). It is clearly visible female intake of dietary fat do not meet the nutritional guidelines. This value intake excessive intake of fat which has been linked to the prevalence of obesity, chronic disease, hypertension and endothelial dysfunction (Dam et al., 2002; Briggs and Kris-Etherton, 2017). Furthermore, high intake of fat and elevate BMI have been associated with heart disease, oxidative stress and cerebrovascular diseases (Schwingshackl and Hoffmann, 2014). An elevate intake of fat can be correlated with the cooking procedure of marinating with oil and the use of clarified butter (ghee) during the preparation of the meals (Talegawkar et al., 2015). The mean (SD) intake of SFA for male and female was 30.34g/day (±7.62) and 27.79/day (±8.89) respectively. The mean (SD) intake of PUFA for male and female was 17.37g/day (±6.76) and 16.58g/day (±4.47) respectively. The mean intake (SD) for MUFA for male and female was 36.63g/day (±11.19) and 34.50g/day (±8.81) respectively. It is clearly visible that MUFA, PUFA and SFA were higher than the recommended guidelines among British Bangladeshi women. High intake of SFA has been linked with cardio-vascular diseases (Svendsen and Retterstøl, 2017). An elevate intake of fat, high BMI and sedentary lifestyle increase the risk of morbidity and mortality in this particular ethnicity (Biswas et al., 2017). Equally the level of cholesterol is also high among this population. Recommended dietary guideline suggest a daily intake of 300mg for both men and women (SACN 2016; Public Health England 2016). Intake for men and women was 386.96 mg/day (±135.88) and 337.70 mg/day (±119.48) respectively. Elevate intake of cholesterol has been associated with hypercholesterolemia and liver malfunctioning. Regular exercise has been effective at reducing LDL level in the blood (Cheeseman, 2008; Bruckert and Rosenbaum, 2011). Low PAL and high intake of cholesterol can trigger the risk of heart stroke and increase cardiovascular diseases (Kanter et al., 2012; Elshourbagy et al., 2013). A randomised controlled trial intervention has been carried out by Bhopal et al (2014) focusing on South Asian individuals. The intensive intervention was aimed to prevent NR-NCDs by weight loss plan and regular physical activities. The intervention was carried out for limited time and had positive reviews with sustainable lifestyles changes among South Asian population living in UK. Public health initiatives targeting healthy eating such as Eat well guide and Action on salt have provided evidence on health improvement and reduced risk of NCDs. These have been positively accepted by the mass population in UK (Wyness and Butriss, 2011; Pombo-Rodrigues and MacGregor, 2014).

Culturally accepted and adapted interventions that follow the national guidelines focusing on health promotion and physical activity have been firmly welcomed by the British Bangladeshi and South Asian community living in the UK as stated previously. Based upon that, similar project should be used to accentuate a high-quality diet and physical activity level among this ethnic minority to reduce the risk of NDCs (Coe and Boardman, 2008; Leung and Stanner, 2011).

“Healthy Eating for South Asian People” is a dietary toolkit developed by the New Zealand’s Ministry of health based on nutrition and exercise. This toolset contains traditional terms used by south Asians such as bhindi (okra), gajar (carrots) and phool gobi (cauliflower). This toolkit was successfully accepted by the South Asian community living in New Zealand on account of the cultural and traditional components of it (LeCroy and Stevens, 2017; Kruger et al., 2012). Diabetes UK has published a leaflet “Healthy eating for the South Asian community” focused on DM type 1 and type 2. However, this leaflet was not designed taking in consideration cultures and South Asian health beliefs. This could be viewed as a cultural conflict of interest (Khunti and Brodie, 2009; Gujral et al., 2013; Vida Estacio et al., 2014). Further analyses and interventions are required in relationship to the intake of cholesterol among British Bangladeshi. Culturally appropriate toolkits should be developed in UK based on traditional cuisines by replacing high fat meals with healthier options such as the use of vegetable oil rather than clarified butter (ghee).

The means (SD) value for protein was 100.98g/day (±16.65) for this research population. Daily male and female intake were 104.95g/day (±19.46) and 100.23g/day (±20.98) respectively. Protein intake excess of 50g in males and 55g in females (SACN 2016; Public Health England

2016). These values do not appear within the range of the recommended criterions. Recommended dietary guidelines for protein suggest a maximum intake of 55g for males and 45g for females per day. The high intake of protein in addition to provide energy also trigger health concerns for this population. The abundant intake of protein, particularly animal protein such as red meat can increase the risk of

CVD, bowel cancer and high cholesterol levels (Bingham, 2006; Delimaris 2013). Animal sources of protein contribute to the increase of saturated fat such as LDL in the body which ultimately boost the chances of developing heart disease and stroke. On the contrary plant protein such as kidney beans and lentil are beneficial for the metabolism and digestive system. Leung and Stanner (2011) reported a higher intake of protein among British Bangladeshis compared to the white Caucasian population. Elevate protein intake combined with sedentary lifestyles and obesity can increase the prevalence of mortality rate among British Bangladeshi population (Nettleton et al., 2017; Gershuni, 2018; Bhopal et al., 2005).

5.6 Discussion of Participants' micronutrient intake

Vitamins and minerals are prominent nutrients to facilitate the maintained of health and the inadequate intake can increase the risk of diseases (Broek et al., 2017). An insufficient intake of vitamin A & D, iron, zinc and iodine has been observed extensively among British Bangladeshis (Akhtar and Arlappa, 2013; (Harding and Aguayo, 2017).

A prominent evidence of unbalanced micronutrient intake was visible in participants taking part in this research. Epidemiological examination of micronutrients showed that British Bangladeshis tend to intake low micronutrients compare to the white Caucasian population (Sachan et al., 1999; Anderson et al., 2005). Participants that do not meet the RNI guidelines are more likely to develop disease compared to healthy individuals following the nutritional standards (Broek et al., 2017).

Dietary guideline for sodium suggests an optimal intake of maximum 2400mg/day for both men and women (SACN 2016; Public Health England 2016). The mean (SD) intake for men and women in this study was 2564.81mg/day (±766.48) and 2301.84mg/day (±568.54) for female respectively. Population means (SD) intake was 2344.07mg/day (±46.62). Although this value does not surpass the recommendation, it is alarming due to the proximity of the data. The mean (SD) intake of salt for men and women was 6.41g/day (±1.92) and 5.75g/day (±1.42) respectively. Nutrition recommendations suggest a maximum intake of 6g/day for both males and females. High intake of salt and sodium is eminent in the male population. The intake of sodium has been found to be beneficial for nerve conductions and the preservation of membrane potentials. Nevertheless, elevate sodium intake high blood pressure leading to heart failure and irregularities in water retention in the metabolism (Larsen et al., 2014; Doukky et al., 2016). Epidemiological survey estimated that over 5 million people in the UK have undiagnosed hypertensions. The reduction of salt has been a public health issue in the UK and internationally. To reduce the exaggerate intake of sodium the UK government has introduced "Action on Salt" interventions to reduce the consumption of sodium. The main objective of this intervention was to co-operate with the food industries and nutritional specialist to reduce the addition of salt in products (Sarmugam and Worsley, 2014).

Epidemiological surveys completed in the past have also highlighted the deficiency of potassium among the British Bangladeshi population**.** Potassium intake for this research population was 2656.92mg/day (±680.15). Mean (SD) intake for male and female was 2986.81mg/day (±593.88) and 2593.81 (±709.36) respectively. Recommended dietary intake for potassium is 3500mg/day for both male and females (SACN 2016; Public Health England 2016). Inadequate intake of potassium can lead to adrenal gland disorder and cause hypokalaemia leading to cardiac arrest and sudden death. Hypokalaemia is known to be a metabolic imbalanced characterised by low potassium level in the body. This disorder can interfere with kidneys functioning and their ability to concentrate urine. Potassium intake is also fundamental for the production of insulin in the body. Potassium has been described to be "cardio-protective" due to its functioning effecting the heart rate and T-waves (Davies, 1999; Kardalas et al., 2018; Lim, 2006).

The average calcium intake for this research study was 669.72mg/day (±356.08), this is less than the RNI. Recommended dietary guidelines suggest an optimal intake of 700mg/day for both male and females (SACN 2016; Public Health England 2016). The adequate intake of calcium is crucial for the correct functioning of the cardiovascular system and nerve conductions. Intaking the recommended amount of calcium is also essential for bone mineralization and muscle metabolism (Rodriguez et al., 2009; Daly and Ebeling, 2010). Calcium deficiency has been associated with bone fractures and rickets disease development. Previous epidemiological cross-sectional survey also highlighted calcium deficiency among British Bangladeshi living in UK (Karageorgou et al., 2018).

Recommended dietary guidelines suggest a magnesium intake of 270mg/day for both male and female for healthy living (SACN 2016; Public Health England 2016). In this research population the mean (SD) intake for magnesium was 324.06mg/day (±7.74). Magnesium is required for more than 300 biochemical reaction in the metabolism. Its main function is to sustain normal nerve and muscle functions (Al Alawiat al., 2018; Jahnen-Dechent and Ketteler, 2012). This mineral also maintains stable heart beats and promotes energy production. It is important to intake an adequate amount of magnesium based on the dietary guidelines.

Copper is an essential mineral for the body, it collectively works with iron to form red blood cells. This mineral is also fundamental for the maintenance of bone, nerves, blood vessels and immune system (Bost et al., 2016; Gaetke and Chow-Johnson, 2014). Copper deficiency can affect physiologic systems of the body, for example the optic nerve function, bone marrow hematopoiesis and central nervous system (DiNicolantonio et al., 2018). Copper intake for this research population was adequate for both men and women, and values were within the recommended guidelines range of 1-2mg/day (SACN 2016; Public Health England 2016). Zinc is also simultaneously an important mineral for the correct functioning of the body. This mineral plays an essential role for the development and function of the immune system. Zinc is not produced in the body for this reason it is crucial to obtain in via diet or supplements (Bagherani and R Smoller, 2016; Plum et al., 2010). Recommended guidelines suggest an intake of 9.5mg/day zinc intake for this study population was proficient for both genders.

Selenium is a trace mineral important for the production of antioxidant enzymes and the prevention of cell impairment (Tinggi, 2008; Weeks and Cooperstein, 2012). The mean (SD) intake of this study population was 56.78ug/day (±10.15). The intake of this research population is below the RNI range of 75ug/day for both male and females (SACN 2016; Public Health England 2016). Low level of selenium can affect the conversion of the thyroid hormone thyroxine (T4) in the body and cause hypothyroidism, including extreme fatigue Selenium deficiency has been associated with depression and cardiomyopathy such as Kershan’s disease (Arthur, 1993; Stoffaneller and Morse, 2015).

Iodine is important for the production of thyroid hormones in the body. Thyroid is required for brain maintenance and maintain a stable immune system (Chung, 2014; Kapil, 2017). Dietary recommendations suggest an intake of 140ug/day for both male and females (SACN 2016; Public Health England 2016). Mean (SD) intake for this research population was 142.37ug/day (±47.13). This value suggests a sufficient daily intake of iodine by British Bangladeshis living in the UK.

Iron intake for this population was 13.33mg/day (±0.70). Average intake for men and women were 15.16mg/day (±3.44) and 12.98mg/day (±2.75) respectively (SACN 2016; Public Health

England 2016). Iron is important for the transportation of oxygen from the lungs in the blood to the body' tissue (West and Oates, 2008; Abbaspour at al.,2014). It is possible to observe the low intake of iron among British Bangladeshi women. This scenario has been also discussed by past epidemiological research where 70% of Bangladeshi women suffer from thalassemia leading to anaemia disorder. Inadequate intake of iron has been associated with cardiovascular and respiratory system complications (Haas JD, 2001; Allen, 2000; Ronnenberg et al, 2004; Ahmed 2000).

Discussion regarding vitamins will be limited in this study, this research population met the majority of vitamins requirements for the body. Excessive intake of Vitamin B12 (Cobalamin) was visible in both male and female among this population (Gamble et al., 2005). The mean (SD) intake for male and female was 5.61ug/day (±2.82) and 4.88ug/day (±2.20) respectively. Recommended nutritional guidelines suggest an intake of 1.5ug/day for both male and females (SACN 2016; Public Health England 2016). An excessive intake of cobalamin can increase the risk of liver disease such as myeloproliferative disorders and chronic myelogenous leukemia. High vitamin B12 may indicate diabetes and liver dysfunction (O'Leary and Samman, 2010). An unbalanced intake of vitamin B12 has been also discussed by Sukumar N. (2016) by assessing vitamins and folate intake with homocysteine (Hcy) levels.

Vitamin D intake was low in this research population. The mean (SD) intake was 2.78ug/day (±0.44). Dietary reference intake suggests an optimal intake of 10ug/day for male and female (SACN 2016; Public Health England 2016). This data has been calculated based on three days of 24-hours dietary intake over the Summer and Autumn months. During this time there was adequate exposure and sunlight to provide the recommended vitamin D via ultraviolet rays from the sunlight spectrum (Webb et al., 2018; Shaw, 2002). Past epidemiological studies have also highlighted a low vitamin D status and risk of polymorphism among British Bangladeshis in general. Atmospheric weather can also a component stopping the absorption of vitamin D.

Clouds and pollution can block UVB rays in the atmosphere before reaching the earth and prevent the synthesis of vitamin D in the skin (Holick, 1995; Agarwal et al., 2002). It has been proven by previous public health study British Bangladeshis have more melalin (darker skin) compared to the white Caucasian population. Individuals with high melalin required a higher amount of sunlight compared with those with low melanin (lighter skin) to produce the same amount of vitamin D in the body (Dawson-Hughes, 2004; Darling et al., 2018). Latest figures suggest that over 90% of British Bangladeshis are Muslim (Alexander, 2011). The main reason behind British Bangladeshi women' vitamin D deficiency is linked with culture and religion. British Bangladeshi Muslim women who always cover their skin are at risk of developing vitamin D deficiency due to the lack of exposure to the sun (Papadakis et al., 2018; Buyukuslu et al., 2014). Previous studies have also highlighter the problem, Allali et al., 2006 found that women who wear veils and wear concealing clothing had higher risk of developing osteoporosis than those who do not. Therefore, culturally appropriate interventions emphasising the importance of vitamin D are required to prevent the development of deficiency in this ethnic minority.

5.7 Discussion of associations between Diet quality and physical activity level

The results of the study show that PAL and HEI score values do not meet the recommended guidelines of a healthy population. Epidemiological investigations have hypothesised that individuals engaging with physical activity are more likely to lead a healthy life with high quality diet (Vina et al., 2012; Bouchard et al., 1994; Warburton et al., 2006). It has been clearly shown by past research that regular exercise works as a curative method to prevent non-communicable diseases. Gillman et al., (2001) found that a low intake of vegetables and fruits was associated with sedentary lifestyles and high intake of saturated fats. Pate et al., (1996) also suggested that high level of physical activity is positively associated with high quality diet. Concurrently, low level of exercise is positively associated with low quality diet. A balanced diet and physical exercise and decrease the occurrence of obesity among British Bangladeshi population. Values from this study revealed low HEI scores and low PAL. Findings in this research indicate that there is an association between physical activity and diet among British Bangladeshis and both values do not meet the recommended guidelines.

5.8 Discussion of study limitations

This research has number of limitations due to biases of a relatively small sample size of 137 participants compared to the number of British Bangladeshis living in the UK. However, results do present a useful contribution to increase knowledge regarding PA and diet quality of this ethnic minority. Self-reported assessment was utilized to assess the dietary pattern of British Bangladeshis. This technique is not suitable for participants suffering from memory loss; this assessment fully relies on the participants' descriptions and remembrance.

Self-reported measurements such as weight and height were also assessed among the participants (n=137). This information's can contain a minor level of unreliability, due to observational inaccuracy or instrumental error (un-calibrated weight machine); these factors can affect the reading of the instrument and provide imprecise information. Environmental errors such as low lighting can also affect the reading procedure (Short et al., 2009; Tennekoon and Hill, 2011)

Under reporting is a limitation associated to self-reporting, this can affect the results of the project. To minimise self-reported biases, it is important to provide clear instruction to participants in relation to portions and providing the units of measurements in the survey for the type of foods consumed, this was presented in this project survey by proving examples of units (g, ml, ounce), method of cooking (grilled, fried, boiled) and type of food consumed (raw, ripe, fresh, frozen) (Schoeller, 1995; Walker and Burrows, 2017).

Another limitation of this method is the time-consuming procedure during the conversion and coding of nutritional data. It has been recommended that a large scale of estimation is the most suitable data collection method with a minimum of three repeat 24-hour recalls (Dwyer, 1998; Gibson, 2005; Lee et al.,1998). The GPAQ was used to assess PAL level among this population. This tool can be used to examine a large scale of samples at relatively low cost. The multilingual option of the questionnaire facilitates the translation and communication procedure and increase accuracy level. In spite the facts of these advantages, requirement of elevate level of mathematical calculation including scoring and converting values are necessary (Watson et al., 2017; Cleland et al., 2014; Wanner et al. 2017). Therefore, the findings of this observational research are interpreted with a degree of caution.

Chapter Six

6.0 Conclusion

The exploration of diet quality and physical activity level among British Bangladeshi living in the United Kingdom have been assessed in this research. Based on the results of the project low HEI scores are associated with low PAL scores; and high HEI score with high PAL.

A positive correlation has been calculated between PAL and HEI scores (0.38 R^2). Both PAL and HEI scores were below the recommended criteria and immediate lifestyle interventions are required focusing on this particular ethnic minority.

Unhealthy diet has been demonstrated to scale down physical activity and increase BMI levels, therefore develop risk of nutrition related NCD.

This ethnic minority has a high risk of developing diabetes type 2 and nutrition related non-communicable diseases due to unhealthy dietary intake and sedentary lifestyles. Based on this study, daily dietary intake of fat, sugar, salt predispose to chronic illness. Inadequate intake of Vitamin D and iron ~~deficiency~~ has been also observed in this ethnic minority.

Previous research has suggested that increased nutritional knowledge can influence food choice and help meet daily dietary reconditions. Epidemiological studies have suggested that nutritional-educational interventions can effectively change individual's prospective upon food and meals (Ha and Caine-Bish, 2011; White at al.,2009). Using the correct method of approach, it is possible to increase awareness and positively affect the food choice. Providing culturally accepted interventions, will assist individuals with poor or moderate diet quality and deliver sustenance toward sound dietary intake. Grafova et al (2006) suggested that, individuals with high nutritional knowledge and awareness are more likely to conduct a balanced diet and maintain a BMI in the normal ranges. This study also concluded that, increasing nutritional knowledge can disease diet related illness and health conditions. Similar analysis carried out by Kruger et al (2002) suggested that nutritional awareness is s factor associated with healthy eating habits and physical activity consciousness. Evidences have shown that culturally accepted health and nutritional interventions can improve participants' lifestyles. Speaking in Bengali and translating the educational program in the native language can increase awareness. Interpersonal interventions should be provided to British Bangladeshis to both men and women based on their tradition, language and religion (Coast et al., 2016; Jones et al., 2017).

A key aspect to promote healthy and balanced eating among British Bangladeshis is to increase nutritional and physical health knowledge. This study suggests that health assessments should take individuals separately based on their age, gender and religion. From these results it is possible to postulate that appropriate interventions and disease risk prevention toolkits should be developed to help this community identify the risks and prevent diseases. Future research should be emphasis on increasing physical activity level and improve health and diet quality among British Bangladeshis.

6.1 Potential Future Projects

1) A larger scale sample research including same number of men and women.
2) A nutritional education intervention to increase nutritional knowledge aimed for British Bangladeshis to reduce NCD risks
3) A comparative research of first-generation and second-generation British Bangladeshi living in the UK.
4) An intervention study focused on increasing the intake of vegetables and fibre and decreasing the intake of SFA and salt.
5) Design and execute a culturally accepted toolkit aimed for British Bangladeshis

These aforementioned projects would require submission of large grant proposal to research charities, government organization and non-government organization to carry out further research.

<u>Appendices</u>

Appendices 1

Table 4.1- Participants age distribution:

18-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60
(n=26)	(n=43)	(n=24)	(n=7)	(n= 9)	(n= 17)	(n= 3)	(n= 5)	(n= 3)

Appendices 2, Table 12: Instruction for the 24-hour repeated dietary recall

Details of the nutrients: - Amount consumed - Time and date/day of consumption - Occasion for eating (breakfast, lunch, dinner, snack)
For each item of food or drink in the list, you are asked to provide additional detail, including: • The time at which the food or drink was consumed • A full description of the food or drink, including brand name where available • Any foods likely to be eaten in combination e.g. milk in coffee • Recipes and other combinations of foods e.g. sandwiches • The quantity consumed, based on household measures, photographs of different portion • sizes of foods, or actual weights from labels or packets • Any leftovers or second helpings
FRUIT • Peeled/unpeeled • Colour – e.g. red/green apple • Tinned – what sort of juice (eg. natural, syrup), how much of the juice did they eat • Juice – 100% or fruit drink, added vitamins?
VEGETABLES • Fresh or frozen or tinned (with or without salt) • Cooking method – boiled with or without salt, baked (with oil / spray?), roasted in oil (what type and how much) microwaved, steamed etc • How much – if using cups is it ¼ cup sliced/whole/mashed/diced, or how much of a whole vegetable (e.g ½ a medium) • Potato – with or without skin • Colour – e.g. red/green capsicum Juice – salted/commercial or freshly juiced
DAIRY • Milk – brand name and fat content • Yoghurt – brand and with fruit or plain or vanilla

- Ice cream – brand and how many cups worth (better than scoops), any additions (e.g. choc chips), fat content
- Cheese – brand, if grated how many cups

MEAT

- Cooking method (e.g. BBQ, grilled, roaster, fried)
- Weight cooked or uncooked (and with or without fat/bone)

Appendices 3, Table 13 - Healthy Eating index score

Score whole fruit	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0	0.5	0.0
Amount Consumed in cups	≥0.40	0.36	0.32	0.28	0.24	0.20	0.16	0.12	0.08	0.04	0.00
Score-Total fruit	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0	0.5	0.0
Amount Consumed in cups	≥0.80	0.72	0.64	0.56	0.48	0.40	0.32	0.24	0.16	0.08	0.00
Score-total vegetables	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0	0.5	0.0
Amount Consumed in cups	≥1.1	0.99	0.88	0.77	0.66	0.55	0.44	0.33	0.22	0.11	0.00

Score green and bean	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0	0.5	0
Amount Consumed in cups	≥0.2	0.18	0.16	0.14	0.12	≥0.1	0.16	0.12	0.08	0.04	0

Score- Total grain	10.0	9.0	8.0	7.0	6.0	5.0	4.0	3.0	2.0	1.0	0.0
Amount consumed in cups	≥1.5	1.35	1.2	1.05	0.9	0.75	0.6	0.45	0.3	0.15	0.00
Score- Dairy	10.0	9.0	8.0	7.0	6.0	5.0	4.0	3.0	2.0	1.0	0.0
Amount consumed in cups	≥1.3	1.17	1.04	0.91	0.78	0.65	0.52	0.39	0.26	0.13	0.00
Score- Total protein	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0	0.5	0.0
Amount consumed in cups	≥2.5	2.25	2.00	1.75	1.50	1.25	1.00	0.75	0.50	0.25	0.00

Score- Seafood & Plant Proteins	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0	0.5	0.0
Amount consumed in cups	≥0.80	0.72	0.64	0.56	0.48	0.40	0.32	0.24	0.16	0.08	0.00
Score- Fatty acids	10.0	9.0	8.0	7.0	6.0	5.0	4.0	3.0	2.0	1.0	0.0
Amount consumed in cups	≥2.5	2.25	2.00	1.75	1.50	1.25	1.00	0.75	0.50	0.25	0.00
Score- Refined grains	10.0	9.0	8.0	7.0	6.0	5.0	4.0	3.0	2.0	1.0	0.0
Amount consumed in cups	≤1.8	2.04	2.28	2.52	2.76	3	3.24	3.48	3.72	3.96	≥4.3
Score- sodium	10.0	9.0	8.0	7.0	6.0	5.0	4.0	3.0	2.0	1.0	0.00
Amount consumed in cups	≤1.1	1.21	1.32	1.43	1.54	1.65	1.76	1.87	1.93	1.98	≥2.0
Score- SFA	10.0	9.0	8.0	7.0	6.0	5.0	4.0	3.0	2.0	1.0	0.00

Amount consumed in cups	≤8	8.88	9.76	10.64	11.52	12.4	13.28	14.16	15.04	15.5	≥16
Score-sugar	10.0	9.0	8.0	7.0	6.0	5.0	4.0	3.0	2.0	1.0	0.0
Amount consumed in cups	≤6.5	8.5	10.5	12.5	14.5	16.5	18.5	20.5	22.5	24.5	≥26

Appendices 4, Table 14

Survey- 24 hours Diet Recall Form

Time	Amount	Description of Food or Drink and Leftovers

Appendices 5, Figure 3- Recommended nutritional guidelines

Starchy carbohydrates. 3-4 a day

Potatoes, bread, rice, pasta or other starchy carbohydrates

Choose 3-4 portions of starchy carbohydrate foods a day – you could have one with each meal and could also include snack-sized portions. Those that are 200kcal or more tend to be the things you would have as a main meal, and those that are less then 200kcal for lighter meals or breakfast.

It's a good idea to include wholegrains like wholemeal breads, brown pasta and wholegrain cereals, and potatoes with skins regularly as they are important sources of fibre. If you're having more than one food from this group in a meal then portion sizes can be smaller, e.g. if having rice and naan bread with a curry. For foods like pasta or rice, both cooked and uncooked portion sizes are included – these gain weight when they are cooked as they absorb water. Unless stated otherwise, the information provided here is based on the food alone without additions e.g. bread without spread, cereal without milk.

Less than 200kcal - for lighter meals and breakfast

Food	Portion size (g)	Calories	How to measure
Flaked breakfast cereals	40g	130-150 kcal	About 3 handfuls
Weetabix-type cereal biscuits (2)	40g	133 kcal	Ready portioned
Wholegrain malted wheat cereal	40g	136 kcal	About 3 handfuls
Shredded wheat type cereal (2 biscuits)	45g	150 kcal	Ready portioned
Multigrain hoops	40g	147 kcal	About 3 handfuls
Muesli	50g	183 kcal	About 3 handfuls
Porridge (dry weight)	45g	171 kcal	About 1 and a half handfuls
2 slices of medium-sliced wholemeal bread	80g	174 kcal	Ready portioned
½ small baguette	70g	184 kcal	Ready portioned
Pitta bread	60g	153 kcal	Ready portioned
Mashed potato (mashed with spread)	180g	184 kcal	About 4 tablespoons
Cooked new potatoes	175g	119 kcal	About 6 small potatoes
Wrap	65g	183 kcal	Ready portioned
Sandwich thins	40g	98 kcal	Ready portioned
Bagel thins	50g	130 kcal	Ready portioned
Garlic bread (¼ small baguette)	50g	174 kcal	Ready portioned
1 medium wholemeal bread roll	60g	146 kcal	Ready portioned
1 small chapatti	45g	148 kcal	Ready portioned
Plain microwave rice	125g	190 kcal	Half a 250g pack

More than 200kcal - mostly for main meals

Food	Portion size (g)	Calories	How to measure
Plain pasta - dried	75g	-	2 handfuls For spaghetti: use your finger and thumb to measure a bunch the size of a £1 coin
Plain pasta - cooked	180g	270 kcal	About the amount that would fit in 2 hands cupped together
Rice - dried	65g	-	About 2 handfuls
Rice - cooked	180g	236 kcal	About the amount that would fit in 2 hands cupped together
Couscous - dried	90g	-	About 2 handfuls
Couscous – cooked	150g	267 kcal	About the amount that would fit in 2 hands cupped together
Large wholemeal bread roll	90g	220 kcal	Ready portioned
Bagel	85g	232 kcal	Ready portioned
Oven chips	165g	257 kcal	About 2 handfuls
Roast potatoes	200g	322 kcal	About 4 small potatoes
Large scone	70g	242 kcal	Ready portioned
Egg noodles - dried	65g	-	Usually ready portioned
Egg noodles - cooked	175g	253 kcal	Usually ready portioned
1 large chapatti	90g	290 kcal	Ready portioned
2 slices thick-sliced bread	94g	204 kcal	Ready portioned
Cooked baked potato	220g	213 kcal	About the size of your fist
Plain naan bread (½ naan)	70g	200 kcal	Ready portioned

Snacks (less than 150kcal)

Food	Portion size (g)	Calories	How to measure
Oat cakes (2)	24g	109 kcal	Ready portioned
Plain rice cakes (3)	21g	81 kcal	Ready portioned
1 slice of medium-sliced wholemeal bread	40g	87 kcal	Ready portioned
Small roll	35g	85 kcal	Ready portioned
Mini wrap	30g	90 kcal	Ready portioned
Mini pitta (2 small, 1 medium)	45g	109 kcal	Ready portioned
Small fruit scone	40g	135 kcal	Ready portioned
Plain popcorn	20g	94 kcal	About 3 handfuls
Malt loaf (2 slices of sliced loaf)	43g	129kcal	Ready portioned
1 crumpet	50g	104 kcal	Ready portioned
cream crackers (3)	24g	107 kcal	Ready portioned

Snacks (less than 150kcal)

Food	Portion size (g)	Calories	How to measure
Canned tuna	60g	65 kcal	Half a medium can about 160g net weight)
Unsalted nuts and seeds	20g	113-137 kcal	About the amount that fits in your palm
Boiled egg (1)	60g	86 kcal	Ready portioned
Prawns	80g	54kcal	About 4 tablespoons
Reduced fat houmous	55g	103 kcal	About 2 tablespoons or about ¼ of a standard pack
*Ham (2 slices)	30g	32 kcal	Ready portioned
Smoked mackerel pate	50g	119 kcal	Use the size of pack as a guide
Peanut butter	20g	121 kcal	About 1 tablespoon
*Cocktail sausages (4) - raw	45g	-	Ready portioned
*Cocktail sausages (4) - cooked	35g	100 kcal	Ready portioned
Ready-made falafel (2)	40g	113 kcal	Ready portioned
*Liver pate (about 1/5 of a 200g pack)	40g	99 kcal	Use the size of pack as a guide

*Red or processed meats- these should be limited to an average of 70g of cooked meat per day (about 500g per week).

Dairy and alternatives. 2-3 a day

It's a good idea to go for lower fat options most of the time. Check food labels and go for those with less saturates, salt and sugars. If you are having plant-based non-dairy alternatives, try to choose those that are low in sugars and fortified with calcium, and ideally other nutrients.

Lower fat options (low or medium for fat on food labels)

Food	Portion size (g)	Calories	How to measure
Milk on cereal (skimmed)	125ml	42 kcal	About half a glass
Milk as a drink (skimmed)	200ml	68 kcal	One glass
Milk on cereal (semi-skimmed)	125ml	58 kcal	About half a glass
Milk as a drink (semi-skimmed)	200ml	92 kcal	One glass
Milk on cereal (whole)	125ml	79 kcal	About half a glass
Milk as a drink (whole)	200ml	126 kcal	One glass
Yogurt (fruit, low fat) small pot	125-150g	98-117 kcal	Ready portioned
Yogurt, plain, low fat	120g	68 kcal	About 4 tablespoons
Soft cheese (spreadable, low fat)	30g	46 kcal	About 3 teaspoons
Cottage cheese	100g	103 kcal	About 3 tablespoons
Unsweetened plant-based milk alternatives on cereal	125ml	23-55 kcal	About half a glass

Lower fat options (low or medium for fat on food labels)

Food	Portion size (g)	Calories	How to measure
Unsweetened plant-based milk alternatives as a drink	200ml	36-88 kcal	One glass
Plant-based yogurt alternative (fruit)	125g	94kcal	One individual pot or about 4 tablespoons

Higher fat options (high for fat on food labels)

Food	Portion size (g)	Calories	How to measure
Hard cheese (e.g. cheddar)	30g	125 kcal	About the size of two thumbs
Reduced fat hard cheese	30g	94 kcal	About the size of two thumbs
Stilton-type cheese	30g	123kcal	About the size of two thumbs
Full fat soft cheese	30g	76 kcal	About 3 teaspoons
Brie-type cheese	30g	103 kcal	About the size of two thumbs

Fruit and vegetables. At least 5 portions a day

One portion is approx. 80g. For dried fruit a portion is about 30g and for fruit and vegetable juices and smoothies a portion is 150ml (limit to a combined total of 150ml a day).

The more variety the better – try to include a range of colours and types. These portion sizes are only a guide and can be larger – as long as they are not served with added sugar or fat you can eat big portions of most fruit and vegetables for relatively few calories. You can combine more than one type to make up your portions, for example in a fruit salad or different types of vegetables in a soup or stew. Fresh, frozen, dried and canned fruit and vegetables can all count. If choosing canned fruit or vegetables go for those in water or fruit juice without added sugars or salt. Dried fruit can count towards your **5 A DAY** but it's best to keep this to mealtimes as it's high in sugars and can stick to teeth.

Portion size examples:

Small fruit:	Two plums, two satsumas, two kiwi fruit, three apricots, six lychees, seven strawberries or 14 cherries.

Protein foods. 2-3 a day

Beans, pulses, fish, eggs, meat and other protein

Apart from oily fish like salmon and mackerel, in this food group for most people it's a good idea not to have the 200kcal or more options too often and to go for those less than 200kcal most of the time. You can also include protein foods as snacks – they can provide a range of nutrients and are a good alternative to sweet snacks.

It's a good idea to include plant-based sources of protein in your diet - like beans, chickpeas and lentils (all types of pulses), which are good alternatives to meat because they're naturally low in fat, and provide fibre, protein, vitamins and minerals – they can also count as one portion of your 5 A DAY. It's recommended that you have two portions of fish a week, one of which should be oily. (Note that there are some restrictions on fish consumption for women and girls – see **NHS pages on fish**). If you eat a lot of red and processed meat (see those foods with *) it's a good idea to cut down – for more information see **NHS pages on meat**. If you're including more than one food from this group in a meal e.g. mince and beans in a chilli, then portion sizes can be smaller – you could use about half the portions that are suggested below.

For foods like meat and fish we have included both cooked and raw portion sizes – these foods lose weight when cooked as they lose water. We've generally used grilling, stewing and baking. Cooking methods that use more oil or fat, such as roasting or frying, will increase the fat and calorie content.

Less than 200kcal - for lighter meals and breakfast

Food	Portion	Calories	How to measure
Chicken breast - raw	160g	-	About half the size of your hand
Chicken breast - grilled	120g	178 kcal	About half the size of your hand
Roast chicken	100g	153 kcal	About 2 and a half slices (calories given for white meat)
Lentils, beans and other pulses	120g	120-140 kcal	About 6 tablespoons
Baked beans	200g	162 kcal	Half a standard 400g can
Eggs (2)	120g	172 kcal	Ready portioned
White fish fillet (not battered or breaded) - raw	140-195g	-	The size of half to a whole hand
White fish fillet (not battered or breaded) - cooked	100-140g	106-148 kcal	The size of half to a whole hand
Tofu	80g	58 kcal	Use the size of pack as a guide
Canned tuna	120g	131 kcal	A whole medium-sized can (about 160g net weight)
Soya mince	100g	110 kcal	Use the size of pack as a guide

Less than 200kcal - for lighter meals and breakfast

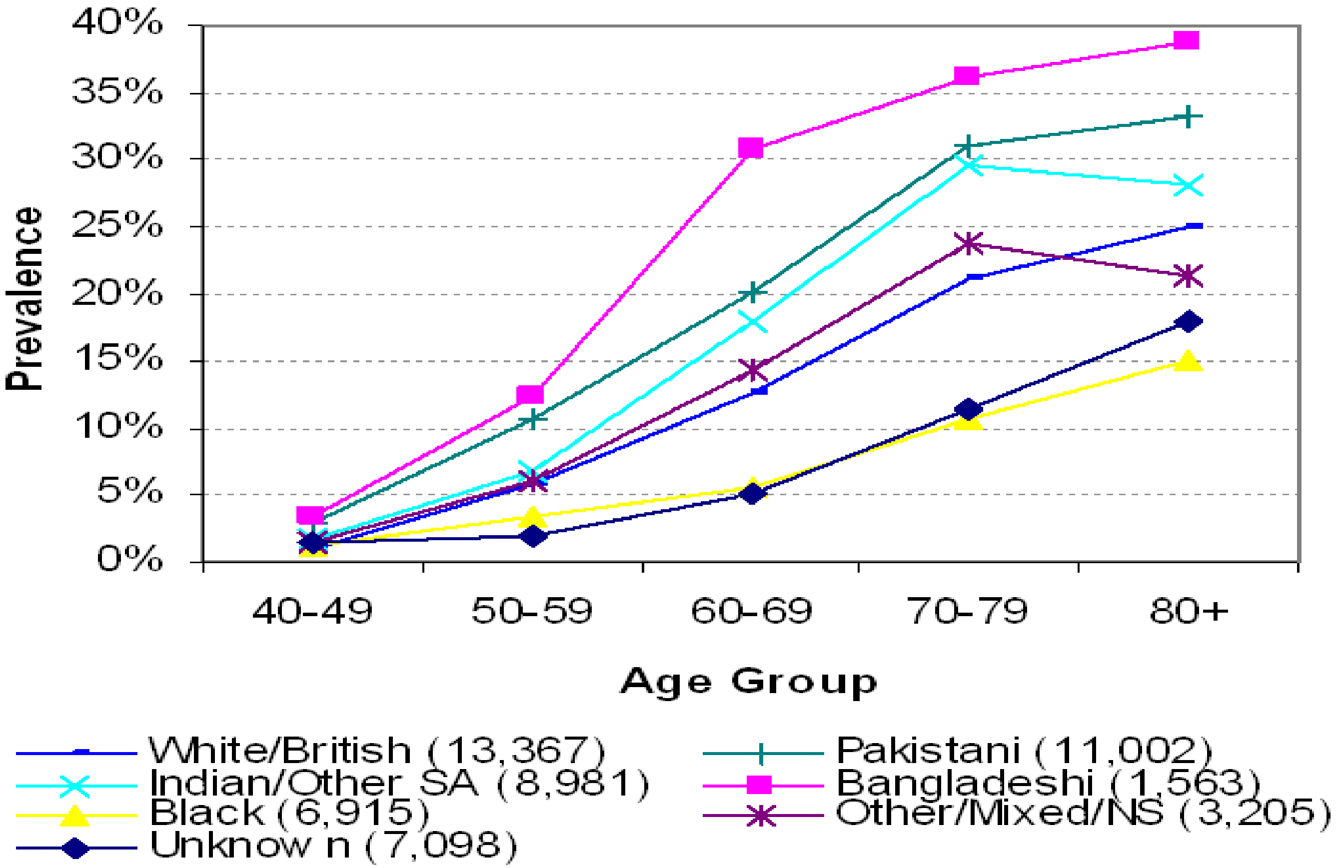
Food	Portion	Calories	How to measure
Quorn mince	100g	103 kcal	Use the size of pack as a guide
Vegetarian sausages (2)	80g	114-154 kcal	Ready portioned
*Bacon (2 slices) - raw	75g	-	Ready portioned
*Bacon (2 slices) - grilled	50g	144 kcal	Ready portioned
*Lean beef mince - raw	125g	-	Use the size of pack as a guide
*Lean beef mince - cooked	100g	157 kcal	Use the size of pack as a guide
*Lean diced stewing pork - raw	150g	-	Use the size of pack as a guide
*Lean diced stewing pork - cooked	100g	169 kcal	Use the size of pack as a guide
*Lean beef stewing steak - raw	125g	-	Use the size of pack as a guide
*Lean beef stewing steak - cooked	100g	185 kcal	Use the size of pack as a guide
Veggie burgers (1)	49-108g	78-147 kcal	Ready portioned
Fish fingers (3)	90g	164 kcal	Ready portioned

*Red or processed meats- these should be limited to an average of 70g of cooked meat per day (about 500g per week).

More than 200kcal - mostly for main meals

Food	Portion size (g)	Calories	How to measure
Salmon fillet - raw	120-165g	-	About half the size of your hand
Salmon fillet - grilled	100-140g	239-335 kcal	About half the size of your hand
Mackerel fillet - raw	125-175g	-	About half the size of your hand
Mackerel fillet - grilled	100-140g	283-396 kcal	About half the size of your hand
*Meat sausages (2 standard size) - raw (Uncooked)	114g	-	Ready portioned
*Meat sausages (2 standard size) - grilled	90g	265 kcal	Ready portioned
*Lean rump steak - raw	175g	-	About half the size of your hand
*Lean rump steak - grilled	130g	310 kcal	About half the size of your hand
*Lamb mince - raw	160g	-	Use the size of pack as a guide
*Lamb mince - cooked	100g	208 kcal	Use the size of pack as a guide
*Beef burger - raw	120-150g	-	Ready portioned
*Beef burger - grilled	80-100g	261-326 kcal	Ready portioned
*Lean stewing lamb - raw	140g	-	Use the size of pack as a guide
*Lean stewing lamb - cooked	100g	240 kcal	Use the size of pack as a guide
Breaded chicken goujons (3)	75g	208 kcal	Ready portioned
Breaded frozen white fish fillet	125g	234 kcal	Ready portioned

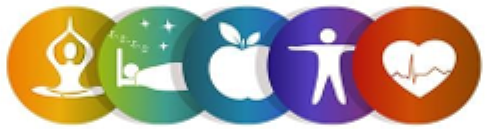
Appendices 6, Figure 2: Prevalence of cardiovascular disease among ethnicities



Appendices 7, Figure 5: Participants information leaflet

Bournemouth University

Do you want to contribute to a survey on dietary intake and physical activity level among the British Bangladeshi population living in the UK?



It has been observed from previous research that the majority of the British Bangladeshis do not meet the dietary recommendation for healthy living.

Bournemouth University are seeking healthy participants to assess dietary intake and physical activity level of the British Bangladeshis

If you decide to take part in this survey, you will be asked few simple questions, that relates to your daily dietary intake (i.e. 1 slice of white bread, a cup of white coffee no sugar etc.) and physical activity that you have performed (i.e. walking slowly 15 minutes, riding bicycle 30 minutes, washing cloths 30 minutes etc.) This survey will take no longer than 25 minutes to complete

To participate in this survey you must:

- Be between the age of (18-60) years
- Be healthy individual with no long-term health complication
- Not be pregnant
- Be able to read and write basic English instruction

This research is being conducted as part of my Master's in research project at Bournemouth University.
If you decide to take part in this survey:
Complete the survey directly: https://www.surveymonkey.com/r/D92VJ3N
Or email me at ssultana@bournemouth.ac.uk I will be able to send you the participant information sheet, agreement form and online survey link.

Confidential Information: No personal identifiable information will be collected in this research and all your data are anonymised. **For more information**: Please contact me: Mrs. Sawda Sultana on ssultana@bournemouth.ac.uk

Appendices 8

Table 15: Government recommendations for energy, macronutrients, salt and dietary fibre for males and females aged 19+ years[2]

Age (years)	19 - 64		65 - 74		75+	
Gender	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**
Energy(MJ/day)	10.5	8.4	9.8	8.0	9.6	7.7
Energy (kcal/day)	2500	2000	2342	1912	2294	1840
Macronutrients						
Protein (g/day)	55.5	45.0	53.3	46.5	53.3	46.5
Fat (g/day) [Less than]	97	78	91	74	89	72
Saturated fat (g/day) [Less than]	31	24	29	23	28	23
Polyunsaturated fat (g/day)	18	14	17	14	17	13
Monounsaturated fat (g/day)	36	29	34	28	33	27
Carbohydrate (g/day) [At least]	333	267	312	255	306	245
Free sugars (g/day) [Less than]	33	27	31	26	31	25
Salt (g/day) [Less than]	6.0	6.0	6.0	6.0	6.0	6.0
Dietary fibre (g/day)	30	30	30	30	30	30

[2]The figures in this table should be used in conjunction with the following information:
Energy figures were derived from SACN Dietary Reference Values for Energy (2011). Figures for all age groups were averaged accordingly. Figures for 19 - 64 year olds have been capped at 10.5 MJ (2500kcal)/day for males and 8.4MJ (2000kcal)/day for females to help address issues of overweight and obesity. The figures for energy in this table relate to the general population and individual requirements may vary.
Protein figures were obtained from Dietary Reference Values for Food Energy and Nutrients for the United Kingdom (1991).
Fat figures were calculated using the energy figures from SACN Dietary Reference Values for Energy (2011). The percentages for which to calculate grams per day of fat (35% food energy); saturated fat (11% food energy); polyunsaturated fat (6.5% food energy) and monounsaturated fat (13% food energy) were obtained from Dietary Reference Values for Food Energy and Nutrients for the United Kingdom (1991).
Carbohydrate figures were calculated using the energy figures from SACN Dietary Reference Values for Energy (2011). The percentage for which to calculate grams of carbohydrate per day (50% total dietary energy) was obtained from SACN Carbohydrate and Health (2015).
Free sugars are any sugars added to food or drinks, or found naturally in honey, syrups and unsweetened fruit juices. The figures for free sugars were calculated using the energy figures from SACN Dietary Reference Values for Energy (2011). The percentage for which to calculate grams of free sugars per day (5% food energy) was recommended in SACN Carbohydrate and Health (2015). No recommendation was made for free sugars for those under 2 years of age.
Salt figures were obtained from SACN Salt and Health (2003). These target salt intakes do not represent ideal or optimum consumption levels, but achievable population goals.
Dietary fibre figures were obtained from SACN Carbohydrate and Health report (2015). These figures are based on evidence in which the consumption of a variety of foods rich in dietary fibre as a naturally integrated component is associated with beneficial health outcomes [SACN Carbohydrate and Health (2015)]. No recommendations were made for children aged under 2 years, however it is recommended that from about six months of age, gradual diversification of the diet to provide increasing amounts of whole grains, pulses, fruits and vegetables should be encouraged.

Appendices 8.1

Table 16 Government recommendations for vitamins for males and females aged 19+ years[4]

Age (years)	19 - 64		65 - 74		75+	
Gender	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**
Vitamin A (µg/day)	700	600	700	600	700	600
Thiamin (mg/day)	1.0	0.8	0.9	0.8	0.9	0.7
Riboflavin (mg/day)	1.3	1.1	1.3	1.1	1.3	1.1
Niacin equivalent (mg/day)	16.5	13.2	15.5	12.6	15.1	12.1
Vitamin B_6 (mg/day)	1.4	1.2	1.4	1.2	1.4	1.2
Vitamin B_{12} (µg/day)	1.5	1.5	1.5	1.5	1.5	1.5
Folate (µg/day)*	200	200	200	200	200	200
Vitamin C (mg/day)	40	40	40	40	40	40
Vitamin D (µg/day)**	10	10	10	10	10	10

[4]The figures in this table should be used in conjunction with the following information:
Vitamin figures were obtained from Dietary Reference Values for Food Energy and Nutrients for the United Kingdom (1991) and SACN Vitamin D and Health (2016).
Niacin equivalent and thiamin figures were cacluated using the energy figures derived from SACN Dietary Reference Values for Energy (2011). Niacin equivalent = niacin + (tryptophan divided by 60)
*Folate: it is recommended that women of child bearing age take a 400µg folic acid supplement daily until the 12th week of pregnancy. This is to help prevent birth defects of the central nervous system, such as spina bifida, in your baby. If there is a family history of conditions like spina bifida (known as neural tube defects), a higher dose of 5mg of folic acid each day may be needed until the 12th week of pregnancy. This is available on prescription from your GP. Women with diabetes and those taking anti-epileptic medicines should speak to their GP for advice, as they may also need to take a higher dose of folic acid.
*Vitamin D: As vitamin D is found only in a small number of foods, it might be difficult to get enough from foods that naturally contain vitamin D and/or fortified foods alone. So everyone, including pregnant and breastfeeding women, should consider taking a daily supplement containing 10µg of vitamin D. Between late March/April to the end of September, the majority of people aged five years and above will probably obtain sufficient vitamin D from sunlight when they are outdoors. So you might choose not to take a vitamin D supplement during these months.
However, some groups of people will not get enough vitamin D from sunlight because they have very little or no sunshine exposure. So the Department of Health recommends that people should take a daily supplement containing 10µg of vitamin D throughout the year if they are not often outdoors, such as those who are frail or housebound; are in an institution such as a care home; usually wear clothes that cover up most of their skin when outdoors. People from minority ethnic groups with dark skin, such as those of African, African-Caribbean or South Asian origin, might not get enough vitamin D from sunlight – so they should consider taking a daily supplement containing 10µg of vitamin D throughout the year.

Appendices 8.2

Table 17:Government recommendations for minerals for males and females aged 19+ years[6]

Age (years)	19 - 64		65 - 74		75+	
Gender	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**
Iron (mg/d)†	8.7	14.8(19-50y) 8.7 (50-64y)	8.7	8.7	8.7	8.7
Calcium (mg/day)	700	700	700	700	700	700
Magnesium (mg/day)	300	270	300	270	300	270
Potassium (mg/day)	3500	3500	3500	3500	3500	3500
Zinc (mg/day)	9.5	7.0	9.5	7.0	9.5	7.0
Copper (mg/day)	1.2	1.2	1.2	1.2	1.2	1.2
Iodine (µg/day)	140	140	140	140	140	140
Selenium (µg/day)	75	60	75	60	75	60
Phosphorus (mg/day)	550	550	550	550	550	550
Chloride (mg/day)	2500	2500	2500	2500	2500	2500
Sodium (g/day)‡	2.4	2.4	2.4	2.4	2.4	2.4

[6]The figures in this table should be used in conjunction with the following information:
Mineral figures were obtained from Dietary Reference Values for Food Energy and Nutrients for the United Kingdom (1991).
†Iron: The figure for women aged 19 – 50 years may be insufficient for women with high menstrual losses where the most practical way of meeting iron requirements is to take iron supplements.

Appendices 9

Table 18: Global Physical Activity Questionnaire

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.

Think first about the time you spend doing work. Think of work as the things that you have to do such as paid or unpaid work, study/training, household chores, harvesting food/crops, fishing or hunting for food, seeking employment. [Insert other examples if needed]. 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? [INSERT EXAMPLES] (USE SHOWCARD)	Yes 1 No 2 If No, go to P 4	P1
2	In a typical week, on how many days do you do vigorousintensity 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?	└┴┘ : └┴┘ Hours : minutes hrs mins	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? [INSERT EXAMPLES] (USE SHOWCARD)	Yes 1 No 2 If No, go to P 7	P4
5	In a typical week, on how many days do you do moderateintensity 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?	└┴┘ : └┴┘ Hours : minutes hrs mins	P6 (a-b)
Travel to and from places			
The next questions exclude the physical activities at work have already that you mentioned. Now I would like to ask you about the usual way you rom places. For example to work, for shopping, toce of travel to and f worship. [insert other examples if needed] market, to pla			
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 P 10	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?	Hours : minutes └┴┘ : └┴┘ hrs mins	P9 (a-b)
Recreational activities			

The next questions exclude the work and transport ou have already mentioned. activities that y Now I would like to ask you about sports, fitness and activities (leisure), [insert relevant terms]. recreational			
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? [INSERT EXAMPLES] (USE SHOWCARD)	Yes 1 No 2 If No, go to P 13	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?	└┴┘ : └┴┘ Hours : minutes hrs mins	P12 (a-b)

Continued on next page

GPAQ, Continued

Physical Activity (recreational activities) contd.			
Questions		Response	Code
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? [INSERT EXAMPLES] (USE SHOWCARD)	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?	└┴┘ : └┴┘ Hours : minutes hrs mins	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. [INSERT EXAMPLES] (USE SHOWCARD)			
16	How much time do you usually spend sitting or reclining on a typical day?	└┴┘ : └┴┘ Hours : minutes hrs min s	P16 (a-b)

Appendices 10, Table 19: HEI–2015 Components & Scoring Standards

Component	Maximum points	Standard for maximum score	Standard for minimum score of zero
Adequacy:			
Total Fruits[2]	5	≥0.8 cup equiv. per 1,000 kcal	No Fruit
Whole Fruits[3]	5	≥0.4 cup equiv. per 1,000 kcal	No Whole Fruit
Total Vegetables[4]	5	≥1.1 cup equiv. per 1,000 kcal	No Vegetables
Greens and Beans[4]	5	≥0.2 cup equiv. per 1,000 kcal	No Dark Green Vegetables or Legumes
Whole Grains	10	≥1.5 oz equiv. per 1,000 kcal	No Whole Grains
Dairy[5]	10	≥1.3 cup equiv. per 1,000 kcal	No Dairy
Total Protein Foods[6]	5	≥2.5 oz equiv. per 1,000 kcal	No Protein Foods
Seafood and Plant Proteins[6,7]	5	≥0.8 oz equiv. per 1,000 kcal	No Seafood or Plant Proteins
Fatty Acids[8]	10	(PUFAs + MUFAs)/SFAs ≥2.5	(PUFAs + MUFAs)/SFAs ≤1.2
Moderation:			
Refined Grains	10	≤1.8 oz equiv. per 1,000 kcal	≥4.3 oz equiv. per 1,000 kcal
Sodium	10	≤1.1 gram per 1,000 kcal	≥2.0 grams per 1,000 kcal
Added Sugars	10	≤6.5% of energy	≥26% of energy
Saturated Fats	10	≤8% of energy	≥16% of energy

1: Intakes between the minimum and maximum standards are scored proportionately.
2: Includes 100% fruit juice.
3: Includes all forms except juice.
4: Includes legumes (beans and peas).
5: Includes all milk products, such as fluid milk, yogurt, and cheese, and fortified soy beverages.
6: Includes legumes (beans and peas).
7: Includes seafood, nuts, seeds, soy products (other than beverages), and legumes (beans and peas).
8: Ratio of poly- and monounsaturated fatty acids (PUFAs and MUFAs) to saturated fatty acids (SFAs).

Appendices 11, Participants Consent/Agreement Form

Participant Agreement Form – Online

Full title of project:
Exploration of diet quality and physical activity level among British Bangladeshi population living in the UK

Name, position and contact details of researcher:

Mrs. Sawda Sultana, Mres Student, s5121098@bournemouth.ac.uk

Name, position and contact details of supervisor:

Dr Swrajit Sarkar, Senior Lecturer, sarkars@bounemouth.ac.uk

In this Form we ask you to confirm whether you agree to take part in the survey by clicking **I Agree**.

You should only agree to take part in the Project if you understand what this will mean for you. If you complete the rest of this Form, you will be confirming to us that:

- You have read and understood the Project Participant Information Sheet attached and have been given access the BU Research Participant Privacy Notice which sets out how we collect and use personal information (https://www1.bournemouth.ac.uk/about/governance/access-information/data-protection-privacy)
- You have had the opportunity to ask questions;
- You understand that:
  - Your participation is voluntary. You can stop participating in the survey at any time without giving a reason, and you are free to decline to answer any particular question(s).
  - If you withdraw from participating in the survey, you may not always be able to withdraw all of your data from further use within the Project, particularly once we have anonymised your data and we can no longer identify you.
  - Data you provide may be included in an anonymised form within a dataset to be archived at BU's Online Research Data Repository.
  - Data you provide may be used in an anonymised form by the research team to support other research projects in the future, including future publications, reports or presentations.

By Pressing **I agree** you consent to take part in the survey

Appendices 12, Participant Information Sheet

Bournemouth University

Participant Information Sheet

The title of the research project

Exploration of diet quality and physical activity level among British Bangladeshi population living in the UK

What is the purpose of the research/questionnaire?

The aim of this research will investigate the dietary quality and physical activity of Bangladeshis living in the United Kingdom.

Why have you been chosen to participate in this research?

You have been chosen because you are a member of the Bangladeshi community, and therefore will be able to offer valuable information regarding dietary quality and physical activity level among this population.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, please read this information sheet carefully and ask me any question that you may have regarding this survey. You can email me at: Mrs. Sawda Sultana, s5121098@bournemouth.ac.uk. You can withdraw from participating in this survey at any time and without giving a reason, simply by emailing on the aforementioned email address. Please note that once you have completed and submitted your survey responses, we are unable to remove your anonymised responses from the study. Deciding to take part or not will not impact upon you.

How long will the questionnaire/online survey take to complete?

During this survey you will be asked few simple questions, which relates to your daily dietary intake (i.e. 1 slice of white bread, a cup of white coffee no sugar etc.) and physical activity that you have performed (i.e. walking slowly 15 minutes, riding bicycle 30 minutes, washing cloths 30 minutes etc.) This survey will take no longer than 25 minutes to complete.

What are the advantages and possible disadvantages or risks of taking part?

The study is being undertaken to explore the diet and physical activity level of the British Bangladeshis living in the UK. The work will enable us to understand the current diet and physical activity undertaken by the British Bangladeshis in the UK. This will then help to design, and device intervention based on current dietary intake and physical activity status among the British Bangladeshis living in the UK.

What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives?

Your daily dietary intake (i.e. 1 slice of white bread, a cup of white coffee no sugar etc.) and physical level activity (i.e. walking slowly 15 minutes, riding bicycle 30 minutes, washing cloths 30 minutes etc.) will be asked and this information will enable us to explore any association between diet and physical activity.

Use of my information

Participation in this study is on the basis of consent: you do not have to complete the survey, and you can change your mind at any point before submitting the survey responses. Once we receive your survey response, your personal information is processed in compliance with the data protection legislation. We will use your data on the basis that it is necessary for the conduct of research, which is an activity in the public interest.

Bournemouth University (BU) is a Data Controller of your information which means that we are responsible for looking after your information and using it appropriately. BU's Research Participant Privacy Notice sets out more information about how we fulfil our responsibilities as a data controller and about your rights as an individual under the data protection legislation. We ask you to read this Notice so that you can fully understand the basis on which we will process your information.

Once you have submitted your survey response it may not be possible for us to remove it from the study analysis, as this might affect our ability to complete the research appropriately or the accuracy and reliability of the research findings.

Sharing and further use of your personal information

As well as BU staff [and the BU student(s)] working on the research project, we will not need to share personal information in non-anonymised form.

The information collected about you may be used in an anonymous form to support other research projects in the future and access to it in this form will not be restricted. It will not be possible for you to be identified from this data.

Retention of your data

All personal data collected for the purposes of this study will be held for one year. Although published research outputs are anonymised, we need to retain underlying data collected for the study in a non-anonymised form for a certain period to enable the research to be audited and/or to enable the research findings to be verified.

Contact for further information

If you have any questions or would like further information, please contact:

Sawda Sultana, s5121098@bournemouth.ac.uk

Swrajit Sarkar, sarkars@bounemouth.ac.uk

In case of complaints

Any concerns about the study should be directed to Sawda Sultana. If you concerns have not been answered, you should contact Professor Vanora Hundley in the Faculty of Health and Social Sciences

Bournemouth University by email to researchgovernance@bournemouth.ac.uk.

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