Stroke in South Asians in the United Kingdom: A Multimethod Study focussing on Bangladeshi.

By

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List of commonly used abbreviations

ADL	Activities of daily living
AF	Atrial Fibrillation
ASU	Acute stroke unit
BHF	British Heart Foundation
BMI	Body mass index
BSREC	Biomedical & Scientific Research Ethics Committee
CCF	Congestive Cardiac Failure
CCG	Clinical Commissioning Group
CHD	Coronary heart disease
CT scan	Computed tomography scan
CVD	Cardiovascular disease
DALYs	Disability adjusted life years
DBP	Diastolic blood pressure
ED	Emergency Department
ESD	Early Supported Discharge
FAST	Face Arm Speech Test
HASU	Hyper Acute Stroke Unit
HBA1c	Glycated Haemoglobin
HDL	High density lipo-protein
HEFT	Heart of England Foundation Trust
IHD	Ischemic heart disease
HS	Hemorrhagic Stroke
IS	Ischemic Stroke
IgG	Immuno gamma Globulin
LDL	Low density lipo-protein
LMIC	Low Middle-Income Countries
LoS	Length of Stay
MDT	Multidisciplinary Team
mRS	Modified Rankin Score
NCD	Non-communicable disease
NICE	National Institute for Health & Care Excellence
NIHSS	National Institutes of Health Stroke Scale
OCP	Oral Contraceptive Pills
OT	Occupational Therapist
PHE	Public Health England
PMH	Past Medical History
PUFA	polyunsaturated fatty acids
PT	Physiotherapist
QALY	Quality of life adjusted years
QOF	Quality and Outcomes Framework
R & D	Research and Development
ROSIER	Recognition of Stroke in the Emergency Room
RTI	Respiratory Tract Infection

SSNAP	Sentinel Stroke National Audit Programme
SLT	Speech and Language Therapists
TB	Tuberculosis
SWBH	Sandwell & West Birmingham Hospital
UTI	Urinary tract infection
WHO	World Health Organisation
WMPHO	West Midlands Public Health Observatory

Glossary (Bhopal 2004)

African	A person with African ancestral origins who self-identifies, or is identified, as African, but excluding those of other ancestry.
Afro-Caribbean/African Caribbean	A person of African ancestral origins whose family settled in the Caribbean before emigrating and who self-identifies, or is identified, as Afro-Caribbean (in terms of racial classifications, this population approximates to the group known as Negroid or similar terms).
Bangladeshi	A person whose ancestry lies in the Indian subcontinent who self-identifies, or is identified, as Bangladeshi. (See also South Asian.) Between 1947 and 1971 the land known as Bangladesh was East Pakistan and before that India. There is no clear-cut equivalent in terms of racial classifications, though historically Northern Indians have been classified as white, and some Indian tribes as aboriginal. (The racial term Malayan, coined by Blumenbach, is forgotten as purposeless.)
Black	A person with African ancestral origins, who self-identifies, or is identified, as Black, African or Afro-Caribbean (see, African and Afro-Caribbean).
Caucasians	An Indo-European. This is Blumenbach's 18th century term for the white race of mankind, which he derived from the people who lived in the Caucasus. This term is usually used synonymously with Caucasoid, European, or White.
Chinese	A person with ancestral origins in China, who self identifies, or is identified, as Chinese. (In terms of historical racial classifications, Chinese approximate to the group known as Mongolian or Mongoloid.)
Ethnicity	The social group a person belongs to, and either identifies with or is identified with by others, as a result of a mix of cultural and other factors including language, diet, religion, ancestry, and physical features traditionally associated with race (see race).
Ethnic minority group	Usually, but not always, this phrase is used to refer to a non-White population. Alternatively, it may be used to describe a specific identifiable group, for example, gypsy travellers, and less commonly, Irish in the UK. Some people consider the phrase inaccurate and prefer minority ethnic group, but the two phrases are used synonymously.
Hindu	A person who regards themselves as culturally, ethnically, or religiously adhering to aspects of Hinduism.

Also an old, now seldom-used term, for Indians. A term occasionally used more or less synonymously with South Asian. In some countries such as Holland the term is used to describe the ethnicity of Surinamese of Indian subcontinent ancestry.

Indian — A person whose ancestry lies in the Indian sub-continent who identifies, or is identified, as Indian (see, South Asian). (Major changes to India's geographical boundaries took place in 1947 when Pakistan was created.)

Indigenous — This term is usually used to mean a person who belongs naturally to a place in the sense of long-term family origins (see Native). This term is sometimes used to identify the majority population, for example, in the United Kingdom as an alternative to the word White. In some parts of the world, for example, Australia, the word indigenous is used specifically to refer to aboriginal populations (for example, Aborigine).

Irish — A person whose ancestry lies in Ireland who self identifies or is identified, as Irish but this label is generally restricted to the White population (see, White).

Muslim — Believing in and practising Islam; connected with the religion of Islam.

Pakistanis — A person whose ancestry lies in the Indian subcontinent who identifies, or is identified, as Pakistani (see South Asian). Some may have birth or ancestral roots in the current territory of India but identify with Pakistan, a country created in 1947.

Race — By historical and common usage the group (sub-species in traditional scientific use) a person belongs to as a result of a mix of physical features such as skin colour and hair texture, which reflect ancestry and geographical origins, as identified by others or, increasingly, as self-identified.

Racism/institutional racism — A belief that some races are superior to others, used to devise and justify individual and collective actions that create and sustain inequality among racial and ethnic groups. Individual racism is usually manifested in decisions and behaviours that disadvantage small numbers of people. Institutional racism, whereby policies and traditions, sometimes unwittingly, favour a particular racial or ethnic group, may be less obvious but may disadvantage large populations.

South Asian — A person whose ancestry is in the countries of the Indian subcontinent, including India, Pakistan, Bangladesh, and Sri Lanka (in terms of racial classifications, most people in this group probably fit best into Caucasian or Caucasoid but this is confusing and is not recommended). This label is usually assigned, for individuals rarely identify with it. (See also Indian, Indian Asian, Asian, Pakistani, Bangladeshi.)

White/White Europeans The term usually used to describe people with European ancestral origins who identify, or are identified, as White (sometimes called European, or in terms of racial classifications, the group known as Caucasian or Caucasoid). The word is capitalised to highlight its specific use. The term has served to distinguish these groups from those groups with skin of other colours, and hence derives from the concept of race but is used as an indicator of ethnicity. There are problems of poverty and excess disease in subgroups of the White population, which cannot be unearthed and tackled by using the label White.

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Raheela B Shaikh 12th April 2022

Declaration

This thesis is submitted to the University of Warwick in support of my application for the degree of Doctor of Philosophy. I confirm that any material contained in the thesis is my own work and has been composed by myself and has not been submitted in any previous application for any degree at another university.

Student Name: Raheela B Shaikh Date: 8 July 2022

Abstract

Background: Stroke is the fourth leading cause of death and a major cause of disability in the UK. Ethnicity is one of the independent predictors of stroke.

Aim: To explore stroke in the South Asian population in the UK, with a focus on Bangladeshis.

Methods: Multi-method study, comprising a systematic review of the epidemiology of stroke in South Asians in the UK and four primary studies:

(i) Secondary data analysis of the Wandsworth Heart and Stroke Study (WHSS) in South London, exploring risk factors associated with stroke in the Bangladeshi population.

(ii) Freedom of Information (FOI) request of Birmingham hospitals to explore stroke admissions by ethnic group.

(iii) Case-note analysis of patients admitted with stroke at a Birmingham hospital, exploring risk factors by ethnic group (White Europeans, Indian, Pakistani, Bangladeshi).

(iv) Audit of the acute stroke pathway at a Birmingham hospital to explore the management of stroke by ethnic group (as above).

Results: The systematic review identified a higher mortality rate from stroke in the South Asian population in the UK. The WHSS showed that risk factors, such as the prevalence of hypertension and diabetes, are highest amongst South Asians compared with White Europeans, with a tendency for the highest risk amongst the Bangladeshi population.

The FOI data showed that the average age of admission for stroke was significantly lower for South Asians compared with White British, being most marked for the Bangladeshi population.

The case-note analysis of stroke patients identified that Bangladeshis had the highest proportion with a past medical history of infection and low post-stroke blood pressure; had the highest proportion with haemorrhagic stroke; and the highest mortality rate. Atrial fibrillation was significantly more common in White Europeans.

No significant differences were recorded in the stroke treatment pathway by ethnicity.

Conclusion: Even though the sample sizes are small, ethnic differences in stroke risk factors have been found which need further exploration, particularly amongst the Bangladeshi population.

A culturally sensitive targeted health promotion programme could potentially reduce the risk of stroke in the Bangladeshi population.

Chapter 1: Introduction

1.1 Epidemiology of Stroke

Stroke is a major, preventable, public health problem for both the developing and the developed world (Johnson *et al.,* 2016). The World Health Organization (WHO) defines stroke as “the clinical syndrome of rapid onset of focal (or global) cerebral deficit, lasting more than 24 hours (unless interrupted by surgery or death), with no apparent cause other than a vascular one” (WHO, 1988). In simple terms, stroke is a “brain attack”; it happens either when a blood vessel ruptures (haemorrhagic stroke) or the blood supply to the brain is obstructed (ischaemic stroke) (National Collaborating Centre for Chronic Conditions, 2008).

Non-communicable diseases (NCDs) constitute 70% of the global burden of disease, ranging from 37% in low-income countries to 88% in high-income countries (World Health Organization, 2017). Out of 56.4 million global deaths in 2015, 39.5 million (almost 70%), were due to NCDs. Of these 39.5 million deaths, 17.7 million (45%) were due to cardiovascular diseases (CVD) making CVD the number one cause of death globally. CVD is a group of heart and blood vessel disorders. CVD comprises cerebrovascular disease, coronary heart disease (CHD), rheumatic and congenital heart disease, peripheral arterial disease and deep vein thrombosis (World Health Organization, 2017). Fifteen million deaths in 2015 were attributed to ischaemic heart disease and stroke and these diseases have maintained their position as the leading causes of death globally for the last 15 years (World Health Organization, 2017). Heart attacks and strokes are caused by blockages to the blood vessels supplying the heart or brain. This blockage is usually due to a combination of risk factors. Heart attacks and strokes contribute 85% of CVD deaths globally (World Health Organization, 2017). Stroke not only has high mortality but also high morbidity worldwide.

1.1.1 Globally

Globally, 10 million people suffer a stroke each year; almost six million people die of stroke and around five million are likely to be left disabled (World Heart Federation, 2015). Of these six million deaths, two thirds occur in developing countries (World Heart Federation, 2015). The incidence of stroke has doubled in the last four decades in developing countries whereas it has declined by 42% in high income countries (Feigin, *et al.*, 2009). People living in low- and middle-income countries have stroke occurrence 15 years earlier and it causes more deaths than in high-income countries (Owolabi, *et al.*, 2015).

There has been a rapid transformation seen in health in the last few decades. The population size is increasing due to people living longer (Institute of Health Metrics and Evaluation, 2013). Stroke predominantly affects elderly people. It is the second leading cause of death globally in populations above the age of 60 years, accounting for 10% of all deaths. Though stroke is less common in people under 40 years of age, it is still the fifth leading cause of death in people aged 15 to 59 years (World Heart Federation, 2015).

1.1.2 South Asian countries

The total population of South Asian countries constitutes 22% of the world population. India, Pakistan and Bangladesh are the most populous South Asian countries (Feigin, *et al.*, 2009). The WHO estimates that 86% of world stroke deaths occur in these countries (Feigin, *et al.*, 2009). In these and other low- and middle-income countries (LMIC), the epidemiological transition has been associated with decreased mortality from infectious disease and the rise of chronic illnesses such as stroke and coronary heart disease (Wasay, *et al.*, 2014).

Pakistan, Sri Lanka and Bangladesh reported a higher prevalence of stroke in younger age groups (Wasay, *et al.*, 2014). Mortality due to stroke is also high in these countries (Wasay, *et al.*, 2014). Apart from traditional risk factors (hypertension, diabetes, hypercholesterolaemia), one of the non-traditional risk factors highly prevalent in these areas is tobacco chewing (Wasay, *et al.*, 2014). In South Asian countries, haemorrhagic stroke is more prevalent than ischaemic stroke (Wasay, *et al.*, 2014).

1.1.3 Bangladesh

According to the World Health Rankings, data published by the World Health Organization in 2011, Bangladesh ranks 84th in the world for stroke deaths (Islam, *et al.*, 2013). In Bangladesh, stroke is the third leading cause of death (Islam, *et al.*, 2013). There were no community-based stroke incidence studies conducted in Bangladesh until 2013 (Islam, *et al.*, 2013) but a few hospitals-based studies have been conducted in major hospitals.

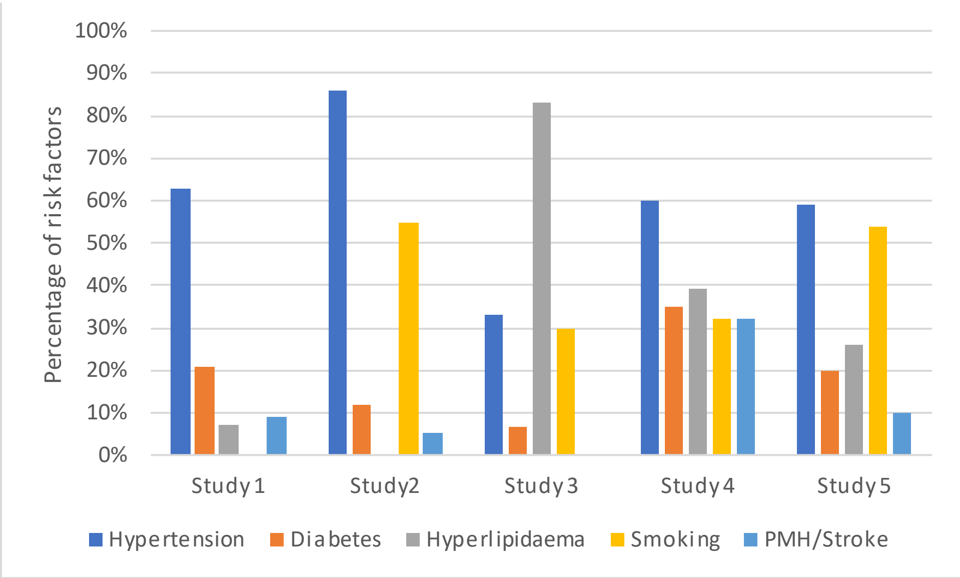


Figure 1.1: Reported risk factors among Bangladeshi stroke patient in Bangladesh in five studies (Study1: Hossain *et al.*, 2011, 2: Siddique *et al.*, 2009, 3: Miah *et al.*,2008, 4: Hossain *et al.*, 2009, 5: Mohammed *et al.*, 2009)

Three hospital-based studies (Hossain, *et al.*, 2011; Miah, *et al.*, 2008; Siddique *et al.*, 2009) reported a higher prevalence of stroke in males compared with females in Bangladesh. Hossain *et al.*, (2011) reported that 74% of patients who had a stroke were male and 26% were female, with a male-to-female ratio of 2.8:1. The other two studies (Miah *et al.*, 2008.; Siddique *et al.*, 2009) reported lower male-to-female ratios but stroke was still higher in males (1.27:1 and 1.35:1 respectively). Stroke prevalence is reportedly more common in people who live in urban areas compared to rural areas (Hossain, *et al.*, 2011). Along with these three studies, there were two other studies (Hossain, *et al.*, 2009; Mohammed, *et al.*, 2009) that reported risk factors among hospitalized patients between 2007-2009. The most common risk factors reported by the five studies are hypertension, diabetes, hyperlipidaemia, smoking, and a past medical history of stroke (Figure 1.1, above). The use of oral contraceptive pills in females is also an important risk factor (Islam, 2013). One of the studies (Study 3) (Miah, *et al.*, 2008) reported hyperlipidaemia as the most influential risk factor rather than hypertension among young stroke patients. However, this may be due to the small sample size (n=50). One of the largest community studies in Bangladesh of 15,627 adults aged 40 years and above found an increasing risk of stroke with increased age (Mohammad, *et al.*, 2011).

All the studies conducted in Bangladesh reported hypertension as a major risk factor among stroke patients of all ages. This thesis will explore whether similar trends have been found in the UK by doing a systematic review of the studies conducted in the UK amongst the South Asian/Bangladeshi populations (Chapter 4).

1.1.4 United Kingdom

In the United Kingdom (UK), stroke occurs more than 100,000 times a year, i.e. one stroke every five minutes, resulting in 38,000 deaths in 2016 (Stroke Association, 2018). One in fourteen deaths are caused by stroke in the UK. In the UK, incidence rates differ depending on the country or region being researched (Feigin, *et al.*, 2003; Wang, *et al.*, 2013). Recent data from Public Health England (2018b) reported a fall in the incidence of first stroke rate by 8% from 1.16/1000 population in 2007 to 1.07/1000 population in 2016. The risk of having a stroke in men is 25% higher than in women but the total incidence of stroke is higher in women due to their longer life expectancy in the UK (Stroke Association, 2017). Strokes are also responsible for around 9,500 premature deaths each year (Scarborough, *et al.*, 2009). This premature mortality is high in people born outside of the UK; for Bangladeshi men it is three times higher than for men born in England (Scarborough, *et al.*, 2009). The relationship between ethnicity and the outcome of a stroke will be explored in detail in Chapter 8.

1.2 Stroke in British South Asians

In the UK, the prevalence of stroke, diabetes and coronary heart disease (CHD) is high in the South Asian community (people of Indian, Pakistani, and Bangladeshi origin), with the Bangladeshi population most severely affected (Balarajan and Raleigh, 1997). In England and Wales, one in twenty patients have a recurrent stroke whilst in hospital (Stroke Association, 2018). People of South Asian origin have a higher prevalence of high blood pressure, high cholesterol and diabetes, compared to the White population in the UK, which increases their risk of stroke (Bhopal, 2019).

Due to a lack of population-based stroke studies in South Asian migrants in the UK, the epidemiology of stroke in this group is limited. The first study in the UK was conducted in London to analyse differences in stroke subtype and risk factor profiles between South Asian and White stroke patients using the St Mary's Hospital's stroke unit database (Banerjee, *et al.*, 2010). The study suggested significant differences that needed further investigation.

Ethnicity is one of the independent predictors of the severity of stroke but there is a lack of information on the impact of South Asian ethnicity on stroke severity (Jones, *et al.*, 2000). Wolfe *et al.* (2002) reported that the incidence of stroke has increased in ethnic minority populations in the UK in recent years. There is also a clear socioeconomic inequality in death rates from stroke as the highest death rates are in the most deprived socioeconomic groups (Townsend, *et al.*, 2012). Ethnicity was not classified by specific ethnic groups but the report mentioned that the standardised rates demonstrated an increased gap between the least and most deprived groups and reported an earlier onset of stroke in the Asian ethnic group (median age in the Asian group of 66.5 years compared to 72 years in the White ethnic group) (Pubic Health England, 2018).

The mortality rate from stroke is reported to be 1.5 times higher in the South Asian population compared to the general population (Wild and McKeigue, 1997). The standardised mortality ratio for stroke is two to three times higher than the national average in men and women born in Bangladesh and now living in the UK (Bhopal, *et al.*, 2005).

In 2001, the Bangladeshi population had the highest rates of illness in the UK (Balarajan & Raleigh, 1997). Bangladeshi men were three times more likely to visit their doctor than men in the general population (Balarajan & Raleigh, 1997). Bangladeshis also had the highest rates of disability and were more likely to smoke than any other ethnic group, with a prevalence of 44% in 1999 in England (Office for National Statistics, 2001). Smoking was very common amongst men (82%) but fewer women smoked (22%), perhaps due to cultural customs (McKeigue, *et al.*, 1988). Overall mortality rates in the Bangladeshi population are higher due to stroke and diabetes as compared with other Asian groups in the UK (Balarajan & Raleigh, 1997). This picture is supported by a study conducted on the South Asian population in the UK. They found that Bangladeshi men have higher mortality compared with other South Asian populations (Gill, *et al.*, 2007).

1.3 Burden of stroke

As one of the leading causes of disability, stroke survivors face restrictions in their daily activities and most of them suffer great dependency on other people for day-to-day living (Truelsen, *et al.*, 2000). Mortality presents only some of the picture of the disease burden. Overall, the burden of disease is calculated by the Disability Adjusted Life Years (DALY).

What does a DALY represent? "One DALY represents the loss of the equivalent of one year of full health" (Mathers, 2008, p.4). Around 35% of people who have survived a stroke are left disabled annually (World Health Organisation, 2010). This places a heavy burden not only on the family but also on society. The burden of stroke was projected to increase from 38 million DALYs in 1990 to 61 million DALYs in 2020 (World Health Organisation, 2010). Stroke is gaining national and global public health attention not only due to premature mortality but also as the second largest contributor to DALYs after ischaemic heart disease in low-middle-income countries and it is the third largest contributor to DALYs in high income countries (Feigin *et al.*, 2014).

Globally, tackling strokes has become not only a public health issue but also an important economic imperative due to the cost involved in patient care (Mensah, *et al.*, 2015). Stroke affects not only an individual's health but also impacts the economic status of individuals, their families and society (Di Carlo, 2009). If these trends in stroke epidemiology continue, there will be almost 12 million stroke deaths, 70 million stroke survivors and more than 200 million DALYs lost globally by 2030 (Feigin, *et al.*, 2014). Stroke is the single largest cause of major disability in the UK. Due to disability and death, income loss is estimated to be approximately 15% of total societal cost, being around £1.33 billion in the UK (Stroke Association, 2016).

Stroke care costs include direct and indirect costs due to treatment and lost productivity, respectively. Direct costs comprise hospital care, primary care, prescribing, rehabilitation and social care costs such as home care and nursing home care for people with impairments in activities of daily living as a result of stroke (Benjamin, *et al.*, 2015). Direct care costs are around 50% of the total, informal care costs 26% and the indirect costs total 24%. Stroke places a burden on communities and the NHS, costing around £3.4 billion per year to the

NHS (Patel, *et al.*, 2017). An individual stroke was estimated to cost £22,000 in the first year and £45,000 over five years in 2016 (Dunn, 2017). The estimated cost of informal care is estimated to be £2.5 billion/year in the UK (Patel *et al.*, 2017).

Currently in the West Midlands it is estimated that the total cost of stroke is £77 million based on average costings (Rogers, 2018). This cost can be minimised by reducing the number of secondary strokes and by minimising disability after stroke. In the acute phase of a stroke, the treatment given and the preventive measures implemented are important elements influencing the outcome of stroke for the patient (Zweifler, 2003).

1.4 Epidemiological transition in Stroke

Changing patterns of a population's disease and health has emerged as an area of interest since 1798 when Thomas Malthus argued that 'population growth will always tend to outrun the food supply' and that 'betterment of the lot of mankind is impossible without stern limits on reproduction'(Cappuccio, 2004, p.387). This is the time when the theory of the epidemiological transition evolved (Cappuccio, 2004).

"The theory of epidemiologic transition begins with the major premise that mortality is a fundamental factor in population dynamics" (Omran, 1971, p.733). The theory of epidemiological transition proposed by Omran (1971) aimed to understand the connections between health patterns and disease and how their demographic, economic and sociologic determinants and consequences interact with each other. The transition seen in England during the 19th century was classified by Omran as a 'Classical' transition, which was defined as a "gradual and progressive change from high mortality and high fertility to low mortality and low fertility" (Omran, 1971, p.753).

Due to epidemiological transitions between 1990 and 2010, life expectancy has increased, so that the leading causes of death have changed, shifting from infectious diseases to non-communicable diseases (NCDs) (Institute of Health Metrics and Evaluation, 2013). Consequently, there is also a global shift in the burden of stroke (Institute of Health Metrics and Evaluation, 2013). IHD and stroke have moved from being the 4th and 5th leading global causes of death to be the 1st and 3rd, respectively (Institute of Health Metrics and Evaluation, 2013) (Figure. 1.2).

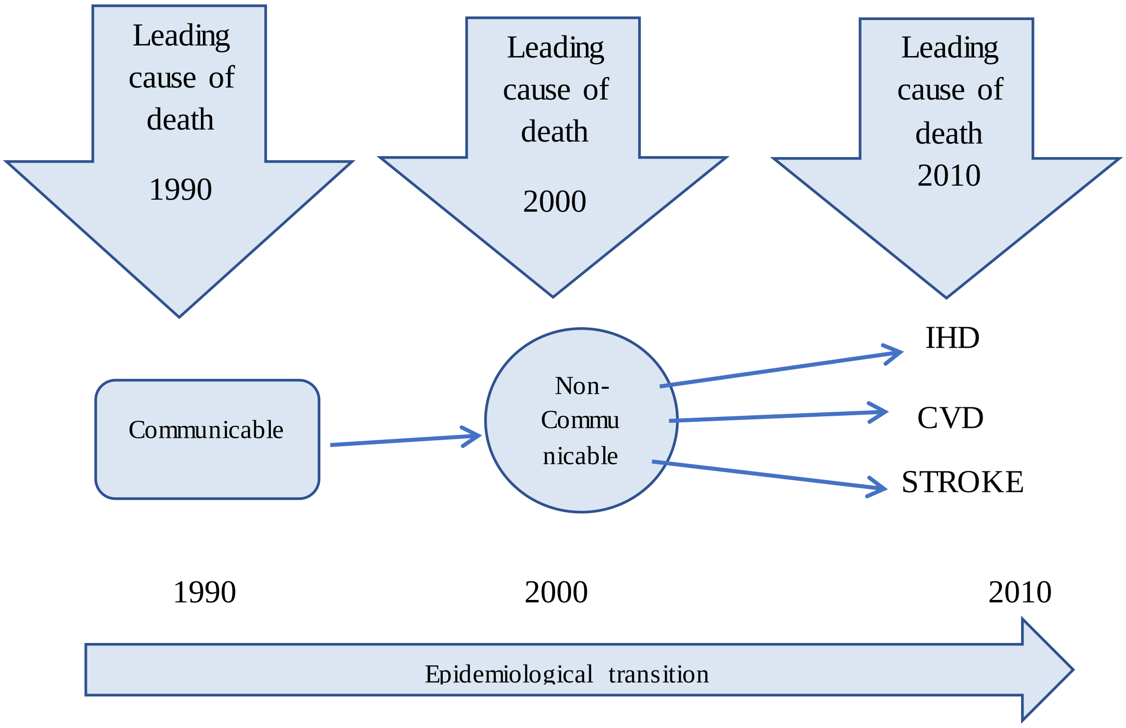


Figure 1.2: Global epidemiological transition from 1990 to 2010 in the occurrence of stroke (Source: Institute of Health Metrics and Evaluation, 2013)

A systematic review by Feigin *et al.* (2014) suggests that stroke was a disease of the elderly. However, this is no longer true. Data from the Global Burden of Disease (GBD) (2010) suggests that there is a shift in incidence of stroke from elderly individuals to those younger than 75 years. Data from 1990 to 2010 shows a decrease in stroke incidence in high income countries, yet an increase in low- to middle-income countries. This increase is evident not only in older people but also in younger persons (Feigin *et al.*, 2009). Along with incidence, there is a decrease in early stroke case fatality in high income and low- to middle-income countries (Feigin *et al.*, 2009).

Significant differences are found in health indicators due to globalisation and these differences occur due to the practice of healthcare, which can be different between the place of origin and destination (MacPherson, 2001). This is a key area of research and this study will highlight it by using available data about ethnic minorities in the UK. This will help us to understand the associations between stroke, its management and association with ethnicity (See chapter 7 and 8).

1.5 Risk Factors associated with stroke

Stroke is multi-factorial in origin. A plethora of putative and confirmed risk factors have been listed and tested in various types of studies. According to Brainin *et al*. (2014) the risk factors for stroke are classified according to their potential for modification and strength of evidence (Table 1.1).

Table 1.1: Classification of risk factors associated with stroke (Brainin *et al*., 2014)

Potential for modification	
Non-modifiable	Age Gender Low birth weight Ethnicity Genetic factor
Modifiable or potentially modifiable	Smoking Excessive alcohol drinking Diabetes Hypertension Atrial fibrillation Dyslipidaemia Carotid artery stenosis Depression
According to evidence	
Well documented	Sickle cell disease Postmenopausal hormonal therapy Poor diet Physical inactivity Obesity Central body fat distribution
Less well documented	Metabolic syndrome Drug abuse Oral contraceptive use Sleep disordered breathing Migraine headache Elevated gamma-glutamyl transferase Hyperhomocysteinemia Elevated lipoprotein Elevated lipoprotein phospholipase Hypercoagulability Inflammation and infection

There are modifiable and non-modifiable risk factors associated with stroke. Modifiable risk factors include diet, obesity, alcohol, lack of exercise, raised cholesterol, high blood pressure, smoking, diabetes, sleep apnoea and atrial fibrillation. Non-modifiable risk factors are increased age, male gender and ethnicity (Higgins & Abbott, 2010). In this study, stroke risk factors among South Asians were stratified and reported as traditional (hypertension, diabetes and hypercholesterolaemia) and non-traditional/novel risk factors (e.g. use of oral contraceptive pills, infection). Obesity, smoking, and physical activity are additional traditional stroke risk factors which are less frequently reported among South Asians in the UK (Chapter 4).

There were differences in all-cause mortality in migrant groups compared with the general population, except in migrants from the Caribbean (Wild and McKeigue, 1997). Irrespective of the country of origin, migrants from South Asia had a higher prevalence of cardiovascular disease compared with the indigenous reference population (Balarajan, 1991; McKeigue & Marmot, 1988; Wild & McKeigue, 1997). As compared with the White population, one of the potentially modifiable risk factors influencing this difference is hypertension, the rate of which was reported to be double in South Asians in the UK (Cappuccio, 1997; McKeigue, *et al.*, 1991).

However, in the Bangladeshi population, mean systolic blood pressure and total and low-density lipoprotein (LDL) have been shown to be lower than in White Europeans (McKeigue *et al.*, 1988). A population-based survey was conducted by Cappuccio, *et al.* (1997) in South London that focused on differences in cardiovascular risk factors between and within each ethnic group, and this has now been analysed for the Bangladeshi, Indian and Pakistani populations (Chapter 5). The incidence of stroke in South Asian migrants has not been studied extensively as there are insufficient data available to carry out these studies. This is focused on in Chapter 4.

1.6 Management of Stroke

Along with disparities in health there are also disparities in healthcare among ethnic minority groups (Szczepura, 2005). These inequalities in access to healthcare services could be due to several reasons, including language barriers, health beliefs and religion, racism in healthcare service delivery and knowledge of, and attitude towards, health (Szczepura, 2005).

The burden of stroke-related disability, along with constraints on NHS resources, demand that stroke care needs to be focussed even more on effective and efficient treatment that will reduce long-term disability and dependency. The quality of stroke care has been shown to have improved continuously since 2013, as audited regularly by the Sentinel Stroke National Audit Programme (SSNAP). The number of high-quality research studies published on what works, and what doesn't, especially in rehabilitation, has rapidly increased. Still there is a lack of studies by ethnic group, particularly focussing on the South Asian sub-group (Bowen, *et al.*, 2016). In a majority of studies reported amongst ethnic minority groups there was evidence for a lower standard of care compared with Caucasians (Stansbury, *et al.*, 2005).

There is evidence supporting that the way stroke care is organised and staffed can make a big difference to the chance of stroke recovery (Bowen, *et al.*, 2016). Stroke care includes pre-hospital care to long-term management after stroke. However, an acute stroke pathway is designed to cover the period from admission to hospital (HASU) to discharge. To treat and prevent further stroke, the NHS in England has reconfigured stroke services into acute and hyperacute stroke units after successful outcomes of centralised stroke units in London in 2010 (Allen, *at el.*, 2017).

By 2014, West Midlands stroke services were reconfigured into hyperacute and acute stroke units. Hyperacute and acute stroke services aim to ensure that the West Midlands population has equal and timely access to world-class stroke care. This service provides expert specialist clinical assessment, rapid imaging, and the ability to deliver 24/7 intravenous 'clot-busting' thrombolysis and 'clot retrieval' thrombectomy treatment (Rogers, 2018). Chapter 8 is going to audit an acute stroke pathway, to explore whether these standards of care are met equally by all ethnic groups.

However, it is still unclear if differences in the management of stroke exist among ethnic minority groups (Stansbury, *et al.*, 2015). Disparities in stroke management by ethnic group are discussed in detail in Chapter 4, and Chapter 8 explores the management of stroke by individual ethnic groups.

1.7 Bangladesh and its social fabric

Present day Bangladesh is the huge delta region formed at the junction of the Ganges and the Brahmaputra rivers. Bangladesh is situated in Southern Asia bordering the Bay of Bengal, Myanmar and India (CIA, 2020). For much of the first millennium A.D., Bangladesh was loosely formed and remained a remote part of different empires (CIA, 2020). During the tenth century, predominantly from Arab and Persian traders, Muslim conversion and settlement began in the region. In the sixteenth century, Europeans established their first trading posts in the region. The western region was predominantly Hindus and Muslims. The region was then known as ‘Bengal’ and became part of British India (CIA, 2020). During 1947, partition between eastern Pakistan and western Pakistan wings led to the Bengali independence movement. Awami League (AL), a political party, led the movement and, supported by India, won the war of independence for Bangladesh in 1971 and became ‘The People’s Republic of Bangladesh’ (CIA, 2020).

It is estimated that the population of Bangladesh is 162 million, making it the 8th most populated country in the world (CIA, 2020). Demographically, the population of Bangladesh is ethnically homogeneous where the Bengali group constitute at least 98% and the other indigenous (Adivasis) ethnic group consists of only 1.1% (2011 est.) (CIA, 2020). Under the 2010 Cultural Institution for Small Anthropological Groups Act, the government of Bangladesh recognised twenty-seven indigenous ethnic groups. The majority of the population defined their religion as Islam (89.1%), followed by Hinduism (10%), Buddhism (0.6%) and Christianity (0.3%). Bangla (a.k.a. Bengali) is an official language of Bangladesh and most (98.8%) of the population speaks Bangla, whereas only 1.2 % speak other languages (CIA, 2020).

1.8 Bangladeshi Population in the UK

South Asians are a group of people from the Indian sub-continent, including India, Pakistan, Bangladesh and Sri Lanka, which continue to be frequently highly ranked as non-UK countries of birth in the National Census data (Office for National Statistics, 2013). Data from the 2011 UK census suggest that there has been a considerable increase in the population groups from different ethnic minority backgrounds compared to ten years previously. According to the 2001 census, 8.7% of the population was of ethnic minority origin, with an increase to 14% in 2011 (Figure: 1.3) (O'Brien & Potter-Collins, 2015).

Recent migration of Bangladeshi people to the UK can be better understood by considering early seafaring connections. Early routes before 1970 were established between certain parts of East Bengal, particularly from Sylhet to East London during the nineteenth century (Garbin, 2005). Sylhet district was located along shipping routes from Assam to Kolkata and international trading ships used to embark from there (Choudhury, 1993). During this period many young Sylheti men visited Kolkata in search of employment on the trading ships (Adams, 1987; Choudhury, 1993, 1995). The first wave of mass migration occurred in the early 1950s from Bangladesh to Britain which was mainly from Sylhet (Adams, 1987).

The period from 1950 to 1962 is considered the “golden age” of migration to Britain. Substantial numbers of international passports were granted to the Bengali sailors and seamen. Predominantly Sylhetis from East Bengal took up this opportunity and came to the UK. Sylhetis who were already employed in Britain started seeking suitable employment for their relatives and friends, and thereby established sustainable ‘chain migration’ for Sylhetis (Das, 2013). A large number of them settled in East London boroughs.

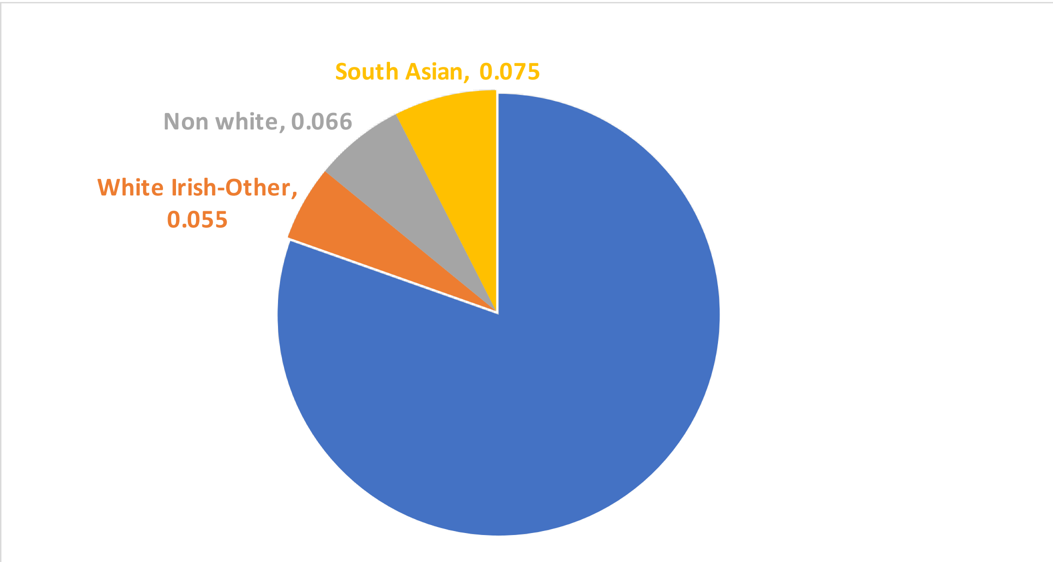


Figure 1.3: Ethnic groups in England and Wales (Source: Census, 2011)

Bangladeshi men started to work initially in steel and textile mills across England but after the collapse of these industries, they turned to small businesses such as tailoring and catering. The majority started working in restaurants and takeaways. The percentage of Bengali migrants working in hotels and catering was 65%; six times the average for Greater London (Piggott, 2004; Baker and Mohieldeen, 2000). Bengali migrants were more likely to be self-employed than other ethnic groups (Das, 2013), but only 2.1% of Bangladeshis compared to 6.1% of total population occupied higher managerial professions (Peach, 2005).

In the 2011 UK census the total Bangladeshi population was 447, 201 (0.8%) (Champion and Falkingham, 2016). People of Bangladeshi origin are found predominantly in Greater London (54.37%), particularly in Tower Hamlets and Newham, followed by Birmingham in the West Midlands (11%) (Figure: 1.4) (Ghee, 2014). 52% were male and 48% female. A considerable number of Bangladeshi people living in the UK are young with a median age of 18 years compared to 37 years for the White population; with around 40% of the Bangladeshi population being less than 16 years of age (Office for National Statistics, 2014). Bangladeshis form one of the UK's youngest and fastest growing communities (Ghaill & Haywood, 2005).

Over the last 50 years, at least two generations of Bangladeshis have been born and educated in the UK. In general, the Bangladeshi population are less well educated and lack knowledge of English (Hashem, 2009). Many have communication difficulties due to their poor level of English understanding (Hashem, 2009). This may be due to the low levels of educational attainment and earnings of this group. According to the latest data in the UK, the employment rate was the lowest in the combined Pakistani and Bangladeshi group (57%) compared to White people (77%), although it increased from 44% in 2004 to 57% in 2018 (Office for National Statistics, 2019). In 2018, 8% of the economically active population were unemployed amongst the combined Pakistani and Bangladeshi group, which is the second highest unemployment rate among all ethnic groups (Office for National Statistics, 2019). Bangladeshis also have higher rates of illness due to poor living conditions (Becars, 2013). The Bangladeshi population is one of the most disadvantaged, minority ethnic groups in the UK, with a socioeconomic profile that is quite different from that of other groups from the Indian subcontinent (Barnard & Turner, 2011).

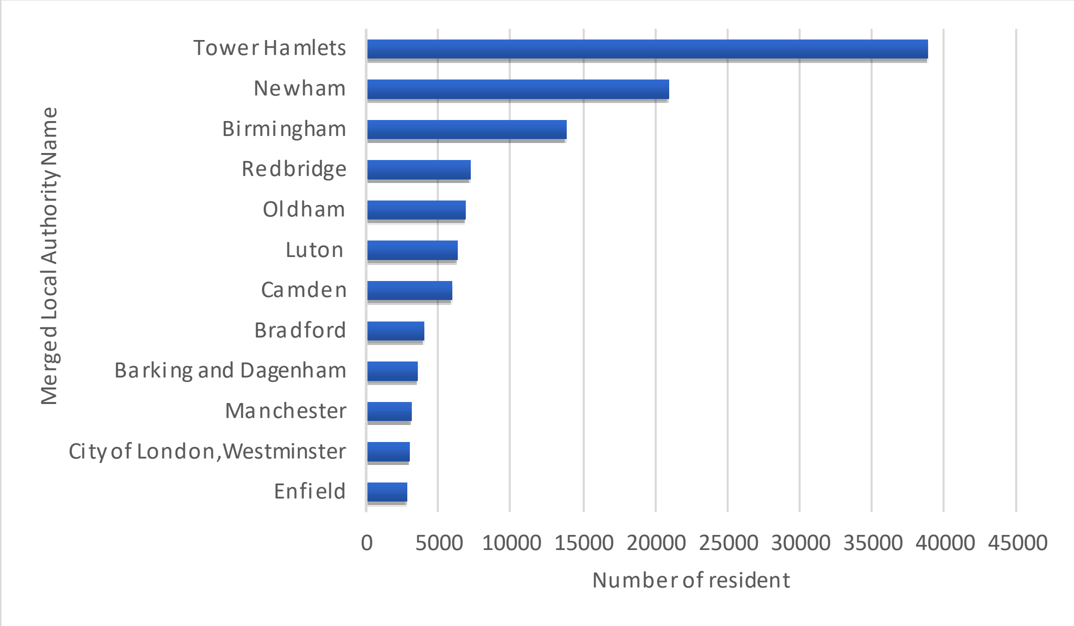


Figure 1.4: Number of residents with the country of birth as Bangladesh residing in Local Authorities in England (Ghee, 2014)

1.9 Why Birmingham?

The studies in this thesis which require new data collection are to be carried out in Birmingham, which is located in the West Midlands. As mentioned earlier, Birmingham has the largest Bangladeshi population outside London (Figure: 1.4). In Birmingham (West Midlands), although hospital admissions for stroke declined between 1997 and 2005, the decline was not statistically significant in South Asians (Gunarthane, *et al.*, 2008a).

The West Midlands has the highest percentage of minority ethnic groups after London: Pakistani at 20.0%, Indian at 15.5% and Bangladeshi 11.7%, and a lower than average White ethnic group at 82.7% and White British at 79.2% (Office for National Statistics, 2012). Birmingham's residents are from a wide range of national, ethnic and religious groups. According to the 2011 population census, a large number of people living in Birmingham said that they belonged to one of the four Asian ethnic groups: Indian, Pakistani, Bangladeshi or Asian 'Other'. This represents 19.5% of the population and 65.8% of the non-White population. The proportion of people aged 15 years and under in Birmingham (34.1%) and England (28.7%) was far higher for Asian people than for the general population in Birmingham (23.4%) and England (20.2%) (2011 Census, 2013).

The Stroke Association reported 32,627 deaths from stroke in England and Wales in 2016/17. In the same year 1,726 inpatient deaths from stroke were recorded in the West

Midlands. The average mortality rate over 75 years for the West Midlands in 2017/18 was 559.4 per 100,000; this is slightly higher than the national mortality rate of 540.5 per 100,000 (Adderly, 2019).

Data from the West Midlands CVD clinical network team indicates a higher than national prevalence of stroke in the West Midlands (1.7% to 2.3%) compared with the national average (1.8%) (Rogers, 2018) and also an above average mortality from stroke for all ages and under-75s. Patients in the West Midlands appear to have poor survival from stroke. The region also has the lowest percentage of stroke patients returning to their usual place of residence: 52.3%, significantly lower than England's average of 56.7% (indirectly age and sex standardised figures) (Rogers, 2018).

These data suggest a need to examine the standard of care in the region. In the West Midlands, 20% of residents are living in Birmingham and it is the largest local authority district (2011 Census, 2013). Birmingham has a younger age structure compared to both the West Midlands and England, as well as fewer pensioners (2011 Census, 2013).

1.10 Rationale of the present study

It is well established that there are health inequalities in migrants in the UK (Evandrou, *et al.*, 2016). These health inequalities are well documented for CVD/stroke risk factors among South Asians in the UK (Kakar, *et al.*, 2006). However, very few studies have documented differences in individual subgroups of South Asians such as Indians, Pakistanis and Bangladeshis. The Bangladeshi population has been reported to have persistently higher stroke mortality than other ethnic groups in the UK. There is a paucity of literature available on stroke amongst the Bangladeshi population. There is a need for studies which focus particularly on the Bangladeshi population comparing them with other South Asian population groups and with White Europeans. There is a lack of evidence to explain the excess mortality amongst the Bangladeshi population. This thesis aims to explore the risk factors associated with stroke in South Asians, focussing mainly on the Bangladeshi population. It intends to focus on issues from the perspective of health inequalities and ethnicity.

This thesis will explore how ethnicity may play a role in the epidemiology of stroke in different ethnic groups in the UK, focussing on Bangladeshis due to their high stroke mortality.

Ethnicity is a complex term and can bias the outcomes of a study. While doing research, ethnic groups need to be considered carefully. A definition or criteria for ethnic groups can impact on the result of a study. A study by Lane *et al.* (2005), which is reported in the systematic review (Chapter 4), was conducted in Birmingham with a sample of South Asians with the majority being Punjabis and only a few Bangladeshis. This definition of South Asians was not fully representative of South Asians' ethnicities. "South Asian" comprises a group of people belonging to countries of South Asian origin (India, Pakistan, Bangladesh, Sri Lanka) (Bhopal, 2019). Punjabis are a sub-group of Indian origin. India has a plethora of sub-ethnic groups which differ from each other in culture, food and lifestyle.

Chapter 2 will focus on the use of the terms ethnicity and race in epidemiology research. It will highlight the difficulties and hurdles that emerged while confirming the exact ethnic origin of patients reported in this thesis. Discussion on the use of the word ethnicity in public health research and associated challenges will be elaborated upon. Strokes in ethnic minorities have been studied extensively in the UK and the USA. The literature on ethnicity and stroke in the UK are well documented but attention is still needed on the pattern of risk factors among South Asians (Kakar, *et al.,* 2006).

There is a need to explore risk factors, along with their pathophysiology, amongst the Bangladeshi population, as recommended by several authors working on the epidemiology of stroke among South Asians in the UK (Bhopal *et al.,* 2005a: Gunarathne *et al.,* 2009). There remains a gap in knowledge, warranting new studies to update current knowledge on this topic. Chapters 5 and 7 will explore the risk factors associated with stroke among South Asians as compared to White Europeans.

The need to fill this gap in CVD/stroke epidemiology in South Asians focussing on the Bangladeshi population in the UK helped shape the research questions in this thesis. The burden of stroke in the Bangladeshi population is not only due to risk factors but could also be due to differences in the management of stroke. This thesis will explore ethnic differences in risk factors for stroke (Chapter 5 & 7), and the management of stroke (Chapter 6 & 8), in South Asians/Bangladeshis compared to White Europeans. For this purpose, a series of studies were planned with multi-method approaches.

1.11: Research Aims and Objectives:

The primary aim of this thesis is to generate new evidence and to fill gaps in current knowledge on stroke among South Asian migrants, specifically focussing on the Bangladeshi population and comparing them with White Europeans in the UK.

The objectives are to:

- Conduct a systematic review of the incidence, prevalence and mortality of stroke, risk factors of stroke, and access to care in the South Asian population, with a special focus on the Bangladeshi population in the UK (Chapter 4).
- Explore CVD risk factors in the Bangladeshi population via secondary data analysis of WHSS and case note analysis of Heart of England NHS Foundation Trust admissions (Chapter 5 & 7).
- Analyse data obtained through the Freedom of Information Act 2000 (FOI), from three hospitals in Birmingham, to describe stroke admissions and explore the differences between South Asian groups and White comparators (Chapter 6).
- Analyse stroke care pathways of patients of Bangladeshi background and compare them with the other ethnic groups (Chapter 8).

The following are the specific research questions for each of the four studies:

Systematic Review (Chapter 4)

- Are the incidence, prevalence and mortality of stroke (ischaemic and haemorrhagic) higher in the South Asian population in the UK compared with the White European population?
- What are the major risk factors associated with high prevalence of stroke in the South Asian (Bangladeshi) population in the UK?
- Are there differences in the clinical presentation, access to acute stroke units, preventive care and clinical outcomes between South Asian patients with stroke and White Europeans as the comparator?

Secondary Data Analysis of the Wandsworth Heart and Stroke Study (WHSS) (Chapter 5)

- What are the major cardiovascular risk factors in Bangladeshi and other South Asian (i.e. Indian and Pakistani) groups and in White Europeans?
- Are there differences in the pattern of individual CVD risk factors among Bangladeshis and other South Asian groups?

Freedom of Information request for hospital admissions for stroke in ethnic minority groups in Birmingham (Chapter 6)

- How many patients are admitted with stroke, by ethnic group, for hospitals in Birmingham?
- Are there are any differences in stroke outcomes by ethnic group?
- What is the proportion of readmissions of patients with stroke by ethnic group for hospitals in Birmingham?

Case note audit of stroke patients comparing the Bangladeshi group with other ethnic groups (White Europeans, Indian, Pakistani) (Chapters 7 & 8)

- Are there differences in the risk factors observed in patients from Bangladesh who have had a stroke in comparison with patients from other ethnic groups (White European, Indian and Pakistani), in a stroke unit in Birmingham? (Chapter 7)
- Are there differences in the stroke care pathway between patients from Bangladesh and other ethnic groups (White Europeans, Indian, Pakistani) in a stroke unit in Birmingham? (Chapter 8)
- Are there differences in the outcome from stroke between patients from Bangladesh and other ethnic groups (White Europeans, Indian and Pakistani) in a stroke unit in Birmingham? (Chapter 8).

Chapter 2: Ethnicity and Stroke in the United Kingdom

2.1 Introduction

Epidemiological research into aetiology, incidence and prevalence of stroke has provided information about the geographical and regional variations in stroke. There is still a lack of clear evidence to explain the basis for this variation (Kakar, *et al.*, 2006). However, differences at geographical and regional levels could be due to 'ethnicity' and 'race'. More research is needed to systematically examine these potential differences among ethnic / racial groups.

How researchers think about 'race' and 'ethnicity' influences their research design, the type of data collected and the analyses they conduct (Gillborn, 1998). This chapter first focuses on the use of the terms "ethnicity" and "race", as well as the challenges in using them in research. The chapter includes a definition of 'ethnicity' and focuses on ethnic inequalities in health and stroke in the UK. These inequalities include several factors such as the role of socioeconomic factors, immigration and education for South Asians in the United Kingdom.

The other purpose of this chapter is to provide an overview of the association between ethnicity and stroke. It summarises how ethnicity is considered in all the studies included in this thesis and how it may influence the outcome of a study. The detailed methodology about how ethnicity was ascertained in the primary data collection is outlined in Chapter 7. How ethnicity may relate to the various risk factors of stroke was discussed in the previous chapter.

2.2 Ethnicity and race as epidemiological variables

"There are many dangers of a gas fuel, particularly burning, but we cannot do without it" (Bhopal, 2014, p.4). The fuel of epidemiology, and some other quantitative and social sciences, is the analysis of differences in the patterns of ill health and disease in populations. Ethnicity and race are rich fuel, providing myriad differences that are challenging to explain (Bhopal, 2014). Ethnicity is a much-studied variable in epidemiology (Whaley, 2003). The term originates from a Greek word meaning a 'people or tribe', but it should not be confused with nationality or migrant status (Senior and Bhopal, 1994).

Characteristics that differ from person to person are called variables. Ethnicity and race are used to subdivide populations as they are potentially valuable exposure variables. Despite being challenging and controversial variables in epidemiology and public health, ethnicity and race are of vital and growing interest for the researcher (Bhopal, 1997). To understand the underpinning aspects of ethnicity and race it is essential to recapitulate the basic definition of 'epidemiology' which is defined as "the study of how often diseases occur in different groups of people and why" (Coggon, *et al.*, 2003, p. 1). The 'different groups of people' could be ethnic groups. Regarding "why" in the above definition, the study to find the cause of disease is a comparative analysis of the risk factors in different populations (Centre for Disease Control and Prevention, 2012).

The concept of race was used for the first time in the eighteenth century (Senior and Bhopal, 1994). Even though *"Much historical research on race, intelligence, and health was racist, unethical, and ineffective"*, still it was extensively studied (Bhopal, 1997, p.1751).

Race is defined as a biological construct of single breeding populations based on superficial phenotypic traits such as skin colour and facial features (Bartley, 2004). This definition based on biological differences between global populations is discredited now, as there is no evidence to justify dividing populations on biological constructs (Bartley, 2004). Global population groups can be characterised by the possession of certain genes, such as those that predominantly influence hair, eye and skin colour, but these are of less importance in predicting susceptibility to disease (Bartley, 2004).

In contrast, ethnicity is a multidimensional concept with several links to health (Cosford and Toleikyte, 2018). Ethnicity is a subjective concept consisting of self-identification and categorisation (Mason, 2004). Montagu defined ethnicity as follows: "An ethnic group represents one of a number of populations, comprising the single species *Homo sapiens*, which individually maintain their differences, physical and cultural, by means of isolating mechanisms such as geographic and social barriers" (Montagu, 1942, p.43). "These differences will vary as the power of the geographic and social barriers acting upon the original genetic differences varies" (Montagu, 1951, p.317).

Defining ethnicity is complex; generally it implies the identification of population groups based on social, cultural and historical variations. Ethnic groups are characterised by organised cultural boundaries such as language, religion and country of origin (Platt, 2006). A more recent report by the Race Equality Foundation working on health inequalities in the UK defines ethnicity as "a form of collective identity that draws on notions of shared ancestry, cultural commonality, geographical origins and shared biological features" (Salway, *et al.*, 2014).

Ethnic minority groups refer to a population group with an ethnic origin different from that of the majority population of the host country (Bulmer, 1996; Modood & Berthoud, 1997). There has been inaccuracy in the recorded ethnicity of patients who self-report as ethnic minority groups. For example, in a study of hospitals records, Indian, Pakistani and Bangladeshi groups were miscoded in between 20% to 35% of all patients who self-reported that they belong to these groups (Saunders, *et al.*, 2013). Hence in this thesis all the South Asian groups were rechecked for correct categorisation by going through the case notes, confirming their language, place of birth and travel history.

A review conducted by Jones *et al.*, on past and current use of 'race' in epidemiological research in the US, reported that half of studies included in reviews between 1921 and 1990 included ethnicity/race (Jones, *et al.*, 1991). This suggests the acknowledgement of the association between health status and ethnicity is not new and it has been noted from the time when quantitative health data were first recorded.

2.3 Ethnicity upon race

The concepts of race and ethnicity are difficult to define but continue to be applied to the study of the health of immigrants and ethnic minority groups in the hope of advancing understanding of the causes of disease. To get a better understanding of the relationship between the health of an ethnic minority group, migration and causes of disease, race and ethnicity are often used, although they are difficult to explain (Bhopal, 1997). The terms "race" and "ethnicity" are often used interchangeably but race is of less analytical value compared to ethnicity (Bhopal, 2004).

In the United States, the history of public health has a special chapter on health inequalities by race and ethnic groups (Cooper, 1994). Kaufman and Cooper argued that the two terms are connected in terms of their reference to a cultural dimension of identity and individuals' self-perception (Kaufman and Cooper, 2001).

Directly or indirectly, race and ethnicity have a major impact on a population's health patterns. Ethnicity and national identity are important defining characteristics of a person's self-identity. Collecting information on ethnicity and identity complements other questions on people's religious affiliation and language to provide a detailed picture of the society they live in and how it is changing (Office for National Statistics, 2012). However, a previous study of racial variation in health assumed race was a valid biological category and genes that determine race are linked to health, and the health of the population is predominantly determined by biological factors (Krieger, 1987). This concept has changed, and race has become more of social construct than a biological construct, making race of limited biological significance (Williams, *et al.*, 1994). There is another limitation to using race in research studies - its validity, and reliability of its measurement. Also, race leaves out several unclassified groups (e.g. Kalahari bushmen/ pygmies) while ethnicity creates a separate category for each group (Bhopal, 1994). Increases in the number of people that belong to multiple racial categories makes it difficult to classify individuals into single race categories, which complicates the interpretation of racial associations in research studies (Mays, 2003).

Cooper *et al*. (1984) have extensively explored the relationship between ethnicity, race and epidemiology in the United States. Ethnicity is regarded as an appropriate classification in public health research and practice; the only objection to this can be the absence of a proper reference system. Cooper, among others, has questioned the application of the concept of race in epidemiology and the scientific validity of its assumptions. There is more literature available in support of the use of ethnicity rather than race (Polednak, 1989; Cruikshank and Beevers, 1989; O'Donnell, 1991; Huth, 1995). In the case of race, it is more useful for differences in social variations in epidemiology rather than biological explanations (Senior and Bhopal, 1994).

This chapter intends to explore and explain the variations in stroke in different South Asian groups compared with White Europeans. Doing the analyses by ethnicity leads to a comparative analysis of disease in different groups. One of the important research questions of this study is 'why is stroke more common in Bangladeshis or other South Asians compared with the White population?'. Considering ethnicity over race is important since ethnicity has the advantage of the recognition of social factors as important determinants of health status (Cooper, 1998).

2.4 Challenges of collecting and assessing ethnicity

In the UK, ethnicity results from differences in many aspects which are important socially and politically, such as race, culture, religion, language and nationality (Parliamentary Office of Science and Technology, 2007). However, to allow data to be collected and analysed, ethnicity is treated as a fixed characteristic. Black and minority ethnic (BME) groups are usually classified by the methods used in the UK census (Parliamentary Office of Science and Technology, 2007). The UK census has 16 ethnic groups, with people asked to indicate to which group they belong (Parliamentary Office of Science and Technology, 2007). Again, this is self-reported and not validated by any other means.

The England and Wales census first asked the question about ethnic groups in 1991 (Office for National Statistics, 2014). The ethnic group question provides information on the population's ethnic characteristics, which can be used by private and public organisations to monitor equal opportunities and anti-discrimination policies. In the UK, statistics are drawn from the Office for National Statistics (ONS) data on ethnic groups, and ethnicity is defined by racial, cultural, and national variations. The most recent classification of ethnicity by the census (ONS), which is also used by researchers, is shown in Table 2.1 (Office for National Statistics, 2014).

Table 2.1 Ethnic categories in the United Kingdom according to census 2011

Ethnic group	Categories
White	English/Welsh/Scottish/Northern Irish/British Irish Gypsy or Irish traveller Other White
Mixed or multiple ethnic group	White and black Caribbean White and Asian White and black African Any other mixed
Asian or Asian British	Indian Pakistani Bangladeshi Chinese Other Asian background, please describe
Black/ African/ Caribbean/ Black British	African Caribbean Any other Black/African/Caribbean
Other Ethnic group	Arab Any other ethnic group, please describe

(Source: Census - Office for National Statistics 2014)

These categorisations by government gain credibility as they play an important role in reflecting ethnic identities in surveys, although they are still criticised by health researchers and activists (Bradby, 2003). The major problem is the lack of theoretical rationale in the categorisation, which leads to a mix of divisions based on nationality, colour, continental origin, racialisation and ethnicity (Bradby, 2003). Furthermore "Health outcomes for minorities are frequently compared against the 'White' group as the index category, implying that the 'White' pattern is not just the majority experience, but also normal and even desirable in some sense" (Senior and Bhopal, 1994; Bhopal and Donaldson 1998).

The term 'Asian' first appeared in the census in England and Wales in 2001 and it describes a person either of Indian subcontinent origin or those from continental Asia (Aspinall, 2003). The term 'Asian' is very popular in North America and the UK. However, it is broad and masks important variations by country of origin, religion, language, diet and other factors related to health and disease (Bhopal, 2004). There has been concern raised by researchers about inappropriate use of the term 'Asian'. There are various uses of the term 'Asian'; for example in England and Wales the term 'Asian or Asian British' is used for the cultural background groups of 'Indian', Pakistani', Bangladeshi', and 'Any other Asian background'. However, in Scotland more importance is being given towards Scottish identity in terminology used for ethnic background, and 'Asian' is defined differently, including 'Asian, Asian Scottish or Asian British'.

The use of the term 'Asian' reflects inconsistency in usage, from being inclusive of other Asian ethnicities (such as Chinese) to being exclusively descriptive of the Indian subcontinent (Aspinall, 2003). Hence the term 'Asian', due to its ambiguities in meaning, is unsatisfactory, and the terms 'South Asian' or 'Indian subcontinent' are preferable (Aspinall, 2003). The South Asian group includes people from the Indian subcontinent, which comprises India, Pakistan, Bangladesh, Nepal and Sri Lanka.

South Asians are heterogenous in terms of their culture, diet, lifestyle and baseline health risk in accordance with their differences in origin, culture and religion (Hussain-Gambles, *et al.*, 2004). South Asians can be distinguished by their geographical location with specific linguistic backgrounds; they speak over 30 languages, with collectively 1600 regional dialects (Faroqi-Shah. 2014). In the UK the South Asian groups, particularly Bangladeshis, distinguish themselves from other groups through language, regional affiliation, religion, dietary regulations and other customs (Faroqi-Shah. 2014).

Bangladesh is a monolingual country with Bengali being the main language, although there are several dialects according to the geographical region (Rani and Tina, 2019). The Bangla dialect in Bangladesh and India differ in phonology, grammar and vocabulary (Shuchi, 2013). In the UK the most widely spoken language by Bangladeshi migrants is Sylheti which is a variant of Bengali (East Bangal dialect), as the majority of Bangladeshi emigrants are from the Sylhet region (Carey and Shukur, 2010). After geographical location and languages, the Bangladeshi population can be distinguished by religion, with eight religions in Bangladesh each with distinct belief systems and lifestyle expectations, although the majority religion is Islam (Devine and White, 2009).

Surnames are considered as an informative marker of ethnic, linguistic and cultural origin (Kandt and Longley, 2018). The majority of Bangladeshis are Muslims (90%), hence Bangladeshi names originate from Arabic, Sanskrit or Persian languages but they are written and pronounced according to the Bengali language (e.g. the Arabic name “Hussain” is written as “Hossain” in Bengali) (Shuchi, 2013). Muslim men in Bangladesh have two or three names and they also use a title (Miah, Khan) either at the beginning or end of their names, while females use titles such as Begum, Bi or Bibi as a second name (Milton Keynes Council, 2013). After marriage, women may adopt their husband’s family name or personal name. Bangladeshi names and surnames are reported to be a consistent marker for ethnicity and composite surnames (hyphenated or spaced such as Riyaz ul Haq) offer better prediction among Bangladeshi and Pakistani individuals (Kandt and Longley, 2018). Bengali names of Indian origin, especially Hindus, usually have a first or last name as well as a nick name (A Guide to Names and Naming Practices, 2006).

There has been an ongoing debate on diversity between and within South Asian populations, with differences reported in both socioeconomic position and cultural values among Indian, Pakistani and Bangladeshi populations (Ali and Atkin, 2004). Despite their high susceptibility towards CVD and DM as a result of being South Asian, there have also been variations observed in both risk factors and outcomes of disease between South Asian populations (Bhopal, 2019). Combining three South Asian subgroups (Indian, Pakistani and Bangladeshi) into one broader group loses information on ethnic variations, which is important to public health programmes (Bhopal, 2013, p.63).

South Asians are under-represented in health research compared to other ethnic minorities (Mason, *et al.*, 2004; Quay, *et al.*, 2017). Inadequate ethnic minority representation in health research has hampered the generalisability of research findings resulting in a lack of tailored healthcare for ethnic minorities (Hussain-Gambles, *et al.*, 2004). In the UK, South Asians make up 7.5% of total population but remain underrepresented in health research (Prinjha, *et al.*, 2020). Even studies with enough numbers of South Asians may not be truly representative of the heterogenous subgroups of the South Asian population (Mason, *et al.*, 2004). Participation in research by the South Asian community may be discouraged by lack of family and community support in making healthcare decisions and engaging in risk-reducing behaviours (Grewal, *et al.*, 2010). There are particular factors which can pose challenge to healthcare service access in South Asian females, such as a lack of English language understanding, unfamiliarity with local services, and a lack of attention to cultural factors by healthcare providers (Nilaweera, *et al.*, 2014).

More recently, South Asians have continued to be underrepresented (Quay, *et al.*, 2017). Another reason for under-representation in research could be traditional religious, dietary, and healthcare practices, which are frequently maintained by South Asians. These practices do not always align with modern Western or allopathic medicine and clinical research approaches (Quay, *et al.*, 2017). The study by Quay, *et al.* (2017) reported factors that could facilitate the participation of South Asian populations in research. These include the desire to improve health, to engage in disease prevention, to contribute to scientific research and a sense of obligation to health care providers (Quay, *et al.*, 2017). There are also barriers including a lack of effort by the researcher to make contact, and language difficulties. Many South Asians have been excluded from research due to language barriers. This barrier can be overcome by recruiting multilingual research assistants or principal investigators from the same ethnic background (Jolly, *et al.*, 2008).

In the UK and the USA investigation of ethnic inequalities are hampered due to data limitations, thus ignoring the heterogeneity between ethnic groups (Nazroo and James, 2003). Consideration of the heterogeneity within the South Asian populations in research has been repeatedly emphasised by researchers in the UK, as implications are empirically important for public health research (Bhopal, 2019). Likewise, there is a marked heterogeneity within India as it is multi-state country with people from different states speaking different languages, with different lifestyles and consuming different diets (Bhopal, 2019). People belonging to any one state of India cannot be representative of India.

2.5 Current research

In the current research, the term 'South Asian' comprises people from the Indian subcontinent, including Indian, Pakistani and Bangladeshi, as individual groups, living in the UK. They are heterogeneous groups and the advantage of considering them as individual groups in this research is to ensure that ethnic variation and significant differences within the "South Asian" domain will not be missed. The comparator group is termed as "European White" in the later research (Chapter 7, 8).

In Chapter 4 (Systematic Review), I have used the same categories as the corresponding authors have used in their studies. This was to prevent creation of any new categories and for consistency (for details please refer to the Glossary). Studies included in the systematic review were not uniform in terms of methodology and ethnicity assessment. There were challenges to using the ethnic categories as defined by the researcher. The majority of the studies defined 'South Asian' as people of Indian, Pakistani and Bangladeshi origin. However, other categories have not been consistently or appropriately defined; the terms 'African-Caribbean', 'Black African' and 'Black Caribbean' have been used inconsistently. For example, a study using the term 'Afro-Caribbean' did not define it (Conway and Lip, 2003). There were a few studies in which the term 'South Asian' had been used loosely. For example, two groups of people from specific regions of India (Punjab) and Bangladeshi were defined as South Asians (Tillin, *et al.*, 2013). Another study by Conway and Lip (2003) used the term 'Indo-Asian' and did not define it. In the Freedom of Information request reported in Chapter 6, the term 'ethnicity' refers to the categorisations provided directly by the hospitals.

Sources of identifying ethnicity in the main research (Chapter 7 and 8):

- Assessment by searching by family name: as being aware of the distinct nature of Bangladeshi names due to my personal background and language, it was easy to differentiate them from Indians and Pakistanis by name.
- Through referral letters, occupational therapy (OT) and physiotherapy (PT) notes
- By identification though their mother tongue, i.e. language

Unfortunately, among the various difficulties in assessing ethnicity and race, an important issue is assessing them accurately. The difficulties in collecting and monitoring ethnicities are as follows:

- Recording of ethnicity in NHS medical records: this has been mandatory since April 1995 but is still not achieved satisfactorily in some case notes
- Self-assessment of ethnicity: the consistency of the measure is affected as it is possible for a person to change their self-assessed ethnic group during their lifetime (Aspinall, 1995).

- Lack of proper ethnicity coding: some ethnic codes are not assigned properly like 'Indian' being coded as 'Pakistani' and 'Bangladeshi' as 'Indian'
- Lack of a valid measurement instrument (Bhopal, 2004)

2.6 Trends in Inequalities in health of Black and minority ethnic groups in the UK

The term inequality refers to difference, variability and unevenness (Bhopal, 2014). Health inequalities are differences in health status between groups of people often driven by inequalities in society (Public Health England, 2017). Health inequalities include the cumulative effects of various health determinants over the life course (Parliamentary Office of Science and Technology, 2007). These determinants of health include lifestyle, material wealth, educational attainment, job security, housing conditions, discrimination and health service quality and access (Parliamentary Office of Science and Technology, 2007). There are differences reported in rates of some diseases by ethnic groups, however the differences are extremely diverse and interlink with many overlapping factors (Parliamentary Office of Science and Technology, 2007). The aim of this study was to examine why stroke is more common in one group compared to other groups and this question lies at the heart of the debate on inequalities in health. It has been found that, in the field of health inequality, analysis by ethnic group is a powerful tool for scientific analysis and for social action (Bhopal, 2004).

The current trend of increasing ethnic diversity in the UK has given ethnic inequalities in health prime importance in current and future research (Aspinall, 2011). A report published by the Office for National Statistics (Figure 2.1) has shown a significant rise in the proportion of the population from ethnic minority groups, although White continues to be the majority ethnic group despite decreasing over the last two decades from 94.1% to 91.3% (White, 2011). The report also summarised data from the Asian/Asian British ethnic group as one of the largest increasing groups between the 2001 and 2011 censuses (White, 2011). One study projected that the White British population will continue to decline to 56% by 2056, with increases in all ethnic minority groups (Coleman, 2010).

Researchers have described inequalities in the distribution of health by social class, gender and ethnicity. Ethnic inequalities in health are frequently reported in the United States and the United Kingdom (Nazroo and James, 2003). In the United Kingdom, heterogeneity found across minority groups due to differences in mortality and morbidity of migrants, such as those of Bangladeshi and Pakistani origin, report poorer health compared to White Europeans (Nazroo and James, 2003). Ethnic health inequalities for most outcomes were reported to be the greatest for Bangladeshi and Pakistani people who have the poorest health in the UK, followed by Caribbean people and then Indian people, compared with Chinese and White people who overall have the best health (Nazroo and James, 2003).

In 1970, Britain was lagging behind other countries in health improvement in spite of its 30 year history of the welfare state (Acheson, 1998). The government set up the Research Working Group on Inequalities in health in 1977, chaired by Sir Douglas Black. The Black report, presented in 1980, explored the trends in inequalities in health (Acheson, 1998). A study by Marmot *et al*. (1984a) published immediately after the Black Report is important in the history of ethnic inequalities in health in the UK. By using death certificate and census data they explored the relationship between country of birth and mortality rates. They found that there was a higher mortality rates among some migrant groups in the United Kingdom (Marmot, *et al*., 1984a).

The UK has a longer tradition of studying socioeconomic inequalities in health compared with the US (Marmot, *et al*, 1984b). Cross-sectional analysis of the Health Survey for England suggests poorer self-reported health in Black Caribbean, Indian and Pakistani women (Cooper, 2003). These findings were confirmed in another study by Becares (2013), which used census data on limiting long-term illness and reported that Pakistani, Bangladeshi, Black Caribbean, White Irish and Other Black groups have worse health outcomes compared with White British people. This scenario is present not only in the UK but around the world. In the United States, Black American and Indian people have poorer health outcomes compared with the host population (Braveman, 2012).

Health inequalities also vary by geographical location among ethnic minorities (Becares, 2013). London is recognised as the most ethnically diverse area, and Wales the least, in England and Wales. The reason for focusing on Bangladeshis / South Asians is because they have highest rate of stroke mortality compared to other ethnicities in the UK (Cooke, *et al.*, 2021). In addition, the Asian/Asian British ethnic group has been identified as one of the categories having the largest population increases between the 2001 and 2011 censuses. The number of people of South Asian origin (Pakistani and Indian) each increased by around 0.4 million (0.5% and 0.6% of the total population, respectively) (Figure 2.1) (White, 2011, p.5).

Black and minority ethnic (BME) groups in the UK have worse health outcomes compared to the general population (Lowth and Jackson, 2015). Patterns of ethnic health inequalities differ from condition to condition; for example, BME groups tend to have higher cerebrovascular disease rates compared to the White British in the UK (Lowth and Jackson, 2015). Among Asians, poorer health outcomes are reported in Bangladeshi and Pakistani groups (Lowth and Jackson, 2015). Irrespective of the country of origin, immigrants from South Asian countries have a higher prevalence of cerebrovascular disease compared with the indigenous population (Balarajan, 1991; McKeigue & Marmot, 1988; Wild & McKeigue, 1997). A comparison of the number of deaths and standardised mortality ratio (SMR) from all causes for the period of 1970-72 and 1989-92 showed that the SMRs have been high for all immigrant groups irrespective of their country of origin compared with the national figures for England and Wales. Table 2.2 also shows a higher SMR for cerebrovascular disease among all immigrant groups during 1989-92 compared to the national average (Wild & McKeigue, 1997).

A modifiable risk factor for stroke is hypertension. The prevalence of hypertension has previously been found to be double in South Asians in the UK compared to the White population (Cappuccio, 1997a; McKeigue *et al.*, 1991). However, the mean systolic blood pressure and total low-density lipoprotein (LDL) in the Bangladeshi population are lower than in White Europeans (McKeigue *et al.*, 1988). From a recent study carried out in Bangladesh, it has been found that there is a high prevalence of hypertension and pre-hypertension in the general Bangladeshi population (Rahman *et al.*, 2015). Apart from these factors, Bangladeshis in the UK have higher prevalence of smoking, diabetes, low physical activity and high plasma triglycerides (McKeigue *et al.*, 1988). In a case-control study of Asian Indian stroke patients, high levels of homocysteine and some genetic polymorphisms were associated with stroke (Biswas *et al.*, 2009). In a systematic review, using England and Wales 1991–93 census data, these ethnic inequalities by country of birth were again noted: the SMR for stroke was the highest among Bangladeshis (324) followed by West/South Africans (315), Pakistanis (148) and Indians (140) (Figure 2.2) (Smith, *et al.*, 2000).

Table 2.2: Numbers of deaths from cerebrovascular disease (ICD codes 430-438) and standardised mortality ratios for the total population and selected immigrant groups

aged 20-69 years in England and Wales for the periods 1970-2 and 1989-92 (Wild & McKeigue, 1997, p.708)

		Men		Women	
Country of birth	Period	Nº of deaths	Standardised mortality ratio (95% CI)	Nº of deaths	Standardised mortality ratio (95% CI)
Total population	1970-2	31 271	195 (191 to199)	27 428	206 (202 to 210)
	1989-92	21 421	100	17 334	100
Scotland	1970-2	533	183 (168 to 199)	425	198 (180 to 218)
	1989-92	554	125 (115 to 136)	416	125 (113 to 137)
Ireland	1970-2	756	234 (154 to 166)	596	235 (216 to254)
	1989-92	758	138 (128 to 148)	553	123 (113 to133)
East Africa	1989-92	56	114 (86 to 147)	43	122 (88 to164)
West Africa	1989-92	67	271 (210 to 344)	26	181 (118 to265)
Caribbean	1970-2	177	394 (338 to 457)	137	463 (389 to547)
	1989-92	360	168 (151 to 186)	212	157 (136 to179)
South Asia	1970-2	244	226 (198 to256)	165	246 (210 to 286)
	1989-92	594	155 (143 to168)	344	141 (127 to157)

Apart from classical risk factors associated with stroke (Table 1.1) there are risk factors in the South Asian population which need further investigation. Cultural and socioeconomic factors are important links to excess rates of cardiovascular disease (CVD) among South Asians (Gunarathne, *et al.*, 2009). For instance, squatting, which is a common posture amongst the South Asian population, is associated with increases in blood pressure by 4-8 mm Hg and this has been suggested as a possible trigger factor for stroke in Indians (Chakrabarti, *et al.*, 2002).

Vitamin D deficiency in the Bangladeshi population residing in London is a widespread problem which might also be associated with increased stroke risk (Boucher, *et al.*, 1995). The Bangladeshi population tends to live in more overcrowded households and this environmental factor could increase the risk of respiratory infection and, in turn, for stroke (Bhopal, *et al.*, 2005a). Other factors such as chewing tobacco or betel leaf are common in Bangladeshi men and women. Further studies will be needed to ascertain the relationship between these factors and stroke (Bhopal, *et al.*, 2005a).

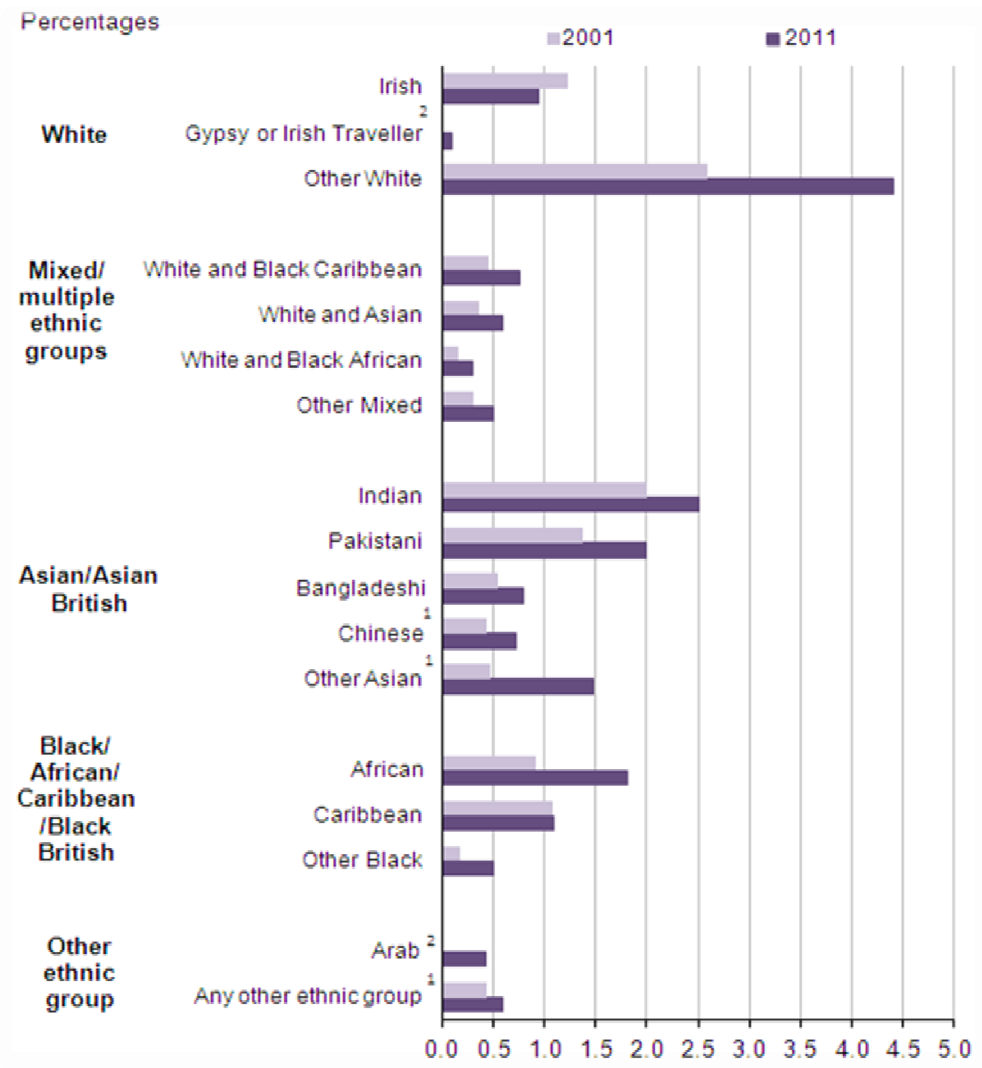


Figure 2.1: Trends in Ethnic Groups, 2001 – 2011, England and Wales-Census - Office for National Statistics (White, 2012, p.5)

2.7 Causes of ethnic inequalities in health/ stroke

This section outlines some of the potential explanations for the inequalities in health found in the South Asian population. Investigations to find the causes of ethnic inequalities in health has been hindered in both the US and UK by data limitations. Other important factors which may have hampered investigation of ethnic inequalities are: inadequate measurement of ethnicity, ignorance of groups due to their heterogeneous nature, observer-assigned ethnicity instead of self-reported ethnicity, and use of surrogate markers, such as using country of birth instead of ethnic origin (Williams, 2002).

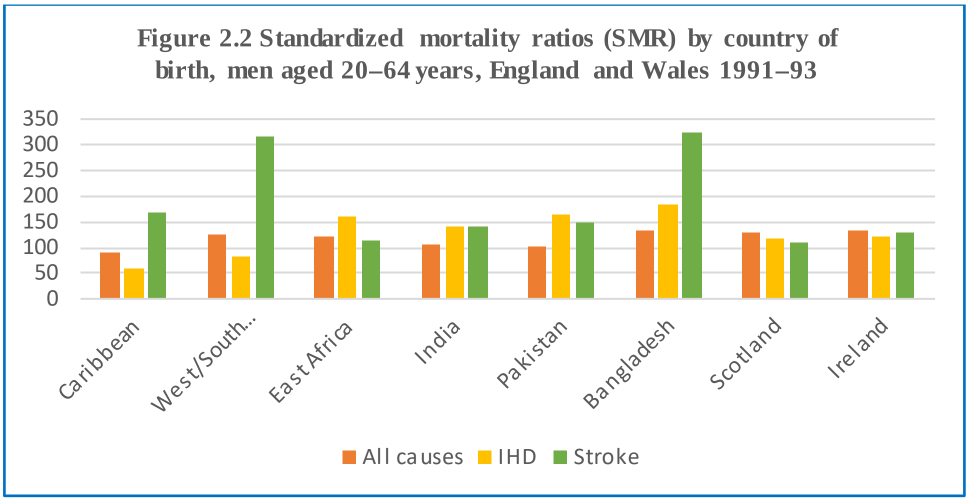


Figure 2.2: Standardised mortality ratios (SMR) by country of birth, men aged 20–64 years, England and Wales 1991–93 (Smith *et al.*, 2000)

2.7.1 Genetics

Genetics may play a role in explaining ethnic inequalities in health, although its role may have been overstated in the past (Whaley, 2003). Indeed, it has been suggested that environmental and social exposures are more important determinants of CVD (Cruickshank, *et al.*, 2001). Whilst there are a small number of conditions, predominately specific inherited genetic diseases, that are associated with certain ethnic groups, these would have a very limited impact on the broader ethnic health inequalities (Smith, *et al.*, 2000).

2.7.2 Social and behavioural

Smoking, drinking alcohol, diet, exercise, notions of health, sexual behaviour, images of the body, lay theories of illness, health beliefs and related behaviours inform culture which is usually assumed to affect health through these factors (Smith, *et al.*, 2000). Smoking is one of the best documented behavioural risk factors related to health and CVD specifically.

Obesity, due to an unhealthy diet, is of concern especially among ethnic minority groups. Controlling diet may have a positive impact on reducing the burden of coronary heart disease, hypertension and stroke among ethnic minority groups (Rudat, 1994). The other common cause of obesity is a low level of exercise among ethnic minority groups. Black and South Asian groups have low levels of exercise, with the exception of young African-Caribbean men (Rudat, 1994).

Religion also plays an important role in some behavioural patterns or lifestyles, such as the prohibition of smoking among Sikhs, the prohibition of drinking alcohol among Muslims and the prohibition of both smoking and alcohol among evangelical Christians (Rudat, 1994). The dietary patterns of some ethnic groups are also influenced by religion, for example a vegetarian diet among Hindu / Gujaratis puts them at greater risk of low levels of vitamin D (Leung and Stanner, 2011). Again, even when the behaviours or beliefs associated with an ethnic group can be shown to account for a particular health pattern, the fluidity of these factors, and the way in which they are constantly refashioned within a culture, needs to be recognized, especially after migration when people have access to the resources of two different cultures.

2.7.3 Socioeconomic

Even though there are significant data available on ethnic differences in health, further research is needed to explore factors associated with the role of socioeconomic position. Socioeconomic inequalities affecting health is not a new concept in public health. In 1845, Engels reported that poor health and mortality in Irish people were due to their poor social living circumstances in England (Engels, 1887). The USA also had similar circumstances reported by Trask (1916), who found that higher death rates among the Black Americans compared with White Americans reflected better social circumstances rather than any inherent differences (Trask, 1916). Wild and McKeigue (1977) reported that socioeconomic factors play a minimal or no role in determining ethnic inequalities in health (Wild and McKeigue, 1997). By contrast, others mention that, along with socioeconomic factors, cultural and genetic factors must also play a role in ethnicity (Nick, 1995). There are studies which argue that socioeconomic inequalities play an important role in ethnic inequalities (Navarro, 1990; Sheldon, 1992).

In the UK, a large proportion of people from ethnic minorities live in deprived areas (Barnard and Turner, 2011), although there are differences between ethnic groups, such as people of Pakistani and Bangladeshi origin being more likely to live in more deprived areas (Tinsley and Jacob, 2006). Whereas Chinese and Irish groups are less likely to live in the most deprived areas, the Bangladeshi group has shown a constant pattern of inequality and relatively low income. As Bangladeshis are one of the minority groups with the highest income inequality, they are consistently the worst off. They also have the highest poverty rate of all groups. It has been recommended that the Bangladeshi group should be investigated regarding their disadvantages (Barnard and Turner, 2011).

Social class inequalities in the UK persist at every age and for all the major diseases. An analysis of health outcomes in England for the Global Burden of Disease study showed that males living in the most deprived region of England in 2013 had a life expectancy 8.2 years shorter than those living in the least deprived region, which was as large a difference as seen in 1990 (Newton, *et al.*, 2015). The life expectancy for women living in the most deprived region in 2013 was 6.9 years shorter than for those in the least deprived region; a small improvement since 1990 when the difference was 7.2 years. (Newton. *et al.*, 2015). An analysis of data from the 1991 census suggested that mortality is inversely associated with socioeconomic status in most ethnic minority populations (Wild, *et al.*, 2007).

2.7.4 Migration

The effect of migration on health is complex; it is not always possible to isolate the effects independently (Steinbach, 2009). Migration is defined as “a permanent or semi-permanent change in residence across administrative boundaries for a period greater than one year” (Jeemon, *et al.*, 2009, pg.19). Migration involves socioeconomic, behavioural and environmental changes. Hence the history of migration plays an important role, and is often a key issue, in explaining patterns of health among migrants (Steinbach, 2009). Migration is considered a stressor and powerful cause of changes in lifestyle and life choices relevant to CVD and DM (Patel, *et al.*, 2006). It is a potential determinant of CVD risk factors; for example, it plays a significant role in dietary change among minority ethnic groups (Patel, *et al.*, 2006). Studies have shown that dietary changes among minority ethnic groups have been associated with obesity, type 2 diabetes and myocardial infarction (Jackson, *et al.*, 2007).

The process of migration can be associated with negative life events, fatalism, unfulfilled expectations, lack of social support, social skill deficits and clashes with the new culture/acculturation. Acculturation, or acculturative stress, refers to stress resulting from an attempt to incorporate host country traits within one’s own culture (Karasz, *et al.*, 2019). Acculturation, along with other social factors such as lack of social support, social skill deficit, unemployment and poverty, might cause mental health deterioration by increasing stress levels among migrants (Karasz, *et al.*, 2019). The impact of acculturation on health behaviours and CVD risk factors could be a mechanism by which migration influences CVD.

For example, a study by Smeeton *et al*. (2009) reported Chinese and Indian people born in the UK were more likely to be obese than those born overseas. Migration affects not only physical health but mental health too.

Depression is the most common mental health diagnosis among South Asians in the UK (Karasz, *et al*., 2019). One study reported high rates of depression and anxiety among South Asians compared to Whites in the UK (Weich, *et al*., 2004). Studies from the UK and US concluded that old age, gender roles, financial difficulties, perception of illness, social isolation and poor physical health were contributory factors for depression among South Asian migrants (Karasz, *et al*., 2019). Another study reported high susceptibility among South Asian women for self-harm and certain mental illness (e.g. depression, anxiety and insomnia) (Karasz, *et al*., 2019). However, Bangladeshi pupils were at decreased risk of psychological distress relative to White UK pupils possibly due to ethnically related protective factors (Costello, *et al*., 1997) such as high levels of family support, religious beliefs, strong cultural identity and cohesion. However, there are factors that increase stress among Bangladeshi migrants causing anxiety and depression such as discrimination at work, racial abuse and sending remittances to relatives back home (Stevanovic, 2012).

A study by Stevanovic (2012) reported that for Bangladesh's economy, remittances constituted one third of foreign exchange earnings. The Sylheti living in the UK send remittances to Bangladesh which can make significant differences in their families' economy (Das, 2013). It was common practice to send remittances to Bangladesh between 1960 and 1970 in the UK; around 85% of migrants used to send remittances to Bangladesh. The practice declined to 20% in 1995 due to increasing living costs, family reunion in the UK and conflicts with family members in Bangladesh (Das, 2013). Sending remittances may help migrants maintain contact with their family and it is an important psychosocial factor associated with stress among migrants (Vertovec, 2002), specifically among Bangladeshis, as remittance is considered not only culturally appropriate but also a religious obligation in Bangladeshi migrants (Stevanovic, 2012). A study reported that sending remittances to Bangladesh was explained as one's moral duty and obligation towards family, which in reality causes increased stress and "high pressure" (Stevanovic, 2012). This high pressure comes from a sense of duty or losing face if one does not comply with expected social roles. Remittance is also considered a status of symbol in Bangladesh (Stevanovic, 2012). Overall, it might be considered a source of additional stress and anxiety among migrants when they struggle with unemployment, racial discrimination and socioeconomic deprivation.

In the UK, despite anti-discrimination law and policies, racial discrimination is an important psychosocial factor associated with migration (Modood, *et al.*, 2002). It has been reported that depression and chronic work stress are independently associated with increased cardiovascular disease and diabetes among South Asians (Bhopal, 2019). Migration associated with these psychosocial factors contributes to poverty, and vice versa, and in the UK there is a well-established association between low socioeconomic status and increased risk of CVD (Bhopal, 2019). There is a complex relationship between ethnicity, socioeconomic position, and CVD. In relation to this study, important consideration is given to ethnicity and type of stroke (haemorrhagic strokes). Among South Asians, the Bangladeshi population is the most deprived ethnic group with high rates of unemployment in the UK (Platt, 2007). A high prevalence of haemorrhagic stroke (which has a high fatality rate) is associated with low socioeconomic status (Bhopal, 2019).

The factors associated with the health of migrants may be affected by the length of stay in the UK (Nazroo and James, 2003), which can cause heterogeneity in stroke risk factors among sub-groups of South Asians.

2.8 Ethnic differences in the stroke risk factors

Apart from the high prevalence of stroke among migrant South Asians in the UK, there are also differences in the occurrence of stroke risk factors such as diabetes, AF (atrial fibrillation) and infections (Gezmu, *et al.*, 2014). In most of the studies focussing on stroke epidemiology, ethnicity is considered an important risk factor (Fustinoni & Biller, 2000).

I will now review the risk factors associated with stroke among South Asians. Chapter 4 is also going to review updated available evidence for these risk factors among South Asians in the UK.

2.8.1 Diabetes Mellitus

As discussed earlier, migration has an impact on health in terms of social and economic changes from the past to the present (Smith, *et al.*, 2000). These can lead to changes in human behaviour and lifestyle which have given rise to an increase in diabetes worldwide (Zimmet, *et al.*, 2001). Within the last century, a dramatic increase has been observed in the prevalence of diabetes worldwide; predominantly in type 2 diabetes (Zimmet, *et al.*, 2001). Type 2 diabetes risk is associated with environmental and behavioural factors such as a sedentary lifestyle, poor dietary habits and obesity (Carulli, *et al*, 2005). Along with genetic susceptibility in different ethnic groups, diabetes increases the risk of coronary heart disease and stroke threefold (Zimmet, *et al.*, 2001). Cardiovascular mortality risk is also increased in those with diabetes (12.0% in people with diabetes compared with 2.2% in those without diabetes) (Zimmet, *et al.*, 2001).

Several research studies have found that diabetes is more common in ethnic minority groups, especially the Indian subgroup of South Asians in the UK (Forouhi *et al.*, 2006; Tillin, *et al.*, 2013). The risk of type 2 diabetes in the UK is increased four- to six-times in South Asians compared with the host populations (Barnett, *et al.*, 2006) (Figure 2.3). Bhopal and Cappuccio also found the prevalence of diabetes to be five times higher in South Asians compared with the White population (Cappuccio, *et al.*, 1997b, Bhopal, *et al.*, 1999). The age at presentation is also significantly younger and the condition remains undiagnosed in up to 40% of South Asian individuals (Barnett *et al.*, 2006). As the duration of diabetes is one of the strongest risk factors for complications, this places South Asian populations at higher risk of cerebrovascular and cardiovascular disease (Barnett, *et al.*, 2006).

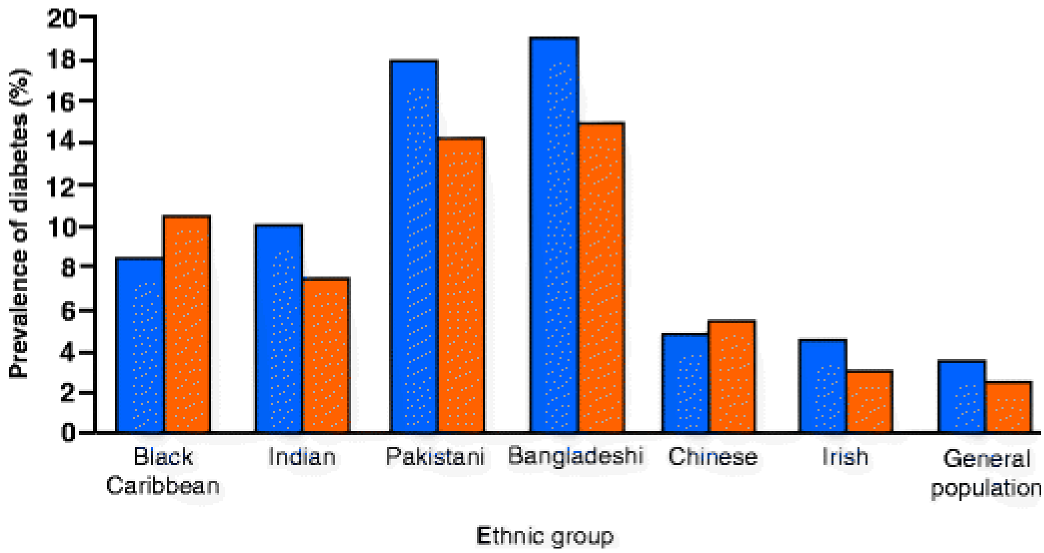


Figure 2.3: Prevalence of diagnosed diabetes by ethnic group in the UK (Blue bar, men; red bar, women) (Barnett, *et al.*, 2006, p.2236)

A study in the US found that the excess risk of stroke, which was independent of blood pressure, may be due to diabetes (Barrett-Connor & Khaw, 1988). Identifying and treating diabetes along with hypertension, cigarette smoking and high LDL cholesterol can reduce the risk of stroke (Kuller, 1995). In the UK, 20% of strokes have been established to be caused by diabetes; diabetes almost doubles the risk of having a stroke (Emerging risk factor collaboration, 2010).

2.8.2 Hypertension

Raised blood pressure (BP) is the strongest single modifiable risk factor for stroke in the general population (Barrett-Connor & Khaw, 1988). Globally, hypertension causes about 54% of stroke and 47% of ischaemic heart disease (Lawes, *et al.*, 2008). The prevalence of raised blood pressure in South Asians compared with Whites varies from one group to another but it is still higher in South Asian people compared with White people (Agyemang and Bhopal, 2002). There are differences within the South Asian groups, as Bangladeshi men are 25% less likely to have high BP than the general population (Agyemang and Bhopal, 2002). This is similar for Bangladeshi women as well (Agyemang and Bhopal, 2002). However, Pakistani women have a 25% higher prevalence of high BP compared with the White population (Barnette, 2006).

As the South Asian population has shown unique patterns of individual susceptibility and severity of stroke and hypertension (Patel, *et al.*, 2006) there is a need for effective strategies around prevention, detection and management of hypertension and diabetes to reduce the burden of stroke (Cappuccio, *et al.*, 1997b).

2.8.3 Hyperlipidaemia

A high level of cholesterol is an important risk factor for stroke. Reducing the level of cholesterol by 1 mmol/L reduces the risk of stroke by more than 21% (Amarenco & Labreuche, 2009). Triglycerides are almost always higher in studies on South Asians compared with those on White populations (Cappuccio, *et al.*, 2003). Bhopal *et al.* reported that South Asian people living in Newcastle had a lower HDL concentration, higher triglycerides and a higher total cholesterol ratio than European people (Bhopal, *et al.*, 1999). Similarly, another study found that South Asian people may have a more adverse lipid profile than White people (Lemieux, *et al.*, 2001). Most studies examining HDL cholesterol concentrations have reported lower levels in South Asian immigrants compared with White Caucasians (Bilen, *et al.*, 2016).

2.8.4 Smoking

The risk of death from stroke is doubled by smoking (Thun, *et al.*, 2013). McKeigue *et al.* (1991) found that smoking rates in South Asian populations overall is the same or less than White males and lower in South Asian women. However, the Health Survey for England (2001) mentioned differences between South Asian groups: 44% of Bangladeshis, 26% of Pakistanis and 23% of Indians smoked cigarettes, compared with 27% of men in the general population (Zaninotto, *et al.*, 2007). Bhopal *et al.* (1999) also found a higher prevalence of smoking among Bangladeshi men compared with Indian, Pakistani and White men, whereas low levels of smoking have been observed in Bangladeshi women (2.4%) and Pakistani women (4.5%) (Zaninotto *et al.*, 2007). Smoking has been found to be less common among Black Caribbean, Black African and South Asian individuals compared with Caucasians due to cultural and religious reasons (Cappuccio *et al.*, 1997b; Tillin *et al.*, 2013b).

A study using Health Survey for England data (from 1999, 2004, 2006, 2007 and 2008) investigated ethnic differences in current smoking status and found a higher prevalence among Bangladeshi and Black-Caribbean men compared to White English men. The differences were explained by socio-economic position, and both Pakistani men and Black-Caribbean women had lower smoking rates than the general population after adjusting for socio-economic status (Karlsen, *et al.*, 2011). A study ‘Stroke in younger people’ conducted in 2012, revealed that 52% of those having strokes under the age of 45 were active smokers and 66% were current or previous smokers (de los Ríos la Rosa, *et al.*, 2012).

2.8.5 Obesity

Obesity has a wide impact on heath being a risk factor for coronary heart disease, stroke, type 2 diabetes, hypertension, metabolic syndrome, osteoarthritis and cancer (Kerry, 2008). It was found that some ethnic groups have elevated risks of some of these conditions, particularly type 2 diabetes and hypertension, even if their BMI is low (Razak, *et al.*, 2007).

The international BMI cut-off points for assessing whether someone is overweight (BMI 25 kg/m^2) or obese (BMI 30 kg/ m^2) have been used for the general population irrespective of ethnicity (NICE, 2014) This does not fit with the explanation of higher CVD risk among South Asians despite a lower BMI, which could be due to a lower muscle mass and more fat at any given BMI value compared to White Europeans (Wells, *et al.*, 2016). In South Asians abdominal obesity is also matter of concern due to the increased risk of hypertension and stroke (Rudat, 1994). Abdominal obesity is also associated with atherosclerotic patterns of lipids (Bhopal, 2019). It has been found that abdominal obesity is associated with dietary habits and low levels of exercise among South Asians (Rudat, 1994).

Table 2.3: WHO Advice for BMI Cut-off for Public Health Action Points

General Population		Asian Population	
Classification	BMI (kg/m^2)	Classification	BMI (kg/m^2)
Underweight	< 18.5	Underweight	< 18.5
Normal Range	18.5 to 24.9	Increasing but acceptable risk	18.5 to 23
Overweight	25.0 to 29.9	Increased risk	23 to 27.5
Obese	30 to 39.9	High Risk	27.5 and above
Severely Obese	40 and above		

Source: NICE guideline: Public Health guideline 2013)

Obesity is defined by the WHO using Body Mass Index (BMI) for the general adult population, with a BMI of 25-29.9 kg/m^2 defined as overweight and a BMI of 30-39.9 kg/m^2 defined as obese (NICE, 2014). However, in the case of South Asians, body fat percentage is much higher at any given BMI (Bhopal, 2019) (Table 2.3). WHO assessed the cut-off for South Asians and concluded the general thresholds were not appropriate for South Asians due to their higher risk of CVD and diabetes (NICE, 2013). The new cut-off points recommended by WHO for South Asian populations has lower thresholds compared to the general population: a BMI of 23-27.5kg/m^2 is described as having an increased risk of ype 2 diabetes, and a BMI above 27.5/m^2 as being at high risk for type 2 diabetes (NICE, 2013).

2.8.6 Diet

As mentioned earlier, migration has played an important role in dietary changes in ethnic minority groups. The change in dietary habits after migration is considered an important risk factor for poor health. Diet is considered as part of the cultural and behavioural factors associated with health (Smith, *et al.*, 2000). It plays an important role in the health and well-being of individuals (Misra, *et al.*, 2009). Specifically, among South Asians' culture, food has a prominent place - it is more than nourishment (Misra, *et al.*, 2009).

The traditional rural South Asian diet is considered cardio-protective, consisting of varieties of grain, rice and pulses, and supplemented by fresh vegetables (Kakde, *et al.*, 2017).

While staple foods vary by region, they tend to contain large amounts of carbohydrate; for example, the main staple food in Northern parts of India and Pakistan is chapatti made from grain flour (predominantly wheat flour), while in Bangladesh it is rice and fish (Holmboe-Ottesen, *et al.*, 2012). After migration, changes in dietary habits are influenced by the food culture of the majority population (Holmboe-Ottesen, *et al.*, 2012). In this nutritional transition, immigrants from South Asian countries in the UK meet an abundance of highly processed foods with a reduction in consumption of traditional staple foods (Holmboe-Ottesen, *et al.*, 2012). Eating an unhealthy diet is not only associated with comorbidities, such as obesity and nutritional disorders, but also with increased disability adjusted life years from ischaemic heart disease (IHD) (Lim, *et al.*, 2012).

From previous research it is evident that the quality of diet among Bangladeshis in the UK is poor compared to other ethnic groups (Ellahi 2014, Sawda, 2020). The Bangladeshi diet in the UK is reported to have a high intake of fat, particularly saturated fats, salt and non-starch polysaccharides (Ellahi 2014). South Asians and Afro-Caribbeans are reported to consume a higher proportion of their salt intake from cooking and table salt, compared with the general population (Cappuccio, *et al.*, 1997a).

As mentioned earlier, the most commonly consumed meal among British Bangladeshi is “dal vaat” (white rice and lentils), “mangsho” (meat) and “shutki mach” (dried fish) (Sawda, 2020). Though the consumption of lentils and meat are beneficial to the body by providing energy and essential nutrients, the fish (shutki mach) used in this diet are predominantly made by marinating clean mach (fish) flesh in saltwater brine for a few hours, drying it under direct sunlight for a few days and lastly conserving it in jars for later consumption (Rana and Chakraborty, 2016). Shutki mach is commonly consumed in the UK, but is store-bought. Daily and excessive consumption of dried fish and white rice that exceeds nutritional guidelines contributes to an increased risk of obesity and chronic disease (Podder, *et al.*, 2018; Jennings, *et al.*, 2014). This is exacerbated by a low fibre intake in British Bangladeshis (20.8g/day, below the recommended nutritional guidelines of 30g/day), due to lower fruit and vegetable intake. Indeed, while there is evidence suggesting that people from ethnic minority groups in the UK may consume more fruit and vegetables than the general population (Scarborough, *et al.*, 2010), Bangladeshi and White men consume less fruit and vegetables compared with Indian and Pakistani men in the UK (Bhopal, 2020). A recent study reported that these nutritional differences result in the Bangladeshi population being at increased risk of chronic diseases, such as CVD, cancer and diabetes, at an earlier age compared to other ethnic groups in the UK (Sawda, 2020).

Another potential dietary factor which is reported as a cardiovascular risk factor among South Asians is the use of clarified butter or ghee. Ghee contains high levels of saturated fats, which are linked to raised LDL cholesterol levels (Kakde, *et al.*, 2017). The traditional South Asian diet consists of lentils, vegetables and grains, and many foods are fried or cooked in ghee/clarified butter, increasing energy or calories. This high consumption of energy can contribute to weight gain (Kakde, *et al.*, 2017). Other factors, such as reuse of cooking oil, high-heat food preparation and high salt intake, are also associated with CVD risk among South Asians (Cainzos-Achirica, *et al.*, 2019). A study by Kakde *et al.* (2017) reported that susceptibility to CHD among South Asians is partly attributed to high-heat food preparation. These dietary changes are influenced by sociodemographic, economic and cultural factors along with duration of stay in the host country (Satia-Abouta, *et al.*, 2002). This evidence suggests that ethnic minorities are at greater risk of having hypertension and stroke. Elimination of trans-fats from food, reducing salt intake and an increased intake of fruits and vegetables, along with a higher intake of wholefoods in the diet, could help minimise adverse health consequences.

2.8.7 Atrial Fibrillation

Atrial fibrillation (AF) is when the heartbeat is irregularly irregular and the heart beats to no discernible pattern or rhythm (Stroke Association, 2017). Due to this, a small pool of blood is left stagnant in the ventricular chambers of the heart which results in clot development over time and causes a stroke (Stroke Association, 2017). AF increases the risk of stroke fivefold (Savelieva, *et al.*,2007) and is responsible for 20% of strokes in England, Wales and Northern Ireland (Benjamin, *et al.*, 1994). Men have a 1.5 times greater risk of developing AF than women (Benjamin, *et al.*, 1994).

These risk factors will be explored systematically in Chapter 4, collating evidence from UK-based studies conducted among the South Asian population.

2.9 Conclusion

The relationship between determinants of health and ethnicity is complex. Although, evidence is available to support the relationship between ethnicity and the outcome of disease, there has been a lack of studies considering heterogeneity within South Asian groups in the prevalence of stroke risk factors and mortality in the UK. There is growing empirical evidence suggesting 'ethnicity' as an important risk factor in the development of stroke and its risk factors, such as diabetes and hypertension. The data suggest that the Asian/Asian British ethnic group is one of the largest and rapidly increasing population groups, and the current trend of increasing ethnic diversity within the UK has given rise to ethnic health inequalities.

Even though nothing can be done to modify 'ethnicity', there is potential to identify risk factors that are associated with ethnicity. This could help in planning culturally appropriate and sensitive policies to prevent and minimise the impact of disease.

The focus of this thesis is to understand the pattern of association between the risk factors of stroke and ethnicity (specifically in Bangladeshis). Even though there are studies conducted among South Asian immigrants for CVD and stroke, few studies focus on the heterogeneity of South Asian groups. In this thesis, I will aim to understand the pattern of disease and risk factors in individual South Asian groups.

Considering the defining components of ethnicity (such as language and place of origin), it is safe to conclude that ethnicity is complex and needs to be considered carefully in research. The issues of ethnic variations in health, aetiology, pathogenesis and the outcomes of diseases are also complex. It is highly unlikely that any one explanation would adequately account for the differences found between individuals of different ethnicities. There are challenges while considering the term 'ethnicity' in research, specifically the term 'South Asians'. Attempts to understand the higher CVD and stroke mortality among South Asians in the UK is hampered by using the broad term South Asian as a single, homogeneous group. Evidence suggests that South Asian groups - Indians, Pakistanis and Bangladeshis - have their own cultural traits and health profiles presenting complex challenges for the researcher while studying their disease pattern. Although the number of studies already published may appear to descirbe sufficient evidence (when considering South Asians as a homogenous group), there is still a lack of studies considering South Asians as individual ethnic groups. It is important for healthcare professionals and policy makers to be aware of the influence of ethnicity on individuals and their pattern of risk factors, and of cultural influences on health, for both personalised care and policy making.

Chapter 3: Methodology

This chapter gives an overview of the overall methodological approach for the research and then briefly describes the research methods for each of the four individual studies. Detailed methods for the study design, data collection and data analysis are described in the individual chapters.

3.1 Research Methodology

To understand fully the characteristics of stroke among South Asians, there are a range of factors, from risk factors to treatment, that need consideration. Therefore, this thesis focuses on risk factors associated with stroke through to the management of stroke, in order to address the main research questions as detailed below:

- What are the major risk factors associated with high prevalence of stroke in the Bangladeshi population in the UK?
- Is the prevalence of stroke (ischemic and haemorrhagic) higher in Bangladeshis in the UK compared with other South Asian groups and White comparators?
- Are there differences in clinical presentation, access to acute stroke unit, preventive care and clinical outcomes in Bangladeshi patients with stroke compared to other ethnic groups?
- Does the management of stroke differ in Bangladeshis in Birmingham, UK, compared to other South Asian groups and White comparators?

Due to the broad nature of the research questions, the overall methodology I have used is a 'multi-method' approach defined as: "When multiple forms of qualitative data (or multiple forms of quantitative data) are collected " (Creswell, 2015, pp.2-3). In my 'multi-method' approach I have chosen to carry out an in-depth inquiry by a series of four studies using a systematic review and three different quantitative methods (Figure 3.1).

A report by Anguera *et al.*, (2018) summarises the views of different authors and their opinion on the use of mixed methods and multi-methods. The difference between mixed methods and multi-methods has been a topic of debate for the last 20 years. Some researchers make a clear and opinionated distinction between mixed methods and multi-methods while others use them as synonyms (Anguera *et al.*, 2018).

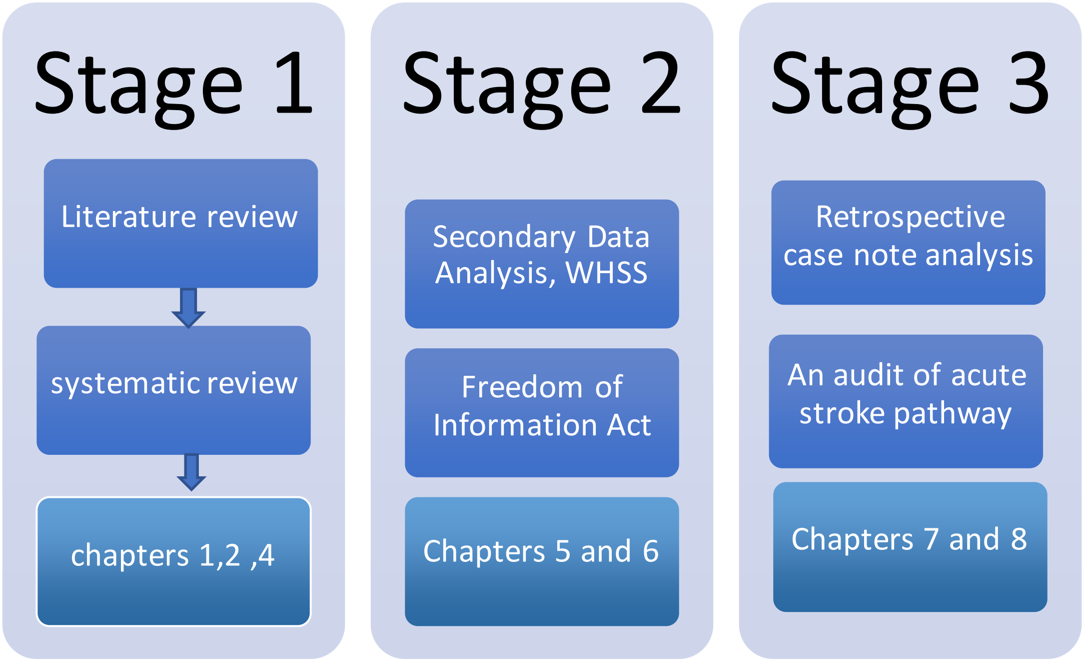


Figure 3.1: An overview of chapters in the thesis

Figure 3.2: Multi-method research-Strategies (Resource: Mills, *et al.*, 2010)

Anguera and colleagues conclude that "We believe that a study will be multi-method when, driven by a common overall research goal, it uses a series of complementary methodologies, chosen according to a given criterion (we propose internal control). According to our proposal, whether it has a predominantly qualitative or quantitative nature has no bearing on its consideration as a multi-method study." (Anguera, *et al.*, 2018, p.11).

Multi-method approaches have advantages over mixed methods as, in mixed methods, we can combine quantitative and qualitative methods only. While in 'multi method' there can be a "mixing of any method" (Nagy, *et al.*, 2016). The other advantage of using multi-methods is that researchers are free to choose any research methods and "do not have to be prisoner of any particular research method or technique" (Robson,1993, p.174).

"Multi-method research programs are based on a methodological research strategy that includes more than one method of collecting data and/or more than one method of analysing the data. Such methods can be based on qualitative techniques, quantitative techniques, or a mix of both." (Mills, *et al.*, 2010) (Figure 3.2).

3.2 Quantitative Research - why quantitative?

Each researcher has their own view on methodology depending on their philosophy. There is a paradigm war between quantitative and qualitative methodologies (Pope & Mays, 2006). Quantitative research is a type of research methodology that collects numerical data and analyses these by using statistical methods (Creswell, 1994). In quantitative methodology, data collected are used to control a phenomenon with the focus on theory testing (derived from previous research to formulate a hypothesis or testable idea), prediction and control (Rose, 2007). Quantitative methodology uses several methods such as experimental research, survey and cohort studies which help to answer, 'how big is X?' or 'how many 'X' are there?' (Pope & Mays, 2006). As compared to qualitative methodology, quantitative methodologies are specific, well-structured and can be explicitly defined and recognised (Kumar, 2011). One of the important advantages of quantitative methodology is that findings can be replicated and retested, whereas in qualitative design findings cannot be replicated (Kumar, 2011). Quantitative research helps to find the extent of variation and diversity among groups and is well suited to the research questions framed in this thesis.

Quantitative methodology is used in this research, as it is widely used in developing guidelines by institutions such as the National Institute for Health and Care Excellence (NICE). NICE make recommendations, based on evidence, about the effectiveness of medical procedures and treatments (NICE, 2009). However, to understand the perspective of the patient and service providers there is a need for qualitative research. Unfortunately, in this thesis qualitative research was not feasible, due to the timeline. This limitation will be acknowledged and discussed in Chapter 9.

My philosophical underpinning is pragmatism, choosing the method that best answers the research questions. Pragmatism has advantages over other paradigms: it frees the researcher from mental and practical constraints imposed by the "forced choice dichotomy between post positivism and constructivism" (Creswell and Clark, 2011). Because of the scarcity of research on the topic of this thesis, the methodology has been designed in a way that makes it possible to answer the research questions from different perspectives in the defined period. Using a multiple method approach to answer the research questions from different angles will help to explore the unsolved puzzle (Meetoo and Temple, 2003).

3.3 Overview of Methods

I undertook the research using a systematic review and three different quantitative data collection methods. Firstly, I carried out a systematic review of the literature on the epidemiology of stroke in South Asians in the UK (Chapter 4). Secondly, I undertook a secondary data analysis of the Wandsworth Heart and Stroke Study (WHSS) in relation to risk factors for stroke in South Asian sub-groups (Chapter 5). Thirdly, I submitted a Freedom of Information Act request to obtain data on admissions due to stroke in Birmingham by ethnic group (Chapter 6). Fourthly, I conducted a study in the Heart of England Foundation Trust (HEFT) which was divided into two parts.

The first part was a retrospective case note analysis of patients admitted with stroke who were of Bangladeshi origin, in comparison with other South Asian groups (Indian and Pakistani) and White Europeans from November 2014 - May 2017 (Chapter 7). The second part was an audit of the acute stroke pathway for patients admitted to HEFT by ethnic group (Chapter 8). Further details on each method are given below.

3.3.1 Systematic review

Designing this systematic review was a challenge. While designing the search strategy all previous reviews were kept in mind so that the gaps in the knowledge could be filled. After a comprehensive search, 26 studies were identified focusing specifically on stroke/CVD in the South Asian population in the UK. This systematic review was quite challenging as the studies found were methodologically heterogeneous, so a narrative synthesis was selected. The next step was to find a way to present the results of the different studies in the same table or under one category. This challenge was solved by categorizing studies according to their outcomes. The other challenge was the quality assessment of the studies. The Newcastle

Ottawa Scale (Wells, *et al.,* 2014) was used after considering various quality assessment scales.

3.3.2 Secondary data analysis of WHSS

Secondary data analysis of the Wandsworth Heart and Stroke Study (WHSS) was performed. The Wandsworth Heart and Stroke Study was a survey, conducted in South London in 1994-96, to measure the prevalence of cardiovascular risk factors amongst ethnic minority groups (Cappuccio., *et al.,* 1998). The data were analysed to compare cardiovascular risk factors in Bangladeshis, Indians, Pakistanis and White Europeans, as data for these sub-groups had not been previously analysed in this way. Chapter 5 provides the detailed methods and analysis of the data.

3.3.3 Freedom of Information Act Request

This was one of the initial stages of this research. Under the Freedom of Information Act (FOIA) 2000, a request for data on stroke was made to three large hospitals in Birmingham. The hospitals were contacted for data on stroke admission by ethnic group. A detailed questionnaire was submitted to the targeted hospitals which included questions on the length of hospital stay, average attendance and re-attendance. The detailed methods are described in Chapter 6.

3.3.4 Retrospective case note analysis

3.3.4 I - Ethical approval

The access to the databases at Heartlands Hospital (one of the hospitals managed by HEFT) required ethical approval. The research protocol was developed after the review of the literature and oral discussion with the head of the Stroke Unit (Dr. David Sandler) at Heart of England Foundation Trust (HEFT). The research protocol along with the research passport obtained from the University of Warwick was submitted for R&D approval to HEFT. An Honorary Contract from HEFT was given. Immediately after the honorary contract was granted, a request was made to access case notes with following criteria:

3.4.4 II- Inclusion criteria for case notes

- All Bangladeshi patients admitted to Heartlands Hospital with a stroke between November 2014-May 2017
- Equal numbers of Indians and Pakistanis matching the above Bangladeshi patients

- Equal number of White European patients as compared to the Bangladeshi patients

3.4.4 III- Exclusion criteria

- Any patient admitted before November 2014

Retrospective data were collected from the case notes of patients admitted to Birmingham Heartlands Hospital. The case notes of Bangladeshi patients admitted to Heartland from Nov 2014-May 2017 along with similar numbers of Indian, Pakistani and White European patients were requested for data collection. Ethnicity was checked by going through case notes and clinical records. The records consisted of all previous GP letters, referral letters, laboratory reports (where available) and hospital admission notes.

Data before stroke admission, at the time of stroke and after stroke were collected for analysis.

Statistical analysis: All the data collected from case notes were entered into an Excel spread sheets and transferred to SPSS software for statistical analysis. A Chi-squared test was performed for categorical variable and ANOVA was performed for group comparisons. The details of statistical tests and analyses are reported in Chapter 7.

3.5 Audit of acute stroke pathway

The Sentinel Stroke National Audit Programme (SSNAP) (2015) identifies the 'Proportion of patients directly admitted to a stroke unit within 4 hours of clock start' (Stroke: Update of NICE guidance, 2014). The Heart of England NHS Foundation Trust data from Birmingham Heartlands Hospital show that 66.0% of patients were admitted to a stroke unit within 4 hours from October to December 2014 but this improved to 75.9% from July to March 2016. Equivalent national data show that 56.9% and 59.8% were admitted to a stroke unit within 4 hours, respectively (Sentinel Stroke National Audit Programme, 2016).

The primary aim was to analyse the data by ethnic group with a specific objective of identifying whether there are variations in the management of acute stroke for South Asians *vs.* White Europeans. Data analysis was performed in SPSS. Chapter 8 has the detailed data analyses. The secondary aim of the audit was to understand the patient journey through the hospital (i.e. location(s) in the hospital and hours/days spent), the patients' management and to identify if diagnostic errors are made that prolong the journey. A detailed analysis was performed to explore what happens to each patient with a stroke, and to help understand what happens to the patients who do not access the stroke unit within 4 hours.

Chapter 4: Systematic Review of the Epidemiology of Stroke in South Asians/Bangladeshi Migrants in the United Kingdom

4.1 Introduction

The overall purpose of this systematic review was to critically appraise and synthesise the current state of knowledge relating to stroke in the South Asian population with a specific focus on Bangladeshis in the UK. This review also plans to identify evidence gaps that new primary studies may seek to address.

Stroke is the second most common cause of death in the world and the fourth biggest killer in the UK (Stroke Association, 2017). It accounts for 9% of all deaths in the UK (Scarborough, *et al.*, 2009). There is an inequality found in mortality for minority ethnic groups compared with the general population, resulting from high premature mortality in this group. The joint report published by the Stroke Association and British Heart Foundation summarises the burden of stroke in England and Wales (Scarborough, *et al.*, 2009). It has shown marked ethnic inequalities in stroke mortality, with Bangladeshi men having a three times higher mortality compared with those born in England and Wales (Scarborough, *et al.*, 2009).

The UK is one of the best places to study migrant South Asian populations because of its multi-ethnic demographic. In the 2011 census, the 'non-White' population constituted 13% of the total UK population of which 8% were Asian or British Asian (O'Brien and Collins, 2015). There is plenty of research on the epidemiology of stroke in the Black population compared with the host population in both the US and the UK (Hajat, *et al.*, 2001; Sacco, *et al.*, 1998). Studies conducted in the UK South Asian population mostly show a higher mortality for stroke in the South Asian population compared with other populations (Gunarathne *et al.*, 2008b) and this needs further exploration. Also, risk factors associated with stroke in the South Asian population, particularly socioeconomic, environmental and dietary factors, need further elucidation (Gunarathne, *et al.*, 2009; Tillin, *et al.*, 2013).

What is already known?

Gunarathne *et al.*, (2009) carried out a systematic review on ischaemic stroke in South Asians, with their literature search carried out in 2005. Their review included 33 global studies on ischaemic stroke comparing South Asians with Caucasians. The review included

28 cross sectional and 5 prospective studies, which were mostly from other countries (non-UK). Seven studies were from the UK. A descriptive analysis was conducted as statistical analysis was not possible due to methodological heterogeneity. The review aimed to focus on the epidemiology of ischaemic stroke among people of South Asian origin with the focus on migrants living in the UK. The secondary objective of the review was to identify environmental exposures that increased stroke risk and to understand the pathophysiology of stroke. The review found a trend for an increase in incidence and prevalence of hypertension and hyperlipidaemia along with ischaemic stroke among South Asians compared to the European population. The review concluded that the high stroke mortality among South Asians could be due to their glycaemic status.

The literature search for my systematic review was carried out in 2015 and updated in 2021 (with the findings integrated). As Gunarathne *et al.* (2009) carried out their database search in 2005, this was outdated, with newer primary studies available. The rapidly changing global epidemiology of stroke indicates an urgent need for an updated review (Feigin, *et al.*, 2015). There were five studies (Hsu, *et al.*, 1999; Bhopal, *et al.*, 2005a: Gunarathne, *et al.*, 2008a; Gunarathne, *et al.*, 2008b; Bourke, *et al.*, 2006) that were in common between my systematic review and that of Gunarathne, *et al.* (2009).

Newer studies published since 2009 have been included in this review; for example, a cross-sectional study by Dalton, *et al.* (2014) concluded that ethnicity is an important CVD risk factor. Two additional studies (Malik *et al.* 2015; George *et al.* 2017) were found in the updated search. The study by Malik *et al.* (2015) showed South Asian diabetic patients are at increased risk of CVD compared to White populations in Scotland. Furthermore, a later prospective study published by George *et al.* (2017) indicates that CHD diagnoses among South Asians is particularly high among younger age groups (under 60 years) compared to White and Black people in the UK. George *et al.* (2017) suggested considering the prioritisation of young South Asian patients for CVD risk assessment.

This review includes studies conducted in the UK South Asians only, whereas Gunarathne *et al.* (2009) included studies from other countries as well. The Gunarathne *et al.* (2009) review was focused on the epidemiology of ischaemic stroke, whilst in the current review there was no restriction by the type of stroke.

This review was conducted to increase the current knowledge of stroke epidemiology and facilitate healthcare planning, prevention and management of stroke.

The aims of this review were to:

a) Find and synthesise published population-based studies of the incidence, prevalence, mortality and case-fatality of stroke from 1990 onwards in the South Asian population in the UK;

b) To review the prevalence of risk factors for stroke in the South Asian population;

c) To synthesise data from the articles focussing on risk prediction models among South Asians, which was not included in the previous review (Gunarathne, *et al.* 2009).

4.2 Methods

4.2.1 Research Questions

This systematic review aimed to answer the following questions:

- Are the incidence, prevalence and mortality of stroke (ischaemic and haemorrhagic) higher in the South Asian population in the UK compared with the White European population?
- What are the major risk factors associated with high prevalence of stroke in the South Asian (Bangladeshi) population in the UK?
- Are there differences in the clinical presentation, access to acute stroke units, preventive care and clinical outcomes between South Asian patients with stroke and the White European population as the comparator?

The review had the following objective:

- To conduct a systematic review of the incidence, prevalence and mortality of stroke, risk factors of stroke, and access to care in the South Asian population in the UK, with a special focus on the Bangladeshi population.

4.2.2 Scoping Search

After a careful preliminary search for systematic reviews on databases such as MEDLINE, EMBASE, PubMed, CINAHL, Cochrane and EBSCO HOST, I could not find a systematic review which exclusively included studies that were carried out on stroke in South Asians in the UK. This emphasised the need for a systematic review on stroke in South Asians in the UK, in particular the Bangladeshi community due to an increased burden of disease in this group.

4.2.3 Study Eligibility

Inclusion Criteria

This review included studies on stroke conducted in the UK where the study population comprises South Asian or Bangladeshi, Indian and Pakistani groups. This review included those studies that compared mortality, prevalence and/or incidence of stroke and stroke risk factors in multi-ethnic groups. All study designs were included, such as cross-sectional, case-control and prospective studies, due to the paucity of data (Table 4.1).

Table 4.1: Inclusion Criteria

Participant/Population	Adult South Asians including those from India, Pakistan, and Bangladesh, who are living in the UK
Outcome	Cardiovascular disease, Stroke, Cerebrovascular disorder
Study Design	Primary studies: case control, cross sectional, cohort study designs, intervention studies conducted in the UK

Exclusion criteria

Papers excluded from the review:

- Papers not published in the English language; unpublished studies (e.g. dissertations, theses), reviews, systematic reviews, case reports, editorials and letters.
- Studies not conducted on humans
- Studies not conducted in the UK population
- Studies not focused on stroke
- Studies conducted in children

4.2.4 Search Strategy

The following electronic databases were searched: MEDLINE (see Appendix 4.1 for the search), CINAHL (see Appendix 4.2 for the search), EMBASE (see Appendix 4.3 for the search), EBSCO host and Google Scholar. The database searches were initially carried out in June 2015. Studies were included from database inception until June 2015. The search strategy was constructed by keeping population, outcome and study designs in mind. The reference lists of included studies were also hand-searched for other relevant studies. All references were managed using EndNote online and duplicates were removed.

The search strategies developed consisted of the search domains "South Asian" (which further included Indians, Pakistanis and Bangladeshi sas populations of interest) and "Stroke" and "Cardiovascular disease/Cerebrovascular accidents". A thorough search was performed using synonyms of the above-mentioned terms in the electronic databases.

To update the literature, the search was rerun (July 2015-March 2021) to find more recently published studies which met the inclusion criteria. Two new studies were included which met the inclusion criteria. The PRISMA chart reflects both searches (Figure 4.2).

4.2.5 Selection of studies

A two-stage study selection process was used. Titles and abstracts were screened by two review authors (RS, JS) for potentially relevant articles. The full text articles were obtained and reviewed for inclusion by two reviewers (RS, JS) (Appendix 4.4) with discrepancies discussed and uncertainties resolved by a third reviewer (FC or WR). The selection of studies, with reasons for exclusion, are presented using a PRISMA flow diagram (Moher, *et al.,* 2009). The updated search articles (full text) were review by two reviewer (RS, JS) and the final selected articles were reviewed by third reviewer (WR).

4.2.6 Data Extraction

Data were extracted and tabulated to include details of study methods (e.g. setting, study design), characteristics of patients (age, sex, ethnicity, setting of research) and outcomes. Information was also collected on those methodological aspects which were considered more likely to introduce potential bias: prospective compared with retrospective study design, data source for cohort identification (e.g. registries, databases, medical notes, Census), patients' selection criteria, definition of risk factors and recurrent events, timing of data collection and method of outcome ascertainment.

4.2.7 Quality Assessment of selected studies

Assessment of the quality of included studies in the review is fundamental for interpretation of the review results. In this review, different study designs were included. The assessment of study quality was made using the Newcastle-Ottawa Scale (NOS) (Figure 4.1) (Lo, *et al.*, 2014). This scale is recommended by the Cochrane Collaboration for the assessment of observational studies and non-randomised studies. It was developed by the University of Newcastle (Australia) and the University of Ottawa (Canada) to assess the quality of non-randomised studies (Margulis, *et al.*, 2014). It is a 'star system' based on three broad perspectives: the selection of the study groups; the comparability of the groups; and the ascertainment of either the exposure or outcome of interest (Margulis *et al.*, 2014).

The three categories (Figure 4.1) consist of eight multiple choice questions. The number of possible answers per question range from 2 to 5. High-quality responses earns a star, totalling up to nine stars. ‘Selection of the study groups’ has four questions, ‘comparability of the groups’ has two questions and ‘ascertainment of either the exposure or outcome’ has three questions. Cross-sectional studies classified as “very good” would score 5 points; “good” studies score 4 points; “satisfactory” studies score 3 points; and “unsatisfactory studies” score 0 to 2 points (Wells, *et al.*, 2014). The summary quality assessment score equals the number of stars earned by each study and is given in the results tables (Table 4.2b, 4.3b, 4.4b, 4.5b).

Figure 4.1: NEWCASTLE - OTTAWA QUALITY ASSESSMENT SCALE

(Adapted for cross-sectional studies) **Selection:** (Maximum 3 stars)

1) Representativeness of the sample:

a) Truly representative of the average in the target population. (all subjects or random sampling)

b) Somewhat representative of the average in the target population. (non-random sampling)

c) Selected group of users.

d) No description of the sampling strategy.

2) Non-respondents:

a) Comparability between respondents and non-respondents' characteristics is established, and the response rate is satisfactory.

b) The response rate is unsatisfactory, or the comparability between respondents and non-respondents is unsatisfactory.

c) No description of the response rate or the characteristics of the responders and the non-responders.

3) Ascertainment of the exposure (risk factor):

a) Validated measurement tool.

b) Non-validated measurement tool, but the tool is available or described.

c) No description of the measurement tool

Comparability: (Maximum 2 stars)

1) The subjects in different outcome groups are comparable, based on the study design or analysis. Confounding factors are controlled.

a) The study controls for the most important factor (select one).

b) The study control for any additional factor.

Outcome: (Maximum 2 stars)

1) Assessment of the outcome:

a) Independent blind assessment.

b) Record linkage.

c) Self report.

d) No description.

2) Statistical test:

a) The statistical test used to analyse the data is clearly described and appropriate, and the measurement of the association is presented, including confidence intervals and the probability level (p value).
b) The statistical test is not appropriate, not described or incomplete.

4.2.8 Data synthesis

Due to diverse study designs, the quantitative findings of the included studies are not appropriate for meta-analysis, making narrative synthesis the most appropriate method of data synthesis. Narrative synthesis or analysis is described as when reviews *"include data* *from different study designs that are not suitable for lumping all together in analysis"* (Ryan, 2013, p.1). Narrative synthesis helps to answer a broad range of questions and explore the similarities and differences between the findings of the studies (Birte, *et al.*, 2012).

4.3 Results

4.3.1 Literature Search

Figure 4.2 presents the PRISMA flow chart summarising the search strategy and process of study selection. In the first stage of screening the titles and abstracts, 144 potentially relevant studies for full-text screening were retrieved. After excluding non-relevant studies, 26 articles met the inclusion criteria for the review.

Following the updated search, an additional 59 titles and abstracts were assessed, and 24 full texts were screened. Two studies which met the eligibility criteria are included in the review.

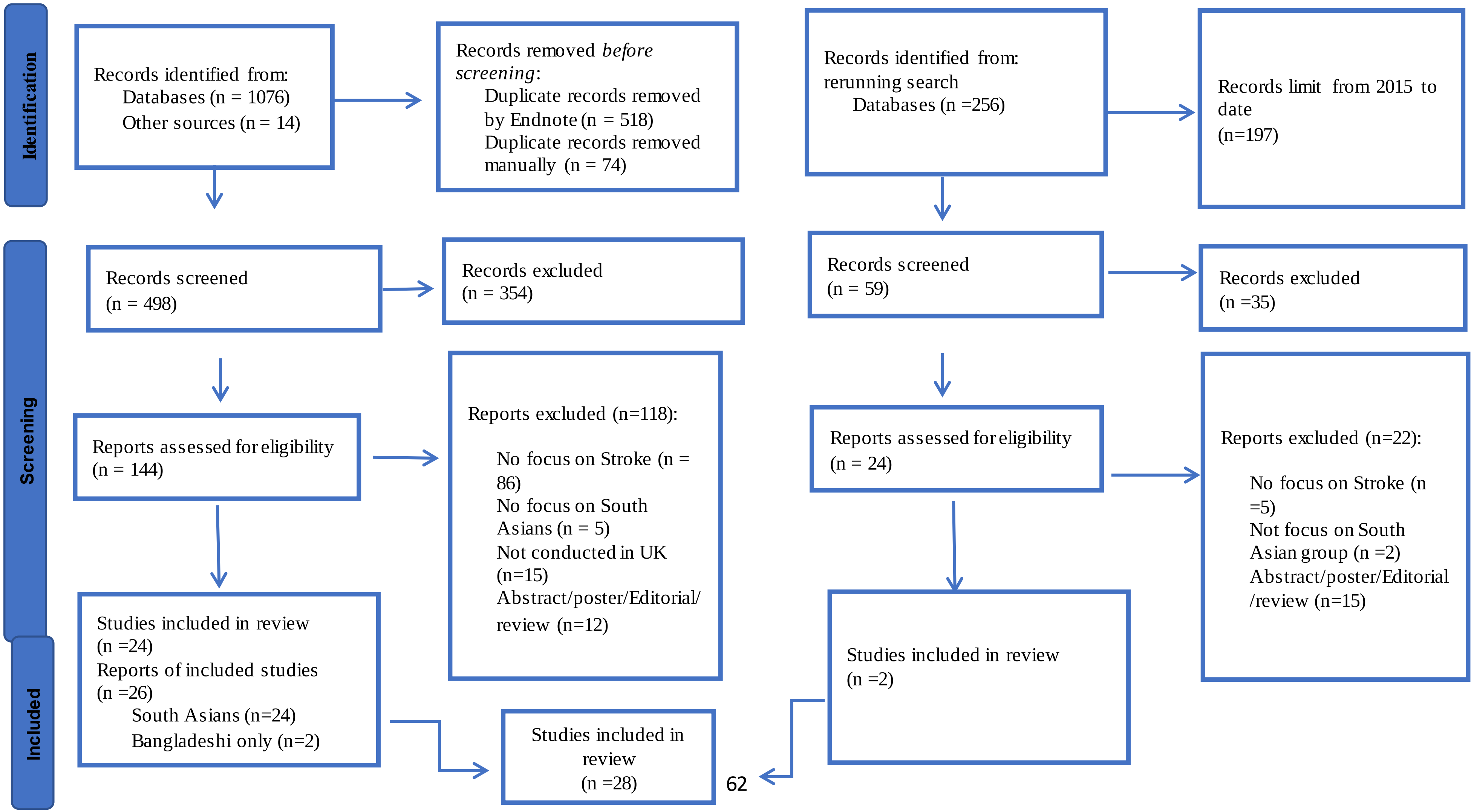
The review synthesised the results into four categories:

1. Trends in stroke epidemiology using studies focussing on incidence, prevalence and mortality of stroke/CVD.
2. Risk factors associated with stroke/CVD.
3. Studies focusing on CVD risk prediction models.
4. Studies focusing on the management of stroke.

Out of the 28 studies, two studies reported on the incidence rate, two studies reported on prevalence and nine studies focused on mortality due to stroke amongst the South Asian population *versus* other population groups (Tables 4.2a and 4.2b). Sixteen studies compared CVD (stroke) risk factors among South Asians/Bangladeshis and other communities (Tables 4.3a, 4.3b and 4.3c), five studies were on risk prediction models (Tables 4.4a and 4.4b) and two studies focused on the management of stroke in South Asians in the UK (Tables 4.5a and 4.5b). Some of the studies are found in more than one category if they presented multiple outcomes; for example, a study which included risk factors as well as mortality as an outcome.

The 28 studies included a total of 1,233,753 participants. The average age of the participants in each study was 30 years and above, involving both males and females. All the studies were carried out in the UK.

Figure 4.2: PRISMA Flow Chart of Search Strategy **Search re-run in 2020**



4.3.2: Studies focusing on Incidence, Prevalence and Mortality of stroke in South Asians

For this section, Table 4.2a presents the characteristics of the included studies and Table 4.2b gives the results from these studies. Studies addressing incidence, prevalence and mortality will be addressed in turn.

Incidence of Stroke

The trend in the incidence of stroke over time in the South Asian population in the UK is unclear since only two studies (Table 4.2a) were identified reporting this data (Hsu, 1999; Hippisley-Cox *et al.*, 2008).

The first study (Hsu, *et al.*, 1999) is a population-based stroke study conducted in Leicestershire in 1996 involving 23 general practices with South Asians including mainly Gujratis from Indian and East African origin who migrated between 1960 and 1970. This study (Hsu, *et al.*, 1999) used the WHO criteria for ‘definite’ and ‘possible’ stroke; and ethnicity was recorded using a fuzzy match name analysis programme. The study compared the incidence of stroke among ‘high Asian’ (80% or more South Asians) and ‘low Asian’ (less than 2% South Asians) general practices. There were no significant differences found among practices individually (p=0.29) nor generally (p=0.72). Hsu *et al.*, (1999) did not mention the mean age of the population. Hsu reported the crude incidence rate of stroke for South Asian migrants (n=74) at 111/1000-person years. The limitations of this study were that the majority of patients amongst the high Asian practices were Gujratis, and thus the population was not representative of the whole South Asian community. The indirect sampling method may have caused an underestimation of the incidence rate among South Asians. The study (Hsu, *et al.*, 1999) did not fulfil the ideal diagnostic criteria for stroke incidence, modified from Sudlow and Warlow (1996). These criteria, which are used to judge population-based stroke incidence studies, include: standard definitions of stroke; standard methods; and standard data presentation including a large sample size (Sudlow and Warlow,1996).

The second incidence study (Hippisley-Cox *et al.*, 2008) is a prospective cohort study using the QRESEARCH database. It involved 531 general practices followed over 15 years (1993 to 2008), with 2.29 million patients. The incidence of stroke was calculated as an age-specific rate per 1000-person years and used ICD-10 criteria for cardiovascular disease classification. Ethnicity was recorded by Read codes for self-assigned ethnicity. The authors gave the results for each ethnic minority group, making comparisons between ethnic groups clearer. The incidence rate of stroke in Hippisley-Cox *et al.* was highest among Bangladeshi men at 24.4/1000 person-years (95% confidence interval: 19.83-29.03) (Table 4.2b), compared with White European men at 10.5/1000 person-years (95% confidence interval: 10.44-10.62). It was also higher among men in Indian, Pakistani, Black Caribbean and other Asian groups compared with the White European male population (Table 4.2b). Amongst the female population, the age-standardised rate of stroke was marginally higher for Pakistani (13.2/1000 person-years) and Bangladeshi (11.3/1000 person-years) populations compared with the host White European female population (7.27/1000 person-years).

The third incidence study (Tillin, *et al.*, 2013) is prospective population-based study from 1988 to 1991. Cardiovascular risk factors (630) were assessed in Europeans (2, 049), South Asians (1,517) and African Caribbeans in the UK. It was a community-based cohort (SABRE-Southall and Brent Revisited) including participants 40 to 69 years of age at baseline, who were selected randomly from 5-year age- and sex-stratified primary care physician lists and workplaces in the London districts of Southall and Brent. The incidence of stroke and CHD was calculated as an age-specific rate per 1000-person years. Stroke was identified using ICD-10 criteria. Ethnicity was based on self-report, parental place of origin, and appearance. Most African Caribbeans (92.5%) were born in the Caribbean, and the remainder were born in West Africa. South Asians were defined as born in Indian subcontinent, and more than half were of Punjabi Sikh origin. The incidence of stroke was significantly higher in African Caribbeans followed by South Asians and lowest in Europeans (Table 4.2b). The incidence of CHD was greater in South Asians and lower in African Caribbeans (Table 4.2b).

There is a need for more population-based stroke incidence studies in South Asians to identify the environmental and other factors that may be associated with the increased risk of stroke among South Asians.

Prevalence of Stroke

There is only one study (Table 4.2a) which has reported the prevalence of stroke and risk factors associated with stroke in South Asians (Potluri & Natalwala, 2009). This study has compared the prevalence of stroke between South Asians and other ethnic groups in the UK, Mauritius and India.

The study was conducted in Birmingham (UK) by Potluri & Natalwala (2009), and calculated ethnic differences in the prevalence of haemorrhagic stroke amongst the multi-ethnic population in Birmingham. It is a population-based study with a well-defined, stable population but it does not use the WHO definition of stroke, instead using a CT scan as evidence of the onset of stroke as a selection criterion. A high prevalence of haemorrhagic stroke was found amongst South Asians which has gradually increased from 1997 to 2005. Of the haemorrhagic stroke patients, the proportion that were within the South Asian population significantly increased from 27.7% in 1997-99, to 29.5% in 2000-02, to 45.8% in 2003-05 ($p<0.001$), with a decrease amongst the European Caucasian population ($P<0.05$). They also showed an almost 5% increase in hypertension rate in the South Asian group with a haemorrhagic stroke from 84.6% in 1997-99 to 88.9% in 2003-05, with hypertension as the main risk factor. Conversely, the prevalence of hypertension was stable amongst European Caucasian (76.0%) and Afro-Caribbean (77.8%) populations who had a haemorrhagic stroke.

Trends in Stroke Mortality

There are nine studies (Table 4.2a) calculating the mortality from stroke in ethnic minorities focusing on the South Asian population in the UK. The majority of these studies have used census data as the denominator for studying ethnic differences in mortality by country of birth. According to these four studies (Balarajan, 1995; Balarajan & Raleigh, 1997; Wild *et al.*, 2007; Harding *et al.*, 2008) stroke mortality has been shown to be persistently high among South Asians migrants compared with people born in England and Wales (Table 4.2b).

Firstly, the study by Balarajan (1995) showed that, for men under 65 years, the Bangladeshi population had the highest age-standardised stroke mortality rate (30.6/100,000 persons) with a rate of 2.5 times that for England and Wales (12.7/100,000 persons). This is followed by the Pakistani (21.1/100000) and Indian (16.7/100,000) populations. A similar pattern was found amongst those aged 65-74 years, with the Bangladeshi population having a stroke mortality rate (539.0/100,000 persons) more than double the norm for England and Wales (Balarajan, 1995).

In a similar study (Balarajan & Raleigh, 1997), the death register for analysis by country of birth between 1988-1992 was used (Table 4.2b). Standardised mortality ratios (SMR) for the age group 20-69 years for those born in Bangladesh were calculated with the age and sex-specific rates for England and Wales as the standard. A high SMR for both cerebrovascular disease of 267 (95% CI, 222-319) and diabetes of 685 (95% CI 529-874) were found for the male Bangladeshi population. These findings support the results from their first study (Balarajan, 1995).

The study by Wild *et al.* (2007) used 2001-2003 mortality data and 2001 census data as the denominator to examine the mortality from all causes and from circulatory disease, in people above the age of 20 years living in England and Wales. All cause SMR was highest among West African women at 121 (95% CI: 114-127) followed by Bangladeshi men at 120 (95% CI: 114-127) and Pakistani women at 106 (95% CI: 101-111), in comparison with mortality for England and Wales at 94 (95% CI: 93-95). Ischaemic heart disease (IHD) mortality was reportedly high among men aged >20 years born in Bangladesh (SMR 175, 95% CI: 158-193) followed by Pakistani (162, 95% CI:152-172) and African men (141, 95% CI: 129-154). Pakistani women (174, 95% CI: 159-192) had the highest IHD mortality followed by Bangladeshi (167, 95% CI: 136-204) and Indian women 149 (95% CI: 142-157). Cerebrovascular mortality was also reported as significantly higher among men born in Bangladesh (SMR 249, 95% CI: 213-292) followed by African (234, 95% CI: 197-278), Pakistani (141,95% CI: 126-159) and Indian men (116, 95% CI: 108-124) compared with men born in England and Wales (95, 95% CI: 95-96). Bangladeshi women also had significantly higher (207, 95% CI: 164-258) cerebrovascular mortality compared to women born in England and Wales at 97 (95% CI: 96-97).

The fourth study (Harding, *et al.*, 2008) recorded trends for mortality from stroke and coronary heart disease among migrants in England and Wales from 1979-2003. Death rates by country of birth were calculated for three periods (Table 4.2b). Stroke mortality was highest for migrant groups in each study period. The main findings of the study were similar to previous studies, with high SMRs for cerebrovascular disease seen among Bangladeshi men and women (Balarajan, 1995; Balarajan & Raleigh, 1997; Wild *et al.*, 2007).

Bhopal (2012) linked the stroke incidence and mortality from NHS databases to national UK census data for ethnicity, to explore inequalities in stroke mortality among ethnic minorities. Age-adjusted mortality rates/100,000 person-years were calculated. Age-adjusted stroke mortality rate was the highest among Pakistani men at 547.8 (95% CI 433.0-662.6) and lowest amongst the 'Other ethnic group' category at 286.9 (95% CI 83.9-489.9), compared with the White Scottish group as the reference population at 454.5 (95% CI 450.2-458.9) (Table 4.2b). Because the 95% CIs for the Pakistani and the White Groups overlap the elevated risk was not statistically significant and, therefore, does not corroborate the higher rates of stroke in the Asian population found by other studies within the Scottish population.

An observational follow-up study (Khattar, *et al.*, 2000) in a hypertensive cohort was conducted to compare racial differences in morbidity and mortality among South Asians, White and Afro-Caribbean populations. South Asians had the highest all-cause events (South Asian: 3.46 *vs* White: 2.50 events/100 patient years), which was due to an excess of coronary events (South Asian: 2.86 vs White: 1.32 events/100 patient years) (Table 4.2b).

There were three studies (Table 4.2b) that reported SMR. All these studies were conducted in Birmingham, West Midlands (Conway & Lip, 2003; Gunarathne *et al.*, 2008b; Lane *et al.*, 2005). The first study (Conway & Lip, 2003) was conducted in an inner-city hospital in West Birmingham, during 1998-2000. Age adjusted all-cause mortality ratio among the Indo-Asian population was 0.90 (95% CI: 0.65-1.27, p=0.56).

The second study was an observational follow-up study (Lane, *et al.*, 2005) which combined the data from two previous studies (Birmingham Factory Screening project and INTERSALT study). This study is unique in exploring cardiovascular and all-cause mortality in relation to baseline demographic characteristics and blood pressure. In this study, total cardiovascular death (n=190) was stratified by ethnicity and sex. South Asian men had the highest proportion of deaths (10.3%) followed by White European (8.5%) and African-Caribbean (6.7%) men. Among women, African Caribbeans had the highest proportion of deaths (6.8%) compared with White Europeans (3.5%). Data for South Asian women were excluded from this study due to insufficient numbers (n=24). After controlling for confounding factors, there were no significant differences in cardiovascular mortality among men from minority ethnic groups.

This study suggested that ethnicity is not an individual risk factor for all-cause and cardiovascular mortality. This may be due to a lack of data on ethnicity in South Asian men and women which is why there is no information on survival status or a link between ethnicity and the risk factors as a single variable (Lane, *et al.*, 2005). Among South Asians, the majority (>90%) were Punjabis and the minority were Bangladeshis. This is not a representative sample of South Asians. South Asians include a heterogeneous group of people with different diets, lifestyles and social factors (Lane, *et al.*, 2005). As in most previous studies, it has been found that high all-cause mortality among South Asians is due to high CHD/stroke mortality, particularly amongst the Bangladeshi population. This could be one of the reasons that there were no significant differences in mortality due to the lower proportion of the sample being drawn from the Bangladeshi population.

The study by Gunarathne *et al.*, (2008b) was conducted over 9 years (1997-2005) in an inner-city teaching hospital in Birmingham. Survival analysis showed a declining trend in hospital mortality rates in all three ethnic groups (Caucasian, South Asian and Afro-Caribbean) (Table 4.2b). The study reported significantly higher 30-day mortality from ischaemic stroke among South Asians between 2000-2002 (p=0.029) and 2003-2005 (p=0.03), although European Caucasians had the poorest survival between 1997-1999 (p=0.03). However, the findings of this analysis are contradictory to the findings of Hsu *et al.*, (1999) in which 1-year mortality following ischaemic stroke was significantly lower in South Asians compared with the White population.

In summary, 7 out of 10 studies conducted in England and Wales have shown significantly higher mortality (SMR, mortality rate) for coronary heart disease and stroke among South Asians compared with the White population (Balarajan, 1995; Balarajan & Raleigh, 1997; Bhopal, *et al.*, 2012; Gunarathne, *et al.*, 2008b Harding, *et al.*, 2008; Khattar, *et al.*, 2000; Wild, *et al.*, 2007). Three studies have shown a similar trend specifically for Bangladeshi men compared with the White population (Balarajan, 1995; Balarajan & Raleigh, 1997; Wild *et al.*, 2007).

Table 4.2a: Summary of the Characteristics of UK studies measuring the stroke frequency and mortality among south Asian /Bangladeshi

Study ID	Study Design/ Methodology	Source of Numerator	Source of Denominator	Setting	Time	Sample size (n)	Patient characteristics	Outcome
Incidence								
Hsu, R., T. *et al*., 1999	Prospective incidence sample survey	Stroke patient identified by stroke nurses during 1996	Leicestershire Health Register of people registered with GP	23 General Practices Leicestershire,	1996	12 'high Asian' and 11 'low Asian' general practices	Age 65+, Sex Both Ethnic groups European White South Asian	Incidence
Hippisley-Cox., *et al*., 2008	Prospective open cohort	Open cohort with a valid Townsend deprivation score	QRESEARCH, GP in England And Wales	531 Genera practices in England and Wales	January 1993 to 31 March 2008	2.3 million Women= 773 291 Men= 762 292 Validation cohort Women=375 763 Men=374 469	Age 35-74 Derivation cohort:49 (41-60) F:48(40-58) Validation cohort 49(41-59) F:47(40-57) Sex Both Ethnic group: White, Asian, Black African, Black Caribbean, Chinese, other	Incidence
Tillin, T., *et al*. 2013	Prospective Population based study	A tri-ethnic community-based cohort from North and West London	Primary care physician lists and workplaces in the London districts of Southall and Brent.	North and West London.	1988 through 1991	2,049 Europeans, Male = 3170, Female = 1026 1,517 South Asians and 630 African Caribbeans	Age 40-69, Sex Both	Incidence

Prevalence								
Potluri, R. and Natalwala, A, 2009	Survival Analysis	Hospital case notes and registry data of patients admitted with a CT scan-proven, first onset, haemorrhagic stroke.	Stroke admissions to Birmingham hospital	Inner-city teaching hospital Birmingham, United Kingdom	1997–2005	91 M=108, F=83 European Caucasians 91 South Asian 66	Age Sex both	Prevalence
Study ID	Study Design/ Methodology	Source of Numerator	Source of Denominator	Setting	Time	Sample size (n)	Patient characteristic	Outcome
Mortality								
Balarajan, R., 1995	Cross-sectional survey and registry analysis	Death registered by country of birth National mortality data by country of birth 1988–1992	Office of Population Census and survey (OPCS) 1991 census	England and Wales	1988-1992	Mortality data England and Wales	Age= 20+ Sex Both	CHD, Stroke Mortality
Balarajan, R., 1997	Mortality data analysis	Those born in Bangladesh derived by country of birth	Census 1981-1991	England and Wales	1997	Bangladeshi 1055 Men 182 women	Age 20-69 Sex Both	Mortality
Hsu, *et al*., 1999	Prospective incidence sample survey	Stroke patient identified by stroke nurses during 1996	Leicestershire Health Register of people registered with GP	23 General Practices Leicestershire,	1996	12 'high Asian' and 11 'low Asian' general practices	Age 65+, Sex Both Ethnic groups European White South Asian	28 days Stroke mortality
Conway and Lip, 2003	Review of registry data	Hospital discharge coding for the identification of patients with any form of intracranial haemorrhage, cerebral infarction or stroke	Hospital Registry data	West Birmingham Stroke registry data from 1998-2000	April 1, 1998 and March 31, 2000	832 in total of which White 582 (70%) Indo-Asian 116 (14%) Afro-Caribbean 134 (16%)	Age White 76 ± 12 [a] Indo Asian 68 ±13 [a] Afro Caribbean 71 ± 10 [a] Sex Both	Mortality

Gunarathne, ***et al.*****, 2008b**	Cross sectional	First-in-a-lifetime stroke International Classification of Disease (ICD) 10th revision, codes 430–438	West Midlands Regional Health Authority Computerised Hospital Activity Analysis register	Sandwell and West Birmingham Hospitals (SWBH) Trust	1997–2005	2405 White 62% Male Asian 59% Male Afro Caribbean	Age White M: 73.4 (10.3) [a] F: 79.2 (10.) [a] South Asian M;68.3 (11.3) F: 68.3 (11.3) [a] Afro Caribbean M: 71.5 (9.1) [a] F:71.5 (9.1) [a]	Stroke mortality
Khattar ***et al.*****, 2000**	Observational follow up study	NHS Central register for mortality Hospital Records Questionnaire to GP	723 patient who had undergone 24 hour intra-arterial ambulatory blood pressure monitoring in hypertensive cohort	District general hospital and community setting in Harrow. England	Baseline 1 January 1979 to 1 January 1993 Follow up 1994 to 19996	528 White, 106 South Asian, 54 Afro-Caribbean	Age White 52.2[b] Asian 46. 3[b] Afro Caribbean 46.8[b]	All cause Mortality
Lane, D. ***et al.*****, 2005**	Observational follow up study	Birmingham screenees and participants of the INTERSALT study	Data from factory	Community settings in Birmingham, UK.	1979 and 1986	2089 White European 340 African-Caribbean men and women, and 195 South-Asian men	Age White M: 43.0(11.9) F: 42.0(12.0) [a] African-Caribbean M: 43.4(11.1) F: 42.0(12.0)[a] South Asian: 34.6(11.4) [a] Sex Both	Mortality
Wild, S.H. ***et al.*** **2007**	Analysis of routine death statistics	Mortality data from 2001 to 2003 by country of birth	Census data from 2001	England and Wales	2001–2003	England and Wales 2001 census population (99.5% of adults)	Age 20+ Sex Both	Mortality from: Circulatory disease IHD, CVD

Harding, S., *et al.* 2008	Census/SMR	Deaths from record 1979–83, 1989–93 and 1999–2003,	Tabulated population data 1981 1991 2001	England and Wales	1979–83, 1989–93 1999–2003,	Death record 1979–83 183412 1989–93 131505 1999–2003 74951	Age 30-69 Both Sexes Ethnic groups By country of birth	Age and sex specific mortality CHD, Stroke
Bhopal, R 2012	Retrospective cohort study	Stroke incidence and mortality from NHS databases	Census 2001 and National Community Health Index (CHI), hospital discharge/deaths database	Census 2001 for Scotland	May 2001 to April 2008	4.65 million	Age 25-85 and Over Sex Both	Mortality

a: mean with (SD), b: mean, CHD: Coronary heart disease, IHD: Ischemic heart disease

Table 4.2b: Summary of Results findings of UK studies measuring the stroke frequency among south Asian /Bangladeshi

Study ID	Key frequency Measure	Group	Statistical Analysis	Quality assessment (Newcastle – Ottawa Quality Assessment Scale)	Quality Score
Incidence					
Hsu, *et al*., 1999	Incidence of Stroke/1000	High Asian practices	No of definite stroke 76/1000 33 notified (43%) N° of possible or definite stroke 85/1000 South Asians 'possible' or 'definite' stroke (74) p=0.29	Selection: *** Comparability Outcome: * *	5
		Low Asian practices	131/1000 56 notified (43%) N° of possible or definite stroke 144/1000 White 'possible' or 'definite' stroke (150)		
Hippisley-Cox., *et al*. 2008	Age Standardised Crude incidence of CVD/1000 (with CI)	White	M: 10.53 (10.44-10.62)[a] F: 7.25 (7.18-7.32)[a]	Selection: *** Comparability Outcome**	5
		Indian	M: 16.88 (14.84-18.91)[a] F: 10.88 (9.23-12.52)[a]		
		Pakistani	M: 20.94 (17.75-24.13)[a] F: 13.24 (10.63-15.85)[a]		
		Bangladeshi	M: 24.43 (19.83-29.03)[a] F: 11.30 (8.46-14.4)[a]		
		Other Asian	M: 15.44 (11.84-19.03)[a] F: 8.41 (5.55-11.27)[a]		
		Black African	M: 7.02 (5.80-8.24)[a] F: 3.78 (2.25-5.31)[a]		
		Black Caribbean	M: 6.21 (4.12-8.30)[a] F: 9.72 (8.35-11.09)[a]		
		Chinese	M: 5.40 (2.51-8.29)[a] F: 4.92 (2.52-7.53)[a]		

Study ID	Key frequency Measure	Group	Statistical Analysis	Quality assessment (Newcastle – Ottawa Quality Assessment Scale)	Quality Score
		Other	M:10.27 (8.26-12.27)[a] F:8.43 (6.56-10.29)[a]		
Tillin, T., *et al.* 2013	Age adjusted Incidence of stroke/1000 (with CI)	White European Age 50-70 Age 70+ yrs	M: 3.4 (2.6-4.4) F: 3.1 (1.0-5.0) a M:12.6 (10-16) F: 9.2 (5.8-15) a	Selection: *** Comparability Outcome:**	5
		South Asians Age 50-70 Age 70+ yrs	M: 5.4 (4.3-6.8) F:5.1 (3.0-8.5) a M: 12.9 (10-17) F: 16.9 (9.3-30) a		
		African Caribbean Age 50-70 Age 70+ yrs	M:3.8 (2.3-6.3) F: 4.9 (2.9-8.1) a M: 17.5 (12-26) F: 12.5 (7.1-22.0) a		
	Age adjusted Incidence of CHD/1000 (with CI)	White European Age 50-70 Age 70+ yrs	M: 17.5(15.6-19.8) F: 8.7 (6.5-11.7) a M: 34.7 (29.9-40.2) F: 16.6 (11.6-23.8) a		
		South Asians Age 50-70 Age 70+ yrs	M: 26.7 (23.9-29.8) F: 19.1 (14.5-25.2) a M:50.2 (42.6-59.2) F: 33.5 (21.1-53.2) a		
		African Caribbean Age 50-70 Age 70+ yrs	M: 8.6 (6.1-12.1) F: 5.6 (3.5-9.0) a M:23.8(16.8-33.6) F: 23.3 (14.4-34.6) a		
Prevalence					
Potluri, R. and Natalwala 2009	Prevalence of Haemorrhagic Stroke	European Caucasians	66 (34.6)[b] p < 0.05)	Selection: *** Comparability Outcome:**	5
		South Asians	34 (17.8)[b] in 1997-2005 27.7% in 1997–99 29.5% in 2000–02 45.8% in 2003–05 (p < 0.001)		
Mortality					
Balarajan, R 1995	Stroke/CHD Mortality by country of birth**	England and Wales	Stroke 12.7 CHD 59.3	Selection: *** Comparability Outcome*	4
		Indian	Stroke 16.7 CHD 90.5		
		Pakistani	Stroke 21.1 CHD 95.5		
		Bangladeshi	Stroke 31.5 CHD 102.4		
		Commonwealth Africans	Stroke 30.6 CHD 36.8		
		Caribbean's	Stroke 23.0 CHD 34.4		
		Irish	Stroke 17 CHD 75.5		

Study ID	Key frequency Measure	Group	Statistical Analysis	Quality assessment (Newcastle – Ottawa Quality Assessment Scale)	Quality Score
Balarajan, R 1997	CVD Mortality by country of birth**	Bangladeshi	M: 267 (122) (222-319)[a] F: 139 (22) (87-210) [a]	Selection: *** Comparability Outcome*	4
Hsu, *et al*., 1999	28 days stroke mortality	High Asian and Low Asian Practices	Percentage of death South Asians 21% (15/70) White 33% (44/135) Odd ratio with 95%CI South Asians 0.37 (0.14-.097) White 1.00	Selection: *** Comparability Outcome: * *	5
Khattar *et al*., 2000	Mortality	White	All cause event rate: 2.50/100 patient-years (p = 0.002) Coronary events 1.32/100 patient-years (p= 0.002) . Age (p < 0.001), sex (p < 0.001)	Selection: **** Comparability Outcome* *	6
		South Asian	All cause event rate:3.46/100 patient- year Coronary events 2.86 /100 patient-years in south Asians Age (p < 0.001), sex (p < 0.001), race: south Asians: Whites, hazard ratio 1.79; p = 0.008), diabetes (p = 0.05), previous history of cardiovascular disease (p < 0.001)		
		Afro-Caribbean	0.90 (p = 0.002) events/100 patient-years		
Lane, D. *et al*., 2005	CV Mortality	White Europeans	M: 125 (8.5) F:2 2 (3.6)[b]	Selection **** Comparability * Outcome**	7
		South Asian	20 (10.3) [b]		
		Afro Caribbean	15 (6.7) F: 8 (6.8) [b]		
Conway and Lip, 2003	All-cause mortality* during follow up period		Odds ratio for death: AF:1.39 (0.78-2.11) p 0.32 Atherosclerotic vascular disease:1.16 (0.76-1.76) p 0.50 Diabetes Mellitus: 1.04 (0.71-1.53) p 0.83 Prior stroke: 1.14 (0.69-1.88) p 0.61 Hypertension: 0.65 (0.46-0.91) p<0.001 Indo Asian 0.90 (0.65-1.27) p 0.56	Selection **** Comparability Outcome**	6

Study ID	Key frequency Measure	Group	Statistical Analysis	Quality assessment (Newcastle – Ottawa Quality Assessment Scale)	Quality Score
			Afro Caribbean: 0.83 (0.60-1.14)		
	During hospital admission		AF:1.29 (1.01-1.91) P<0.05 Atherosclerotic vascular disease:1.26 (0.96-1.65) p 0.11 DM: 1.22(0.95-1.56) P 0.12 Prior stroke: 1.11 (0.80-1.53) P 0.53 Hypertension: 0.66 (0.53-0.84) P 0.01 Indo Asian 0.69 (0.40-1.20) p 0.19 Afro Caribbean: 0.89 (0,56-1.41) p 0.62		
Wild, S.H. *et al.* 2007	Mortality by country of birth*	India	CVD M 3859, 118 (114–122) F 3283, 128 (123–132)[a] IHD M 2,527, 131 (126–137) F1672, 149 (142–157)[a]	Selection: ** Comparability Outcome**	
		Pakistan	CVD M 294, 141 (126-159) F 254, 139 (122-158)[a] Ischaemic Heart Disease M 1044, 162 (152-172) F 452,174 (159-192)[a]		
		Bangladesh	CVD M 169, 249 (213 –392) F 79, 207 (164–258)[a] IHD M 409, 175 (158–193 F 97,167 (136–204)[a]		4
Harding, S., *et al.* 2008	Stroke Mortality by country of birth *	England and Wales	1979-83 32465, 58.8 (38.9 - 26.8)[a] F:28405, 45.6 (29.6 – 20.6)[a] 1989-93 21772, 38.9 (38.4-39.5)[da] F: 18120, 29.6 (29.2-30.0)[a] 1999-2003 15256, 26.8 (26.4-27.3)[a] F: 18120, 29.6 (29.2-30.0)[a]	Selection: ** Comparability outcome:*	3
		India	1979-83 M: 491, 97.4 (54.9 - 35.2)[a] F: 304, 64.0 (56.8-71.3)[a] 1989-93 395, 54.9 (49.5-60.4)[a] F: 269, 39.1 (34.4-43.8)[a]		

Study ID	Key frequency Measure	Group	Statistical Analysis	Quality assessment (Newcastle – Ottawa Quality Assessment Scale)	Quality Score
			1999-2003 M: 328, 35.2 (31.4-39.1)[a] F:236, 26.1 (22.8-29.5)[a]		
		Pakistan	1979-83 M: 80, 58.5 (43.2-73.8)[a] 1989-93 173, 64.2 (54.3-74.1)[a] F: 93, 47.1 (36.7-57.5)[a] 1999-2003 M: 328, 35.2 (31.4-39.1)[a] F:236, 26.1 (22.8-29.5)[a]		
		Bangladesh	1979-83 62, 117.1 (123.8 – 83.5)[a] 1989-93 130, 123.8 (99.2-148.4)[a] 1999-2003 147, 83.5 (68.3-98.8)[a]		
Gunarathne, *et al.*, 2008b	30 Day Stroke mortality*	Patients admitted with non-hemorrhagic stroke	1997-99: 319 (275-264)[a] 2000-2002: 303 (257–349)[a] 2003-2005: 273 (226-320)[a] p 0.03	Selection: ** Comparability * Outcome**	5
Bhopal, R 2012	Mortality*	White Scottish	M: 454.5 (450.2-458.9) F: 459.9 (455.9-464.0)[a]	Selection: ** Comparability outcome**	4
		Indian	M: 476.1 (349.7-602.6)[a] F: 351.9 (217.4-486.4)[a]		
		Pakistani	M: 547.8 (433.0-662.6)[a] F:492.7 (348.4-637.1)[a]		
		Other Ethnic group	M: 286.9 (83.9-489.9)[a] F: 296.8 (111.4.-482.2)[a]		

* Age adjusted death rate per100,000 population ** Age adjusted death rate per1000 population

[a:] Events (n), death rate (95% confidence interval), [b:] =n (%)

4.3.3 Studies focusing on risk factors associated with stroke in South Asians

In the previous section a number of studies were identified which showed an excess risk of stroke in ethnic minority groups originating from South Asia who are living in the UK. This section provides further data synthesis of the studies which have explored risk factors associated with high incidence and prevalence of CHD, CVD and stroke among South Asians. To successfully implement primary and secondary preventative strategies there is an urgent need to explore in detail the risk factors associated with stroke in various ethnic groups (Hajat, *et al.,* 2001). There are 17 studies which have been conducted in the UK in these ethnic minority groups which have examined the risk factors associated with cerebrovascular disease and stroke and ethnicity (Tables 4.3a, b, c).

The characteristics of all 17 studies are summarised in Table 4.3a, including the study design, the source of the numerator and denominator, year of the study, sample size and breakdown by ethnic group and the risk factors examined for each study. The results are presented using two tables, with Table 4.3b presenting the risk factors calculated as categorical variables (% with 95% CI or SD) and Table 4.3c presenting risk factors calculated as continuous variables (mean with 95% CI, or SD).

The Wandsworth Heart and Stroke Study is a cross sectional study conducted by Cappuccio *et al.* (1998) examining the cardiovascular risk profile within ethnic minority groups. It is a population-based survey conducted in Wandsworth Health Authority in South London, where 25% of residents were born outside of the UK. The findings showed a high prevalence of hypertension amongst the African group and a high prevalence of diabetes in the South Asian group, compared with the White European group. The study reported on a large number of variables in all three ethnic groups (further detail in chapters 5). These included socio-economic and lifestyle factors (Cappuccio, *et al.*, 1998) and novel risk factors such as homocysteine levels, levels of vitamin C and the use of oral contraceptive pills which are believed to further increase the CVD risk among South Asians (Cappuccio, *et al.,* 2002). There are a further two papers included in the review which present data from the Wandsworth Heart and Stroke Study (Brindle, *et al.*, 2006; Cappuccio, *et al.,* 2002)

In this section, the studies will be presented by outcome (risk factor) starting with the most common risk factors calculated in all studies, to the single or rare risk factors examined in a small number of studies.

4.3.3.1: Hypertension

Hypertension is one of the important classical risk factors associated with CVD and stroke in minority ethnic groups. In the UK, there have been a number of studies carried out with Black Africans (Lemic-Stojcevic *et al.*, 1996; Cruickshank *et al.*, 1996; Cappuccio *et al.*, 1997) and Black Caribbeans (Friday, 1989; Lemic-Stojcevic *et al.*, 1996) which have shown a high prevalence of hypertension. There are 17 studies which have reported an association between ethnicity and cardiovascular/stroke risk factors among Caucasians and South Asians (Table 4.3a). In these studies, the prevalence of hypertension has been calculated as a percentage and/or as a mean systolic and diastolic blood pressure. The studies were categorised as studies conducted among the general population and among stroke patients, to get the clearest picture of the prevalence of hypertension by ethnic group.

The studies conducted in the UK have mainly shown that the prevalence of hypertension is higher in South Asians as compared with the White population (Figure 4.3).

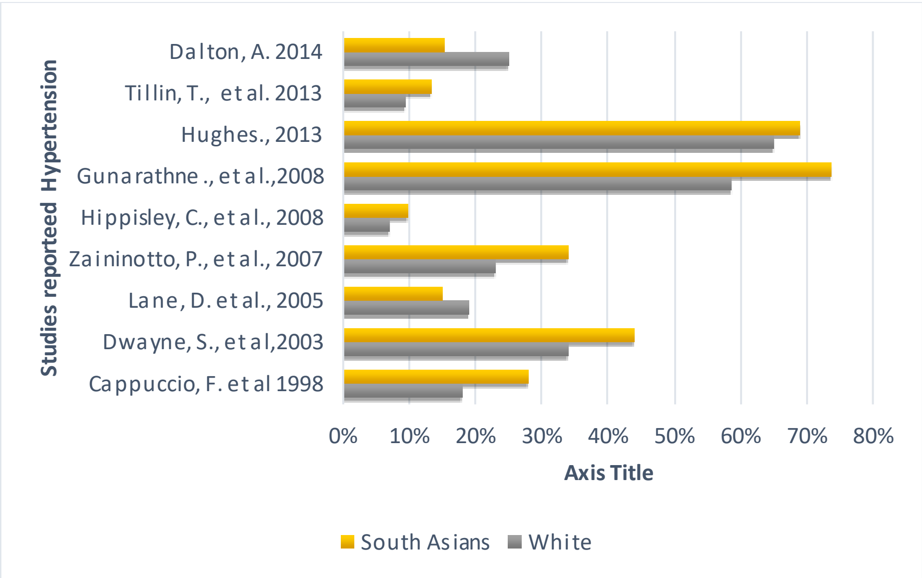


Figure 4.3: Studies reporting the prevalence of Hypertension by ethnic group (South Asians vs White)

Studies conducted among the general population

Cappuccio *et al.* conducted a population-based survey in Wandsworth, South London (Cappuccio *et al.*, 1998). Hypertension was defined according to International Society of Hypertension (ISH)/WHO criteria as 160 mmHg for systolic blood pressure (SBP) and 95 mmHg for diastolic blood pressure (DBP). The age-adjusted prevalence of hypertension was calculated for men and women. The overall prevalence of hypertension was 28%. After men of African origin [37% (95% CI 31- 44)], South Asian men had the highest prevalence of hypertension of 28% (95% CI 22-34) compared with the White population at 18% (95% CI 13-24) (Table 4.3b). The study also reported the mean systolic and diastolic blood pressure with 95% confidence intervals. Values were significantly different for migrant groups compared with the White population. Mean SBP and DBP were significantly higher among men of African origin (mean difference 5.9/5.5mmHg) and South Asian (3.1/3.3mmHg) origin compared with White men (Table 4.3c). Women of African (10.6/7.5mmHg) and South Asian (4.4/2.6mmHg) origins also had and higher mean systolic and diastolic blood pressure than White women (Table 4.3c). The study also reported the mean resting heart rate with 95% CIs, which was significantly faster among both South Asian men at 66.9 b/min (95% CI: 66.5, 68.2) and women at 69.3 b/min (95% CI: 67.9, 70.6) compared to White men 64.0 b/min (95% CI: 62.6, 65.4) and women 64.9 (95% CI: 63.7, 66.1) and African men 64.4 b/min (95% CI: 62.9, 65.8) and women 66.3 (95% CI: 65.2, 67.4).

A decade later, a similar study was conducted by Hippisley-Cox *et al.*, (2008). This was a prospective cohort study conducted in England and Wales, predicting cardiovascular risk among different ethnic groups. They used ICD-10 codes for case identification. They reported that the highest prevalence of hypertension was amongst Black African and Caribbean men followed by Indian, Bangladeshi and Pakistani populations compared with White men (Table 4.3b). Among women, the highest prevalence of hypertension after Black African and Caribbean women was in the Indian (9.6%) and Bangladeshi (9.5%) populations compared with the Pakistani (7.7%) and White (7.0%) populations (Table 4.3b). The study reported a high mean SBP among White men (136mmHg) (Table 4.3c) as compared with South Asian men (Indian 133mmHg, Pakistani 131mmHg, Bangladeshi 126mmHg).

The study by Dalton *et al.* (2014) is cross-sectional and used data from the Health Survey for England. Hypertension was defined as BP≥140/90 mmHg. The findings, surprisingly, showed a significantly higher prevalence of hypertension amongst White men (28.8%) compared with South Asians (16.5%). White women also had the highest prevalence of hypertension (23.3%) compared with Black (17.1%) and South Asian (14.1%) women. Mean SBP in men was highest in the Black population (135.5mmHg) followed by White (133.0 mmHg) and Indian (127.9 mmHg) populations. Amongst women, the mean SBP was similar in the Black and Indian populations (123.3mmHg) and was highest amongst the White population (127.4 mmHg) (Table 4.3c).

Another study (Lane, *et al.*, 2005) used the definition of hypertension from the British Hypertension Society (SBP ≥ 160 mmHg, DBP ≥95 mmHg) and reported a high prevalence of hypertension amongst African-Caribbean men (26.9%) and found no significant differences between European and South Asian men (14.9%). As previously mentioned, the study has one important limitation in that the sample for the South Asian only has male participants, and the majority (90%) are from one specific community (Punjabi). Another important finding of this study is the proportion of previously undetected cases of hypertension among South Asians after adjustment for age, sex and general practice. This could be the reason for the similar rate of documented hypertension among European men and South Asian men.

Another study reported that Bangladeshi women (57.5%) and Black Caribbean men (31.5%) had a higher prevalence of hypertension compared with other groups (Zaninotto, *et al.*, 2007). This study reported several risk factors associated with CVD amongst individual ethnic minority groups in comparison with the general population (Table 4.4b). Zaninotto *et al.* (2007) used guidelines from the British Hypertension Society to define hypertension amongst their population (BP≥140/90 mmHg). Another study (Hughes *et al.*, 2013) reported a high percentage of hypertension amongst South Asians compared with White Europeans (Table 4.3b). In this study, blood pressure was recorded three times as per British Hypertension Society guidelines (Hughes *et al.*, 2013). However, no statistically significant differences were found for either mean SBP and DBP between groups (Hughes, *et al.*, 2013).

Another study reported cardiovascular risk factors by gender (Tillin, *et al.*, 2013), using a prospective population-based survey. Case identification criteria were not the standard WHO criteria, with resting blood pressure was measured using a random-zero sphygmomanometer. The prevalence of hypertension was similar in South Asian men (13%) and women (13%). The highest percentage of hypertension was amongst the African Caribbean population and lowest among Europeans (Table 4.3c). Mean SBP was highest amongst African Caribbean women (131mmHg (SD =17)) and lowest amongst European women (120mmHg (SD =17)). Again, South Asian men and women showed no differences in mean SBP. Mean DBP was significantly different amongst South Asian men (81mmHg) compared to women

(77mmHg). Mean DBP was similar amongst South Asian men and Afro-Caribbean men (81mmHg) (Table 4.3c).

The remaining studies reported the risk factor of hypertension among stroke patients.

Studies conducted in stroke/CVA patients

Conway and Lip (2003) conducted a review of hospital registry data of patients who had an acute non-haemorrhagic stroke over a period of two years (1998-2000). Hypertension was defined as BP $\geq$160/90 mmHg on two separate hospital stays. The prevalence of hypertension was high amongst the Afro-Caribbean patients (51%) followed by Indo-Asians (44%), with lowest in the White population (34%) ($p<0.001$). SBP and DBP means were not calculated. A higher prevalence of hypertension was found amongst South Asians compared with the White Europeans (Table 4.3b). A similar result was reported by Gunarathne *et al.*, (2008b) who reported a high prevalence of hypertension amongst South Asians (73.7%) compared with White Europeans (58.6%) (Table 4.3b). In this study, blood pressure was recorded two consecutive times (Gunarathne, *et al.*, 2008b).

A study of stroke survivors reported a similar prevalence of hypertension in the Bangladeshi group (63%) compared with the White European (60%) group (Bourke, *et al.*, 2006). A cohort study by Malik, *et al.*, (2015) was conducted on diabetes patients living in Scotland. They reported baseline mean SBP and DBP in White, multiple ethnicity, Indian, Pakistani, Other Asian (Bangladeshi were merged in this group due to small numbers) and Chinese, and African-Caribbean groups. Other Asian (131/78 mmHg) and Pakistani groups (134/79 mmHg) had a lower mean BP compared to the White group (141/79 mmHg) ($p<0.0001$). The study recorded information on anti-hypertensive treatment and found that the White (48.9%) and multiple ethnicity group (47.2%) had a higher percentage of patients on anti-hypertensive treatment compared with the other ethnic groups (Table 4.3b). George *et al.*, (2017) conducted a prospective cohort study to examine the burden of CVD in South Asians, White and Black patients. The South Asian group included Indian, Pakistani and Bangladeshi people; White include White British, White Europeans and other White groups; and Black included those from African, Caribbean or other Black groups. Similar to Malik *et al.*, (2015), George, *et al.*, (2017) reported that White patients (6.2%) are more likely to be hypertensive than South Asians (4.2%), whereas Black patients (6.7%) had the highest percentage with hypertension. The findings of Malik *et al.* (2015) resonate with George *et* *al.*, (2017): South Asians are less likely to be prescribed BP-lowering medication compared to the White hypertensive population.

Overall, 10 out of the 17 studies including risk factor information reported a higher prevalence of hypertension among South Asians compared with the White population (Table 4.3b). Hypertension is not only associated with stroke but also with a high prevalence of diabetes in South Asians (Zaninotto, *et al.*, 2007). The next section will summarise the results of the studies for diabetes mellitus.

4.3.3.2: Diabetes mellitus

The prevalence of diabetes mellitus (DM) is the second most important risk factor associated with a high prevalence of cardiovascular disease and stroke amongst minority ethnic groups. Most included studies with risk factor information (14/17) reported DM as an important risk factor (Table 4.3b).

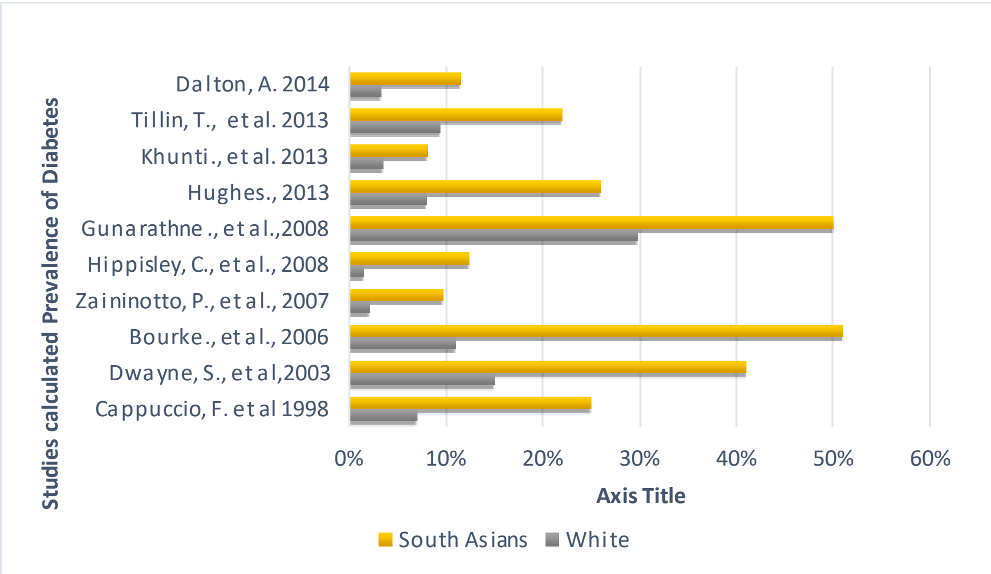


Figure 4.4: Studies presenting the prevalence of Diabetes by ethnic group (South Asians vs White)

Studies conducted among the general population

The Wandsworth Heart and Stroke Study (WHSS) calculated the prevalence of diabetes as per the WHO criteria (Fasting glucose $\geq$ 7.8mmol/l or post-loading glucose $\geq$11.1mmol/l) (Cappuccio, *et al.*, 1998). Age-adjusted diabetes prevalence was significantly higher amongst South Asian men (25%) as compared with African (18%) and White (7%) men. DM was less prevalent amongst women compared with men, but similar patterns were observed for ethnic groups with the highest prevalence amongst Indian women (20%) followed by African women (15%) compared with White women (5%) (Table 4.3b). In addition, there was a striking difference in the fasting serum plasma glucose levels amongst ethnic groups. The White group had the lowest mean glucose (5.14 mmol/L) and the highest was in South Asian men at 5.67mmol/L (95% CI 5.50, 5.83, $p<0.001$).

Dalton *et al.* (2014) reported that the highest prevalence of diabetes was amongst South Asian men (12.7%) and women (10.3%), followed by Black and White men and women (Table 4.3c). Dwayne *et al.* (2003) reported a significantly higher prevalence of diabetes among South Asian (41%) and Afro-Caribbean (42%) populations compared with the White population (13%) (Table 4.3c).

In the study by Hippisley-Cox *et al.*, (2008) the prevalence of diabetes was significantly higher in Bangladeshi men (16.8%), followed by Indian men (13.3%) and Pakistani men (12.0%), compared with White men (2.1%). Women showed a similar trend except for Pakistani women (14.2%) who had a higher prevalence of diabetes than Indian women (11.7%) (Table 4.3b). Khunti *et al.* (2013) conducted a cross-sectional analysis of the population from a screening study in Leicestershire, with differences found in the risk of diabetes and CVD between ethnic groups. These results need further exploration to elucidate whether they are due to genetic or environmental factors, or a combination of the two. Even though there are limited data on the association between microvascular disease with diabetes and CVD in South Asians, diabetes is one of the causes of microvascular disease. One study reported that reduced microvascular density may result in a higher risk of CVD in South Asians (Hughes, *et al.*, 2013).

Studies conducted in stroke and diabetic patients

Bourke *et al.* (2006b) reported a significant difference between Bangladeshi (51%) and European (11%) populations for the prevalence of diabetes, with an overall increased prevalence of CHD amongst the Bangladeshi population. Further evidence of a high prevalence of diabetes amongst the Bangladeshi population was found in the study by Zaninotto *et al.* (2007). Here, the age-standardised prevalence of diabetes was significantly higher among Bangladeshi (12.6%) and Pakistani (11.0%) men and women compared with the White population ($p<0.001$) (Table 4.3b). Along with a high prevalence of diabetes, a study by Chowdhury *et al.*, (2006) reported a high percentage of Bangladeshi patients with HbA1c>10mmol/l (17.1%) compared to Europeans (12.5%) in London.

Poor survival in South Asian stroke patients is reportedly due to diabetes (Gunarathne, *et al.*, 2008). A study by Potluri *et al.*, (2009) was conducted among diabetic patients of South Asian origin in the UK, Mauritius and India. It found a higher prevalence of cardiovascular risk factors among South Asians in the UK and Mauritius compared with India ($p<0.05$). The mean Hb1Ac was significantly higher in India (8.68) compared to the UK (8.30). Microvascular complications of diabetes, such as neuropathy, nephropathy and retinopathy, were more common in South Asians in India compared with the UK, due to poor diabetes control. Conversely, cardiovascular disease was significantly more prevalent in South Asians in the UK and Mauritius compared to India. In this study, Potluri *et al.*, (2009) used NICE UK guidelines as a standard to achieve diagnostic consistency for the prevalence of complications due to diabetes (Table 4.2b). The mean age of all groups were similar (Table 4.2a). The higher prevalence of stroke in South Asians could be due to inherent genetic or lifestyle factors, or variations in the medical management of stroke.

Tillin *et al.*, (2013) used WHO criteria to define diabetes. The prevalence of diabetes was significantly higher amongst South Asian men (22%) and African Caribbean women (21%), whereas the lowest prevalence was recorded amongst White women (4%) (Tillin *et al.*, 2013). Insulin resistance and diabetes are more common in South Asian and Afro-Caribbean populations when compared to the White European population (Tillin, *et al.*, 2013). The mean HbA1c was also significantly higher among South Asians (5.6 mmol/l) and Afro-Caribbeans (5.6 mmol/l) as compared with Europeans (5.4mmol/l) (Table 4.3c).

Malik *et al.*, (2015) used data available for people with diagnosed diabetes in Scotland in the Scottish Care Information-Diabetes (SCI-Diabetes) dataset. This is an electronic patient record of National Health Service (NHS) Scotland patients with diabetes. They included patients with type 2 diabetes to investigate ethnic differences in CVD rates in a large prospective cohort. The study reported significantly higher mean HbA1c among Pakistanis (8.5mmol/mol) and African-Caribbeans (8.4mmol/mol). In addition, the mean duration of diabetes at baseline was highest among Indians and Pakistanis. The study also reported

Pakistani, Other Asian (Bangladeshi) and African-Caribbean people were younger at diagnosis than those who were White (Table 4.3c).

Finally, a study by George *et al.*, (2017) supports the findings from elsewhere that South Asians (6.0%) have higher prevalence of diabetes compared to White people (2.5%). Overall, all studies reported diabetes as an important risk factor for CVD among South Asians. The prevalence of diabetes was highest among South Asians compared to White groups (Figure 4.4) and Malik *et al.* (2015) reported that South Asians had longest duration of diagnosed diabetes. Among these studies, 3/17 (Hippisley-Cox *et al.*, 2008; Bourke *et al* 2006b; Zaninotto *et al* 2007) reported a higher prevalence of diabetes among Bangladeshis specifically compared with other South Asian and White populations. A large-scale study of the prevalence of diabetes in stroke patients by ethnicity is therefore needed in order to understand the role of diabetes and its impact on the outcomes of stroke in Bangladeshis.

4.3.3.3 Obesity

The prevalence of obesity was reported in four studies (Cappuccio *et al.*, 1998; Lane, *et al.*, 2005; Zaninotto *et al.* 2007; Dalton *et al.*, (2014) (Table 4.3b). These studies were conducted in the general population. Cappuccio *et al.*, (1998) reported a higher prevalence of obesity (BMI>27kg/m^2 (moderate) and BMI>30kg/m^2 (severe) amongst African men (39%) and women (40%) than in White men (31%). South Asian men and women had a significantly lower prevalence of obesity (24% and 20%) compared with Africans. This is despite the mean waist-to-hip ratio being high amongst South Asians (0.944). The South Asian (39.1%) group reported lower levels of regular exercise compared with White Europeans (51%) (Cappuccio, *et al.*, 1998).

A study by Lane *et al.* (2005) reported the prevalence of obesity (BMI>30kg/ m^2) in three ethnic groups (White Europeans, African-Caribbean, South Asian). The prevalence of obesity was highest among African-Caribbean men (22.2%) and women (38.5%) followed by White European women (15.8%) and men (12.7%). South Asians had the lowest prevalence (9.2%).

Zaninotto *et al.* (2007) reported a high waist-to-hip ratio in Indian men (OR 2.73, 95% CI: 1.43-5.22) followed by Bangladeshi men (OR 1.50, 95% CI: 0.53-3.95), compared with White Europeans (OR 1.21, 95% CI: 1.07-1.36). Among women, Bangladeshis had the highest waist-to-hip ratio (OR 2.56, 95% CI: 0.62-10.48) followed by Indian women (OR 1.80, 95% CI: 0.85-3.83). Despite the high waist-hip-ratio, the prevalence of obesity (BMI> 30.0kg/m^2) was lowest among Bangladeshi men (5.2%) but highest among Pakistani women (32.4%). Another study by Dalton *et al.*, (2014) reported high levels of obesity (BMI>30kg/m^2) amongst Black women (45.7%), with the lowest prevalence being among South Asian men (11.9%) (Table 4.3b). The mean BMI was similar between Black and White men, whereas it was higher in Black women (Table 4.3c). The study by Malik *et al.*, (2015) reported lower a mean BMI among Pakistani and Chinese people (26.0) when compared to White people (31.8). Among South Asians, Pakistanis had a higher (30.2) BMI compared to Indians (28.8) (Table 4.3c). The study by George *et al.*, (2017) reported broadly similar BMIs in all ethnic groups (Table 4.3c).

All four studies reported a lower prevalence of obesity among South Asians compared to White and African populations, despite the fact that the mean hip-to-waist ratio was high among South Asians. Among South Asians, the Bangladeshi population was reported to have the lowest prevalence of obesity with the highest waist-to-hip ratio. There are a lack of studies on obesity among South Asians in the UK, and within the Bangladeshi population specifically, which have considered the adjusted WHO BMI criteria of 23kg/m^2 for overweight and 27.5kg/ m^2 for obesity which have been suggested for use in South Asian populations (Stegenga., *et al.*, 2014).

4.3.3.4: Hypercholesterolaemia

In general, hypercholesterolaemia is present in almost a quarter of stroke patients, but in South Asian population studies more than half of patients have raised cholesterol levels (Cappuccio *et al.*, 1998, Gunarathne, *et al.*, 2009). The South Asian population is susceptible to an atherogenic lipid profile. This includes high levels of triglycerides and low levels of high-density lipoprotein (Gunarathne *et al.*, 2008a).

Cholesterol levels were reported in five studies conducted in the general population (Cappuccio *et al.*, 1998; Chowdhury *et al.*, 2006; Dalton *et al.*, 2014; Gunarathne *et al.*, 2008a; Zaninotto, *et al.*, 2007). Cappuccio *et al.*, (1998) reported a high prevalence of hypercholesterolaemia (>5.2mmol/l) among White men (78%) followed by South Asian men (68%), with the lowest prevalence reported among South Asian women (19%) (Table 4.3b). Zaninotto *et al.*, (2007) reported high cholesterol levels (>5.0mmol/l) amongst 61.1% of the

White male population, which was similar for Indian men (59.3%) followed by Bangladeshi men (55.5%). Among South Asian women, 55.5% of the Bangladeshi group had a significantly high cholesterol (>5.5mmol/l) compared with other South Asian groups (Indian women: 51.6%, Pakistani women: 52.3%). It shows that there is heterogeneity among South Asians when considered by individual ethnic group (e.g. Indian, Pakistani, Bangladeshi). Gunarathne *et al.*, (2008a) reported mean values for hyperlipidaemia, being highest amongst South Asians (10.8 mmol/l) followed by Europeans (9.2 mmol/l). Hyperlipidaemia has significant increased in prevalence among South Asians between 1997-2005. Dalton *et al.*, (2014) reported a high percentage of individuals with total cholesterol levels >5mmol/l amongst the White population (87.5%) which was similar among South Asian (81.6%) and Black male (81.9%) populations. A further study reported that total cholesterol levels were significantly higher in the Bangladeshi population (31.6%) than White Europeans (26%) (Chowdhury, *et al.*, 2006). However, a stroke management study by Bourke, *et al.*, (2006) reported that cholesterol levels were measured less often in Bangladeshis (25%) compared with the White group (75%, p<0.0001). Malik *et al.,* (2015) reported that Other Asians (43.3%) and African-Caribbeans (40.9%) had the lowest percentage of treatment for high cholesterol levels compared to the White group. This could be partly explained due to lower cholesterol levels among Indian, Pakistani (4.9mmol/l), and Other Asian (4.9mmol/l) and Chinese (4.7mmol/l) groups compared to the White group (5.0mmol/l).

4.3.3.5: Atrial fibrillation

In this review, four studies (Conway and Lip, 2003; Bourke *et al.*, 2006; Hippisley-Cox *et al.* 2008; Gunarathne *et al.* 2008) reported the prevalence of atrial fibrillation (AF) among ethnic minority groups. Atrial fibrillation is a common type of cardiac arrhythmia, the prevalence of which increases with age. AF is associated with a 3-5 times increased risk of stroke which is influenced by age and other risk factors such as diabetes, hypertension and CVD (Mathur, *et al.*, 2013).

The study by Hippisley-Cox *et al.* (2008) was conducted in the general population. They reported a higher prevalence of atrial fibrillation in White men (0.6%) followed by Indians (0.3%), Pakistanis (0.2%) and Bangladeshis (0.1%).

Two of the studies were conducted in populations with stroke (Conway and Lip, 2003: Gunarathne *et al.*, 2008b) and one with diabetes (Bourke *et al.*, 2006). The study by Conway and Lip (2003) reported that, despite a high prevalence of diabetes and hypertension amongst South Asian populations, atrial fibrillation (AF) was a less common risk factor. The prevalence of AF was reported to be significantly higher amongst the White population (13%) compared with Indo-Asian (1%) and African (3%) populations, even after age and sex adjustment (Conway & Lip, 2003). Bourke *et al.* (2006) showed that the prevalence of atrial fibrillation is lower in the Bangladeshi population (4%) compared with the White population (13%) ($p<0.05$).

Gunarathne *et al.* (2008b) found the prevalence of atrial fibrillation had remained stable over the last ten years. Similar to previous studies, they also reported a higher prevalence of atrial fibrillation among Whites (34.8%) compared with South Asians (11.8%) ($p<0.001$). This risk factor needs more population-based studies to understand the ethnic differences in the UK (Gunarathne, *et al.* 2008).

4.3.3.6: Smoking

There are several lifestyle risk factors directly associated with a high prevalence of CVD amongst all ethnic groups. Thirteen out of fifteen studies reported smoking status (Table 4.3c) amongst the study population. Studies by Bourke, *et al.*, 2006, Tillin, *et al.*, 2013 and Malik, *et al.*, (2015) were conducted in populations with diabetes, while the remaining studies were conducted in the general population. Cappuccio *et al.* (1998) found a lower prevalence of smoking amongst South Asian men (22.5%) compared with White men (34.5%) and South Asian women (2.8%).

Lane *et al.* (2005) also reported smoking prevalence in the overall South Asian group (33.8%). They found that smoking prevalence was significantly higher in African men (50.2%) followed by White men (41%) (Lane, *et al.*, 2005). Other studies which considered South Asians in one group (Dalton, *et al.*, 2014; Hughes, *et al.*, 2013; Khunti, *et al.*, 2013; Tillin, *et al.*, 2013) all reported a higher prevalence of current smoking among White Europeans and Afro-Caribbeans compared with South Asians (Table 4.3c).

A study by Zaninotto *et al.*, (2007) reported a significantly higher prevalence of smoking among Bangladeshi men (43.5%) compared with all other groups. Amongst women, the Chinese had the highest prevalence of smoking (31%) with the lowest amongst Bangladeshi women (2.1%). Similarly, Hippisley-Cox *et al.*, (2008) reported a significantly higher percentage (53.2%) of current smokers amongst Bangladeshi men compared with other ethnic groups.

Similar findings were found in other reports. A study by Chowdhury *et al* (2006a) found a higher prevalence of smoking amongst the Bangladeshi population (28%) compared with Europeans (22%). The findings of another study reported a significantly higher prevalence of smoking among Bangladeshis (41%) compared with Europeans (37%) (Bourke, *et al.*, 2006b). Brindle *et al.* (2006) reported similar findings, with the highest prevalence of smoking found amongst the Bangladeshi population (50%) compared with all other groups (Table 4.3c). The study by Malik *et al.*, (2015) reported higher percentages of "ever smoking" among White (72.8%) compared to Indian (48.8%) and Pakistani (48.2%) people. The Other Asian group (which included Bangladeshis) had a higher percentage (51.6%) of those who ever smoked compared to Indian and Pakistani groups. George *et al.*, (2017) reported similar findings: South Asians were more likely to be in the category of "never smokers" (78%) compared to White people (62.9%), while the percentage of current smokers were similar among South Asians and White individuals (17%).

Overall, the prevalence of smoking was high among the White population compared to other ethnic groups. When examining individual South Asian ethnic sub-groups, five studies showed a higher prevalence of smoking among Bangladeshi men compared to all other ethnic groups, whereas Bangladeshi women had the lowest prevalence of smoking among all ethnic groups.

4.3.3.7: Other risk factors

Some studies have reported on other risk factors, such as a past medical history or family history of CVD, stroke, DM or CHD. One study reported a high prevalence of past medical history of stroke among South Asians (13%) compared with Whites (9%) (Conway & Lip, 2003). In contrast, a high prevalence of CHD was reported among the general population (5.2%) as compared with South Asians (4.1%) (Brindle, *et al.*, 2006). Bourke *et al* (2006b) reported a higher proportion of previous CVD history among Europeans (63%) compared with Bangladeshis (48%). Bangladeshis were among those with the highest rate of stroke (1.9%) with the lowest being found in the Chinese (0.9%) (Zaninotto, *et al.*, 2007). Along with the higher prevalence of CVD and CHD among South Asians, Malik *et al.*, (2015) reported that the Other Asian group (the group with Bangladeshis) were younger at diabetes diagnosis (48.7 years) while Indians and Pakistanis had the highest mean duration of diabetes (4.8 and 4.7 years, respectively). Also, Pakistanis and Other Asians were almost 9 years younger than other groups when they had CVD. This finding is supported by George *et al.*, (2017). They reported that age at CVD diagnosis was younger in South Asians (61.5 years) compared to White (71.2 years) and Black (62.1 years) people. 60.9% of South Asian, 47.8% White and 40% Black individuals with CVD were diagnosed before the age od 60 years.

A family history of CHD was reported to be significantly more common among the Indian (18.5%) and Pakistani (12.1%) populations compared with the Bangladeshi population (6.3%) (Hippisley-Cox., *et al.*2008). An explanation for the low family history of CHD among Bangladeshis could be the presence of a communication/language barrier hindering the process of eliciting an accurate history.

Apart from a previous history of CHD, there are other risk factors that were found to be different between ethnic minorities and White populations. For example, the level of daily exercise and consumption of vegetables are far lower than in the White population, whereas ethnic minorities have a higher consumption of fatty foods. (Cappuccio, *et al.*, 1998). On the other hand, South Asians have lower levels of alcohol consumption when compared to the White Population. (Cappuccio, *et al.*, 1998; Tillin, *et al.*, 2013a; Zaninotto, *et al.*, 2007).

Table 4.3a: Characteristics of Studies comparing CVD (Stroke) risk factors among South Asians

Study ID	Study Design /Methodology	Source of numerator	Source of Denominator	Setting	Year(s) of Study data	Sample size (n)	Risk Factors	Patient characteristics
Studies based in general population.								
Cappuccio, F. *et al* 1998 **Cappuccio *et al*., 2002**	Population based cross sectional survey WHSS	9 General practices	Wandsworth Health Authority	Nine general practices in London, UK	March 1991 to July 1996	1458 Male = 698, Female= 760	Anthropometry measures SBP, DBP Lifestyle risk factors Smoking Serum sodium Serum Potassium Serum Creatinine Serum Triglycerides Plasma glucose	Age 40-59 Sex Both Ethnicity South Asian, African and White population
Khattar *et al*., 2000	Observational follow up study	NHS Central register for mortality Hospital Records Questionnaire to GP	723 patient who had undergone 24 hour intra-arterial ambulatory blood pressure monitoring in hypertensive cohort	District general hospital and community settings in Harrow. England	Baseline 1 January 1979 to 1st January 1993 Follow up 1994 to 1996	Follow up data on 688 of 723 528 White, 106 South Asian, 54 Afro-Caribbean	Age, SBP, DBP, BMI, H/O CVD, Smoking, Cholesterol, DM	Age White 52.2 Asian 46. 3 Afro-Caribbean 46.8

Study ID	Study Design /Methodology	Source of numerator	Source of Denominator	Setting	Year(s) of Study data	Sample size (n)	Risk Factors	Patient characteristics
Lane, D. *et al*., 2005	Observational follow up study	Birmingham screenees and participants of the INTERSALT study	Data from factory	Community settings in Birmingham, UK.	1979 and 1986	Male=1893, Female=731 2089 White European and 340 African-Caribbean men and women, and 195 South-Asian men	Age Ethnicity SBP, DBP Cigarette smoking Alcohol consumption H/O hypertension and vascular disease, BMI	Age White Europeans M:43.0 (11.9), F:42.0 (12.0) Africa-Caribbean 43.4 (11.1), F:41.4 (10.9) South Asians 34.6 (11.4) Sex Both
Brindle, M., *et al*. 2006	Risk prediction models	Risk factor data from HSE Risk factor and disease prevalence data from the black Africans	Health Surveys for England 1998 and 1999 The Wandsworth Heart and Stroke Study	Two community-based surveys WWHS and Health Surveys for England 1998 and 1999	1998-1999	Indian = 263 Pakistani = 205 Bangladeshi=149 Chinese= 132 Black Caribbean= 137 Black African = 51 Irish = 247 General population = 2594	Age, Total cholesterol, HDL cholesterol, SBP, Current smoker Waist: hip ratio BMI Diabetes, CHD diagnosed MI, CHD prevalence CVD prevalence Current smoker	Age Indian = 43.9 Pakistani = 42.6 Bangladeshi = 40.6 All South Asian = 43.2 Chinese = 44.3 Black Caribbean = 40.7 Black African = 47.4 Irish = 44.0 General population = 44.3 Sex Both
Chowdhery, T., *et al*.2006	Cross sectional study	Patient diagnosed with type 2 diabetes	Diabetes database DIAMOND	United Kingdom	2003-2004	2074 Male=1088, Female=986	Age, Sex, Ethnicity, BP Duration of diabetes, Smoking status BMI, Total cholesterol	Age European = 56.8 (5.4) Bangladeshi = 52.1 (6.7) Sex Both

Study ID	Study Design /Methodology	Source of numerator	Source of Denominator	Setting	Year(s) of Study data	Sample size (n)	Risk Factors	Patient characteristics
		with full data available					HbA1c. Presence of Macrovascular disease	
Zaininotto, P., *et al.* 2007	Cross sectional survey	Sample drawn from the Postcode Address File	HSE 1999 and 2004	England and Wales	1998 and 2003	2362 Black Caribbean, 2467 Indian, 2204 Pakistanis, 1985 Bangladeshis, 1385 Chinese, 2398 Irish, and 30,744 adults from the general population	BP, Diabetes BMI, Smoking status Alcohol drinking Waist–hip ratio total cholesterol C-reactive protein Socio economic status	Age 16 and over Sex Both
Hippisley-Cox., *et al.* 2008	Prospective open cohort	Open cohort with a valid Townsend deprivation score	QRESEARCH practices in England and Wales	531 practices in England and Wales	January 1993 to 31 March 2008	Women = 773,291 Men= 762 292	Age, Sex Smoking status SBP, Total serum cholesterol, BMI Family H/O CHD, AF, Type 2 diabetes Townsend deprivation score, Rheumatoid arthritis, Chronic kidney disease	Age 35-74 Sex Both

Study ID	Study Design /Methodology	Source of numerator	Source of Denominator	Setting	Year(s) of Study data	Sample size (n)	Risk Factors	Patient characteristics
Hughes., *et al*.2013	Cross sectional survey	Random sample of people with equal numbers of South Asians	London Life Science Prospective Population Study (LOLIPOP)	College Healthcare NHS Trust		287 Male = 191, Female = 96 European, South Asian all Punjabi Sikh	Age, Sex, Diabetes, BMI, SBP and DBP, HbA1c Smoking status Alcohol drinking Waist–hip ratio Total cholesterol Fasting triglycerides	Age 35–75 years for men and 55–75 years for women. Sex Both
***Khunti*., *et al*. 2013**	Cross sectional data analysis	Aged 40–74 inclusive without diagnosed existing vascular disease	20 general practices Leicestershire ADDITION-Leicester study	General practices in the Leicestershire and Rutland Strategic Health Authority		3707 Male=1728 Female=1979 874 South Asians and 2833 White Europeans	Age, Diabetes, BMI, Hypertension Smoking, Alcohol Hyperglycaemia Obesity HbA1c Socio economic status	Age 40–75 =White European 25–75 years inclusive if they were of Asian, Black or Chinese ethnicity Sex Both
Dalton, A. 2014	Cross sectional study	Respondent with valid risk scores.	Health Survey for England	Health Survey for England	2003 and 2004 surveys	11468 Male = 5125, Female = 6343	Age, Sex, Ethnicity Deprivation, Smoking Hypertension, Diabetes BP, Cholesterol/HDL BMI, Family H/O CVD Heart failure, Chronic kidney disease, AF Rheumatoid arthritis	Age 35-74 Sex Both

Studies based on CVA participant

Study ID	Study Design /Methodology	Source of numerator	Source of Denominator	Setting	Year(s) of Study data	Sample size (n)	Risk Factors	Patient characteristics
Conway and Lip., 2003	Review of registry data	Hospital discharge coding for the identification of patients with any form of intracranial haemorrhage, cerebral infarction or stroke	Hospital Registry data	West Birmingham Stroke registry data from 1998-2000	April 1, 1998 and March 31, 2000	832 in total, of which, 116 (14%) Indo-Asian 134 (16%) Afro-Caribbean	AF, Hypertension Diabetes Previous Stroke Myocardial infarction Angina, Unstable angina Peripheral vascular disease, Atherosclerotic vascular disease	Age White 76 ± 12 Indo Asian 68 ±13 Afro Caribbean 71 ± 10 Sex Both Ethnicity Indo-Asian, Afro-Caribbean and White population
Bourke., *et al.*, 2006	Cross sectional- Categorical data analysis	Patients from the UK Bangladeshi and White (English, Scottish, Welsh) communities with diagnosis at discharge of ischaemic stroke	Royal London Hospital	Royal London Hospital, UK	1997–2002	Male=162, Female=103 265 patients 186 of White and 99 of Bangladeshi ancestry	Previous CVD\` Hypertension Diabetic, AF Smoking Cholesterol	Age 60-62 mean age Sex Both
Gunarathne., *et al.* 2008	Cross sectional	First-in-a-lifetime stroke International Classification	West Midlands Regional Health Authority	Sandwell and West Birmingham	1997–2005	2405 Male = 1221, Female= 1284	Hypertension Diabetes AF, Heart failure Hyperlipidaemia	Age 1997–2005-73.9 (10.9) 2000–2002-74.8 (11.0 2003–2005-75.8 (11.1) Sex Both

Study ID	Study Design /Methodology	Source of numerator	Source of Denominator	Setting	Year(s) of Study data	Sample size (n)	Risk Factors	Patient characteristics
		of Disease (ICD) 10th revision, codes 430–438	computerised Hospital Activity Analysis register	Hospitals (SWBH) Trust			Myocardial infarction	
Potluri, R., *et al.*, 2009	Analysis of hospital case notes and registry data	Patient notes and comparing patient investigation reports	Diabetes clinics in the UK (n = 351), Mauritius (n = 173) and India (n = 263).	UK Mauritius and India	_	787 South Asian patients UK 351, Mauritius 173 India 263	Retinopathy CVD Nephropathy Neuropathy HbA1C	Age India 57.9 (9.62)[a] Mauritius 57.1(9.74) [a] UK 57.7 (9.91) [a] Sex Both
Mathur, R., *et al.* 2011	Cross sectional	Adult patients (18 years) with diagnostic Read Codes for hypertension, IHD, heart failure, stroke, and diabetes.	GP-registered population in the three PCTs.	147 of the 151 general practices in Tower Hamlets	31-Mar-09	843 720. White south Asian Black	SBP and DBP, Total cholesterol HbA1c	Age >18 years Sex Both
Tillin, T., *et al.* 2013	Prospective Population based study	A tri-ethnic community-based cohort from North and West London	Primary care physician lists and workplaces in the London districts of Southall and Brent.	North and West London.	1988 through 1991	2,049 Europeans, Male = 3170, Female = 1026 1,517 South Asians and 630 African Caribbeans	Age, Diabetes, treated hypertension, Known CHD, Known stroke, SBP and DBP, BMI Waist circumference, Waist-to-hip ratio, Total cholesterol, Triglycerides, HDL	Age 40-69 Sex Both

Study ID	Study Design /Methodology	Source of numerator	Source of Denominator	Setting	Year(s) of Study data	Sample size (n)	Risk Factors	Patient characteristics
							cholesterol, Apolipoprotein Fasting glucose, Fasting insulin, Smoking, Alcohol	
Malik *et al*., (2015)	Prospective Population based study	People with type 2 diabetes living in Scotland	Data from Scottish Care Information-Diabetes	National Health Service (NHS) Scotland.	2005-2011	114,450 White 797 Indian 2249 Pakistani 319 Other Asians 387 Chinese 301 African-Caribbeans 466 Other ethnicity	Age, BP at baseline, Smoking, HbA1C BMI Waist-to-hip ratio, Total cholesterol, LDL, HDL	Age >17 Sex Both Patients diagnose with type 2 diabetes
George *et al*., (2017)	Prospective Population based study	Patient free of diagnosed CVD at study entry	Clinical Practice Research Database (CPRD), ONS, HES, MINAP*	225 General practices	1997-2010	971,283 White, 38,292 South Asian, 30,896 Black and 27,847 Mixed/Other patients	Age, Hypertension, Diabetes, BP at baseline, Smoking, BMI, Total cholesterol, LDL, HDL Age at CVD events	Age≥30 Sex Both Patients free of diagnosed CVD.

MINAP: Myocardial Ischaemia National Audit Project registry

Table 4.3b: Results of Studies comparing CVD (Stroke) risk factors among South Asians: Categorical variables of Hypertension, Diabetes, Obesity, Hypercholesterolaemia, and Atrial Fibrillation

Study ID	Ethnicity	Hypertension		Diabetes		Obesity		Hypercholesterolaemia		Smoking		AF/Other	
		F	M	F	M	F	M	F	M	M	F	F	M
Cappuccio, F. *et al* 1998[a]	White	290 (13) (9-17)	233 (18) (13-24)	210 (5) (3-5)[d]	181 (7)	290 (18) (14-24)	232 (31)	274 (36) (31-43)	226 (78) (77-83)	80 (34.5)	94 (32.4)		
	African	341 (40)	208 (37) (31-44)	245 (15) (11-20)	156 (18)	339 (40) (35-45)	208 (39)	333 (22) (17-27)	197 (58) (51-65)	35 (16.8)	29 (8.5)		
	South Asians	252 (26) (21-32)	253 (28) (22-34)	192 (20) (15-27)	211 (25)	251 (20) (15-25)	252 (24)	230 (19) (14-24)	239 (68) (62-74)	57 (22.5)	7 (2.8)		
Conway, and *Lip*, 2003[b]	White	582 (34)		82 (15)								582 (13)	
	African	134 (51)		134 (42)								134 (3)	
	South Asians	116 (44)		116 (41)								116 (1)	
Lane, D. *et al.*, 2005[b]	White Europeans	78 (12.7)	282 (19.1)			96 (15.8)	187 (12.7)			292 (47.6)	604 (41)		
	African-Caribbean	33 (28.2)	60 (26.9)			28.5 (5.5) P<0.001	49 (22.2)			19 (16.2) P<0.001	112 (50.2)		
	South Asians	NA	29 (14.9)			NA	18 (9.2)			NA	66 (33.8)		
Chowdhury, T., *et al.* 2006[a]	Europeans									133 (22.1)	122 (21.8)	HbA1c>10.0%: 145 (12.5)	
	Bangladeshis									136 (28.1)	6 (1.4)	161 (17.1)	

Bourke., *et al.*, 2006[b]	Europeans		11(60)		20 (11)								25 (13)
	Bangladeshi		50 (63)[a]		40 (51)[a]								3 (4)
Zaninotto, P., *et al.*, 2007[a]	General population	22.2 (21.5-22.9)	24.6 (23.8-25.4)	1.9 (1.7-2.1)	2.5 (2.2-2.8)	20.9 (20.3-21.5)	17.9 (17.3-18.5)	58.6 (57.8-59.4)	61.1 (60.2-62.0)				
	Black Caribbean	33.6 (30.8-36.4)	31.5 (28.2-34.8)	7.3 (5.9-8.7)	6.4 (4.9-8.0)	31.6 (29.2-34.0)	20.6 (18.0-23.2)	48.7 (45.5-51.9)	52.2 (48.5-55.5)				
	Indian	28.2 (25.5-30.9)	29.5 (26.6-32.4)	5.7 (4.4-7.0)	8.6 (7.0-10.2)	19.8 (17.6-22.0)	12.5 (10.6-4.4)	51.6 (48.4-54.8)	59.3 (56.0-62.6)				
	Pakistani	44.8 (41.6-48.8)	24.4 (21.5-27.0)	12.3 (10.4-142)	11.0 (9.1-12.9)	32.4 (29.7-35.1)	14.8 (12.7-16.9)	52.3 (48.8-55.8)	54.1 (50.6-57.7)				
	Bangladeshi	57.5 (54.0-61.0)	18.1 (15.2-21.0)	8.4 (6.7-10.1)	12.6 (10.5-14.7)	16.7 (14.4-19.0)	5.2 (3.8-6.6)	55.5 (51.7-59.3)	55.5 (51.6-59.4)				
	Chinese	25.0 (21.4-28.6)	20.2 (16.6-23.8)	3.9 (2.5-5.3)	4.0 (2.5 5.5)	5.7 (4.0-7.4)	6.0 (4.2-7.8)	50.3 (45.8-54.8)	58.9 (54.2-63.7)				
Hippisley-Cox., *et al.*, 2008[c]	White	7.0	5.5	1.5	2.1					25.4	32.2	0.4	0.6
	Black African	17.3	15.6	6.8	8.6					4.4	16.6	0.2	0.3
	Black Caribbean	24.8	14.0	10.3	9.0					15.9	40.6	0.2	0.3
	Indian	9.6	12.0	11.7	13.3					8.1	23.7	0.2	0.3
	Pakistani	7.7	5.7	14.2	12.0					5.8	32.9	0.4	0.2
	Bangladeshi	9.5	6.4	14.4	16.8					12.8	53.2	0.2	0.1

	other Asian	9.6	8.3	7.1	10.3		10.5	28.3	0.2	0.3
	Chinese	9.8	6.1	5.2	3.8		6.1	28.0	0.1	0.1
	Other	13.6	9.3	6.4	7.9		18.2	34.4	0.1	0.1
Gunarathne ., *et al.*,2008 [a]	White Europeans		58.6 (56.3-60.9)		29.8 (27.6-31.9)	9.2 (7.8-10.5)				
	Afro-Caribbean		80.0 (76.2-85.5)		56.9 (51.1-62.8),	6.6 (3.6-9.5)				9.0 (5.7-12.4)
	South Asians		73.7 (69.5-77.8) p<0.001		50.3 (45.6-55.0) p<0.001	10.80 (7.9-13.7) p<0.01				11.8 (8.7-14.8) p<0.001
Pothuri, R., 2009	South Asians (UK)			Retinopathy 2.6% Nephropathy 2.3% Neuropathy 5.1% HbA1c 8.30%						
	South Asians (Mauritius)			Retinopathy 2.3% Nephropathy 10.5% Neuropathy 1.2%						
	South Asians (India)			Retinopathy 16.3% Nephropathy 20.5% Neuropathy 8.4% HbA1c 8.68%						
Hughes., 2013 [b]	Europeans	93(65)		11(8)			75 (52)			
	South Asians	98 (69) P 0.5		37 (26)			4 (3) P<0.001			

Khunti, *et al.* 2013[a]	White Europeans			49 (3.4) (2.4,4.2d)	52 (3.9) (2.9, 5.0)					254 (17)	265 (20.1)	
	South Asians			35 (7.4) (5.1,9.8)	36 (9.0) (6.2, 11.8)					2 (0.4)	70 (17.1)	
Tillin, T., *et al.* *2013*[b]	Europeans	55 (11)	139 (9)	21 (4)	112 (7)					30%	34%	
	Afro-Caribbean	79 (28) P<0.001	69 (20) P<0.001	60 (21) P<0.001	64 (18) P<0.001	`				9% P<0.001	27% P<0.001	
	South Asian	34 (13) P=0.46	169 (13) P<0.001	44 (7) P<0.001	278 (22) P<0.001					2% P<0.001	16% P<0.001	
Dalton, A. 2014[a]	White	23.3 (22.0-24.5)	28.8 (27.3-30.3)	2.8 (2.3-3.3)	3.9 (3.3-4.5)	23.7 (22.4-24.9)	25.2 (23.8-26.6)	84.8 (83.7-85.8)	87.5 (86.5-88.6)	29.1 % (27.8-30.4)	31.4% (29.9-32.9)	
	South Asians	14.1 (11.7-16.5)	16.5 (13.9-19.2)	10.3 (8.2.4-12)	12.7 (10.3-15.1)	26.9 (23.8-29.9	11.9 (9.6-14.2)	74.5 (71.5-77.5)	81.6 (78.8-84.4)	3.9% (2.6-5.2)	40.7% (37.2-44.3)	
	Black	17.1 (14.1-20.0)	31.7 (27.5-35.9)	8.9 (46.6-11.1)	6.8 (4.5-9.1)	45.7 (41.8-49.6)	21.7 (18.0-25.4)	68.4 (64.7-72.0)	81.6 (78.8-84.4)	15.2 (12.4-18.0)	45.3 (40.8-49.8)	
Khattar *et al.*, **2000**[b]	White			528 (5)						110 (21)		Previous CV 528 (7)
	South Asian			106 (17)						21 (20)		106 (7)
	Afro Caribbean			54(15)						8 (15)		54(7)

Malik., *et al.,* 2015	White	Hypertension treatment 55,943 (48.9)		83,189 (72.8)
	Multiple Ethnicity	1,206 (47.2)		1,983 (77.7)
	Indian	361 (45.3)		386 (48.4)
	Pakistani	986 (43.8)		1,084 (48.2)
	Other Asian	94 (29.5)		164 (51.6)
	Chinese	177 (45.7)		186 (48.3)
	African-Caribbean	100 (33.2)		142 (47.2)
George *et al.,* 2017 a	White	6.0 (6.0-6.1)	2.5 (2.5-2.6)	17.3 (17.2-17.4)
	South Asian	4.2 (4.0-4.4)	6.0 (5.8-6.2)	17.3 (17.2-17.4)
	Black	6.7 (6.5-7.0)	4.6 (4.3-4.8)	12.6 (12.3-13.0)
	Other	3.8 (3.6-4.1	2.9 (2.7-3.1)	14.3 (13.9-14.8)

a: frequency percentage (%) with 95% confidence interval, b: frequency count (n) with percentage c - %

Table 4.3c: Results of studies comparing CVD (Stroke) risk factors among South Asians: Continuous variables of BP (SBP and DBP), Cholesterol, BMI, smoking and others

Study ID		SBP (mmHg)		DBP (mmHg)		Total Cholesterol (mmol/L)		BMI (kg/m^2)		Other	
		F	M	F	M	F	M	F	M	F	M
Capuccio, F. *et al* 1998[a]	White	123.5 (121.5,125.6)	127.9 (125.5,130.3)	77.2 (76.1,78.3)	82.1 (80.7,83.4)	6.21 6.08, 6.34)	6.21 (6.07, 6.35)	26.1 (25.5, 26.7)	25.8 (25.3, 26.3)	Alcohol >14units/wk 31 (11.0)	Alcohol >21units/wk 68 (30.1)
	African	134.1 (132.2, 136.0)	133.8 (131.3, 136.3)	84.7 (83.7,85.7)	87.6 (86.2,89.0)	5.66 (5.53, 5.78)	5.45 (5.30, 5.60)	29.3 (28.8, 29.8)	26.4 (25.9, 26.9)	24 (0.9)	12 (5.8)
	South Asians	127.9 (125.7, 130.1)	131.0 (128.7,133.3)	79.8 (78.6,81.0)	66.9 (65.5,68.2)	5.66 (5.52,5.80) (P<0.001)	5.74 (5.61, 5.88) (P<0.001)	27.1 (26.5, 27.8) P<0.001	24.8 (24.3, 25.2) P<0.001	2 (0.8)	19 (7.6)
Lane, D. *et al.*, 2005[c]	White Europeans	123.8 (20.8)	130.2 (18.6)	72.9 (12.3)	80.8 (13.6)			25.5 (4.4)	26.0 (3.7)		
	African-Caribbean	137.2 (26.9) P<0.001	136.1 (22.6%)	83.8 (17.0) p<0.001	82.7 (16.2%)			28.5 (5.5) P<0.001	26.7 (3.6)		
	South Asians		127.3 (20%)		79.9 (14%)				25.1 (3.8)		
Chowdhery, T., *et al.* 2006 [a]	Europeans	129 (90-180)		79 (65-110)				27.2 (23.5-36.8)		HbA1c % 605 (52.1)	
	Bangladeshis	131 (80-180)		81 (65-110)				27.9 (22.4-30.4)		552 (58.7)	

Hippisley-Cox., *et al.*, 2008[c]	Whites	133	136	3.9	4.5	26.1	26.6	Townsend: 0.65	0.5
	Black African	138	139	3.6	3.9	29.4	26.6	3.66	4.3
	Black Caribbean	136	136	3.5	4.0	28.7	26.7	3.66	3.7
	Indian	130	133	4.0	4.6	26,4	5.7	1.06	1.1
	Pakistani	129	131	4.3	4.9	28.4	26.3	2.58	2.6
	Bangladeshi	126	126	4.6	5.2	26.1	25.0	5.77	5.5
	other Asian	130	132	4.0	4.7	25.4	25.5	2.09	2.2
	Chinese	125	127	3.7	4.3	23.4	24.0	1.95	2.5
	Other	131	134	3.8	4.4	27.0	26.5	2.80	3.0
Mathur, R., *et al.* n2011[a]	White	Reached blood pressure<140/90: 37942 (1)		Reached cholesterol target<4mmol: 29620 (1)				HbA1c level of <7.5%: 9998 (1)	
	South Asians	26560, 1.56 (1.43-1.71)		23883, 2.00 (1.81-2.22)				14988,1.01 (0.91-1.13)	
	Black	21712, 0.75 (0.70-0.80)		172590.96 0.96 (0.90-1.93)				7558, 0.91 (0.81-1.04)	
	Other	3444, 1.09 (0.98-1.22)		2803,1.12 (0.97-1.30)				1316, 1.04 (0.87-1.24)	

Hughes., 2013[c]	Europeans	142± 18		82± 10		5.5± 1.1		27.8± 5.2		HbA1c 5.7 (5.4,5.7)	
	South Asians	145±17		82±8		5.2±1.1	P 0.01	26.9±4.4		6.0 (5.7, 7.0) P<0.001	
Khunti., *et al.* 2013[c]	White Europeans							27.5 (5.3)	27.8 (4.1)	High CVD risk: 67 (4.6) (3.5,5.7) CKD 194 (13.0) (11.3,14.7)	CVD risk 426 (33.1) (30.5,35.6) CKD 61 (4.6) (3.5, 5.8)
	South Asians							27.6 (4.9) P< 0.722	26.3 (4.2) P<0.001	11(2.4) (1.0,3.8) CKD: 17 (3.7) (2.0,5.4)	High CVD risk 152 (39.1) (34.2,43.9) CKD 6 (1.5) (0.3,2.7)
Tillin, T., *et al.* 2013[c]	Europeans	120±17	123±17	75±11	77±11	6.0 (5.2-6.9)	6.0 (5.3-6.8)	26.1±4.6	26.2±3.9	HBA1c 5.5 (5.3-5.8)	5.6 (5.4-5.8)
	Afro-Caribbean	131±17 (P<0.001)	128±17 (P<0.00)	82±12 (P<0.001)	81±12 (P<0.001)	5.6 (4.8-6.5) p<0.001	5.4 (4.8-6.3) (p>0.001)	29.4±5.0 P<0.001	26.4±3.3 (P 0.44)	(NA)	(NA)
	South Asian	125± 21 (P<0.001)	125± 17 (P<0.001)	77± 10 P=0.010	81± 10 (P<0.001)	5.7 (5.0-6.5) P<0.001	5.9 (5.2-6.6) P=0.002	27.5± 4.6 P<0.001	25.9± 3.3 P=0.008	5.8 (5.5-6.1) P<0.001	5.9 (5.9-6.3) P<0.001
Dalton, A. 2014[a]	White	127.4 (126.8-127.9)	133.0 (132.5-133.5)					27.3 (27.1-27.4)	27.8 (27.7-27.9)	QRISK2: 14.0% (13.4-14.7)	25.9% (25.1-26.7)
	South Asians	123.3 (123.3-124.4)	127.9 (127.0-128.8)					27.9 (27.6-28.2)	26.2 (25.9-26.4)	16.5% (14.5-18.8)	29.9% (27.6-32.4)

	Black	123.8 (122.7-124.9)	135.5 (134.2-136.9)			30.0 (29.6-30.4)	27.2 (26.9-27.5)	14.7 (12.5-17.2)	25.7 (22.5-29.3)
Khattar *et al.*,2000 [c]	White	173.3 (23.5)		103.0 (12.9)	6.0 (1.2)	26.9 (4.4)			
	South Asian	161.3 (19.9)		101.3 (12.5)	5.6 (1.1)	25.6 (3.6)			
	Afro Caribbean	173.4 (25.7) (p<0.001)		106.1 (13.0) P NS	5.5 (1.0)	27.3 (3.8)			
Conway and Lip, *2003* [b]	White								PMH/Stroke: 53 (9) PMH/AF 76 (13)
	Afro-Caribbean								PMH/Stroke: 22(16) PMH/AF 4(3)
	Indo Asians								PMH/Stroke: 16(13) PMH/AF 2(1)
Bourke.*et al.*, *2006* [b]	Europeans								PMH/CVD: 117(63)
	Bangladeshi								38 (48)
Zaininotto, P., *et al.*, *2007* [a]	General population							Alcohol: 30.6 (29.9-36.3)	46. (45.847.4)
	Black Caribbean							19.1 (17.0-21.2)	30.0 (27.1-32.9)
	Indian							6.7 (5.3-8.1)	23.2 (20.8-25.6)
	Pakistani							0.7 (0.2-.1.2)	3.5 (2.4.4.6)
	Bangladeshi							0.7 (0.2-1.2)	0.9 (0.31.5)

	Chinese					11.0 (8.7-13.3)	14.3 (11.6-17.0)
Malik, *et al.*, 2015c	White	141	79	5.0±1.4	31.8±6.6	HBA1c 7.8±1.8	
	Multiple Ethnicity	140	79	5.1±1.4	31.8±6.7	7.7±1.8	
	Indian	136	79	4.9±1.2	28.8±5.2	8.0±1.7	
	Pakistani	134	79	4.9±1.6	30.2±5.8	8.5±2/0	
	Other Asian	131	78	4.9±1.1	28.7±5.2	7.8±1.8	
	Chinese	135	77	4.7±1.0	26.0±3.9	7.8±1.6	
	African-Caribbean	140	82	5.0±1.3	31.1±6.8	8.4±1.2	
George, *et al.*, 2017	White	130.6 (130.5-130.6)	78.6 (78.5-78.6)	5.5 (5.5-5.5)	26.6 (26.6-26.7)	Age at CVD onset 71.2 (71.1-71.3)	
	South Asian	122.9 (122.7-123.1)	76.8 (76.7-77.0)	5.1 (5.0-5.1)	25.6 (25.5-25.7)	61.5 (60.9-62.0)	
	Black	127.1 (126.8-127.3)	78.6 (78.5-78.8)	5.0 (5.0-5.1)	27.8 (26.7-27.9)	62.1 (61.2.-62.9)	
	Other	122.6 (122.3-122.9)	76.2 (76.1-76.4)	5.2 (5.2-5.3)	25.4 (25.3-25.5)	67.2 (66.5-67.9)	

a: mean with 95% confidence interval, b: OR with 95% confidence interval c: mean with (SD)

4.3.4 Cardiovascular risk prediction/assessment model

This review has found that there is a high prevalence of CVD and stroke amongst ethnic minority groups, which is a leading cause of morbidity and mortality around the world (Robert, *et al.*, 2014). To prevent this mortality and morbidity, identification of at-risk individuals is required. The identification of at-risk individuals will help to plan preventive strategies and public health interventions. This can be done by quantifying the risk of CVD by using risk prediction models (Goh, *et al.*, 2014). There were seven studies in this review which reported a cardiovascular risk prediction model among ethnic minority groups (Table 4.4a).

The purpose of these risk prediction models is to clinically evaluate the risk of development of CVD through the identification of high-risk individuals via a scoring system, and then to prioritise resources to those who are at higher risk of CVD.

The seven studies included the Framingham score, FINRISK, SCORE and ETHRISK, CHADS2, CHA2DS2VASc, QRISK and JBS2 prediction models. The Framingham score was first used in the ongoing Framingham heart study which started in 1940 in the town of the Framingham, Massachusetts, USA. This study pioneered the development of tools demonstrating the importance of CVD risk factors for the development of disease (Levy & Kannel, 1988). The Framingham study has helped clinicians to understand the ways in which mortality rates can be reduced by modifying risk factors (modifiable risk factors mentioned earlier in Chapter 1).

The Systematic COronary Risk Evaluation (SCORE) risk prediction model is a risk scoring system developed for use in the clinical management of cardiovascular risk in European clinical practice (Conroy., *et al.*, 2003).

QRISK and QRISK2 were developed to calculate the 10-year risk of CHD and CVD incidence and/or mortality (Damen, *et al.*, 2016). They were developed using electronic primary health care records of patients registered with GPs in the UK (Hippisley-Cox *et al.*, 2008). In the UK a new cardiovascular disease risk score (QRISK) was developed and validated against the established Framingham and cardiovascular disease algorithm and a newly developed Scottish score (ASSIGN) (Hippisley-Cox, *et al.*, 2007). It includes additional risk factors for cardiovascular disease, such as deprivation, family history of premature coronary heart disease, body mass index, and the effect of existing antihypertensive treatment (Hippisley-Cox, *et al.*, 2008). QRISK2 is a modified version with additional factors added such as ethnicity and other clinical conditions (Hippisley-Cox, *et al.*, 2008). Earlier risk scores underestimated risk amongst minority groups due to the absence of ethnicity in the risk prediction models (Cappuccio, *et al.*, 2002).

The analysis in WHSS compared the age-adjusted 10-year risk of CHD, CVD and stroke among South Asians using the Framingham equation (Cappuccio, *et al.*, 2002). The study reported significant differences amongst ethnic groups (Table 4.4b). The 10-year risk of CHD was higher amongst the South Asian population (9.2%, 95% CI 8.6-9.9) followed by White (8.8%, 95% CI 8.2-9.5) and African (7.0%, 95% CI: 6.5-7.5) groups. The predicted risks for stroke were higher among African individuals (1.7%, 95% CI: 1.5-1.9) followed by South Asian (1.6%,95 % CI: 1.5-1.8) and White (1.4%, 95% CI: 1.3-1.6) individuals (Table 4.4b). The drawback of this study was that the age group was restricted to 40-59 years only and so the results cannot be generalised to other age groups.

The Framingham risk score underestimated the risk of CVD/CHD in the South Asian population (Arabi, *et al.*, 2005*)*. To overcome this, Arabi *et al.* (2005) devised an evidence-based adjustment to the Framingham score to assess a more accurate CHD risk for South Asians. The results predicted the number of South Asians who would require lipid-lowering drugs as a preventative strategy (Arabi, *et al.*, 2005).

Bhopal *et al.* (2005) used the Newcastle Heart Project for exploration of the predictive capacity of three risk prediction models (FINRISK, Framingham and SCORE) amongst South Asians (Table 4.4b). Originally, the FINRISK model was evaluated from the population-based FINRISK study conducted in Finland in 1972. This study was initiated to carry out the evaluation of the North Karelia Project, a large community-based non-communicable disease intervention which aimed to reduce blood pressure in the community through better prevention, identification and management. The main objective of the study was to decrease the very high cardiovascular disease mortality in the province of North Karelia, Eastern Finland (Borodulin, *et al.*, 2018). The FINRISK model is based on 10-year cohort follow up from three different cohorts (1982, 1987 and 1992). It estimates an individual's 10-year risk of coronary heart disease and stroke, and their combination. The risk prediction is based on sex, age, diabetes, smoking behaviour, serum total and high-density lipoprotein (HDL) cholesterol concentrations, systolic blood pressure, diabetes and family history of heart disease (Borodulin, *et al.*, 2018).

Bhopal *et al.* (2005b) found heterogeneity among South Asians and Europeans when it came to cardiovascular risk prediction. The FINRISK (CHD) predicted risk was constructed using the European population as baseline (100) and found the highest risk to be among Bangladeshis (6.02%, SMR = 154, 95% CI: 128-187) followed by the Pakistani (5.03%, SMR = 129, 95% CI:114-146) and Indian (3.85%, SMR=99, 95% CI:85-115) populations. However, the SCORE model (CHD mortality) resulted in a significantly lower (Table 4.4) risk among all South Asian groups (1.31%, SMR=82, 95% CI 76-91) compared with White Europeans (1.58%, SMR=100), possibly due to the lack of DM and HDL as risk factors in the model (Bhopal, *et al.*, 2005b). The predicted risk of the Framingham model (for stroke) using the European population as baseline (100) was the lowest among Bangladeshis (0.31%, SMR=52, 95% CI: 35-77) followed by the Indian (0.40%, SMR=68, 95% CI:50-92) and Pakistani (0.48%, SMR=81, 95% CI:62-105) populations (Table, 4.4b). The Framingham model (CHD) has suggested a higher risk in South Asians (9.02%, SMR=122, 95% CI 110-136) compared to White Europeans (7.36%, SMR=100) (Bhopal, *et al.*, 2005b).

The study by Brindle *et al.*, (2006a) produced a web-based risk prediction tool by recalibrating the Framingham risk score (ETHRISK). Sex- and ethnic-specific 10-year risk scores were calculated for CHD and CVD from the Health Survey for England and WHSS data. The risk was the highest among Bangladeshi (12.8%) and Pakistani men (12.6%) after adjustment for smoking, SBP (130mmHg) and cholesterol ratios. Amongst women, the Pakistanis had the highest risk (6.6%) and the Chinese had the lowest risk (1.2%) (Table 4.4b).

Another study (Hippisley-Cox, *et al.*, 2008) developed a new risk prediction model from the previously available QRISK and Framingham scores, named QRISK2. South Asian migrants were reported to have an increased risk of cardiovascular disease compared to the host population (Hippisley-Cox, *et al.*, 2008). They reported that QRISK2 identifies that 14.2% of Bangladeshis and 10.1% of Indians are at a high estimated risk of CVD compared to estimates of 7.2% and 4.2% when using the Framingham Score. The adjusted cardiovascular risk among South Asians was 45% higher than in White Europeans. Specifically, compared to White Europeans, Indian men had a 45% higher risk of CVD (95% CI: 29%-63%), Bangladeshi men a 67% higher risk (95% CI: 40%-101%), and Pakistani men a 97% higher risk (95% CI: 70%-129%). Bangladeshi men had a higher percentage of individuals deemed to be at high risk when using QRISK2 (31%) and Framingham (34%) predictions, followed by Pakistani men (QRISK2 (30%) and Framingham score (32%)), and Indian men (QRISK2 (21%) and Framingham score (28%)). The lowest proportion of high-risk individuals was seen among White men (QRISK2 (14%) and Framingham score (22%)).

Mathur *et al.*, (2013) used the CHADS2 and CHA2DS2VASc models for the first time to report the stroke risk among South Asians and other groups (with AF). In 2001, the CHADS2 score (congestive heart failure, hypertension, age ≥75, diabetes mellitus, prior stroke or transient ischemic attack (doubled)) was proposed and validated in a registry of hospitalised AF patients, to help identify 'high risk' stroke patients. There was a shift from identifying 'high risk' to 'truly low risk' of ischaemic stroke, hence the CHA2DS2VASc score (congestive heart failure, hypertension, age ≥75 (doubled), diabetes mellitus, prior stroke, or transient ischemic attack (doubled), vascular disease, age 65 to 74, female) is now used for stroke prevention in AF patients (Yoon and Joung, 2018).

The data by Mathur *et al.*, (2013) used were from general practice records from South and East London. Although the prevalence of AF is low amongst South Asians, this study has shown a high risk for stroke ($CHA^2DS^2VASc>1$) compared with the Afro-Caribbean and White populations. The study has also shown that South Asians with AF are younger with a higher prevalence of diabetes and hypertension compared with the White population. The prescribing of warfarin is poorly related to risk in all ethnic groups (Mathur, *et al.*, 2013).

The study conducted by Dalton *et al.* (2014) was cross-sectional and used data from the Health Survey for England. In this study, risk estimation for CVD among South Asians was measured by using QRISK2 and the Joint British Societies 2 (JBS2) algorithm. QRISK2 includes ethnicity and the Joint British Societies 2 (JBS2) algorithm uses *post hoc* adjustments for ethnicity (Dalton, *et al.*, 2014). Differences in median high-risk scores were found to be the highest among South Asian men (7.5%, interquartile range 3.6-12.5) compared with White men (3.0%, 0.7-5.9).

Table 4.4a: Studies focussing on Risk Prediction of Stroke in the South Asians

Study ID	Study Design/ Methodology	Source of numerator	Source of Denominator	Setting	Year(s) of Study data	Sample size (n)	Variables included in the model	Patient characteristics
(Cappuccio *et al*., 2002)	Cross sectional Survey	1386 men and Women with no history of CVD	WHSS*	9 General practices, South London	1996-98	457 White 447 South Asian 464 African	Age, SBP, DBP, DM, Smoking, Cholesterol CHD, CVD, Stroke	Age Mean M/F White 50.4/49.1, South Asian 49.2/48.7, African origin 51.6/50.2 Sex Both
Arabi *et al*., 2005	Analysis of data from Health survey for England	Those without pre-existing symptomatic disease and free of vascular disease.	Health survey for England	England and Wales	1998-1999	4497 Male=2053, Female=2444	SBP, DBP, DM Total cholesterol HDL cholesterol, Smoking	Age 35-64 Sex Both Ethnicity Black Caribbean, Indian, Pakistani, Bangladeshi, Chinese and Irish
Bhopal, R.*et al*., 2005a	Population survey and registry analysis Newcastle Heart Project Mortality data analysis	Newcastle Health and Lifestyle Survey (NHLS) for Europeans and A name analysis of the	National mortality data by country of birth 1994–1997	Newcastle upon Tyne, UK	New Castle Heart project April 1993 and October 1994 and South Asians between	Europeans (362) 85 Indian, 129 Pakistani 48 Bangladeshi. Male = 750	SBP, DM Cholesterol, HDL-cholesterol Smoking	Age 25-74 Sex Both Ethnicity Europeans and South Asians

Study ID	Study Design/ Methodology	Source of numerator	Source of Denominator	Setting	Year(s) of Study data	Sample size (n)	Variables included in the model	Patient characteristics
		FHSA register for the South Asian population.			May 1995 and March 1997	Female = 758	FINRISK SCORE model	
Brindle, M., *et al.*, 2006	Risk prediction models	Risk factor data from HSE Risk factor and disease prevalence data from the black Africans	Health Surveys for England 1998 and 1999 Wandsworth Heart and Stroke Study	Two community-based surveys WWHS and Health Surveys for England 1998 and 1999	1998-1999	Indian = 263 Pakistani = 205 Bangladeshi = 149 All South Asian = 617 Chinese = 132 Black Caribbean = 137 Black African`= 51 Irish = 247 General population = 2594	Age, DM Total cholesterol, HDL cholesterol, SBP, Waist: hip ratio BMI Current smoker MI,,CHD prevalence CVD prevalence	Age[a] Indian = 43.9 Pakistani = 42.6 Bangladeshi = 40.6 All South Asian = 43.2 Chinese = 44.3 Black Caribbean = 40.7 Black African = 47.4 Irish = 44.0 General population = 44.3 Sex Both

Study ID	Study Design/ Methodology	Source of numerator	Source of Denominator	Setting	Year(s) of Study data	Sample size (n)	Variables included in the model	Patient characteristics
Hippisley-Cox., *et al*. 2008	Prospective open cohort	Open cohort with a valid Townsend deprivation score	QRESEARCH practices in England and Wales	531 practices in England and Wales	January 1993 to 31 March 2008	Women = 773,291 Men= 762 292	Age, Sex Smoking status SBP, Total serum cholesterol, BMI Family H/O CHD, AF, Type 2 diabetes Townsend deprivation score, Rheumatoid arthritis, Chronic kidney disease	Age 35-74 Sex Both
Mathur, *et al*., 2013	Cross sectional study	Patient age 18 and over diagnosed with AF	General Practices records South and East London	United Kingdom	2008-2011	6292	Age, Sex Hypertension, Type 2 diabetes Vascular disease, AF	Age 18 and above Sex Both Ethnicity White European And Bangladeshi

Study ID	Study Design/ Methodology	Source of numerator	Source of Denominator	Setting	Year(s) of Study data	Sample size (n)	Variables included in the model	Patient characteristics
Dalton, A., 2014	Cross sectional study	Respondent with valid risk scores.	Health Survey for England	Health Survey for England	2003 and 2004 surveys	11468	Age, Sex, Ethnicity Deprivation, Smoking Hypertension, Diabetes Blood pressure Cholesterol/HDL, BMI Family history of CVD Heart failure, Chronic kidney disease Rheumatoid arthritis, AF	Age 35-74 Sex Male=5125, Female=6343 Ethnicity White, Asian or British Asian Black or Black British

a=mean, b=mean with (SD) *WHSS: Wandsworth Heart and Stroke Study

Table 4.4b: Results of Studies focussing on Risk Prediction of Stroke in the South Asians

Study ID	Risk prediction models	Ethnic group	Risk prediction -ratio of 10year risk	Quality assessment (Newcastle - Ottawa Quality Assessment Scale)	Score
Cappuccio *et al.*, 2002)	Framingham equation for CHD, Stroke and CVD	White	CHD: 8.8 (8.2-9.5) Stroke: 1.4 (1.3-1.6) CVD: 11.9 (11.0-12.7)	Selection: **** Comparability** outcome*	7
		African	CHD: 7.0 (6.7-7.5) Stroke:1.7 (1.5-1.9) CVD: 12.5 (11.6-13.4))		
		South Asians	CHD: 9.2 (8.6-9.9) Stroke: 1.6 (1.5-1.8) CVD: 10.5 (9.7-11.2) p<0.001		
Arabi, *et al.*, 2005	Adjustment Framingham risk prediction model for CHD	White		Selection: **** Comparability outcome**	6
		South Asians	Age+10 1.88 (1.09-4.50) TC=2.8 1.83(1.29-2.92) TC:HDL+1.8 1.82(1.18-3.30) TC:HDLx1.5 1.77 (1.34-2.44) SBP+50 1.80 (1.30-2.64)		
Bhopal, R. *et al.*, 2005b [a]	FINRISK (CHD)[1] SCORE (CHD mortality)[2] Framingham (CHD)[3] Framingham (Stroke)[4]	Europeans	3.90 (100)[1] 1.58 (100)[2] 7.36 (100)[3],0.60 (100)[4]	Selection: **** Comparability * outcome**	7
		South Asians	4.76 (110,135)[1] 9.02 (110,136)[3] 0.42 (57,87)[4] 1.31 (76, 91)[2]		
		Indian	3.85 (85, 115)[1] 1.26 (69,91)[2] 7.56 (88,119)[3] 0.40 (50,92)[4]		
		Pakistani	5.03 (114, 146)[1] 1.37 (79,97)[2] 9.43 (113,146)[3] 0.48 (62,105)[4]		
		Bangladeshi	6.02 (128, 187)[1] 1.26 (67,95)[2] 11.02 (123,182)[3] 0.31 (35,77)[4]		
Brindle, M., *et al.* 2006[a]	ETHRISK (Modified Framingham) for CHD and CVD	General population	CHD: M: 0.95 (0.62-1.28), F: 1 CVD:M: 1. F:1	Selection: *** Comparability outcome**	5
		Indian	CHD: M:1.31(0.92-1.70) F:0.77 (0.30-1.24) CVD:M: 1.34 (0.97-1.71) F:0.78(0.39-1.17)		
		Pakistani	CHD: M: 1.41(0.88-1.94) F:1.40 (0.62-2.18) CVD:M: 1.32 (0.87-1.77) F: 133 (0.70-1.96)		
		Bangladeshi	CHD: M: 1.53 (0.88-2.18) F:0.97(0.32-1.62) CVD:M: 1.39 (0.82-1.96) F: 0.93 (0.38-1.48)		

Study ID	Risk prediction models	Ethnic group	Risk prediction -ratio of 10year risk	Quality assessment (Newcastle - Ottawa Quality Assessment Scale)	Score
Hippisley-Cox., *et al.* 2008	QRISK2 Framingham (CVD)	White	QRISK2: M: 14% F: 7% Framingham: 22% F: 8%	Selection: *** Comparability outcome*	4
		Indian	QRISK2: M: 21% F: 10% Framingham: 28% F:05%		
		Pakistani	QRISK2: M: 30% F: 18% Framingham: 32% F: 07%		
		Bangladeshi	QRISK2: M: 31% F: 14% Framingham: 34% F: 07%		
Mathur,. *et al*., 2013[b]	$CHADS_2$ and CHA2DS2VASc score for Stroke	White	CHA2DS2VASc 92.8 OR: 1 $CHADS_{2:}$ 84.3, OR 1	Selection: *** Comparability * outcome**	6
		Black African	CHA2DS2VASc: 93.9,1.13 (0.76-1.69) p 0.538 $CHADS_{2:}$ 86.1, 1.06 (0.82-1.37)		
		South Asian	CHA2DS2VASc 96.0, 1.67 (1.02-2.73) p 0.041 $CHADS_{2:}$ 89.8, 1.42 (1.04-1.93)		
Dalton, A., 2014 [a]	QRISK2 and JBS2 for CVD (Percentage high risk)	White	JBS2 95%CI: M: 32.7(31.7-33.8) F 12.3 (11.5-13.1) QRISK2 95%CI: M 25.9 (25.1-26.7) F:14.0 ()13.4-14.7)	Selection: *** Comparability outcome*	4
		Black	JBS2 95%CI: M: 33.8(30.2-37.9) F: 10.9 (8.8-13.5) QRISK2 95%CI: M: 25.7(22.5-29.3) F:14.7(12.5-17.2)		
		South Asian	JBS2 95%CI: M: 32.7(31.7-33.8) F: 14.0 (11.8-16.6) QRISK2 95%CI: M:29.9 (27.6-32.4) F:16.5(14.5-18.8)		

a: % with 95% CI b: %, OR with 95 %CI

4.3.5 Stroke management studies

The studies included in this review have shown a high prevalence of CHD/CVD and stroke among South Asians. Hypertension, diabetes, hypercholesterolaemia and obesity were reported as traditional risk factors amongst South Asians. Apart from these traditional risk factors there is another important factor to consider: the management of stroke amongst South Asians. National stroke guidelines in the UK aim to provide equal care for all patients after a stroke but there are no specific guidelines targeting communities on the basis of their susceptibility to those different stroke risk factors due to ethnicity (Bourke, *et al.,* 2006).

The studies that focused on different aspects of management of stroke among South Asians are mentioned in Table 4.5a. In the first study in Table 4.5a, Hsu *et al.,* (1999) found that access to treatment was earlier for South Asian patients after stroke compared with the White population. In contrast a later study by Bourke *et al.* (2006) showed a delay in access to care in South Asians after stroke which was likely to have impacted on appropriate treatment. Hsu *et al.* (1999) found a higher post-stroke 28-day mortality among White patients (33%) compared with South Asians (21%). The Bangladeshi population has been focused on by Bourke *et al.* (2006) in South London to find out if there are any differences in the management of stroke between Bangladeshi and European populations. This could be a reason for the levels of secondary cerebrovascular and cardiovascular disease among them. One of the factors calculated for the assessment of management is the measurement of cholesterol concentration, found to be significantly lower among Bangladeshis (25%) compared with White (76%) populations ($p<0.0001$). Other results reported by this study were that Echo and CT/MRI were performed significantly more frequently in Bangladeshis (76% and 82%) compared with European (37% and 69%) populations. Bourke *et al.* (2006a) reviewed the dispensing of drugs and found statin therapy to be given to Bangladeshis 7% less frequently compared with Europeans, although there was no significant difference in lipid lowering drug prescribing rates post-discharge (Europeans 36%, Bangladeshi 29%). However, there was a significant difference reported in warfarin dispensing for Europeans (8%) and Bangladeshi (1.3%) populations.

Table 4.5a: Studies focussing on the management of stroke

Study ID	Study Design/ Methodology	Source of numerator	Source of Denominator	Setting	Year(s) of Study data	Sample size (n)	Outcome	Patient characteristics
Bourke, *et al*., 2006	Cross sectional-Categorical data analysis	Patients from the UK Bangladeshi and White (English, Scottish, Welsh) communities with a diagnosis at discharge of ischaemic stroke	Royal London Hospital	Royal London Hospital, UK	1997–2002	265 patients 186 of White 79 of Bangladeshi ancestry	Acute stroke management in major London hospitals	Age 60-62 mean age Sex Male = 162, Female = 103 Ethnicity White European and Bangladeshi
Hsu, *et al*., 1999	Prospective incidence sample survey	Stroke patient identified by stroke nurses during 1996	Leicestershire Health Register of people registered with GP	23 General Practices Leicestershire,	1996	12 'high Asian' and 11 'low Asian' general practices	Management of stroke patients in the community	Age 65+ Both Sexes Ethnic groups

Table 4.5 b: Result of Studies focussing on the management of Stroke

Study ID	Group	Outcome	Summary of result	Quality assessment (Newcastle - Ottawa Quality Assessment Scale)	Score
Hsu, *et al.*, 1999	White ('Low Asian' practices|)	(44/135) 33% with definite stroke died within 28days 21% of admission χ^2=3.24, d.f=1 p=0.07	Few numbers of South Asians are managed in the community in first seven days of stroke 28 days mortality is less in South Asians compared with Whites after stroke	Selection: *** Comparability outcome**	5
	South Asians ('High Asian' practices|)``	(15/70) 21% with definite stroke died within 28 days 12% were not admitted to hospital			
Bourke,*et al.*, 2006	Europeans	Measurement of Cholesterol 141 (75%) Neuroimaging 129 (69%) Statin therapy 67 (36%)	Measurement of cholesterol concentrations are undertaken less often in those from a Bangladeshi background compared with White Europeans. Neuroimaging and echocardiography is performed more often in Bangladeshis compared with White Europeans	Selection: *** Comparability * outcome*	5
	Bangladeshi	Measurement of Cholesterol 20 (25%) p<0.0001 Neuroimaging 65 (85%) P<0.0001 Statin therapy 67(36%) P<0.0001			

4.4 Discussion

This review has provided updated evidence on the epidemiology of stroke in the South Asian population in the UK, with a specific focus on the Bangladeshi population where available. This is the first comprehensive review conducted in the UK focusing on stroke epidemiology among South Asians, and in particular Bangladeshis. This review has revealed that there is a lack of studies specifically in Bangladeshi migrants focusing on stroke epidemiology and pathophysiology in the UK. Research into established stroke risk factors has not thoroughly investigated individual South Asian groups. Apart from hypertension, an increased prevalence of diabetes and smoking are reported as the most common risk factors among South Asians. Risk factors which can explain excess mortality among South Asians appear to be reported less frequently, such as type of stroke, abdominal obesity and hip-to-waist ratio.

The review has shown differences in CVD and stroke epidemiology by ethnic group. It has provided updated evidence on the incidence, prevalence and mortality of stroke and CVD/stroke risk factors among South Asian groups compared to White Europeans in the UK. The majority of included studies reported differences by considering the South Asian population as one group, whereas only a few studies reported results by considering heterogeneity between South Asian groups (Indian, Pakistani, Bangladeshi). The findings suggest that the term ‘South Asian’ is too broad as an ethnic group. Instead, individual South Asian groups need to be considered for data analysis and interpretation.

In this review, in similar fashion to the previous review (Gunarathne, *et al.*, 2009), studies were included which considered South Asians as individual subgroups and also as a single group. It was found that the studies which considered South Asian groups individually showed significant differences between them, whereas considering South Asian as one ethnicity can bias the results of a study. For example, studies focusing on individual South Asian groups reported higher premature stroke/CHD mortality among Bangladeshis (Balarajan, 1995). Differences in risk factor profiles were also evident when subgroups were considered; for example, Bangladeshis having a lower prevalence of obesity, higher smoking rates and a higher waist-to-hip ratio (Zaninotto, *et al.*, 2007). Also, despite the high CHD mortality, low blood pressure was observed amongst the Bangladeshi population (Hippisley-Cox *et al.*, 2008). These differences were not only observed in risk factor profiles but also reported in acute stroke management explorations among Bangladeshis and White Europeans (Bourke, *et al.,* 2006).

The high CVD mortality among South Asians, specifically in Bangladeshis, has been described by studies focusing on sub-groups of South Asians. In the last three decades there has been a large amount of work done on traditional risk factors for stroke amongst South Asians as compared with the White population. However, few studies focused on stroke risk factors in the Bangladeshi population. The limited number of population-based cohort studies in the UK focusing on Bangladeshis as an individual ethnic group could be due to their low percentage of the population compared to other ethnic groups (0.8%). There was only one stroke prevalence study in this review focusing on South Asians in the UK (Potluri & Natalwala, 2009). The results have clearly shown a significantly higher incidence and mortality rate from stroke amongst South Asians compared with the White population (Table 4.2b) in the UK.

Studies which combined South Asian subgroups into one group reported results for the overall South Asian group compared to other ethnic groups. For example, 60% of primary studies in this review reported higher stroke mortality in South Asians, while the study by Lane *et al.*, (2006) reported no significant differences in the prevalence of hypertension among South Asians and Whites. As the South Asian group in this study included of a majority (>90%) of Punjabis and a minority of Bangladeshis, this may explain the findings. Hypertension and diabetes were shown to be increasing in prevalence and were the most common CVD risk factors reported by all studies. The studies which have reported outcomes by South Asians as a single group have shown a higher prevalence of obesity among South Asians, while a few studies reported a higher prevalence of hypertension among Bangladeshis compared to other South Asians.

In this review, along with hypertension, a few studies reported differences in systolic and diastolic blood pressures amongst South Asian and White groups. A high blood pressure is associated with a poorer outcome of stroke. Bangladeshis have a low SBP compared with other groups, yet still they have poorer stroke outcomes. This dispels the traditional belief that all South Asians have higher blood pressure. A large-scale dataset on this variable needs to be explored in pre- and post-stroke patients to compare its impact on the outcomes of stroke.

The second most commonly reported risk factor was diabetes. It is evident that hypertension, diabetes and glycaemic status among South Asians are independent predictors for poor stroke outcome. The evidence is well supported by a recent study where South Asians have a significantly higher prevalence of diabetes compared to Whites (George, *et al.*, 2017). This could explain the higher CHD mortality in Bangladeshis as a few studies reported a higher prevalence of diabetes among Bangladeshis compared to Indians and Pakistanis. In this review it is evident that a high prevalence of CVD in UK South Asians is due to an increased susceptibility of developing insulin resistance, which is a well-described hypothesis in the field of stroke and CVD epidemiology (Barnette, *et al.*, 2006).

Apart from hypertension and diabetes, hyperlipidaemia is a common risk factor reported in studies focusing on CVD risk factors among South Asians. Along with high glycaemic status, South Asians are known to have an atherogenic lipid profile, comprising high triglycerides and low high-density lipoprotein cholesterol and raised lipoprotein (Gunarathne *et al.*, 2008). In this review it is evident that there is heterogeneity between South Asians' lipid profile as well. For example, Bangladeshis have higher cholesterol levels compared to Indian and Pakistani groups (Chowdhury *et al.*, 2006). One study in the review reported higher cholesterol levels in the White group compared to South Asians (Dalton *et al.*, (2014). One of the important findings of management studies in this review showed that simple measurement of cholesterol levels among Bangladeshis is less likely to be undertaken compared to the White population. This needs further studies to explore discrepancies in treatment received between South Asians and the White population, and the role of elevated lipoprotein in determining stroke aetiology among individual South Asian groups.

Only a few studies reported risk factors such as obesity (waist-to-hip ratio), smoking, atrial fibrillation, diet and low levels of exercise among South Asians (Table 4.3a). The studies that reported prevalence of obesity also reported waist-to-hip ratio among South Asians. Waist-to-hip ratio provides an estimate of abdominal obesity, an emerging major public health challenge among South Asians (Misra and Shrivastava, 2013). Abdominal obesity in South Asians is associated with type 2 diabetes and cardiovascular disease. In this review studies reported a high waist-to-hip ratio in Bangladeshis (Zaninotto, *et al.*, (2007); this can help to exaplain the excess stroke mortality among them. A low prevalence of obesity among

Bangladeshis could be due to poor nutrition and low socioeconomic status. It is evident that the Bangladeshi community in the UK is a disadvantaged and deprived group compared to the general population (Barnard and Turner, 2011). This deprivation is multifactorial. One of the factors related to food deprivation is poor access to high-quality food resulting in undernutrition and nutritional disorders (Vaughan, 2011). While there is nutritional transition, the report by the National Obesity Observatory predicted that the prevalence of obesity is going to be low among Bangladeshi men in 2050, whereas for women it is predicted to increase (Barry, 2014).

Studies which have reported higher mean BMI and higher obesity risk among Pakistanis in the UK compared to Indians and Bangladeshis (Diaz, *et al.*, 2007; Rennie and Jab, 2005). A study in London (Cappuccio, *et al.*, 2007) reported a higher risk of obesity among Muslims than in Hindus. The authors suggests a deficit in the literature on obesity by ethnic group, specifically in South Asians. They concluded that it may not be appropriate to group South Asians (Indian, Pakistani, Bangladeshi) together, specifically in the analysis of risk factors which may differ substantially between these subgroups.

Those risk factors which are less commonly reported in studies of South Asians focusing on CVD/stroke need careful consideration. A narrow focus on traditional risk factors cannot fully explain the burden of CVD among South Asians. Obesity and low levels of exercise and diet are interrelated and can provide explanation for the high prevalence of diabetes among South Asians. Similarly, AF is a less commonly studied risk factor among South Asians which needs consideration when examining the CVD risk factor profile between ethnic minorities and Caucasians.

Apart from marked differences in these risk factors, differences were reported by type of stroke as well. There was only one study which reported on the type of stroke and found a higher prevalence of haemorrhagic stroke amongst the South Asian population (Potluri and Natalwala, 2009). South Asians were not classified individually, and so this needs further exploration by subgroups to identify which, if any, group has a higher prevalence of haemorrhagic stroke. There is a need for more studies to understand the pathophysiology of stroke in terms of their types (ischaemic and haemorrhagic) among Bangladeshis. Studies focusing on the pathophysiology of stroke could help to understand the unsolved mystery of excessive stroke mortality among Bangladeshis. These differences were observed for risk factors and type of stroke but also showed variations in detection and management of stroke by ethnic groups.

From management studies it is evident that stroke management differs according to ethnic group which influences stroke outcomes, though the number of studies was small. There is sufficient evidence to support the need for more cohort studies for CVD risk prediction models focusing on South Asians, and specifically for Bangladeshi patients because of their high stroke mortality. This could help to reduce the burden of stroke among them.

4.4.1: Strengths

This review, compared to previous reviews, has some advantages. The review included studies that have been conducted exclusively in the UK and included South Asians. This makes it unique and more focused on the situation in this country. Previous reviews by Bhopal, *et al.*, 2002 and Gunarathne, *et al.*, 2009, on stroke epidemiology in South Asians included studies from various countries, including the UK. In addition, this review was more focused on stroke amongst Bangladeshi migrants in the UK, which was not a focus in previous reviews.

This review has summarised risk factors by the type of population, such as studies conducted in the general population and in those who have had CVD/stroke. Another strong feature of this review is that it has included risk prediction model studies which has not been included in any previous reviews on stroke in South Asian migrants in the UK.

This review has followed systematic review methodology including two people independently reviewing the titles, abstracts and full-text papers for the selection of studies. Quality assessment was also carried out using a validated tool, the Newcastle-Ottawa Scale (NOS) (Lo, *et al.*, 2014).

4.4.2: Limitations

Despite specific focus on Bangladeshis, the number of studies and the data on this population was small. This review has included studies with samples drawn from specific locations such as GP practices (Mathur, *et al.*, 2013) and factories (Lane, *et al.*, 2005). This may have led to a potential sample bias, since South Asians who were not registered with the GP and who were unemployed or in other occupations were excluded from the studies.

Heterogeneity in study design and ethnic sub-groups limited data synthesis. A meta-analysis was therefore not feasible.

There is a lack of studies focusing on genetics, environmental and socio-economic factors. There was also limited research on the management of stroke among South Asian stroke survivors to detect any ethnic inequalities.

4.4.3: Implications for research

The review emphasises a need for further primary large studies monitoring the secular trends in the epidemiology of stroke in the South Asian population, specifically for the Bangladeshi ethnic group. Comparative studies are needed by ethnic group but also in different populations by health status, such as studies in the general population and in populations with CVD. It is challenging to use the term South Asians for people from India or Pakistan or Bangladeshi only. There is considerable heterogeneity among the South Asian group in terms of their CVD risk factors, presentation and duration of risk factors (George, *et al*., 2017). Another important factor while considering the heterogeneity of individual ethnic groups from South Asia are their different cultural and social backgrounds.

The current literature review suggests that there is a need to explore the exact relationship between stroke and ethnicity among South Asians living in the UK. These ethnic minority groups are growing in the UK. To reduce the burden of stroke among Bangladeshis, larger studies are needed to examine aetiology, detection, and management of stroke. Also, there is a need to focus on a wide range of CVD risk factors among South Asians, apart from traditional risk factors (hypertension, diabetes and hypercholesterolaemia), such as obesity, smoking and low level of exercise. There are also novel risk factors which need attention in future studies such as diet, vitamin D levels, infectious diseases, chewing of tobacco and mental illness.

There is an urgent need for studies focusing on the primary and secondary management of stroke amongst ethnic minority groups, with the focus to find the reason for poor stroke outcomes in Bangladeshi patients. Exploration of different aspects of poor management, such as late or delayed presentation of stroke, cultural misunderstanding, prescriptions and use of medication, follow-up appointments, communication gaps and post-stroke management services are needed, as well as physiotherapy and occupational therapy (Bourke, *et al.*, 2006a). Further studies should examine the differences between South Asian and White populations, and within South Asian subgroups, in the management of stroke at all stages from presentation at the emergency department until discharge and beyond.

Considering South Asian sub-groups individually would help in the development of preventative strategies for stroke control and its management in both hospital and community settings. The high prevalence of hypertension and diabetes in South Asians (and Bangladeshis) could be due to the epidemiological transition. Younger age groups in South Asians need to be prioritised for CVD risk assessment, as the presentation of CVD tended to occur at a younger age in South Asians compared to Whites (George, *et al.*, 2017). Future studies are needed to examine, systematically, the health of the Bangladeshi population in England and Wales, specifically at a national level. This is not only a challenge for commissioners of care but also a public health concern of health inequalities. If equity in health and healthcare is to apply to all those living in this country, then there is a need to target the Bangladeshi population.

4.4.4: Conclusion

In conclusion, this review found differences in the incidence and prevalence of stroke among South Asians and White Europeans. Mortality due to CVD/stroke was persistently high among South Asians in the UK when compared to White Europeans. Marked heterogeneity was also found in risk factors associated with CVD/stroke among South Asian and White Europeans. Risk factors were reported in a hierarchy of traditional or most commonly reported factors to those less commonly reported. It reflects past research which was predominantly focused on the most common CVD risk factors. However, other less-explored risk factors such as BMI, oral contraceptive pill use and level of physical activity in individual South Asian communities need further attention. Studies summarising the CVD risk assessment tools highlighted the importance of considering South Asian ethnicity in risk prediction models, as models without ethnicity as a component underestimated the risk of CVD among South Asians compared to White Europeans in the UK. The studies' reported management of stroke were contrasting in terms of access to stroke treatment among South

Asians and White Europeans. There was insufficient evidence to conclude that management differences exist between South Asians and White Europeans.

In future studies, ethnic groups originating from South Asia need to be considered individually due to their heterogeneity in health, social and cultural background. The analyses in further chapters (5, 7 and 8) are going to consider the heterogeneity among South Asians by considering them individually.

Chapter 5: The Wandsworth Heart and Stroke Study 1994-96: Analysis for South Asian Sub-Groups

5.1 Introduction

Since 1961 cardiovascular disease (CVD) mortality has fallen by more than 50%. Around 320,000 deaths were attributed to CVD in 1961 in the UK (BHF, 2018). From the latest report by the British Heart Foundation, cardiovascular disease causes more than 25% of all deaths in the UK; estimated to be around 150,000 each year, or one death every three minutes. Cardiovascular disease is the most common cause of death (BHF, 2018). The risk factors associated with CVD are described in detail in Chapter 1 (Table 1.1). As mentioned in Chapter 1, there are non-modifiable risk factors such as age, sex, family history and ethnicity but CVD risk can be reduced by controlling important modifiable factors, such as high blood pressure, increased body weight, smoking and physical inactivity. The current evidence on associated risk factors with cardiovascular disease and their differences between ethnic groups are narrated in detail in chapter 4. CVD and stroke are more common among ethnic minority groups compared to White Europeans in the United Kingdom (UK) (Cappuccio, 1997). In 1996, there were three million people who belonged to an ethnic minority group. This has now doubled, but with a similar distribution around inner cities and with similar specific health needs (Census 2011, 2013).

Evidence suggests cardiovascular diseases differ according to ethnicity. South Asians have a high incidence of coronary heart disease (CHD) as well as stroke and diabetes (Balarajan, 1991). Whether these differences are due to environmental and modifiable risk factors, such as diet, lifestyle and migration, is still a hot topic (Brindle, 2006). Since 1980, several surveys have been conducted in individual ethnic groups as well as in combined groups (Cruickshank, *et al.*,1980; McKeigue & Marmot, 1988; McKeigue *et al.*, 1991; Simmons *et al.*, 1991; Simmons *et al.*, 1992; Chaturvedi, *et al.*, 1993). There is a need for focused and individual preventive and therapeutic strategies for each ethnic minority group (Cappuccio, *et al.*, 1998). Cultural factors influencing acceptability and susceptibility may interfere with uptake and compliance of preventative therapy in these groups (Cappuccio, *et al.*, 1998). As discussed in Chapter 1, South Asians have a 1.5 times higher stroke mortality compared to White populations (Banerjee, *et al.*, 2010).

A study mentioned in Chapter 4 (Bhopal, *et al*, 1999) reported differences in coronary risk factors in South Asians (Indian, Pakistani and Bangladeshi). The systematic literature review found a need for research to consider each South Asian ethnic group individually since combining data from all can be misleading, masking important differences between groups (Bhopal, *et al*, 1999).

5.1.1 Wandsworth Heart and Stroke Study (WHSS)

The Wandsworth Heart and Stroke Study (WHSS) was a population-based cross-sectional survey of 1577 men and women resident in a geographically defined area of London (Cappuccio, *et al.*, 1998). All participants (523 White, 549 African, and 505 South Asian) underwent comprehensive screening of physical measurements, a questionnaire, and blood and urine tests. The results were summarised by these three groups; for example, South Asians were shorter with a lower BMI compared to other ethnic groups. Hypertension was more common among Africans followed by South Asians, whereas diabetes was most prevalent among South Asians followed by Africans. Among all findings it was not clear which South Asian group contributed to the high or low prevalence of risk factors. This analysis will explore the data by considering South Asians as individual groups (Indian, Pakistani, Bangladeshi).

So far there is sufficient evidence to suggest that there are differences in the prevalence of cardiovascular risk factors among ethnic minority groups compared to the host population. In the past few decades there has been a shift from CVD being the main cause of death to being the second most common cause of death in the UK (Townsend, *et al*, 2016). CHD has retained its position as the single biggest cause of death in the UK (Bhopal, 2018). Overall, cardiovascular disease presents a large health burden in the UK (Bhopal, 2018).

5.1.2 Wandsworth Health and Stroke Study (WHSS) – New Analysis for South Asian subgroups

Further analysis of the WHSS dataset in the current study intends to focus specifically on 48 participants originally from Bangladesh; to describe their cardiovascular risk profile and compare them to the remainder of the South Asians (mainly from India, Pakistan) and the White Europeans. The aim of the study was to estimate the prevalence of the major cardiovascular risk factors in both men and women of different ethnic backgrounds. A further aim was to identify risk factors associated with stroke among Bangladeshi.

The reason for performing further analysis of the Wandsworth Heart and Stroke Study was because of the relatively large sample of ethnic minorities, in particular Bangladeshis (n=48). Further analysis of the WHSS dataset in the current study intends to focus on South Asian subgroups individually, whereas the original analysis was performed by considering South Asians as a single group. This chapter summarises the results of the updated retrospective analysis of WHSS data by individual South Asian groups (Cappuccio., *et al.*, 1998). A detailed analysis of risk factors in South Asians in WHSS will help in understanding the prevalence of risk factors associated with individual South Asian groups in the UK compared with White Europeans (i.e. since the study was carried out).

The WHSS has a distinct advantage as the study included many ethnic minorities. Secondly, it is a population-based survey whereas selecting a specific sample such as 'working class' may have a high chance of selection bias. As a greater number of minority ethnic groups, particularly Bangladeshis and Caribbeans, are unemployed or in part-time work compared with other groups, they have not been represented appropriately in the past (Cappuccio, *et al.*, 1998). The WHSS sample included both men and women, so gender differences can also be assessed. It is also an important study in terms of the epidemiological perspective of diabetes and hypertension in different ethnic groups, being the first in focussing on the detection, management and control of diabetes and hypertension in ethnic groups. It has an advantage over previous studies which focussed only on diabetes (McKeigue & Marmot, 1988; Simmons, *et al.*, 1991) or only on specific ethnic groups, e.g. only Indians (as mentioned earlier). It was of prime importance as the first survey after the Health of the Nation strategy was launch in England (1992-1997) by the Department of health (DH). It focused on a strategic approach to improve overall population health. One of the key aims was to improve hypertension and diabetes in terms of their detection, management and control (Department of Health, 1992). The WHSS has been published extensively over the years. It contains a wealth of measures, from traditional risk factors (e.g. blood pressure, smoking, lipid and metabolic profile), to novel factors (e.g. vitamins, oral contraceptive pills (OCP) usage, hormone replacement therapy (HRT) and inflammatory markers). A large number of collected risk factors were stored in a database in an anonymised form and are available for further analyses (Cappuccio, *et al*, 1998). Assessment of these risk factors is of importance when developing prevention strategies.

This chapter addresses the following research questions:

- What are the major cardiovascular risk factors in Bangladeshi and other South Asian (i.e. Indian and Pakistani) groups and in White Europeans?
- Are there differences in the patterns of individual CVD risk factors among Bangladeshis and other South Asian groups?

The objective is to:

- Explore CVD risk factors in the Bangladeshi population via a secondary data analysis of WHSS and comparing the risk factors by sub-group of South Asians.

5.2 Methods

5.2.1 Study Population

A total of 1577 men and women, aged 40-59 years, equally distributed in three ethnic groups (White, South Asian and people of African origin) living in Wandsworth, a borough of South London, were screened between 1994 and 1996 for cardiovascular risk factors. Wandsworth had at the time a population of approximately 190,000 with 25% of residents born outside of the U.K.; 12% were of African descent and 6% of Indian or Pakistani origin.

From the former Wandsworth Health Authority, 65 general practices were selected. They ranged from single-handed general practitioners to group practices and fund-holding ones. The distribution of the population across these practices was uneven. For instance, the majority of those originating from the Caribbean lived in the Wandsworth-Clapham-Battersea area and in Streatham; West Africans were mostly concentrated in Balham, Mitcham and Streatham, and South Asian communities lived predominantly in Balham, Tooting, Mitcham, and Wandsworth. Hence, a random sampling method was adopted for each ethnic group to obtain groups of equal size to consider these demographic characteristics (Cappuccio *et al.*, 1998).

After the survey and assessing the suitability and willingness of 65 practices, 9 were selected. From each practice, the list of registered men and women aged 40-59 residing within the study area were obtained. Chinese, Japanese or Vietnamese names were excluded. Patients with cancer, severe disability, severe psychiatric disturbance or pregnant women were also excluded. The study was designed so that there were approximately 250 people in each gender and ethnic group stratum. All names of South Asian and West African origin were selected.

The study was approved by the Local Ethics Committee. Informed consent was obtained from all participants. Participants attended a dedicated screening unit at St. George's Hospital between 08:00 am and 12:00 noon after an overnight fast. Their invitation letters asked them to refrain from smoking and from taking vigorous exercise for at least one hour before the visit and to bring all medications with them for checking (Cappuccio *et al.*, 1 998).

5.2.2 Study Sample for the Current Analysis

Even though South Asians have a high risk of cardiovascular disease compared to White Europeans, there are differences within South Asian groups in terms of cardiovascular mortality and the prevalence of CVD (Gill, *et al.*, 2007). A reason for considering Indian, Pakistani and Bangladeshi separately as ethnic groups is to avoid adverse health consequences resulting from considering these group together as homogenous (Gill, *et al.*, 2007). The dataset for this analysis includes 1028 individuals from WHSS, of whom 523 were White European, 380 Indian, 77 Pakistani and 48 Bangladeshi.

5.2.3 Dataset

This was a secondary analysis of the WHSS dataset based on 65 variables ranging from physical, blood and urine measures. Data were collected by different means such as direct physical measurements and blood and urine samples by standard methods as mentioned in detail elsewhere (Cappuccio., *et al.*,1998), and further details are given in the following section. Totals that do not add up to the total for the whole population were due to missing values. The main emphasis was on comparisons between the three ethnic groups Indian, Pakistani and Bangladeshi versus the White European group, and disaggregation by gender. This is new analysis of the WHSS dataset, which has not been carried out previously.

5.2.4 Variables

Ethnicity was recorded at the time of interview based on the answers to a combination of questions including place and country of birth, language, religion, history of migration and parental country of birth in accordance with the 1991 Census for England (Cappuccio, *et al.*, 1998).

Height was measured to the nearest cm with a ruler attached to the wall in subjects without shoes. Weight was measured to the nearest 0.1kg on an electronic scale (Marsden 770. Marsden Weighing Machine Group Ltd., London, England) with subjects wearing light clothing without shoes. Body mass index (BMI) was calculated as weight in kg divided by the square of the height in meters.

Systolic and diastolic blood pressures were taken three times, two minutes apart, with an automatic ultrasound sphygmomanometer (Arteriosonde Roche) by nurses who had attended training sessions for standardisation of the procedure. It was measured in the left arm with an appropriate cuff size to the arm circumference.

A urine Diastix (BM-Test 8: Boehringer Mannheim, Mannheim, Germany) was used to check for the presence of glycosuria. Fasting venous blood was taken in the seated position without stasis.

An oral glucose tolerance test was carried out in participants not known to be diabetic and without glycosuria (defined as urinary glucose 25.5 mmol/l). This involved drinking 75 g of dextrose monohydrate (Glucose BMS, Bio-Medical Services Ltd., York, England) dissolved in 250 ml of tap water over 5 minutes, with a second venous blood sample taken 2h later (±5 min). Blood samples were processed within 2-3h. Fluoride plasma was used for the determination of glucose by the glucose oxidase method.

Blood for lipids was collected in plain Vacutainer tubes, left to clot, spun at 3000 rpm for 10 min at 4^0C and serum separated and stored at 4^0C until assayed. *High-density lipoprotein (HDL)* cholesterol was separated from the other lipoprotein fractions by precipitation with sodium phosphotungstat and magnesium chloride. Serum insulin concentration was determined by a two-site ELISA using commercially available monoclonal antibodies raised against human insulin (Novo Nordisk A/S. Denmark). *Serum electrolytes* were measured by an ion-selective electrode (Beckman Electrolyte EA2. Brea. California, USA), *creatinine* by the picric acid colorimetric method, *uric acid* by an enzymatic colorimetric method, lipids by automated methods (Cobas Mira. Roche. Milan. Italy), and Vitamin C using plasma prepared from blood drawn into a citrate bottle.

For urinary sodium, potassium, creatinine and calcium a 24h urine sample was collected. Participants were instructed in detail about the method of collection. Time and volume of collections were immediately recorded. Aliquots were taken and stored at -20 ^{o}C until assayed.

A detailed questionnaire on lifestyle and demographics was administered. It included *demographics* (place of birth, language, religion. history of migration, parental place of birth, socio-economic status, family and personal medical history and drug therapy), *smoking status* (non-smoker, ex-smoker, current smoker), *alcohol consumption* (beer, wine and spirits, whether they drank during weekdays or at weekends), and *leisure time physical activity (LTPA)*. Physical activity was calculated against the level that the WHO recommend for physical activity in adults: at least 150 minutes of moderate-intensity physical activity throughout the week or at least 75 minutes of vigorous-intensity physical activity throughout the week (WHO, 2018). Leisure time physical activity (LTPA) was assessed by the Liverpool questionnaire after modification. LTPA was assessed for a recall period of l4 days preceding the interview by one interviewer using a fixed protocol. Subjects were shown lists of leisure activities and reported which of these (and any others not shown) they had performed during the past 14 days and on how many occasions. All reported activities were noted on similar lists by the interviewer. The duration of activity was noted according to a predefined classification of intensity (Cappuccio, *et al.*, 1998).

5.2.5 Analysis

SPSS 24 software was used for the data analysis. Descriptive statistics were used to explore demographic and socioeconomic characteristics. To determine the associations between categorical variables, Chi-squared tests of independence were performed. Differences between White European and South Asian groups for continuous variables were assessed using general linear models by gender. The mean and standard deviation, percentages and 95% CI were calculated for each ethnic group for corresponding continuous variables. A pairwise comparison was performed to find differences among or within groups. Proportions were calculated, and chi-squared tests used to compare each ethnic minority group with the White European group. Since the groups differed in their age distribution, all analyses were performed after age adjustment.

5.3 Results

5.3.1 Demographics of the ethnic groups

A total sample size of 1028 individuals were selected, of which 523 were White European (50.9%), 380 Indian (37.0%), 77 Pakistani (7.5%) and 48 Bangladeshi (4.7%) (Table 5.1). Among the ethnic minority groups, the Bangladeshi group (mean age 47.8 years) were younger than the White Europeans (mean age 49.8 years) (Table 5.1). All ethnic minority groups had a significantly lower proportion of females except the Bangladeshi group (62.5% female) (Table 5.2).

Among White Europeans, 89.5% of participants had English as their first language and 10.5% had 'other' as their first language. Among South Asians, 12.6% of Indian participants had English as their first language which was the highest among all South Asians. After English, Gujarati was the most common language (19.2%) followed by Urdu (6.3%) and Bengali (5%). Among South Asians, the Indians were the only group who can speak more than two languages apart from English (Table 5.2). Among South Asians, 53.3% of Indians were born in India and 36.7% were born in East Africa. 96.1% of those of Pakistani origin were born in Pakistan and 3.9% born in East Africa. All participants of Bangladeshi origin were born in Bangladesh (Table 5.2). The median length of stay in the UK was 25 years for Pakistanis, 23 years for Bangladeshis and 22 years for Indians, showing a similar pattern of migration to the UK. Among South Asians the majority were Hindus (49.7%) followed by Muslims (38.4%). Among South Asians, most Indians were Hindu (66%). Most Bangladeshis (98.0%) and Pakistanis (94.8%) were Muslims (Table 5.2).

Table 5.1: Characteristics of Ethnic groups aged 40-59 years in the Wandsworth Heart & Stroke Study, 1994-1996*

		White European (n=523)		Indian (n=380)		Pakistani (n=77)		Bangladeshi (n=48)	
		N	%	N	%	n	%	N	%
Mean age (SD)		49.8 (5.6)		49.5 (5.9)		49.2 (5.2)		47.8 (5.1)	
Age	<45	142	27.2	116	30.5	23	29.9	20	41.7
	45-49	113	21.6	84	22.1	22	28.6	11	22.9
	50-54	134	25.6	85	22.4	13	16.9	11	22.9
	>55	134	25.6	95	25.0	19	24.7	6	12.5
Sex	Female	290	55.4	185	48.7	37	48.1	30	62.5
	Male	233	44.6	195	51.3	40	51.9	18	37.5
Language	English	468	89.5	48	12.6	1	1.3	1	2.1
Level of Education	more than 19	105	20.1	175	46.1	38	49.4	28	58.3
	16-19	216	41.3	145	38.2	27	35.1	8	16.7

	15 or less	193	36.9	53	13.9	9	11.7	10	20.8
Social Class	IV+V	79	15.1	51	13.4	8	10.4	1	2.0
	IIINM+M	241	46.1	149	39.2	33	42.9	20	41.6
	I+II	187	35.8	160	42.1	29	37.7	23	48.1
	Total	507	96.9	360	94.7	70	90.9	44	91.7
Vegetarianism	Yes	21	4.0	136	35.8	1	1.3	1	2.1
	No	501	95.8	243	63.9	76	98.7	47	97.9
Smoking	Current	185	35.4	51	13.4	13	16.9	5	10.4
	Ex	171	32.7	44	11.6	5	6.5	6	12.5
	'Never'	166	31.7	285	75.0	59	76.6	37	77.1

Results are frequencies (n) and percentages (%)

*Analysis by individual South Asian group, in primary study analysis was done by combining South Asians as single group.

Table 5.2: Characteristics of Ethnic groups aged 40-59 years in the Wandsworth Heart & Stroke Study, 1994-1996

		White European (n=523)		Indian (n=380)		Pakistani (n=77)		Bangladeshi (n=48)		P value
		N	%	n	%	n	%	n	%	
Length of Stay in UK Median (SD)		30	(10.5)	22	(7.0))	25	(9.2)	23	(7.4)	
Language	English	468	(89.5)	48	(12.6)	1	(1.3)	1	(2.1)	
	Gujarati	0		195	(51.6)	1	(1.3)	0		
	Urdu	0		14	(3.7)	50	(65.8)	0		
	Bengali	0		4	(1.1)	0		47	(98)	
	Punjabi	0		11	(2.9)	20	(26.3)	0		
	Hindi	0								
Religion	C of E	239	(45.7)	3	(0.8)	0	0	0	0	
	Catholic	124	(25.6)	21	(5.5)	3	(3.9)	0	0	
	Orthodox	12	(2.3)	0		0	0	0	0	<0.05
	Baptist	4	(0.8)	1	(0.3)	1	(1.3)	0	0	
	Presbyter	5	(1.0)	1	(0.3)	0	0	0	0	
	Muslim	6	(1.1)	68	(17.9)	73	(94.8)	47	(98)	
	Hindu	0	0	250	(66.0)	0	0	1	(2.1)	
	Sikh	0	0	7	(1.8)	0	0	0	0	
Pl	UK & Ireland	440	(84.5)	0		0		0		<0.05

Europe	48	(9.2)	1	(0.3)	0		0	
North America	7	(1.3)	0		0		0	
South Asia	7	(1.3)	202	(53.3)	74	(96.1)	48	(100)
East Africa	3	(0.6)	139	(36.7)	3	(3.9)	0	
West & south Africa	6	(1.2)	6	(1.6)	0		0	
Far East	1	(0.2)	6	(1.6)	0		0	
West indies	4		15		0		0	
Central & South America	5	(1,0)	10	(2.6)	0		0	

*Analysis by individual South Asian group, in primary study analysis was done by combining South Asians as singe group.

5.3.2 Socioeconomic characteristics

Marital status reflects the socio-cultural and religious differences among and within the ethnic groups. The highest proportion of married participants was among the Pakistanis (87.0%), followed by Bangladeshis (85.4%) and Indians (84.7%), whereas there were significantly fewer married participants among White Europeans (53.2%). Correspondingly, White Europeans had the highest proportion of divorced (15.3%) participants, in comparison to Indians (4.2%), Pakistanis (2.6%) and Bangladeshis, none of whom were divorced (0%). On the other hand, Bangladeshis had the highest proportion of widowed participants (10.4%), compared to Indians (6.1%), Pakistanis (5.2%) and White Europeans (5.4%). (Table 5.3)

The Standard Occupational Classification system uses the occupation of the household head to classify participant's social class (Office of Population Censuses and Surveys, 1990). Social class I and II represent professional and managerial levels, respectively. Bangladeshis constituted the highest proportion (52.3%) in class I and II, followed by Indians (44.4%), and White Europeans were the lowest (36.9%)t. The proportion of unskilled manual workers were similar among all groups with the highest proportion in White Europeans (15.1%) followed by Indians (13.4%), Pakistanis (11.4%), and Bangladeshis (2.3%). (Table 5.3). In contrast of traditional findings, the Bangladeshi group had a higher proportion at professional and managerial level, but this was congruent with this group also having the highest proportion of those with a higher level of education (19 and above) in this study.

Examining the relationship between socio-economic status and ethnicity is as complex as ethnicity and health. There could be various reasons for this complexity. One could be that the definition is a valid proxy measure of socio-economic status in White Europeans, but it has not been appropriately validated among ethnic minority groups (Cappuccio, *et al.*, 1998).

The methods used in White European populations may not be able to adequately reflect socioeconomic disadvantage among ethnic minority groups, such as housing. For instance, South Asians were reported to own their house, either directly or through a mortgage, more often than White European (82% vs 67%). Along with occupation, other measures such as the level of education or income need to be considered to represent more complex socio-economic characteristic of the ethnic group (Cappuccio, *et al.*, 1998).

Level of education. There were significant ethnic differences in educational achievement, with ethnic minority groups (69.7%) having achieved higher educational levels then White Europeans (30.3%). There was a higher proportion of Bangladeshis in education after 19 years (58.3%) compared to White Europeans (20.1%). A significantly greater proportion (36.9%) of White Europeans had 15 or fewer years of education. (Table 5.3).

Table 5.3: Socioeconomic characteristics of Ethnic groups aged 40-59 years in the Wandsworth Heart & Stroke Study, 1994-1996

		White European (n=523)		Indian (n=380)		Pakistani (n=77)		Bangladeshi (n=48)		P value
		N	**%**	**n**	**%**	**N**	**%**	**N**	**%**	
Level of Education	More than 19	105	(20.1)	175	(46.1)	38	(49.4)	28	(58.3)	<0.05
	16-19	216	(41.3)	145	(38.2)	27	(35.1)	8	(16.7)	
	15 or les	193	(36.9)	53	(13.9)	9	(11.7)	10	(20.8)	
Social Class	IV+V	79	(15.1)	51	(13.4)	8	(11.4)	1	(2.3)	.066
	IIIM+NM	241	(46.1)	149	(44.4)	33	(47.1)	20	(45.5)	
	I +II	187	(36.9)	160	(44.4)	29	(41.4)	23	(52.3)	
Marital Status	Single	95	(18.2)	9	(2.4)	1	(1.3)	2	(4.2)	<0.05
	Married	278	(53.2)	322	(84.7)	67	(87.0)	41	(85.4)	
	Common Law	21	(4.0)	4	(1.1)	2	(2.6)	0	0	
	Separated	21	(4.0)	6	(1.6)	1	(1.3)	0	0	
	Divorced	80	(15.3)	16	(4.2)	2	(2.6)	0	0	
	Widowed	28	(5.4)	23	(6.1)	4	(5.2)	5	(10.4)	

5.3.3 Lifestyle factors characteristics

Lifestyle factors play an important role in determining cardiovascular risk, especially when they are subject to changes following migration. The common lifestyle factors associated with cardiovascular outcomes measured in this analysis are smoking, exercise and diet. Smoking is one of the key risk factors associated with CVD. Ethnic minority groups in this study had fewer current smokers than White European (13.7% v 35.4%) (Table 5.1). South Asians had the highest proportion of never smokers (75.4%) compared to White Europeans (31.7%) (Table 5.1). Among South Asians, Indians had the highest prevalence of people who never smoked (52.1%). When the variable 'smoking' was analysed by gender, it was found that White European women had a higher proportion (32.4%) of current smokers compared to South Asian women (2.7.%). Within South Asian groups, Indian women had a higher prevalence of current smoker status (5.0%), followed by Bangladeshi women (2.0%) and none from the Pakistani group (Appendix Table 5.1).

Di*et al*so plays an important role in defining the risk of CVD (Cappuccio, *et al.*, 1998). In this analysis, Indians had the highest proportion of vegetarians compared to all other groups (35.8%). The mean plasma vitamin C levels were calculated after adjustment for age in this analysis. The levels were highest in White Europeans at 45.8µmol/l compared with South Asians (Indian 37.4 µmol/ l, Pakistanis 36.4 µmol/l, Bangladeshis 26.4 µmol/l) (Appendix Table 5.2). Bangladeshis had significantly lower levels of Vitamin C compared with Indian, Pakistani and White European groups (Appendix Table 5.2).

Irrespective of the fact that Indians had a higher proportion of vegetarians (Table 5.1) there was not much difference between plasma Vitamin C levels between Indians and Pakistanis, whereas Bangladeshis had the lowest levels. Vitamin C is an important dietary antioxidant and also a biomarker for fruit and vegetable intake (Carter, *et al.*, 2013). It helps in protecting LDL from oxidation by free radicals that enhance their atherogenic potential resulting in protection against CVD (Gale, *et al.*, 1995). The findings of this analysis are consistent with previous studies, where consistently lower levels of vitamin C have been reported among South Asian adults in the UK (Ness, *et al.*, 1999, Harding, *et al.*, 2008; Carter, *et al.*, 2013). A nutritional study by Donin, *et al.*, (2010) describes similar findings in children, where lower vitamin C intake was reported among South Asians, particularly marked in Bangladeshi children. The lower level of vitamin C may be due, in part, to a lower consumption of fresh fruits and vegetables and also to differences in cooking habits amongst the Bangladeshi community, with overcooking of vegetables. Another study by Donin *et al.*, (2016) reported that lower levels of plasma vitamin C among South Asians could be partly explained by their high insulin resistance. However, the study showed that dietary fruit, vegetables and vitamin C intake were not associated with CVD risk markers (Donin, *et al.*, 2016). Other factors such as smoking, high BMI and a low socioeconomic status have been associated with low levels of vitamin C (Anitra, *et al*, 2018). It is evident now that there is an inverse association between level of vitamin C and chronic diseases such as stroke and diabetes (Anitra, *et al*, 2018). However, there is a lack of studies focussing on the association between stroke and level of vitamin C among South Asians, including Bangladeshis.

White European women had a significantly higher use of hormone replacement therapy (HRT) (25.7%) compared with women from ethnic minority groups. Pakistani women had the highest proportion of the ethnic minority groups (15.4%), followed by Indians (9.4%) and Bangladeshis (3.2%) (Appendix Table 5.3). This marked difference needs to be explored as long-term use of HRT may benefit South Asian women in terms of its protective effect on the heart and bones, while oral contraceptive pill use increases the risk of stroke (Henderson and Lobo, 2012). Usage of oral contraceptive pills (OCP) was higher among South Asians (7.0%) compared to White European (2.8%). Among South Asians, Bangladeshis had a higher (6.5%) usage of oral contraceptives compared to Indians (0.5%). Among Pakistanis there was no evidence of OCP use in this study.

Levels of moderate (>150min/wk) and hard physical activity (>75min/wk) were calculated according to WHO criteria (Appendix 5.5). White Europeans had a higher proportion of moderate (27.3%) and heavy exercise (13.8%) minutes per week. Among South Asians, Indians and Pakistanis had higher proportions undertaking moderate exercise (16.3% and 16.8%) compared to Bangladeshis (6.2%). Indians had the highest proportion undertaking heavy exercise (4.7%) followed by Bangladeshis (4.2%) and Pakistanis (3.9%). Lack of physical activity is a well-documented risk factor for many non-communicable diseases including CVDs. Lack of physical activity, especially among ethnic minority groups, is of great concern particularly among Bangladeshid.

5.3.4 Anthropometric characteristics

There were significant differences in anthropometry by ethnic group. Among men, South Asians were lighter and shorter with a lower BMI. Within South Asians, Bangladeshis had a significantly lower mean weight (65.9 Kg) and BMI (23.8) compared to Indians (71.9 Kg, BMI 24.7) and Pakistanis (74 Kg, BMI 25.2) (Appendix Table 5.4). To understand these subgroup differences a multiple comparison test was performed (LSD test). This test helps to provide pairwise comparison of subgroups (Appendix Table 5.4). South Asians had greater waist-to-hip ratio compared to White Europeans. Pakistanis had greater waist-to-hip ratio than Bangladeshis and Indians (Table 5.4).

Table 5.4: Age adjusted anthropometry, blood pressure and heart rate in men aged 40-59 years in the Wandsworth Heart & Stroke Study 1994-96

	White European (n=230)		Indian (n=190)		Pakistani (n=38)		Bangladeshi (n=17)		P value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Height	174.7	6.7	170.3	6.5	171.2	6.1	166.2	6.2	<0.001
Weight	78.7	13.7	71.9	11.8	74.0	13.0	65.9	8.7	<0.001
Waist circumference	92.2	11.1	90.4	9.7	93.1	11.2	87.4	6.5	0.001
Hip circumference	99.9	7.2	96.3	6.9	97.8	6.5	92.2	4.6	<0.001
Waist-to-Hip Ratio	0.92	0.06	0.94	0.06	0.95	0.07	0.95	0.04	<0.001
Body Mass Index	25.8	4.2	24.7	3.5	25.2	4.1	23.8	2.2	0.17
Heart rate	64.0	10.6	66.1	10.1	70.3	10.6	65.7	11.0	<0.001
Systolic BP	127.8	18.5	130.9	19.3	128.0	16.4	129.5	17.9	<0.001
Diastolic BP	82.1	10.4	85.9	10.7	84.6	10.3	84.0	9.0	<0.05

Despite a smaller mean hip circumference, Bangladeshi men had a comparable mean waist circumference to the other South Asian groups. All South Asian groups had a significantly higher mean systolic and diastolic blood pressure than White Europeans. (Table: 5.4 and Appendix Table 5.4). Among South Asians, Indians had the highest systolic and diastolic blood pressure compared to Bangladeshis and Pakistanis. Heart rate was found to be significantly faster in both men and women of South Asian groups compared to White Europeans (Table 5.4, 5.5). Among South Asian men, Pakistanis hade higher heart rates than both Indians and Bangladeshis.

In women, South Asians were shorter in height than White Europeans (Table 5.5). The mean weight and BMI in Pakistani women were significantly higher than in White Europeans. Bangladeshi women were shorter and lighter than all other groups. Waist-to-hip ratio was highest among South Asians. Among South Asians, Pakistanis and Bangladeshis had higher waist-to-hip ratios than Indians.

Table 5.5: Age adjusted anthropometry, blood pressure and heart rate in women aged 40-59 years in the Wandsworth Heart & Stroke Study 1994-96

	White European (n=285)		Indian (n=177)		Pakistani (n=36)		Bangladeshi (n=30)		**P value**
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Height	161.4	6.9	155.2	5.5	156.4	5.19	153.4	5.4	<0.001
Weight	67.7	13.2	64.1	11.4	72.5	11.3	61.6	13.0	<0.001
Waist circumference	81.7	11.6	84.7	11.6	93.1	11.0	85.4	12.4	<0.001
Hip circumference	102.5	9.7	101.5	8.8	105.8	8.7	97.5	8.7	0.005
Waist-to-Hip Ratio	0.8	0.7	0.8	0.1	0.9	0.1	0.9	0.1	<0.001
Body Mass Index	26.0	5.1	26.6	4.7	29.7	4.7	26.1	4.9	<0.001
Heart rate	64.9	9.9	68.3	11.0	73.3	9.9	70.7	10.5	<0.001
Systolic BP	123.0	18.6	127.7	17.9	127.0	22.1	125.8	20.8	<0.001
Diastolic BP	77.1	9.2	79.8	9.5	79.4	10.3	80.5	12.4	<0.001

5.3.5 Traditional risk factors: Hypertension, diabetes, Dyslipidaemia, Obesity

According to ISH/WHO criteria, hypertension is defined based on systolic blood pressure (Grade I: 140-159, Grade II 160-179, Grade III ≥ 180mmHg) and /or diastolic pressure (Grade I: 90-99, Grade II 100-109, Grade III ≥ 110mmHg). The proportion of grade I SBP and DBP was higher among South Asians (19.2% and 17.2%) than White European (14.9% and 9.6%). While the proportions of grade II hypertension were similar in White Europeans and South Asians, grade III proportiond were higher among South Asians (1.38%) than White Europeans (0.8%). Within the South Asian subgroups there were similar proportions of grade I and III systolic blood pressure (Table: 5.6). The proportion of grade II SBP was higher among Indians (4.7%) compared to Pakistani (2.5%) and Bangladeshi (2.7%). Diastolic blood pressure in the Bangladeshi group had a significantly higher proportion of grade I hypertension (25%) than the Indian (17.2%) and Pakistani (13%) group.

Table 5.7 presents the major CVD risk factors by South Asian ubgroup. The proportion of hypertension was higher among South Asians (26.3%) compared to White Europeans (15.1%). Within the South Asian group, Indians (27.1%) and Bangladeshis (27.1%) had higher proportion of hypertension than Pakistanis (22.1%).

Table 5.6: Ethnic group (WHO Blood pressure classification) Wandsworth Heart and Stroke Study 1994-96

	European White (n=523)		Indian (n=380)		Pakistani (n=77)		Bangladeshi (n=48)	
	SBP	**DBP**	**SBP**	**DBP**	**SBP**	**DBP**	**SBP**	**DBP**
Normotensive	416 (79.5)	456 (87.2)	278 (73.2)	291 (76.6)	59 (76.6)	61 (79.2)	37 (77.1)	33 (68.8)
Grade I	78 (14.9)	50 (9.7)	74 (19.5)	65 (17.2)	14 (18.1)	10 (13.0)	9 (18.75)	12 (25.0)
Grade II	22 (4.2)	15 (2.9)	18 (4.7)	18 (4.7)	2 (2.5)	5 (6.5)	1 (2.3)	3 (6.25)
Grade III	4 (0.8)	1 (0.2)	5 (1.3)	3 (0.8)	1 (1.2)	(0.0)	1 (2.0)	0 (0.0)

Results are (n) and percentages (SBP; Systolic blood pressure, DBP: diastolic blood pressure)

Diabetes was defined using WHO criteria (World Health Organisation, 1985); that is, a fasting glucose ≥ 7.8 mmol/l or glucose 2h after oral loading ≥ 11.1 mmol/l or both. There was another category added for subjects who at the time of the study had already been diagnosed with diabetes (known diabetic) and those with Diastix glycosuria at the time of screening were assumed to be diabetic. It has been found that White European had a significantly lower prevalence of known diabetes compared to South Asians. Within South Asians, the Bangladeshi group had the highest prevalence of known diabetes followed by Pakistanis and Indians (Table 5.7).

Table 5.7: Prevalence rates of major risk factors for cardiovascular disease among ethnic subgroups-Wandsworth Heart and Stroke Study 1994-96

Risk Factors	White European (n=523)		Indian (n=380)		Pakistani (n-77)		Bangladeshi (n=48)		Total		P Values
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	
Hypertension	79	(15.1)	103	(27.1)	17	(22.1)	13	(27.1)	212	(20.6)	<0.001
Diabetes	11	(2.1)	42	(11.1)	10	(13.7)	10	(20.8)	73	(7.1)	<0.001
Hypercholesterolaemia	391	(74.7)	244	(64.2)	45	(58.4)	24	(50.0)	24	(72.7)	<0.159
Current Smoker	185	(35.4)	51	(13.4)	13	(16.9)	5	(10. 4)	25	(24.7)	<0.001

Results are frequencies and (%)

If using WHO's criteria for the general population - overweight (BMI 25-29.9/kg/m^2) and obesity (BMI ≥30/kg/m^2) - there were no significant differences in the prevalence of overweight among White Europeans and South Asians. Pakistanis had a higher proportion of overweight (35.2%) and obesity (23.9%) than Bangladeshis (overweight (27.7%) and obesity (10.6%)). However, if using WHO criteria for South Asians, Bangladeshis had a higher percentage (47.9%) of overweight (BMI 23.5-27.5) followed by Indians (38.4%) and Pakistanis (29.8%). In the high-risk category (BMI >27.5), Pakistanis had the highest proportion (49.3%) of obesity followed by Indians (28.6%) and Bangladeshis (22.9%) (Table 5.8).

Table 5.8: WHO criteria for BMI Cut-offs for Obesity for general population and among South Asian subgroups-Wandsworth Heart and Stroke Study 1994-96

WHO criteria for General Population					
	White Europeans (n=523)	**Indian (n=380)**	**Pakistani (n=77)**	**Bangladeshi (n=48)**	**Total**
	n (%)	n (%)	n (%)	n (%)	n (%)
BMI<25	252 (49.7)	189 (52.2)	29 (40.8)	29 (61.7)	499 (50.6)
Overweight (BMI>25-29)	167 (32.9)	121 (33.4)	25 (35.2)	13 (27.7)	326 (33.3)
Obesity (BMI>30)	88 (17.4)	52 (14.4)	17 (23.9)	5 (10.6)	162 (16.4)
WHO criteria for South Asians					
BMI<23.5	Xxx	125 (32.8)	16 (20.7)	14 (29.2)	156 (31.2)
Overweight (BMI 23.5-27.5)	Xxx	146 (38.4)	23 (29.8)	23 (47.9)	192 (38.0)
Obesity (BMI>27.5)	Xxx	109 (28.6)	38 (49.3)	11 (22.9)	158 (31.2)

Hypercholesterolaemia was defined as a total cholesterol above 5.2mmol/l. More than 50% of entire sample had hypercholesterolaemia. The White European population had the highest prevalence, followed by Indians, Pakistanis and Bangladeshis (Appendix Table 5.6). Significant differences in lipid profile were observed among South Asians and White Europeans. Specifically, among South Asians, Bangladeshis had higher triglyceride levels (2.0) compared to White Europeans (1.4), with the lowest HDL cholesterol (0.89) among all ethnic groups (Appendix Table 5.7). This marked difference can help to understand the role of atherogenic profiles in Bangladeshis and premature stroke mortality. Also, it demonstrates that there is a heterogeneity within the broad South Asian group.

5.3.6 Biochemical and Metabolic characteristics

Serum creatinine was significantly higher in Bangladeshi people compared to other ethnic groups (Appendix Table 5.7).

Metabolic profiles of lipids, glucose and insulin is reported in the appendix (Appendix Table 5.7). There were significant differences between South Asians and White Europeans in WHSS, and in this analysis serum glucose was higher in South Asians compared to White Europeans. Indians, among South Asians, had the highest levels.

Homocysteine levels were found to be highest (13.5µM) among Indians and lowest among Bangladeshis (9.2µM). High levels among Indians may be due to their vegetarianism. (Appendix Table 5.7).

A past medical history of angina was more common among White Europeans and Indians and significantly less common in Pakistanis and Bangladeshis. A past medical history of heart attack was high among Indians (50%) and White Europeans (40%), compared with Bangladeshis (5%) and Pakistanis (5%). The Bangladeshi and Pakistani groups had no cases with a history of coronary thrombosis whereas Indians and White Europeans had high numbers. Bangladeshis had a higher proportion of a history of ischemic heart disease (6.3%) compared to all other ethnic groups. A past medical history of stroke was significantly more common among Bangladeshis and Indians compared to White Europeans (Appendix Table 5.8).

5.4 Discussion

5.4.1 Summary

The results of the present analysis suggest that risk of cardiovascular disease is not uniform among South Asians. The present analysis helped in identifying important differences between White Europeans and South Asians. The analysis further helped to identify differences within the South Asian group (Indians, Pakistanis, and Bangladeshis) for many cardiovascular and lifestyle risk factors (see Table 5.7 for a summary).

The results also refute the belief that South Asians have similar cardiovascular risk factors. The belief may have arisen from combining ethnic subgroups and examining a narrow range of factors. Differences in the cardiovascular risk factors among South Asians and White European populations are evident (Cappuccio, *et al.*, 1998). The findings of this secondary analysis support the previous assertions which establish significant variations in the cardiovascular risk factors among South Asians living in England and Wales (Cappuccio, *et al.*, 1998).

The majority of South Asian participants living in Wandsworth were born in the Indian subcontinent, and yet there were detectable differences in physical, social, cultural and lifestyle factors between the subgroups. Among physical measures it was found that Bangladeshi women had the lowest height and weight compared to Indians, Pakistanis and White Europeans. Although Bangladeshi women had the lowest average body weight and height, they are more prone to cerebrovascular diseases.

Considering the differences in percentage of body fat of Europeans (9.1%) and Asian Indians (21.2%) with identical BMI (22.3kg/ m^2), a WHO expert committee recommended the cut-off points for BMI of >23.5kg/m^2 among South Asians for overweight and 27.5kg/m^2 for obesity (Shaikh, 2019). This suggests that the percent of body fat and BMI need to be considered carefully among South Asians when measuring obesity. In this analysis, considering the WHO BMI cut off points for South Asians, Bangladeshis had a higher percentage of overweight, while Pakistanis had a higher percentage of obesity. Pakistanis demonstrated consistency in the general BMI cut-off categories as well, with a higher prevalence of overweight (25-29.9 kg/m^2) and obesity (>30 kg/m^2) compared to all other ethnic groups. These findings are consistent with previous studies conducted in South Asians (Wang, *et al.*, 1994; Dudeja., *et al.*, 2001; Shaikh, *et al.*, 2016). Obesity has also been reported by other researchers as a common risk factor among British Bangladeshis and Pakistani groups (Sengupta, *et al.*, 2013).

The Foresight report by the UK government reported an increasing trend in obesity among ethnic minority groups (McPherson, *et al.*, 2007). Among South Asians, Pakistani men and women, along with Black Africans, are projected to have a significant increase (50%) in obesity along with the White population (57%) by 2050 (McPherson, *et al.*, 2007). A more recent study by Garcia, *et al.* (2017) reported that 24.3% of British Bangladeshis living in the United Kingdom are obese with a cohort mean of 25.81 kg/m^2 based on South Asian BMI cut-offs.

This study has shown a high prevalence of major risk factors among South Asian subgroups compared to the White Europeans. Hypertension and diabetes are the two most important risk factors identified and their prevalence was high among South Asians compared to White Europeans. Within South Asian subgroups there were marked differences. Hypertension was more common among Indians and Bangladeshis. The latter group, along with a higher percentage of overweight, had the highest prevalence of diabetes. In contrast, hypercholesterolaemia and smoking were more prevalent in White Europeans compared to South Asians.

This study showed a unique lipid profile among South Asians, particularly Bangladeshis (Appendix Table 5.7). Bangladeshis had higher levels of triglycerides and lower levels of HDL compared to Indians and Pakistanis, with the latter two groups having similar mean triglyceride and HDL levels. In a previous study, Bangladeshis in the UK showed a unique lipid profile when considered as an individual group (Bhopal, et al., 1999). The findings of the current study support the large body of evidence suggesting that high levels of triglycerides are a risk factor for CVD. However, the results should be interpreted with caution as the sample size was relatively small for Bangladeshis (n=48).

Studies from Bangladesh have shown higher levels of triglycerides (2.02 mmol/L) (Das, *et al.*, 2012), along with higher levels of total cholesterol (4.84 mmol/L; 4.53 mmol/L), among urban populations compared with rural populations (Das, *et al.*, 2012; Akanda, *et al.*, 2016). However, Akanda, *et al.*, (2016) have reported higher levels (1.74mmol/L) of triglycerides among rural populations compared to those living in urban (1.49mmol/L) locations and similar levels of HDL among both groups (Akanda, *et al.*, 2016). The latest relevant study from Bangladesh also supports the findings by reporting significantly higher levels of triglycerides (1.11mmol/L) and total cholesterol (4.47mmol/L), and lower levels of HDL, in urban populations compared to the WHO recommended lipid range (Akter, *et al.*, 2020).

The important factors associated with differences in lipid profiles between rural and urban populations in these studies are explained by dietary habits, physical inactivity and socioeconomic status (Das, *et al.*, 2012; Akanda, *et al.*, 2016; Akter, *et al.*, 2020). The rural population in Bangladesh consumes plant protein more often than animal protein due to easy access to fresh and low-cost vegetables. Conversely, the urban population consumes more animal protein, due to higher income. A diet of predominantly vegetables contains less saturated fat and cholesterol, and a greater amount of dietary fibre, which is helpful in lowering serum cholesterol (Akanda, *et al.*, 2016). Das, *et al.*, (2012) found a strong association between physical inactivity and lipid profile in urban and rural populations. The differences between rural and urban populations' lipid profiles may be associated with different levels of physical activity. The rural population, due to agricultural work, tend to be more active than urban population, who may have sedentary lifestyles (Das, *et al.*, 2016; Akanda, *et al.*, 2016).

Migration is associated with changes in lifestyle, culture and dietary habits which may influence CVD risk profile (Hussain, *et al.*, 2013). The first-generation Bangladeshi migrants in the UK are mainly from rural parts of Bangladesh, consuming higher levels of meat, processed food and lower levels of traditional vegetables in the UK. These unhealthy food habits could be due to an unavailability and high cost of traditional foods (fruits and vegetables) during the earlier days of migration. This scenario has changed: traditional ingredients are more easily accessible throughout supermarkets and there are also specific shops selling Bangladeshi foodstuffs, although some of the items are still expensive (Jennings, *et al.*, 2014).

There are indications that diets were diverse among all groups in the current study. The nutritional composition of diet plays an important role in CVD and CHD aetiology. The ethnic differences among South Asians in social and cultural factors are associated with differences in the nutritional composition of diet as well (Higgins and Dale. 2010). There are studies conducted among South Asians focusing on diet composition and its association with disease risk, such as with diabetes, CVD and CHD (Donin, 2015; Khunti, 2017). The most commonly reported dietary factors associated with poor health outcomes among South Asians are excessive consumption of energy-dense foods, high salt and sugar intake and high fat intake (Emadian, *et al.*, 2017). Also, a low intake of micronutrients has been reported among South Asians, specifically Bangladeshis, such as vitamin C and vitamin D, which have been associated with an increased risk of CVD and diabetes (Donin, *et al.*, 2016). The evidence is supported by a recent study where Bangladeshis were reported to have a lack of fibre and antioxidants, and lower levels of vitamin D, which makes this population more prone to CVD and diabetes at an earlier age in comparison to other ethnicities (Sawda, 2020). However, there is a lack of studies in the subgroup of South Asians focussing on specific components of diet which are beneficial or harmful in terms of risk of stroke.

In the current study, Indians had the highest proportion of vegetarians compared to all other groups. Levels of homocysteine (Hcy) were higher among South Asians than White Europeans. Homocysteine levels were significantly higher among Indians thana Pakistanis and Bangladeshis. High levels of homocysteine in the blood (>15µmol/l plasma tHcy) are positively associated with the risk of stroke, CHD and vascular diseases (Cappuccio, *et al.*, 2002). The high levels could be due to genetic variations in metabolism and non-genetic causes such as a shortage of vitamin B12 or folic acid. Low vitamin B12 and high homocysteine concentrations have been shown to increase risk of CVD due to an increased thrombotic tendency (Obesrsby, *et al.*, 2013). B12 deficiency is common among vegetarians, which can raise homocysteine levels (Bhopal, 2019). However, the evidence base is slim; it needs population-based studies among South Asians in the UK to explore the association between excess level of homocysteine and susceptibility to CVD.

Along with lipids, low levels of exercise were identified among the Bangladeshi population compared to White European, Indian and Pakistani populations. The result is supported by previous studies (Hayes, *et al.*, 2002; Fischbacher, *et al.*, 2004) and consistent in the most recent study by Sawda (2020), which showed markedly lower levels of physical activity in Bangladeshi men and women. With regard to low levels of physical activity among Bangladeshis, there are several factors associated specifically with them. Bangladeshis are predominantly Muslim, and Muslim females, due to their religious beliefs and other cultural factors, may have barriers to access physical activity opportunities (Jepson, *et al.*, 2012). Such factors include dress code, modesty, lack of single-sex facilities and disease perceptions (Higgins and Dale, 2010). Though it is evident that cultural and religious factors are an important barrier to physical activity among Bangladeshi and Pakistani women, Bangladeshi and Pakistani men also have reported lower levels of physical activity (Higgins and Dale, 2010). Hence religious and cultural factors may only be partially attributable to low physical activity among these groups. Unemployment is another important factor associated with low level or insufficient physical activity among Bangladeshis, reported not only in the UK (Higgins and Dale, 2010) but also in Bangladesh (Hanif, *et al.*, 2021). The high level of unemployment followed by higher rates of poverty among Bangladeshis could be an important risk factor associated with a low level of exercise and overweight. It is evident that among ethnic minority groups, higher rates of poverty are consistently reported among Bangladeshis and Pakistanis in the UK (Office for National Statistics, 2020). Another interesting fact is that there is no word for ‘physical activity’ in the Sylheti dialect of Bangladeshi language (Sylheti dialect, commonly use Bangali language in the UK), (Leung and Stanner, 2011) and this could have an impact on communicating physical activity awareness in the Bangladeshi population (Sawda, 2020). However, there is also a lack of culturally acceptable guidelines for physical activity for the Bangladeshi community in the UK. There is a need for further studies examining perception and behaviours of the Bangladeshi community towards physical activity.

Apart from traditional risk factors, usage of oral contraceptive pills (OCP) was high among Bangladeshi women compared to White Europeans. Use of OCP increases the risk of cerebral infarction by nine times (Hossain, *et al.*, 2009). Usage of OCP could also increase the risk of stroke in women with hypertension and migraine (Hossain, *et al.*, 2009). It has been reported as an important stroke risk factor among women in Bangladesh as well (Islam, *et al.*, 2013). Despite high OCP usage in Bangladeshis, they have the youngest generation compared to Indians and Pakistanis in the UK (Ghaill and Haywood, 2005).

Use of hormone replacement therapy (HRT) among South Asian women was low compared to White Europeans. For the last sixty years, hormone replacement therapy has been used among postmenopausal women to treat oestrogen deficiency (Gerval and Stevenson, 2017). There is substantial evidence from various large-scale studies which shows that the use of HRT among postmenopausal women can prevent CHD and CVD (Gerval and Stevenson, 2017). Hormone replacement therapy assessment among South Asian women may be less common compared to White Europeans. HRT assessment provides an opportunity for health promotion, assessing cardiovascular risk factors and discussing screening (Harris, *et al.*, 1999). There is a need to explore the differences in uptake of HRT among South Asians and White Europeans in the UK.

Along with factors such as physical activity, social deprivation and diet transition; level of education also affects the health status of individuals (Leung and Stanner, 2011). It is an important social determinant of health inequalities among minority ethnic groups (Vaughan, 2011). The low level of education among Bangladeshis is one of the reasons for their slow transition into a higher social class than that of their parents (Platt, 2007). In contrast, in this study, it was found that levels of education were higher among Bangladeshi, with a high proportion of Bangladeshis in professional and managerial-level job. This could be due to response bias, as those who responded to invitation could be better educated with a higher occupational status. A poor understanding of the English language has been reported as a reason for non-participation in research by Bangladeshis (Hussain-Gambles, *et al.*, 2004). The reason for the high proportion of managers in the Bangladeshi group in this study could be because Bangladeshis usually work in supermarkets, retail outlets, and fast-food restaurants, and owners call or refer to themselves as manager (Salway, 2008). A report based on census (1999, 2001, 2011) gave an overview of educational attainment by ethnic group. It reported an overall improvement in educational attainment in ethnic minorities; specifically, while educationally disadvantaged groups (Pakistani and Bangladeshi) improved in their level of education, they remained lower compared with White Europeans (Lymperopoulou and Parameshwaran, 2014). These findings are consistent with the latest report on ethnic health inequalities from the King's Fund, which reported Bangladeshis as the most disadvantaged minority ethnic group in the UK, reporting poorer health compared to other minority ethnic groups (Raleigh and Holmes, 2021)

Along with the traditional risk factors, diet, a low level of physical activity, use of OCP and a low Vitamin C among Bangladeshis could help to explain their excess CHD mortality.

5.4.2 Strengths and limitations

The advantages of conducting secondary data analysis of the WHSS dataset is that it is a multi-ethnic dataset of people living in the same geographical setting who underwent the same research protocol. It included many variables with a potential for further analysis and exploration. The dataset contained ethnicity data alongside other relevant social and economic measures, and explored ethnicity and CVD risk factors. In the WHSS, standardised methodologies were used for the assessment of risk factors across different ethnic groups, thus avoiding systematic bias between groups. It included men and women in each ethnic group so that analyses of sex differences in risk could be performed such as smoking analysis by sex.

A potential bias in the study could be in the selection of subjects. The majority of participants in the Indian group were predominantly from the Gujarati community. As India is a large country with many ethnic subgroups, studying predominantly the Gujarati community does not represent all Indians.

The study was conducted between 1994-1996, so is almost over 20 years old, and this is one of the main limitations of the study. Much research has been focused on South Asians globally but there is relatively little research about CVD and stroke among individual South Asian subgroups in the UK. This analysis gave the opportunity to observe the differences in risk factors in each South Asian subgroup from the early period of their migration to the UK, which can be compared with present data.

Another limitation of this study was that the sample size was small and at risk of not being representative, therefore the findings cannot be generalised. Due to the increasing size of the ethnic minority population there is a need for a multicentre study of the Bangladeshi population, to obtain a large sample and a better understanding of CVD risk factors.

Among South Asians, apart from established risk factors, there is a need for further exploration of novel and less well studied risk factors. Assessing cardiovascular risk factors among South Asians requires a specifically designed risk prediction model, focussing on subgroups of South Asians individually due to heterogeneity in their risk profiles. Interventions developed for ethnic minorities should be validated and assessed to consider cultural acceptability, which will likely affect uptake and compliance, and underlying susceptibility, which may vary the effectiveness of preventive and treatment options in different ethnic groups.

These actions will require the involvement of both public health professionals (prevention and detection) and secondary health care settings (appropriate investigation and detection and management).

5.4.3 What does this study add?

This study highlights the importance of considering South Asians as individual subgroups (Indian, Pakistani and Bangladeshi). South Asians as a homogenous group conceals important differences in CVD risk profiles between subgroups of South Asians. This analysis found substantial differences in CVD risk profiles specifically in Bangladeshis compared with Indian, Pakistani and White European populations.

The prevalence of hypertension and diabetes was higher among South Asians. Within South Asians, the Bangladeshi group had a higher prevalence of diabetes compared to Indian and Pakistani groups. The Bangladeshi group had unique lipid profiles compared to other groups. Bangladeshis also had higher rates of overweight, associated with very low levels of physical activity. Apart from traditional risk factors, Bangladeshi showed a higher use of OCP which is associated with an increased risk of CVD. Another interesting finding is that hypercholesterolaemia was more common in White Europeans compared to the South Asians. Other findings of the present study suggest that there are also differences in the social, cultural, physical and dietary factors among Indian, Pakistani and Bangladeshi groups.

This analysis was intended to compare the prevalence of traditional and novel risk factors among South Asian sub-groups and White Europeans. Analysis was conducted in individual South Asian and White European groups to give an overall view of how the burden of cardiovascular risk factors differed among these individual South Asian groups two decades ago. This study can act as baseline if and when new studies are conducted, to compare transition in CVD risk factors among South Asians. It is important for health service providers to understand how the overall burden of cardiovascular disease and associated risk factors in the UK are changing over time between South Asians of migrant origin and White Europeans.

Chapter 6: Hospital admissions for stroke in ethnic minority groups: experience at Birmingham Hospitals using a Freedom of Information request.

6.1 Introduction

Stroke not only causes death but is a leading cause of disability in the UK (Stroke Association, 2017). Stroke reoccurrence rate in hospitalised patients is around 6%, i.e. 1 in every 17 patients admitted to hospital will have another stroke (Stroke Association, 2017). For the management of stroke, primary and secondary prevention play a vital role in reducing its burden both on the individual and at community level. The aim of the present chapter was to describe routine hospital data on patients admitted for stroke collected under the Freedom of Information Act, and to analyse and compare selected healthcare outcomes by ethnic group for different hospitals in Birmingham and Solihull. The purpose for using the Freedom of Information Act as a tool to gather data was to gain access to epidemiological data linked with stroke across hospitals in Birmingham.

The UK Freedom of Information Act (FOIA) 2000 came into full force in 2005. It enables, "the disclosure of information held by the public authorities or by persons providing services for them"(legislation.gov.uk, 2000). FOIA can play a useful role in research as it provides rich volumes of data swiftly especially from healthcare systems without any ethical approval (Fowler, *et al.*, 2013). Still, there is a lack of studies using FOIA and there is need for greater use of FOIA in healthcare research (Fowler, *et al.*, 2013). Hammond *et al.*, (2017) describe the uses of FOIA akin to the use of a scalpel. A skilled person uses a scalpel to improve life whereas in an unskilled hand it is just a 'sharp knife' (Hammond, *et al.*, 2017). FOIA is not a research design or a method but a pathway for research which may help in the formulation of a research hypothesis (Bourke, *et al.*, 2012).

The Heart of England Foundation Trust (HEFT) (one of the largest Hospital Trusts in England) was contacted. It included Birmingham Heartlands Hospital, Solihull Hospital and Community Services, Good Hope Hospital and Birmingham Chest Clinic. In addition, Sandwell and West Birmingham Hospitals NHS Trust (SWBH) and Queen Elizabeth (QE) Hospital Birmingham were also contacted under the FOIA (for data in order to understand if there are any differences in local stroke outcomes and services).

From April 2018, the Queen Elizabeth Hospital Birmingham and Heart of England NHS Foundation Trust (HEFT) merged to form one organization named University Hospitals Birmingham NHS Foundation Trust (UHB). The present chapter is going to refer to

University Hospitals Birmingham NHS Foundation Trust (UHB) as HEFT (Heart of England Foundation Trust), which was the name at the time the research was started. HEFT sees and treats more than 150,000 people every year with over 1.2 million admissions and has nearly 11,000 staff. There are around 250,000 admissions at their emergency departments each year.

Traditionally, stroke patient care was provided within departments of general (internal) medicine, neurology, or medicine for the elderly, whereas it has been now replaced by a more focused approach in hospitals as organised stroke units (Langhorne and Ramchandra, 2020). Variations exist between and within stroke unit care in hospitals. These variations affect stroke management in terms of access to stroke diagnosis, treatment, secondary prevention and rehabilitation (Langhorne and Ramchandra, 2020). The main objectives of the stroke services in the West Midlands are to provide fully integrated stroke services from prevention to rehabilitation. The expectations are improved clinical outcomes (reduced mortality), reduced disability and reduced length of hospital stay (Adderley, at el., 2019).

After the publication of the Department of Health’s National Stroke Strategy for England major changes were recommended in the delivery of stroke care. It identified that care in a stroke unit was the single biggest factor that can improve outcomes after stroke (Department of Health, 2007). In England, Wales and Northern Ireland, in an effort to improve the quality and efficiency of stroke care, every hospital that routinely admits stroke patients now has a specialist stroke unit, to improve the quality and efficiency of stroke care (Lugo-Palacios, at el., 2019). In 2010 these units were first centralised in London and Greater Manchester in specialised acute stroke units. After this successful reconfiguration, NHS England approved the plan for different stroke services’ reconfiguration in the West Midlands in 2014 (Birmingham, Solihull and Black Country). The six hospital trusts in the Midlands deliver nine Hyper Acute Stroke Units (HASU) (Adderley, at el., 2019).

HASUs provide expert specialist clinical assessment in the first 72 hours after stroke and Acute Stroke Units (ASU) provide specialist care to patients who need to remain in hospital after HASU phase (Adderley, at el., 2019). Organised care in stroke units is associated with better quality of care and reduced death and disability (Zhu, *et al*., 2009). However, the impact of stroke units on length of hospital stay is less well-defined. Length of stay (LoS) is the single largest determinant of inpatient hospital costs and is available readily compared to other outcome indicators (Lugo-Palacios, at el., 2019).

Length of stay varies in stroke units; patients are discharged when they are medically stable. The variations in LoS occur because patients have different characteristics or are diagnosed and treated differently, and also due to the characteristics of the hospital where their treatment is delivered (Lugo-Palacios, 2019). These variations are observed among various stroke teams across the UK (Lugo-Palacios, 2019). The average length of stay is expected to be 20 days but one third of stroke survivors require inpatient rehabilitation for more than four weeks (Hussain, 2017). Reduced length of stay in stroke units could be due to organised stroke unit care. As mentioned, stroke causes a heavy economic burden on the NHS, so reducing length of hospital stay will impact the cost of long-term stroke care (Hussain, 2017). The average cost per inpatient day was £407 in West Midlands in 2014. Stroke accounts for 2.6 million bed days with direct cost of £2.8 billion (Hussain, 2017).

This chapter addresses the following research question:

- What is the number of patients admitted with stroke by ethnic group for hospitals in Birmingham?
- Are there any differences in stroke outcomes by ethnic group?
- What is the proportion of re-admissions for patients with stroke by ethnic group for hospitals in Birmingham?

The objectives are:

To analyse data obtained through the Freedom of Information Act 2000 (FOI), from three hospitals in Birmingham; and to describe stroke admission and compare differences between the South Asian group and White comparators.

6.2 Methods

Anonymized aggregated data of adult patients presenting with stroke to A&E by ethnic group from 1st January 2006 to 31st December 2014 were obtained from the NHS Trust across three hospitals (HEFT, Queen Elizabeth hospital and Sandwell and West Birmingham hospital), via a FOI request. The questions were simply stated, carefully considered and details written in the application for data request. The data request was made through emailing FOI departments of relevant hospitals. Data were requested from each Trust to measure the quantity and quality of stroke care, such as the number of admissions for a stroke, and the number which were readmissions, length of hospital stay (LoS) and age of stroke patients, disaggregated by ethnic group (see Table 6.1 and Appendix 6.1). Ethical approval was not required, as it was a FOI request and all data obtained were aggregated and anonymous.

Table 6.1	**Questions submitted to hospital under FOIA**
	How many patients presented with stroke to A&E by ethnic origin for the period from 01 Jan 2006 to 31 Dec 2014?
	What was the length of hospital stay of patients with stroke by ethnic origin for the period from 01 Jan 2006 to 31 Dec 2014?
	What was the age range and average age of patients presented with stroke by ethnic origin for the period from 01 Jan 2006 to 31 Dec 2014?
	How many patients presented with stroke to A&E by ethnic origin were re-admissions for the period from 01 Jan 2006 to 31 Dec 2014?

A&E admission and re-admission with stroke were requested from all hospitals. Age was also requested as age is an important non-modifiable risk factor. Risk of stroke increases as age increases (Hsu, *et al.*, 1999), although minority ethnic groups tend to have a diagnosis at a younger age compared to White Europeans (George, *et al.*, 2017) . Like any other method of data collection, this method has its own limitations (discussed later), such as selection bias, confounding, errors and missing data. Still, these data may provide an insight into overall age pattern of stroke by ethnic group between the period of 01st Jan 2006 to 31st Dec 2014 in Birmingham.

Length of hospital stay (LoS) and death are important health outcome measures of stroke. LoS is a major element in determining economic burden of stroke (Kim, *et al.*, 2013). Also, LoS and death are used increasingly to compare and monitor quality of care under services provided by hospitals (Bottle, *et al.*, 2013). LoS is an important factor in calculating quality and cost of care included in stroke patients' management (Kim, *et al.*, 2013). LoS was requested from all hospitals. The aggregate data were obtained from these three hospitals under FOIA 2000, which is shown in the tables below (Table 6.1-6.5)

6.3 Results

All three NHS Trusts/hospitals contacted in Birmingham replied within 20 days, complying with the 20-day time limit under FOIA 2000 (Fowler, *et al.*, 2013). Heart of England NHS Foundation Trust (HEFT) replied earliest, within 8 days. Table 6.2 provides details of A&E admissions and re-admissions with a diagnosis of stroke, for the specified period from January 2006 to December 2014 at HEFT, QE and SWBH. Data was reported by age range with mean age given by ethnic group. The ethnic groups were categorized according to the classifications from the 2001 census. The data in Table 6.2 provides an overall picture during this period. A total of 13,098 patients with acute stroke attended A&E across HEFT and SWBH (Table 6.2). A total 2,928 patient attended QE hospital with acute stroke.

Table 6.2: Admission and re-admission for patients who had a primary diagnosis of stroke (1/1/2006-31/12/2014) at HEFT, and Sandwell & West Birmingham Hospital (SWBH)

	HEFT			SWBH		
Ethnic Origin	**Admissions**	**Re-admission**		**Admissions**	**Re Admissions**	
	N	**N**	**%**	**N**	**n**	**%**
White British	5121	720	14	2151	218	12.9
Indian	126	41	32.5	510	61	11.9
Pakistani	507	74	14.6	236	28	11.8
Bangladeshi	55	7	12.7	64	7	10.9
Chinese	7	1	14.2	23	4	17
Caribbean	167	31	18.6	429	53	12.3
Irish	110	12	10.9	106	10	9.4
Other White Background	33	02	06	1133	198	17.4
African	24	5	20.8	36	7	19.4
Any Other Black Background	23	06	26.0			
White & Black Caribbean	14	3	21.4			

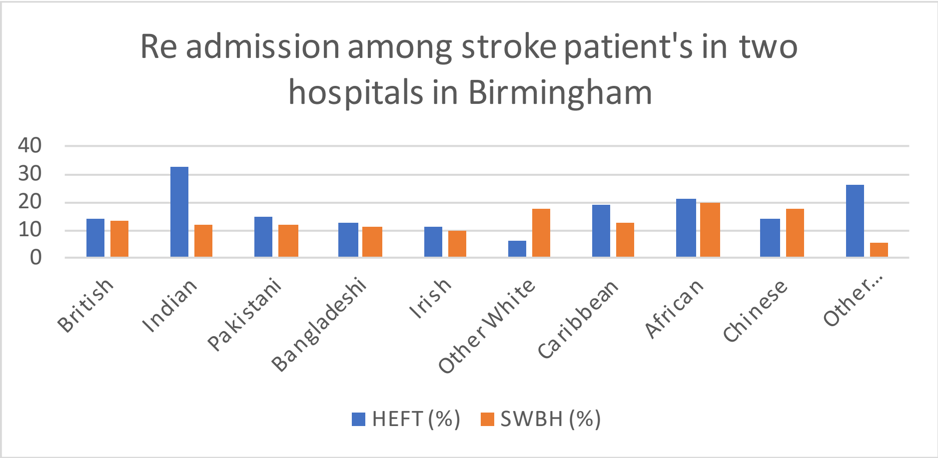


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Figure 6.1: Re admission for patients who had a primary diagnosis of stroke (1/1/2006-31/12/2014) at HEFT and SWBH hospitals in Birmingham.

908 of the 6,395 (14.2%) patients with stroke were re-admissions. In HEFT, Indians had the highest stroke recurrence (32.5%) compared to all other groups (Table 6.2). QE provided data on admissions only. Re-admission data was insufficient to draw a conclusion, as data was suppressed due to reasons of confidentiality as the numbers were small (<5). The data from SWBH show that re-admission rate was high among Africans (19.4%) followed by Other Whites (17.4%). There were no significant differences in stroke recurrence among South Asian groups from SWBH.

Table 6.3: Age range and average age for patients who had a primary diagnosis of stroke (1/1/2006-31/12/2014) at HEFT, QE and Sandwell & West Birmingham Hospital (SWBH)

	HEFT		QE		SWBH	
Ethnic Origin	**Age Range**	**Average Age**	**Age Range**	**Average age**	**Age Range**	**Average Age**
(White) British	0-108	73	16 - 114	73	4-108	73
Indian	18-99	65	18 - 95	67	18-102	70
Pakistani	3-95	64	19 - 96	64	21-101	69
Bangladeshi	20-88	67	40 - 83	64	32-89	63
Chinese	40-89	62	23-110	67	43-85	67
Caribbean	21-94	73	23 - 93	69	28-96	72
Irish	43-95	76	29 - 93	75	51-92	75

Other White Background	24-98	71	20-98	68	24-104	75
African	16-77	54	27 - 82	59	18-85	56
White & Black Caribbean	45-91	75	20-91	54	43-85	67
Any Other Black Background	19-87	60				

Table 6.3 presents data on age range and average age of stroke patients at the time of admission to A&E in all three hospitals. Across the three hospitals, the average age of all ethnic groups did vary except for the British group which had the similar average age of 73. South Asians subgroups all had a stroke at younger average age compared to (White) British patients at HEFT (Table 6.3). QE data suggest that among South Asians, Bangladeshi (64 years) and Pakistani (64) groups were younger than Indians (67), similar to SWBH where Bangladeshi (63) and Pakistani (69) groups were younger than Indians (70). There is no difference in the average age between South Asians (Indians, Pakistani and Bangladeshi).

Table 6.4 summarizes the average length of hospital stay in patients discharged with a diagnosis of stroke in all three hospitals (HEFT, QE, SWBH) (See also Figure 6.2). Although no statistical test was performed on the data obtained from these hospitals some interesting findings emerged, which need to be interpreted with caution. The role of chance, bias and elimination of confounding was not assessed due to the intrinsic limitation of the method of data collection. Chinese patients had the longest length of hospital stay in all three hospitals compared to other ethnic groups. The average length of stay at HEFT for all stroke patients was 20 days. LoS at HEFT will be discussed in depth in Chapter 8 as a part of an audit of the acute stroke pathway at the Hyperacute stroke unit (HASU).

Table 6.4: Average Length of stay for patients who had a primary diagnosis of stroke (1/1/2006-31/12/2014) HEFT, QE and SWBH

Ethnic Group	HEFT	QE	SWBH
British	20	15	24
Indian	16	18	23

Pakistani	17	13	17
Bangladeshi	22	13	17
Caribbean	28	20	26
Irish	20	17	24
Chinese	42	25	34
African	19	14	13
Other Asian Background	8	17	27
Total average LoS	20.3	18	24.3

LoS: Length of stay, HEFT: Heart of England Foundation trust, QE: Queen Elizabeth.

SWBH: Sandwell and West Birmingham

In QE Hospital, the overall average length of hospital stay was 18 days. The shortest average length of stay was observed among Bangladeshis and Pakistanis (13 days each), while at SWBH, Africans had the shortest average length of stay followed by Bangladeshis and Pakistanis. At SWBH the overall average length of stay was 24 days, which was the highest of all three hospitals.

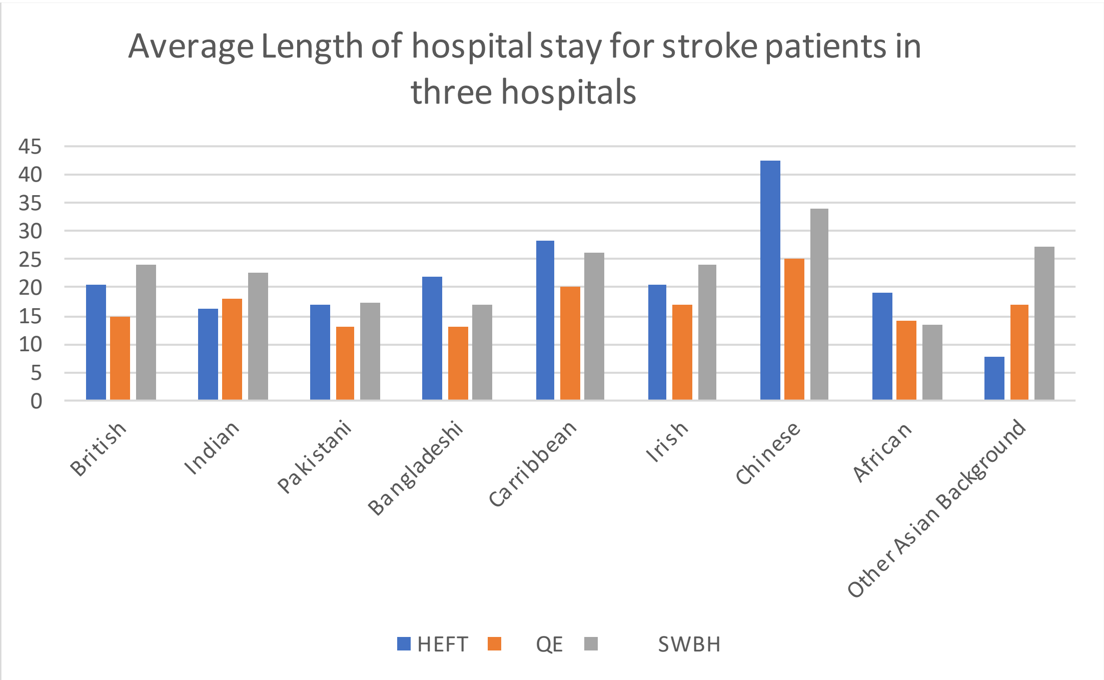

Figure 6.2: Average Length of hospital stay for stroke patients at HEFT, QE and SWBH hospitals in Birmingham (1/1/2006-31/12/2014)

Table 6.5 reports the number of deaths with a diagnosis of stroke admitted to A&E in QE hospital. Exact numbers are not available where there are fewer than 5 deaths, due to confidentiality. The average age at death was 73 years for Bangladeshis and 82 for British (Whites).

Table 6.5: Deaths in A&E with an A&E Diagnosis of Stroke (QE Hospital) (1/1/2006-31/12/2014)

	Male	Female	Min. age	Max.age	Avg.age
British	<5	6	54	114	82
Caribbean		<5	78	78	78
Bangladeshi	<5		73	73	73

6.4 Discussion

6.4.1: Summary

FOIA is a valuable tool, that should be maximised in future research. The response time was within the limit outlined in the Act and all questions were answered. The data collected under the FOIA provided insight into the access to data and quality of healthcare provision for stroke patients among South Asians and other ethnic groups in the Birmingham area.

The highest number of stroke patients attended A&E at HEFT. This can be explained on the basis that HEFT received stroke patients from Good Hope Hospital and Solihull Hospital as well. South Asian stroke patients were significantly younger compared to the British patients and the mean age varied between hospitals. The Irish had the highest average age at onset of stroke in all three NHS Trusts/hospitals followed by the British (Table 6.3). It has been reported that in acute stroke patients, age along with stroke severity and pre-stroke disability contribute to up to 70% of early death and poor outcomes (Turner, *et al.*, 2015). The present data supports previous findings among South Asians, that the Bangladeshi ethnic group have stroke at a younger age than Indians and Pakistanis (QE and SWBH), except in HEFT where Indians are the youngest followed by Pakistani and Bangladeshi groups. Across the three hospitals it was found that Bangladeshis present with stroke 8.4 years younger than the British, on average. Having a (often disabling) stroke 10 years earlier is a two-fold problem. First, the costs of treatment, rehabilitation and care to support with activities of daily living

(ADL) will be greater, and secondly, there will be a greater loss of earnings as a result of disability due to stroke. The findings corroborate with those of previous studies (chapter 4) which showed that South Asians are more prone to CVD, stroke, hypertension and diabetes at younger ages compared with the White population (Chaturvedi, 2003; Gunarathne *et al.*, 2008). Birmingham has been reported as the youngest city in Europe with 40% of the population aged under 25 years, which warrants action to increase stroke prevention and awareness strategies among at-risk groups (Adderley, *et al.*, 2019). Advanced age is associated with a longer length of hospital stay and poor stroke outcome (Curtain, *et al.*, 2017).

Length of stay is an important indicator for the outcome of stroke. Length of stay varies according to the hospital and the services provided at the site. Hospitals with a HASU have a shorter length of stay compared to hospitals with acute stroke units (ASU) or only rehabilitation units (Adderley, *et al.*, 2019). The reasons are multifactorial, with length of stay depending on the type of stroke, severity of stroke and pre stroke co-morbidities (such AF, CCF, disability, hypertension) (Curtain., *et al.*, 2017). The average length of stay for all patients was the longest at Sandwell and West Birmingham hospital (24.3 days) and shortest in QE hospital (18 days) (Table 6.4). The shorter length of stay can be due to organised stroke unit care and is an important indicator for improved outcomes of stroke management (Stroke Unit Trialists' Collaboration, Cochrane Database, 2007). Early supported discharge (ESD) was reported as one of the reasons for shorter length of hospital stay in acute stroke patients, with 38% of patients in the West Midlands receiving ESD services (Adderley, *et al.*, 2019). ESD is an intervention for adults with mild to moderate stroke, involving a transfer from the inpatient environment to the community setting (NICE, 2017).

Another factor associated with shorter length of stay could be patient that were admitted from care settings pre-stroke being referred to their care setting post-stroke, as intensive acute stroke rehabilitation for patients with pre-stroke disability is less beneficial compared to their ongoing pre-stroke disability care management. It is established that admission to stroke units is associated with a shorter length of stay compared to admissions to other wards (Busingye, *et al.*, 2018). There is a need for early admission to stroke units which can reduce death and disability after stroke. It is important to calculate the time between having a stroke and being admitted to a stroke unit. Among South Asians, Bangladeshi and Pakistani patients had the shortest LoS at QE and SWBH, whereas at HEFT Bangladeshis had the longest LoS. The causes for the shortest LoS among Bangladeshi and Pakistani groups cannot be explored by hospital due to limitations with the data provided but it could be due to better stroke management at the respective hospitals or high mortality within 30 days among the South Asians compared to the White population (Gunarathne, *et al.*, 2008a). The latter is supported by evidence from a recent report from the West Midlands Stroke Clinical Network (2019), with higher stroke incidence and mortality rates reported among lower socioeconomic groups. The latest report from the ONS (Office for National Statistics) reported in England and Wales, Birmingham, Walsall and West Bromwich are among the most deprived cities and towns (Prothero, 2016), which are all highly populated by the South Asian community (Adderley, *et al.*, 2019).

The Chinese group had the longest LoS among all ethnic group across all three hospitals. Previous studies reported a challenge while considering the association between longer LoS and clinical complications, with it being difficult to determine whether the cause for longer length of stay at stroke units could be due to medical complications or whether a longer length of stay caused medical complications (Ingeman, *et al.*, 2011). In this study it was not possible to find the causes associated with length of stay due to limited data availability under FOIA. Other factors associated with longer LoS could be a delay in transfer of care or care packages (Adderley, *et al.*, 2019).

Apart from clinical factors, other factors could be communication barriers (English language), cultural beliefs, trust in the medical system or professionals, perception of disease, genetic make-up, presentation of disease, expectations from professionals, and differences in physiological response to drugs and treatment (Adderley, *et al.*, 2019). Though the reasons for shorter LoS are unclear, there is evidence which observed a shorter LoS in South Asians patients with stroke, diabetes and myocardial infarction. A study by Potluri, *et al.*, (2015) reported a significantly shorter LoS among South Asians patients with ischemic stroke in Birmingham. They also suggested that an important factor that was associated with shorter LoS was the support provided by family members in the South Asian community. In South Asians, including among the Bangladeshi community, family support is strong and is associated with positive caregiving experience (Merrell, *et al.*,2005). Another factor that could be associated with shorter LoS was that less support was offered by hospitals to ethnic minorities at the time of discharge (Potluri, *et al.*, 2015). However, this study (Potluri, *et al.*,

2015) did not examine the role of community-based specialist discharge facilities, which was recognised as able to support discharge and improve patient outcomes. These disparities need further research particularly a more detailed qualitative and quantitative exploration by ethnic groups to study underlying causes of long or short LoS. Addressing the underlying causes for longer hospital stay in an appropriate and culturally sensitive way may reduce the burden of disease treatment on the NHS.

Stroke readmission is another important outcome which was requested under FOIA by ethnic group. Stroke reoccurrence is considered as an important stroke outcome measure, as around 10,000 recurrent strokes can be prevented each year if minor strokes or transient ischemic attacks (TIA) are managed in time (Stroke Association, 2016). Although all hospitals were requested for data on recurrent stroke, only HEFT and SWBH provided the data. Data provide by the QE Hospital was inadequate, because much of the data on readmissions in the cells for different ethnic groups was suppressed for reasons of confidentiality. On average, re-admission rate was higher at HEFT than SWBH, and it may be explained based on its stroke unit which receives patients from three other sites. High recurrent stroke admissions at HEFT may also be due to a larger catchment area with predominantly South Asians, since the risk of recurrent stroke is higher among South Asians compared to White Europeans (Dhamoon, *et al.*, 2016). Another population-based study among South Asians from Canada reported a higher prevalence of recurrent stroke among South Asians compared with non-South Asians (Dhamoon, *et al.*, 2016). Other factors that may contribute to high re-admissions at HEFT could be past positive experiences of patients or their relative, friends or carers, availability of high-tech facilities such as HASU, and healthcare staff of South Asian origin (as this may reduce anxiety and communication barriers). Although the data collected under FOIA were limited, it still provided important differences in stroke outcome by individual South Asian groups. Indians had a significantly higher number of readmissions at HEFT compared to all other ethnic groups, while Bangladeshi and Pakistani groups at both sites were similar to the White population. As mentioned earlier in chapter four, the South Asian population have a higher (fourfold) prevalence of diabetes compared to the White population in the UK. Diabetes is one of the important factors associated with recurrent stroke among South Asians (Dhamoon, *et al.*, 2016).

6.4.2: Strengths

One of the advantages of FOIA was that the data were obtained very quickly and without requiring any ethical approval. The data obtained was not only on the number of stroke patients but also on other stroke outcome indicators such as LoS, recurrence and the average age of patients. The requested data were fully anonymous, thus not compromising any aspect of confidentiality and privacy. The procedure for obtaining the data was relatively easy. Data requested under FOIA can be either on paper or in an electronic format. It enables the collection of a large amount of data at minimum cost compared to a cohort study which requires huge amounts of money and resources. It is easy to interpret the data, as the data were aggregated by each hospital trust for the variables requested. This method could potentially be very useful for comparing the performance between similar stroke services across the region. It does not require special software (like SPSS) or set of skills or extensive training to interpret the requested stroke data. The study was retrospective hence the data collected may not be completely accurate but it still gives ideas for what to collect in future studies, such as to collect or request factors associated with length of hospital stay like type of stroke and pre-stroke disability status.

6.4.3: Limitations

Like any other method of data collection, data collected under FOIA has its own limitations. First, I had no control over the accuracy of data. The quality of the data collected at different hospitals may vary and inaccuracies will seriously undermine the quality of data. Second, the completeness of data may not be uniform across all Trusts. For example, some hospital staff may not ask about the ethnic origin of patients or may miss a number of recurrent strokes. Staff who are insufficiently trained may not be able to capture the patient's data in real time and the data will consequently be incomplete. Third, there may be chances of bias in selection of patients due to unmeasured variables, limitations of health-related measures or risk factors. Fourth, inaccuracy in the recording of ethnicity data is another important weakness in FOIA. The NHS focuses more on completeness of data rather than accuracy (Saunders, *et al.*, 2013)). Overall, among all ethnic groups it is estimated that the self-reported ethnicity is erroneously reported in 4.9% of hospital records (Saunders, *et al.*, 2013). Misclassification of ethnicity can potentially lead to bias, such as the "other ethnic group" category may have a large number of people from higher risk ethnic groups. Fifth, the data provided were not raw data; instead it was aggregated data which limited further investigation. For example, the mean age and average length of stay across all hospitals by ethnic group could not be assessed.

6.4.4: Implications

Use of FOIA data can help service planners to undertake economic evaluations in terms of usage of resources and to recognise differences in stroke outcomes by ethnic groups to reduce ethnic inequalities in communities. In hospitals, beyond completeness of data, more emphasis should be directed towards data accuracy especially in ethnicity recording (Saunders, *et al.*, 2013). Variations in LoS in South Asian groups and other ethnic groups warrants qualitative and quantitative research to explore underlying causes. Understanding and identifying appropriate barriers to shorter length of stay may help to increase bed availability in hospitals and reduce unnecessary financial burden on the NHS.

Likewise, age - a non-modifiable risk factor for stroke - is also an important indicator in stroke outcome. Identifying at-risk groups (young, disadvantaged groups) could be helpful in targeting stroke awareness programmes. Patients of Bangladeshi origin developed stroke approximately 8 years earlier (mean age 63 years) than British patients (mean age 73 years). The data collected under FOIA could help to identify and minimise risk factors (age, recurrent stroke) and improve stroke outcomes (mortality, LoS) by ethnic group. This study provided insight into what data would need to be collected in the audit in chapter 8.

6.4.5: Conclusion

In conclusion, the analysis of data obtained under FOIA provided a brief overview of stroke outcomes (LoS, mortality and reoccurrence of stroke) by ethnic group in three major Birmingham hospitals (HEFT, QE, SWBH). Indians had the highest recurrence of stroke. Although the data was limited by missing information, the results are supported by the evidence from other available studies.

Chapter 7: Retrospective case notes analysis of risk factors associated with stroke in Bangladeshi.

7.1 Introduction

During the last four decades risk factors for stroke in different ethnic groups have been the focus of research in both developed and developing countries (Hussain, *et al.*, 2013). There is still a lack of complete understanding of the factors associated with excess stroke mortality and morbidity in ethnic minority groups, especially in the Bangladeshi population (Balarajan & Raleigh, 1997; Bhopal *et al.*, 2005a).

This retrospective case note analysis was conducted at Heartlands Hospital, which is based at the heart of a bustling, dynamic community in Birmingham, Heart of England NHS Foundation Trust (HEFT, 2016). The hospital is now part of University Hospitals Birmingham NHS Foundation Trust. It is one of the largest acute hospital trusts in the country, serving a diverse population of 1.2 million people across Birmingham, Solihull, Sutton Coldfield and South Staffordshire (HEFT, 2016). Heartlands Hospital serves a predominantly multi-ethnic urban population of 250,000 and admits about 32,000 patients annually (HEFT, 2016). Heartlands Hospital occupies a large site consisting of modern buildings and offers a highly extensive array of facilities and procedures for its patients and visitors.

Heartlands Hospital now manages all emergency stroke admissions across the Heart of England NHS Foundation Trust in its Hyper Acute Stroke Unit (HASU) which opened in October 2014. Stroke units provide organised stroke care, whereas HASUs provide organised care with 24/7 specialist clinical assessment with rapid imaging and the ability to deliver intravenous thrombolysis within 72 hours (Rudd, 2017).

The team sees patients from across Birmingham, Solihull, Sutton Coldfield, South Staffordshire and Warwickshire. There are 30 stroke beds at Heartlands Hospital, made up of 16 hyper acute and 14 acute beds, plus a further 15 acute beds at Solihull and 22 acute beds at Good Hope Hospital. Guidelines for the management of acute stroke are available throughout the hospital. Once the patient is stable, they are discharged home or transferred to an acute bed at their local hospital if they require rehabilitation. The team sees between 5 and 20 new patients per day, making it one of the biggest and busiest centres in the UK.

The Sentinel Stroke National Audit Program (SSNAP 2015) measures the 'Proportion of patients directly admitted to a stroke unit within 4 hours of clock start' (Stroke: Update of NICE guidance, 2014). Clock start refers to "the date and time of arrival at first hospital for newly arrived patients, or to the date and time of symptom onset if the patient is already in hospital at the time of their stroke" (Royal College of Physicians, 2017). Data for the Heart of England NHS Foundation Trust from Heartlands Hospital shows that 53.9% of patients were admitted to the stroke unit within 4 hours from October to December 2014, but this improved to 66.1% from January to March 2015. Equivalent national data shows that 56.9% and 53.6% were admitted to a stroke unit within 4 hours, respectively (Sentinel Stroke National Audit Program, 2015).

The aim of this detailed case note analysis was to answer the following question:

- Are there differences in the risk factors observed in patients from Bangladesh who have had a stroke in comparison with patients from other ethnic groups (White European, Indian and Pakistani), in a stroke unit in Birmingham?

With the objective to:

- Explore CVD risk factors in the Bangladeshi population via the case note analysis of patients who have had a stroke from Heart of England NHS Foundation Trust.

The study consists of two components. The first part (chapter 7) is a retrospective case note analysis of patients who were admitted to the HASU at Heartlands Hospital with an acute stroke between October 2014 to April 2017. Only patients whose ethnicity were identified as South Asians (Bangladeshi, Indians and Pakistanis) and White Europeans were included.

The second part associated with the case note analysis intended to understand the journey of stroke patients in hospital and the management of stroke by ethnic group and consisted of an audit of the compliance with the acute stroke care pathway. This aspect is reported in Chapter 8.

7.2 Methods

7.2.1 Research Governance and Ethical Considerations

This study was performed in HASU at Heart of England NHS Foundation Trust (HEFT), Birmingham. Before commencing the study, a research protocol was submitted to the Biomedical & Scientific Research Ethics Committee (BSREC) at Warwick Medical School, University of Warwick, in July 2016 for ethical approval. Full BSREC approval was granted in November 2016 (BSREC reference: REGO-2016-1819) (Appendix 7.1).

Meanwhile, the protocol was submitted with the application for a research passport to cover this audit at HEFT. The audit was registered with the Research and Development Department at the Heart of England Foundation Trust. An Honorary Contract was obtained from HEFT from February 2017 until February 2018 (see Appendix 7.2). After securing the Honorary Contract, I attended the Trust induction, and data collection started immediately afterwards.

7.2.2 Study Design

The study design was a retrospective audit of case-notes of stroke patients admitted to HEFT.

7.2.3 Sample

A list of 2,971 patients admitted for a stroke between October 2014 (start of the new stroke unit) and April 2017 was obtained from the stroke audit coordinator. In the database, ethnicity was coded according to the UK census to 18 ethnic groups (ONS, 2013).

A series of steps were followed in order to identify the sample for the audit from the Stroke Unit database. Firstly, 18 patients identified as Bangladeshi (code K) were obtained. Secondly, I went through the full list by name and surname to find any patients of Bangladeshi ethnicity who had been misclassified under other categories. Six Bangladeshi patients were identified which had been misclassified as Pakistani and other ethnic groups. Thirdly, the ethnicity of the 24 patients identified as Bangladeshi were confirmed by going through case notes, referral letters and GP letters. Fourthly, patients belonging to White European, Indian and Pakistani ethnicities were identified by matching to the age and sex of the Bangladeshi group to create similar groups apart from ethnicity. Due to the unavailability of some case notes, matching was not exact but performed as closely as possible. Bangladeshi patients (cases) were stratified by age and sex, for example using age strata 35-44 and 45-55 and so on. Likewise, a random sample of White Europeans, Indian and

Pakistani patients were drawn from the SSNAP database, followed by tracking of case notes of these patients.

At the start of the study, it was planned to take a 1:2:2:2 sample, with two Indian, two Pakistani and two White European patients matched to each Bangladeshi patient. Due to time constraints caused by delayed R&D approval at the Trust it was changed to 1:1:1:1 sampling. The final list of 96 patients, comprising 24 patients from each of the four ethnic groups, White European, Indian, Pakistani and Bangladeshi, was created and anonymised (patient ID, date of birth and post code were not included).

7.2.4 Data sources

A data extraction form was set up in Excel (see Appendix 7.3). Medical case notes were obtained from all three hospital sites of Solihull, Good Hope and Heartlands. All variables relating to stroke diagnosis, treatment, and outcomes were extracted from the medical records of patients and entered into the data extraction form in Excel held on the NHS Trust computer. As it was a retrospective case note analysis, details were extracted for the important variables from two sources, detailed below.

7.2.4.a Data from Stroke Database

Firstly, data were extracted from the stroke database of the stroke unit which is a robust database used for reporting results to SSNAP (Sentinel Stroke National Audit Programme) for all stroke patients admitted to hospital or who suffered an acute stroke whilst in hospital. The processes for collecting and entering these data on the stroke dataset are robust and confirmed by the clinical lead of Heartlands Hospital who has overall responsibility for data quality (George, 2017). Data was collected on demographics (age at stroke, sex, ethnic group) and comorbidities or past medical history (PMH). The PMH of hypertension, diabetes, AF, stroke/TIA and CCF refers to a known diagnosis or history in primary/secondary care health records or from regular prescribed medicines.

7.2.4.b Data from Case Notes

Data were extracted from case notes from A&E at the time of stroke, from previous hospital admission notes, the hospital discharge summary, referral letters from GPs, blood test reports and urine test reports. It was found that Physiotherapist and Occupational Therapist notes were informative and gave details especially for lifestyle factors like diet and language of communication, whereas the history of smoking and alcohol, and level of exercise were not available for all patients. There was missing data for a number of variables.

The following variables were extracted from the case notes of individual patients: blood pressure, serum glucose and HbA1c levels, lipid profiles, urea and electrolytes and other related information were extracted for three time-points - pre-stroke, at the time of stroke and post-stroke. Other variables are mentioned in Table 7.1. Hypertension and hyperglycaemia were calculated from blood pressure and serum glucose (or HbA1c) measurements of individual patients according to WHO's criteria. Blood pressure was categorized as hypertensive if $\geq$140/90mmHg and normotensive if <140/90mmHg (World Health Organization, 2017). According to WHO's criteria for diabetes "an HbA1c of 48mmol/mol (6.5%) is recommended as the cut off point for diagnosing diabetes and clinical history" (Diabetes UK, 2011, no pagination). Apart from these risk factors, a previous history of any hospital admissions was also reviewed for risk factors associated with stroke. All reported history of infections was documented as per the clinical diagnosis written in the notes. Information such as history of tuberculosis (TB), respiratory tract infection (RTI) and any surgeries were included. Previous history of TB usually confirmed the patient's country of origin, as hospital notes give details of infections acquired during their home visit. Along with these details, medications were also recorded (if taken for hypertension, diabetes or AF). The variables extracted are summarised below in Table 7.1.

Table 7.1: Variables recorded from case notes at HEFT from October 2014-April 2017

	Component	Description /Definition
Demographics	Age, Sex, Ethnicity Religion, Employment status, Family and personal history. Medical history of co-morbidities	Age at the time of stroke. This was completed by stroke coordinator. Age was available for all patients. Sex was recorded and cross checked with previous clinical notes Religion was not available for all patients; it was traced from clinical case notes from GP. Employment status was not available for all patients, it was found by going through all previous clinical notes. Family and personal history were searched by going through all available notes in case file. Past medical history of co-morbidities recorded from SSNAP database.
Physical Measurements	Weight, BMI, BP	Weight: records were not consistent, so the weight at the time of stroke, before stroke and after stroke were recorded The body mass index (BMI) was calculated if height and weight were available, otherwise available BMI was recorded. Systolic and diastolic blood pressure readings were recorded at three points: at the time of stoke, before stroke and after stroke.
Lifestyle	Smoking, Alcohol, Diet Pan/betel nut, Exercise	Smoking status: recorded as current or ex-smoker and never smoked. Alcohol (beer. wine and spirits) and whether they drank or not. Diet: Vegetarian/ Non vegetarian Pan/ betel nut use were recorded from case notes. Level of exercise recorded as active or non-active from physiotherapist notes.
Blood tests	Serum glucose, HbA1c GFR*, Urea & electrolyte Lipid profile Liver function test Hemoglobin Vitamin D	HbA1c was recorded for patients with or without diabetes. This was not available for all patients. GFR recorded for patients with kidney disorders at the time of stroke. Urea and electrolytes: Serum sodium, serum potassium, urea, creatinine. Lipid profile: High-density lipoprotein cholesterol (HDL), Low density lipoprotein cholesterol (LDL), total cholesterol recorded as available. Liver function test were recorded from latest admission. Haemoglobin: recorded from patient's previous case notes. Vitamin D is recorded in selected patients, where available.
Medication		Medication recorded before and after stroke.

***GFR: Glomerular filtration rate**

7.2.5 Statistical analysis

After data extraction, the final master copy of the Excel datasheet was checked, and data cleaning was performed by fixing dates to a specific format. All the readings were standardised in one unit such as HbA1c from mmol/mol to % and weight from stones/pounds to kilograms. All data was then standardised as continuous or categorical variables as per the requirement of the statistical package SPSS. Ethnicity codes and all other data were checked again for any inconsistencies in units of measurement. The variable "Age" was categorized into four age bands as described in Table 7.2.
All statistical analyses were performed using IBM-SPSS software – version 24 (IBM Corp., 2016). The data were transformed into coded variables and then transferred to SPSS software for data analysis. Descriptive statistics were used to summarise demographic and clinical variables for findings at the onset of stroke, pre and post stroke. For continuous variables the mean and standard deviation (SD) were reported and a one-way analysis of variance (ANOVA) was used to determine whether there were any statistically significant differences between the means of the four ethnic groups. For categorical variables frequencies and percentages were reported. The main emphasis was to compare the Bangladeshi population with the White European, Indian and Pakistani groups. Pearson's chi-square test for categorical variables were undertaken to examine any differences between ethnic groups. Where the p value was significant, the follow up test Z-test was performed (with Bonferroni correction).

A linear mixed model was used to examine the association between systolic blood pressure at three different time points by ethnic group. The mixed model analysis was performed by including random effects terms for patients to consider multiple blood pressure readings from the same patient. To allow for different mean profiles for different ethnic groups, the linear mixed model included interaction terms for ethnicity and time.

7.2.6 Missing data: For some variables, data were not recorded in the case notes of some patients and was added to the dataset as 'missing'. For example, pre-stroke blood pressure readings were often missing, especially among Bangladeshi patients as they did not have any previous case notes. Eighteen patients had missing data on pre-stroke blood pressure and 17 patients has missing data on post-stroke blood pressure.

7.3 Results

7.3.1 General characteristics of the sample

The socio-demographic and lifestyle characteristics of the 96 stroke patients (52 males and 44 females) are summarized in Table 7.2. The Bangladeshi group had 14 males and 10 females. The patients' language of communication was obtained from their case notes, specifically physiotherapist and occupational therapist notes. The lowest proportion of level of understanding of the English was reported among Bangladeshi (45.8%) compared to White Europeans, Indians and Pakistanis. Unemployment (includes housewives who are categorised as unemployed) tended to be higher amongst the Bangladeshi group (45.8%) followed by Pakistanis (41.7%). Due to the retrospective approach, occupational status was classified as per the record in the case notes. It was not a standard classification as the case notes usually only mentioned if the patient was employed, unemployed or retired/house-wife.

In terms of lifestyle factors, alcohol use was reported to be the lowest in Bangladeshi (0 %) and highest in White Europeans (70.8%). Similarly, the rate of smoking was the lowest among Indians (16.7%) compared to White Europeans (70.8%). Smoking status by gender showed the majority of White European women smoked (77.8%) compared to Bangladeshi, Indian and Pakistani women who were predominantly non-smokers. Bangladeshi men had the highest proportion of smokers (78.6%) followed by and Pakistani men (69.2%). Vegetarianism was reported in 16.7% of Indians, and 0% for the other groups

7.3.2 Past medical history of co-morbidities/risk factors

Data were collected on the presence of risk factors and previous comorbidities such as hypertension and dementia (Table 7.3). Figure 7.1 shows the proportion of overall risk factors among all study participants. Hypertension was the most common risk factor, reported amongst 93.8% of the stroke patients in this study. The other risk factors in the top five were diabetes mellitus, dyslipidaemia, previous stroke and infections.

Table 7.3 shows in detail the distribution of past medical history of co-morbidities/risk factors among stroke patients by individual ethnic group. Hypertension was the commonest risk factor amongst all ethnic groups, ranging from 91.7% (White Europeans, Pakistani and Bangladeshi) to 100%. (Indian). On the other hand, the proportion of patients with diabetes was higher in all South Asian groups than in White Europeans, albeit the difference was not statistically different.

Table 7.2: General characteristics of stroke patients admitted at HEFT October 2014-April 2017, by ethnic group.

		White Europeans		Indian		Pakistani		Bangladeshi		Total	
		N	%	N	%	N	%	N	%	N	%
Age	<45	0	0	0	0	1	4.2	2	8.3	3	3.3
	45-49	0	0	0	0	3	12.5	1	4.2	4	4.1
	50-54	2	8.3	3	12.5	2	8.3	1	4.2	8	8.3
	>55	22	91.7	21	87.5	18	75	20	83.3	81	84.3
Mean age (years)		76		73		65		67			
Sex	Female	9	37.5	14	58.3	11	45.8	10	41.7	44	45.8
	Male	15	62.5	10	41.7	13	54.2	14	58.3	52	54.2
Language understanding	English	24	100	21	87.5	15	62.5	11	45.8	71	73.9
Alcohol consumption	Yes	17	70.8	7	29.2	3	12.5	0	0	27	28.1
	No	7	29.2	17	70.8	21	88.5	24	100	69	71.9
Employment status	Employed	11	45.8	11	45.8	13	54.2	8	33.3	43	44.7
	Unemployed/	4	16.7	7	29.2	10	41.7	11	45.8	32	33.3
	NR/Retired	9	37.5	6	25.0	1	4.2	5	20.8	21	21.8
Vegetarianism	Yes	0	0	4	16.7	0	0	0	0	4	4.1
	No	24	100	20	83.3	24	100	24	100	92	95.9
Smoking	Yes	17	70.8	4	16.7	11	45.8	11	45.8	43	43.7
	No	7	29.2	20	83.3	13	54.2	13	54.2	53	55.3
Smoking Men	Yes	10	66.7	3	30.3	9	69.2	11	78.6	33	63.4
	No	5	33.3	7	70.7	4	30.7	3	21.5	19	36.6
Smoking Women	Yes	7	77.8	1	7.1	2	18	0	0	10	22.7
	No	2	22.2	13	93	9	82	10	100	36	81.3

NR: not reported

The third highly reported risk factor (Figure 7.1) among all stroke patients was dyslipidaemia. The proportion of patients with dyslipidaemia was high in all South Asian groups (Indian 62.5%, Pakistani 70.8%, Bangladeshi 70.8%) compared to White Europeans (41.7%). A past medical history of stroke was the highest among Indians (62.5%) and the lowest among Pakistanis (29.2%). Congestive cardiac failure (CCF) rates were similar among Bangladeshi and Indians (16.8%), whereas the highest proportion was observed among White Europeans (25%) and the lowest among Pakistansi (4.2%). However, these differences were not statistically different between the four groups.

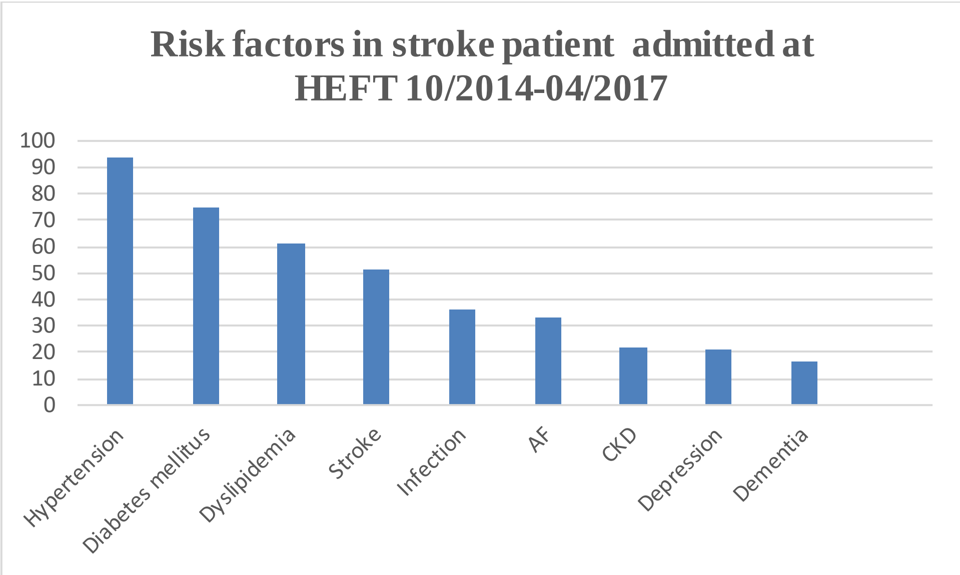

Figure 7.1: Past medical history or co-morbidities (%) reported among stroke patients admitted at HEFT October 2014-April 2017

This case note analysis showed the proportion of stroke patients who had Atrial Fibrillation (AF) was statistically significantly different across the four ethnic groups (p=0.001). *Post hoc* analysis using the Z-test with Bonferroni correction showed a higher proportion amongst White Europeans (70.8%) compared to all three South Asian groups (20.8%). This difference was also reported in the systematic review (Chapter 4).

Apart from these traditional risk factors, an important risk factor among South Asians was infection. Past medical history of infection was higher among Bangladeshis (50%) compared to White Europeans (8.4%). This is further explored by the type of infections reported (Figure 7.3), including urinary tract infection (UTI), tuberculosis (TB) and *H. pylori*. This shows that the Bangladeshi group have the highest proportion of UTI and *H. Pylori* infections, but not tuberculosis. Tuberculosis was the highest amongst the Pakistani group followed by the Indian ethnic group.

Table 7.3: Past medical history reported among stroke patients by ethnic group admitted at HEFT October 2014-April 2017

		White Europeans (24)		Indian (24)		Pakistani (24)		Bangladeshi (24)		Total		P value
		N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	
Infection	UTI	1	4.2	2	8.3	1	4.2	6	25.0	10	10.4	<0.005
	H. Pylori	0	0	0	0	0	0	4	16.7	4	5.7	
	TB	1	4.2	3	12.5	5	20.8	2	8.3	11	11.4	
	No H/o infection	22	91.6	19	79.2.	18	75.0	12	50.0	71	74	
AF		17	70.8	5	20.8	5	20.8	5	20.8	32	33.3	<0.005
Hypertension		22	91.7	24	100	22	91.7	22	91.7	90	90.9	.545
Diabetes		15	62.5	21	87.5	17	70.8	18	75.0	73	76	.261
Dyslipidaemia		10	41.7	15	62.5	17	70.8	17	70.8	59	59.7	.124
CCF		6	25.0	4	16.8	1	4.2	4	16.8	15	15.6	.258
Stroke		14	58.3	15	62.5	7	29.2	13	54.2	49	51.4	.091
Depression		6	25.0	5	20.0	6	25.0	3	12.5	20	20.8	.587
CKD		6	25.0	4	25.0	5	20.0	5	20.0			.918

No H/o: no history of, AF: Atrial fibrillation, CCF: Congestive cardiac failure, CKD: Chronic kidney disease

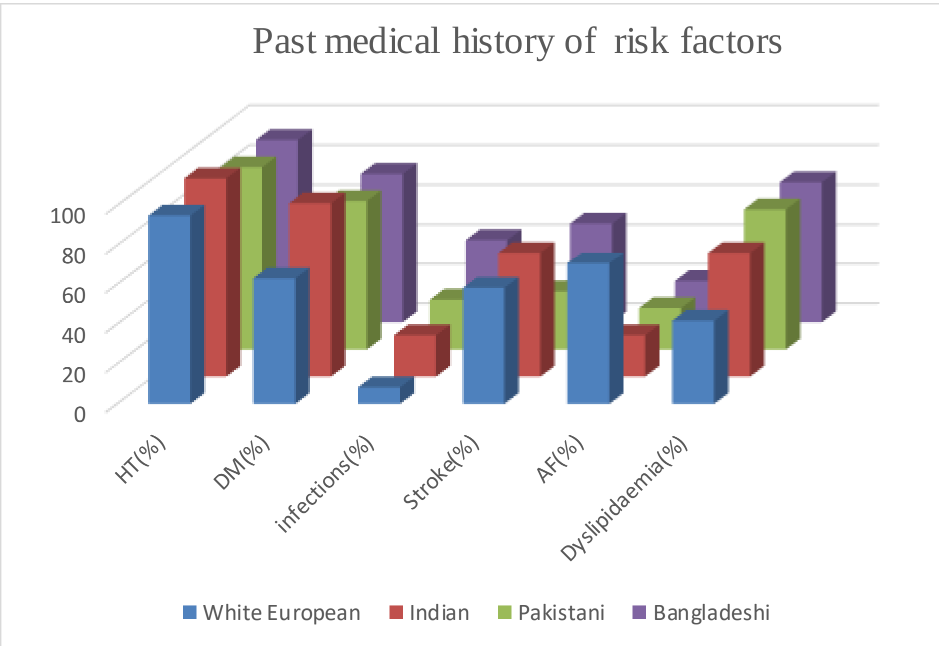

Figure 7.2: Past medical history of risk factors reported among stroke patient by ethnic group admitted at HEFT October 2014-April 2017

The analysis of variance (ANOVA) test was performed for BP, metabolic characteristics and lipid profile to explore ethnic differences across the four groups at the time of stroke (Table 7.4). Although none of the variables showed any statistically significant variation by ethnic group (Table 7.4), some trends are of interest. Both systolic (SBP) and diastolic (DBP) blood pressures were higher in South Asian groups, with the highest levels amongst Bangladeshis, despite the latter group being younger and lighter in weight than all other groups. Likewise, both fasting blood glucose and levels of HbA1c were higher among Bangladeshis as compared to the White European, Indian and Pakistani groups suggesting a greater predisposition to diabetes or worse diabetic control. The lipid profile in Bangladeshis suggests a tendency to much lower HDL-cholesterol levels (perhaps in part related to much higher smoking rates, especially in men) and higher triglycerides levels While, mean serum triglyceride levels in Bangladeshis were similar to the Indian and Pakistani group (Table 7.4).

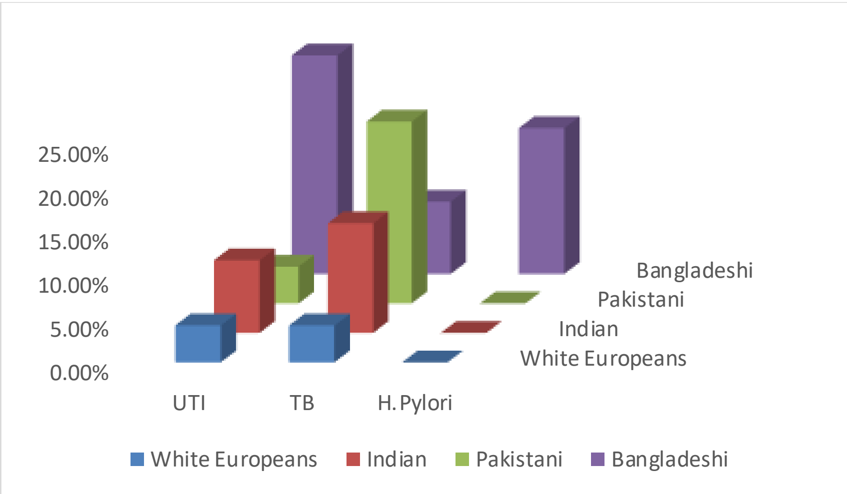

Figure 7.3: Past medical history of infections reported among stroke patient by ethnic group admitted at HEFT October 2014-April 2017

Metabolic syndrome is defined as the presence of at least three of the five following clinical features: elevated triglycerides, low high-density lipoprotein (HDL) cholesterol, elevated blood sugar, elevated blood pressure and elevated waist circumference (Lear and Gasevic, 2019). Metabolic syndrome is considered a simple tool to identify people with insulin resistance who are at risk of type 2 diabetes (T2D) and CVD. Even though Table 7.4 presents four of five clinical measures that define metabolic syndrome, it is lacking in standard definitions for clinical measurements due to the retrospective analysis of the case notes. The other reason for not considering metabolic syndrome was that there was inadequate information recorded in the case notes for each component of metabolic syndrome for each of the patients. For example, only 8 Bangladeshi patients and 7 White European patients had their HDL cholesterol recorded in their case notes (Table 7.4), and with this degree of missing data it was not possible to reliably decide whether patients met the criteria for metabolic syndrome, or not.

Table 7.4: Mean SBP & DBP, biochemical, metabolic and lipid profile of stroke patients at the time of stroke by ethnic group at HEFT Oct 2014-April 2017

	White Europeans			Indian			Pakistani			Bangladeshi			p-value
	N	Mean	S D	N	Mean	S. D	N	Mean	S. D	N	Mean	S. D	
SBP (mmHg)	24	156.0	26.02	24	164.4	27.03	24	149.5	28.9	24	167.1	34.30	.157
DBP (mmHg)	24	80.92	12.60	24	84.50	14.40	24	86.63	21.09	24	89.13	16.06	.376
Weight (kg)	20	76.89	16.82	20	72.95	11.95	20	74.33	15.69	13	65.68	13.10	.188
Serum glucose (mmol/l)	19	9.04	5.37	19	9.00	4.36	15	10.01	5.94	18.	14.4	17.0	.285
HB1Ac (%)	8	8.04	1.47	15	7.32	1.88	12	7.7	1.5	12.	13.9	2.1	.416
Serum urea (mmol/l)	15	10.77	7.09	12	9.01	7.32	14	9.51	5.57	12	7.38	2.04	.538
Serum creatinine (mmol/l)	17	172.5	207.1	12	139.9	117.8	13	170.2	247.6	10	105.3	23.8	.786
Serum Albumin	12	30.83	3.97	11	29.27	4.24	13	32.0	5.41	9	31.8	1.61	.402
Serum LDL (mmol/l)	6	2.90	1.49	8	2.58	.53	7	3.41	1.41	7	2.81	1.07	.576
Serum HDL (mmol/l)	7	1.25	.39	9	1.19	.30	9	1.06	.311	8	.94	.20	.225
Serum triglyceride (mmol/l)	9	1.64	.95	8	2.35	.82	9	2.21	.72	9	2.24	1.26	.427

The figure in Appendix 7.4 presents the individual serum glucose levels in stroke patients before, at and post-stroke. As a large number of readings before and after stroke were missing, detailed statistical analysis was not performed. The Bangladeshi group had the highest mean serum glucose level at the time of stroke (14.4 mmol/l) followed by the Pakistani, White European and Indian groups, although the mean values were not statistically different (Table 7.4).

Table 7.5 provides details of blood pressure patterns in stroke patients before, during and after a stroke by ethnic group. Although there are no statistical differences between ethnic groups, some interesting insights can be drawn. Systolic blood pressure is an important risk factor for stroke (Eastwood, *et al.*, 2015). It was found that at the time of stroke and post-stroke, Bangladeshis had the highest average and maximum systolic readings. This finding may suggest a plausible explanation for the high stroke mortality among Bangladeshi patients admitted with a stroke (Chapter 4).

Table 7.5: Mean SBP of stroke patients at HEFT by ethnic group, Oct 2014-April 2017 at three points (pre-stroke, at stroke and post-stroke)

	Means of Systolic blood pressure (mmHg) pre, at and post stroke				
	White Europeans (n=24)	Indian (n=24)	Pakistani (n=24)	Bangladeshi(n=24)	P value
Pre stroke					
Mean	152.8	153.4	143.4	150.3	.509
Std deviation	27.5	25.7	19.4	26.7	
Minimum	110	113	103	104	
Maximum	216	201	188	220	
At stroke					
Mean	156	164	149.5	167.1	.157
Std deviation	26	27	28.9	34.3	
Minimum	114	123	110	118	
Maximum	200	222	223	252	
Post stroke					
Mean	158.4	163.2	151.5	166.5	.455
Std.deviation	28.5	21.9	29.3	37.8	
Minimum	79	118	113	114	
Maximum	206	210	208	255	

Appendix Figures 7.5 and 7.6 present a time trend analysis (pre- and post-stroke) of blood pressure recordings among all stroke patients by ethnic group. Appendix Figure 7.5 shows systolic blood pressure trends in individual White European, Indian, Pakistani and Bangladeshi stroke patients. It shows raw data before processing in SPSS. It shows that the blood pressure readings at the time of stroke, and after stroke, were high among some Bangladeshi patients. Even though the number of patients was small it still gives an indication of the need for further research on time trends analysis of stroke patients by ethnic group. Appendix Figure 7.6 presents diastolic blood pressure readings by individual ethnic group. It shows similar patterns for diastolic blood pressure at the time and post-stroke among the South Asian group while White Europeans had a uniform pattern, i.e. a high-post stroke diastolic blood pressure.

7.3.3 Mixed model: linear analysis of systolic blood pressure

After descriptive analyses of individual-level data (Appendix 7.4 and 7.5) and calculation of the means for systolic blood pressure at the three time points (pre-, at and post-stroke), further analysis was undertaken to understand the pattern in systolic blood pressure readings in the Bangladeshi group compared with the other three groups (White European, Indian and Pakistani). To estimate the mean blood pressure profiles over time, I fitted a linear mixed model that included a random effects term for patients account for having multiple blood pressures readings from the same patient. Time point has been considered as a nominal variable to allow non-monotonic shapes over time. To allow for different mean profiles for different ethnic groups, the linear mixed model included an interaction term for ethnicity and time.

Ethnicity at timepoint (pre-, at and post-stroke):

The interaction between ethnicity and time was not statistically significant (p=0.381, Table 7.6) but this may be attributed to a small sample size. For example, the mean systolic blood pressure profile for Bangladeshis is different from the other ethnic groups though not significant statistically (Figure 7.4). The profiles from the linear mixed model are different from the raw data mean profile (Figure 7.4). This may be attributed to two Bangladeshi patients with very high post-stroke blood pressures which influenced the raw mean.

The global p value for ethnicity was not significant (p=0.197) but post-stroke some pairwise differences were significant (Table 7.6). Using the pre-stroke time point as a reference, the Bangladeshi group showed higher systolic blood pressures (SBP) compared to the other three ethnic groups (estimated differences: White European: -3.70 mmHg, Indian: -0.97 mmHg, Pakistani: -11.25 mmHg) but the differences were not statistically different. At the time of stroke, Bangladeshis had higher mean blood pressure than Pakistanis (mean difference= -7.34 mmHg), who had lower mean blood pressures than Indians and White Europeans, but the differences were not statistically significant. Post-stroke the Bangladeshi group had the lowest SBP, followed by Pakistanis, White Europeans and Indians, with the difference with Indians (difference=24.32 mmHg, p=0.026) and White Europeans (difference=21.16 mmHg, p=0.044) being statistically significant. The confidence intervals are, however, wide.

Table 7.6: Mixed model: systolic blood pressures time trend analysis by comparing Bangladeshi with other groups.

Predictor	Difference (95% CI)	p-value
Effects of ethnicity on SBP at different time points		
Ethnicity at pre- stroke		[0.197] ‡
White European	-3.70 (-22.17- 14.76)	0.963
Indian	-0.97(-19.43-17.50)	0.918
Pakistani	-11.25 (-29.26-6.77)	0.220
Bangladeshi†		
Ethnicity at stroke		
White European	7.75(-9.02- 24.52)	0.363
Indian	3.96 (-12.81- 20.73)	0.642
Pakistani	-7.34 (-24.47-9.80)	0.399
Bangladeshi†		
Ethnicity at post stroke		[0.197] ‡
White European	21.16 (0.61 to 41.70)	0.044
Indian	24.32 (2.90 to 45.73)	0.026
Pakistani	10.51 (-10.04 to 31.07)	0.315
Bangladeshi†		
Estimated time profile for different ethnic group		
Time profile for White European		[0.02] ‡
Pre-stroke	-14.33 (-32.93-4.27)	0.130
At stroke	6.17 (-11.06-23.40)	0.480
Post-stroke†		
Time profile for Indian		[0.02] ‡
Pre-stroke	-14.75 (-34.75-5.07)	0.144
At stroke	-0.78-(-19.04-14.47)	0.933
Post-stroke		
Time profile for Pakistani		[0.02] ‡
Pre-stroke	-11.23 (-29.25-6.80)	0.220
At stroke	1.73(-15.7- 19.16)	0.845
Post-stroke†		
Time profile for Bangladeshi		[0.02] ‡
Pre-stroke	10.53 (-6.17 to 27.24)	0.215
At stroke	19.58 (3.51 to 35.65)	0.017
Post-stroke†		
Time-Ethnicity interaction	-	[0.381]‡

† Baseline category ‡: Global p value, CI= Confidence interval

Time profile for ethnicity:

The mean systolic blood pressures pre-stroke, at time of stroke and post-stroke were unequal (p=0.02). Bangladeshis pre-stroke and at stroke had a higher systolic blood pressure than post-stroke, with the mean blood pressure difference between at-stroke and post-stroke being statistically significant (difference=19.58 mmHg, p=0.017).

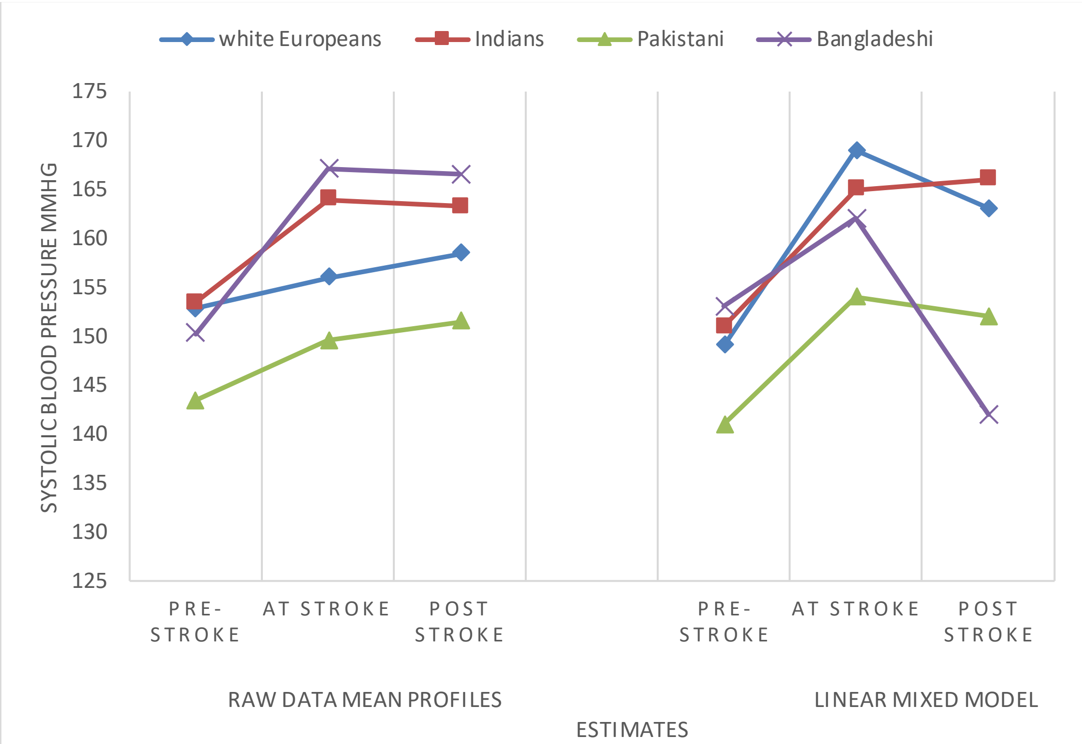

Figure 7.4: Mean SBP of stroke patients at HEFT Oct 2014-April 2017 at three points (Pre-, at and post-stroke): raw data profiles & linear mixed model estimates.

7.4 Discussion

7.4.1 Summary

In this retrospective case note analysis the main emphasis was to find whether there are any differences in the risk factors observed in patients from Bangladesh who have had a stroke in comparison with patients from other ethnic groups (White European, Indian and Pakistani), in a stroke unit in Birmingham. In the past, studies have been conducted on the prevalence of stroke risk factors in stroke patients and the general population (Chapter 4). This detailed case note analysis had the advantage of getting three readings by sub-groups of South Asians and at crucial time-points for the important variables although the sample size was small. In the South Asian group some risk factors were more common (such as a PMH of infection in Bangladeshis), some were less common (smoking in Bangladeshi women, consumption of alcohol in Bangladeshis) and some were at similar levels (PMH of diabetes, PMH of hypertension) compared to White Europeans.

Past medical history

This study collected variables beyond the traditional risk factors which has helped to understand the causes of stroke among Bangladeshis. For example, a past medical history plays an important role in the prognosis of stroke. One of the significant findings of this study was the prevalence of a PMH of infection among the Bangladeshi group. Acute infections, especially UTI,s have been reported to be associated not only with an increased risk of stroke but also with triggering cardiovascular events (Smeeth, *et al.*, 2004). A greater number of Bangladeshi had a past medical history of infection, which has been identified as an important stroke risk factor needing further exploration by ethnic group (Bhopal, *et al.*, 2005a). This finding is supported by previous studies, which have reported significantly higher plasma concentrations of IgG (immunoglobulin gamma - a marker of exposure to infection) in South Asians than in the White European population (Fischbacher *et al.*, 2003; Fischbacher *et al.*, 2004). This study supports the hypothesis that a history of infections among Bangladeshis is related to excess risk of stroke among them, although further large studies need to be conducted to test this hypothesis.

Another significant finding was a history of atrial fibrillation (AF), with a significantly higher number of White Europeans affected, and this is consistent with previous findings (Bourke, *et al.*, 2006). AF is reported to be relatively uncommon among South Asians compared to White Europeans (Bourke, *et al.*, 2006). AF, along with congestive cardiac failure (CCF) or coronary heart disease (CHD), doubles the risk of stroke in men and trebles the risk in women (Wolf, *et al.*, 1991). The famous Framingham heart study reported that atrial fibrillation was the sole cardiovascular condition to exert an independent effect on stroke incidence among persons aged 80-89 years (Wolf, *et al.*, 1991). Age could be one of the explanations for the high prevalence of AF among White Europeans compared to South Asians, as South Asians have stroke at a younger age than White Europeans (Mathur, *et al.*, 2013). Other reasons for the low prevalence of documented AF among non-Caucasians in Britain could be a lack of information on the prevalence of AF among them (Narayan, *et al.*, 1997), the prevalence of anticoagulant treatment, and the factors that influence doctors' decisions in treating AF, including the investigation of patients with this arrhythmia, which need further exploration by ethnic group (Cowan, *et al.*, 2013).

Smoking

This study has shown that a high proportion of patients who have had a stroke were cigarette smokers (White Europeans, 70.8%, Bangladeshi, 45.8%, Pakistani, 45.8%) in all groups except Indians (16.7%). This contrasts to the low prevalence of smoking in the population of England, which has reduced from 15.5% in 2016 to 14.9% in 2018 (Niblett, 2018). The high prevalence of smoking in this study could be explained based on its categorisation as smoker and non-smoker rather than current smoker, ex-smoker and non-smoker. Smoking rates differ in the general population by ethnic group and by sex as well; for example, White Europeans have higher prevalence of smoking compared to South Asian men (Banerjee, *et al.*, 2010). Within South Asian sub-groups, Indians have a significantly lower smoking prevalence compared to Bangladeshis and Pakistanis. Bangladeshi had a higher smoking rate (43%) than the national average of 27% in the UK (Karlsen, *et al.*, 2011).

In this study, Bangladeshi men had the highest proportion of male smokers (78%) compared to White Europeans, Indians and Pakistanis. However, there has been a transition in the prevalence among South Asians groups, with an increase in the number of smokers in the Pakistani community as compared to a previous study (White, *et al.*, 2006) which reported a significantly higher prevalence of smoking among Bangladeshi males (49%) compared to Pakistani males (28%). This study, along with previous studies (discussed in Chapters 4 and 5), reported lower rates of smoking among South Asian women compared to White Europeans. One study reported that the risk of stroke increases six-fold among smokers as compared to non-smokers (Bonita, *et al.*, 1999). This not only has an effect on the smokers but can also be associated with (all types of) stroke in the wife/partner of smokers (Qureshi, *et al.*, 2005). Bangladeshis also use tobacco in other forms (e.g. bedi) which need to be considered in stroke prevention strategies.

Hypertension

The study showed a similar distribution of hypertension in all four groups, but differences were observed in blood pressure readings and glucose levels among South Asians and White Europeans post-stroke. Though the prevalence of hypertension and diabetes were not statistically significantly different in this study, they are still considered as the leading risk factor in global CVD epidemiology (Battu, *et al.*, 2018). A history of hypertension can impact on blood pressure during a stroke and can worsen the outcome of stroke.

Hypertension is also a common cause of haemorrhagic stroke, which is reported to be more common among the South Asian population in a study by Potluri and Natalwala, (2009) mentioned in Chapter 4. In the last two decades a transition in the prevalence of hypertension has been reported, not only in White Europeans but also in South Asians (Qureshi, 2008). The systematic review (Chapter 4) and WHSS (Chapter 5) reported that hypertension was less common among Bangladeshi men and women than among Indians and Pakistanis.

In this study, an increased systolic blood pressure was observed among 75% of acute stroke patients. Elevation of the blood pressure above normal (>140/90 mmHg) is an acute hypertensive response within 24 hours of stroke (Qureshi, 2008).This could be due to several factors, including a pre-existing elevated blood pressure or undiagnosed hypertension (Alqadri, *et al.*, 2013). Other factors could be infection, stress related to hospitalization, pain, activation of cortisol, raised intracranial pressure and impaired cardiac baroreceptor sensitivity (Appleton, *et al.*, 2016).

At the time of stroke, the highest mean systolic blood pressure was observed in the White Europeans followed by Indian, Bangladeshi and Pakistani groups. This result is consistent with the previous evidence (Chapter, 4) where Bangladeshis have lower mean SBP and DBP (Bhopal, *et al.*, 1999; Primatesta, *et al.*, 2000) compared to Indians and Pakistanis which can be explained by the low BMI among Bangladeshis. The blood pressure monitoring among hypertensive patients at different time points (pre-, at and post-stroke) need further exploration in a large sample. This could be helpful to explain persistent high stroke mortality in Bangladeshis compared to White Europeans, even with low systolic blood pressure at the time of stroke (Bhopal, *et al.*, 2005b).

However, whether higher SBP should be lowered or not during an acute stroke is debated among professionals (Alqadri, *et al.*, 2013). Lowering systemic blood pressure may reduce cerebral blood flow, which could increase infarction in stroke patients (Alqadri, *et al.*, 2013). Any compromise of cerebral blood flow could potentially increase ischaemia of brain cells, adding further damage (Alqadri, *et al.*, 2013).

In this analysis, the results are presented in two ways. Firstly, we compared the means of raw data and secondly, by the use of a linear mixed model in SPSS, analysed statistical significances by ethnic group. The raw data analysis showed the highest mean SBP (at- and post-stroke) in the Bangladeshi group (Table 7.5). This is because all patients were included in the raw data analysis. However, in the linear mixed model analysis, the Bangladeshi patients who had excessively high blood pressures readings were removed as outliers (Figure 7.4). The results of the raw data analysis were likely skewed by the identified outliers. The study reported significant differences in post-stroke mean SBP (linear mixed model analysis), which was reported as being lower among Bangladeshis compared to White Europeans. This finding is consistent with previous findings, where Bangladeshis had a lower SBP compared to White Europeans (Agyemang & Bhopal, 2002). This finding is interesting, as the Bangladeshi group have a low mean SBP, yet still they have a higher stroke mortality compared to White Europeans. Another explanation for high stroke mortality among Bangladeshis could be the excessively increased SBP readings (at and post-stroke) in a certain proportion of people, which were removed as outliers in the statistical analysis as mentioned earlier. This shows that there is need to investigate the blood pressure readings in a large sample of Bangladeshi stroke patients, at- and post-stroke, to explore the impact of outliers (excessive SBP readings) on stroke outcomes, particularly in Bangladeshi patients who died within 30 days from the onset of stroke.

It is known that post-stroke high blood pressure is associated with poor outcomes such as recurrent stroke and death within 28 days of stroke (Leonardi-Bee, *et al.*, 2002). Also, data from the International Stroke Trial (IST) showed a direct relationship between post-stroke high SBP and mortality (Willmot, *et al.*, 2004). A large international trial Enhanced Control of Hypertension and Thrombolysis Stroke Study (ENCHANTED) reported that acute blood pressure management at the time of stroke reduces the risk of intracranial haemorrhage but does not affect or improve the functional outcome (Anderson, *et al.*, 2019). However, in Bangladeshis, despite their lower systolic blood pressure, a higher cerebrovascular mortality is reported. This paradoxical relationship can be explained by several factors including a high prevalence of smoking and PMH of infection among Bangladeshi men compared to White Europeans, Indians and Pakistanis. The other factors which could be associated with higher cerebrovascular mortality in South Asians reported by other researchers include adverse lipid profiles, lower levels of physical exercise and lower socioeconomic status among Bangladeshis (Battu, *et al.*, 2018). Apart from these, another important factor highlighted by researchers is hyperglycaemia in South Asians.

Serum glucose

Serum glucose at the time of stroke is an important determinant in the outcome of stroke especially amongst South Asians (Gray, *et al.*, 2007). As mentioned earlier, diabetes is an important modifiable traditional risk factor for stroke which is reported to be three times higher among South Asians as compared to White Europeans (Tillin, *et al.*, 2013).

Although the majority of stroke patients have diabetes at the time of stroke, Bangladeshi patients had a high mean serum glucose (mean 14.4 mmol/l) albeit, not statistically significant. This could be stress hyperglycaemia which plays a very important role in the outcome of stroke, such as dependency or intracerebral haemorrhage (Lindsberg & Roine, 2004)). Hyperglycaemia can be controlled but there is not enough evidence that this could minimise poor stroke outcomes (Lindsberg & Roine, 2004). Hyperglycaemia during stroke, and its impact on the outcome of stroke, need further exploration in detail.

From the retrospective case note analysis the duration of a diagnosis of diabetes and hypertension was observed but cannot be analysed for all groups due to missing data. It was reported that White Europeans develop diabetes and hypertension almost ten years later then South Asians (Barnett, *et al.*, 2006).

Metabolic syndrome

The pattern of traditional risk factors observed in this study are consistent with chapters 4 and 5, even though the results of this analysis are not statistically significant perhaps due to the small sample size. It shows heterogeneity in CVD risk factors at different time points within South Asian groups. It was observed that Bangladeshis had a similar prevalence of hypertension and diabetes but showed a unique lipid profile as mentioned in Chapter 5.

The cluster of metabolic syndrome features (high BP, hyperglycaemia and low HDLs and high triglycerides) occur more often among South Asians (Lear and Gasevic, 2019). It identifies people at increased risk of type 2 diabetes and CVD. As mentioned earlier the presence of the metabolic syndrome cannot be elicited in this study due to missing information within the clinical data. Still, it was evident that the Bangladeshi group had shown elevated blood glucose and low HDLs which can be the focus of future research. However careful consideration is needed while considering metabolic syndrome among South Asians, as its criteria differ according to race/ethnicity. The most commonly used definition considers waist circumference due to differences in visceral adipose tissue among different race/ethnic groups (Lear and Gasevic, 2019).

Bangladeshis tend to have a typical CVD risk factor profile: differences were observed in BP and serum glucose levels with no differences in prevalence of hypertension and diabetes. The unique lipid profile, along with hyperglycaemia and other metabolic syndrome factors, promote atherosclerosis, which decreases the blood flow through stenosis and is a major cause of CVD (Frostegard, 2013). This finding is supported by a study from Bangladesh, which shows a high proportion of dyslipidaemia not only among high-risk CVD participants but also among participants not at high risk of CVD (Fatema, *et al.*, 2014). Having a stroke at a younger age and a high rate of smoking may contribute to worse stroke outcomes in Bangladeshi patients. The INTERHEART study recommended that South Asians should have CVD risk factor assessment 10 years earlier than Caucasians to gain a better understanding of these differences (Yusuf, *et al.*, 2005).

Although this study aimed for age and sex matching, Bangladeshi patients were younger at the time of stroke compared to White Europeans. This could be due to the unavailability of case notes to match age and sex as planned.

7.4.2 Strengths

The main advantage of this study is that it focused exclusively on South Asian sub-groups, in particular on Bangladeshis, and compared them to the host White European population. All previous studies on stroke risk factor prevalence have been focused on South Asians as one group in the UK. This study was conducted in Birmingham, which has the largest number of Bangladeshis after London, while most of the previous studies were conducted in London. The retrospective study design allowed the collection of information on factors which contributed to stroke before it happened, without a huge expense. A prospective study would have been costly and time consuming. Risk factors were recorded not only at the time of stroke but also before and after stroke, and outcomes were compared between and within the groups. Finally, coding of ethnic group was confirmed manually by going through various sources mentioned earlier so no Bangladeshi patients were missed.

7.4.3: Limitations

The small sample size of 24 patients from each ethnic group is not representative of the populations and therefore the findings cannot be generalised. I could not sample in the ratio of 1:2:2:2 as planned (1 Bangladeshi to 2 each from other sub-groups) due to time limitations. The small sample size limited the statistical power of the study. If I had been able to increase the sample using a 1:2:2:2 ratio this would have increased the statistical power of the study to be able to detect any true differences between groups. Risk factors which just missed statistically significance in this study, such as diabetes and dyslipidaemia, could therefore be due to the small sample size. Furthermore, age and sex matching was as close as feasible but was not exact due to missing case notes, resulting in sampling of imperfectly matched patients.

As the sample size was small, sub-analyses by age group were not performed, which may have given a clearer picture of high and low readings by age group. Not all three time point readings were available for all patients.

A key weakness of the retrospective design was missing data for variables of interest which hampered detailed analyses of important variables. For example, there was limited information on variables such as HDL/LDL cholesterol readings, diet and employment status. All of the five components for the metabolic syndrome were also not available for each patient in the case notes. A prospective study design would have resulted in more complete data collection. Future prospective studies should aim to measure all the five components of the metabolic syndrome, so that the presence of the metabolic syndrome in patients who have had a stroke can be assessed for differences across ethnic groups. Also, height and weight was not available for all case notes, which hampered the BMI calculation for all patients.

The information available for some important variables were also not precise and standardised such as for smoking status, consumption of alcohol and social class. These variables could not be classified according to standard classifications due to missing information from the case notes. For example, employment status was usually referred to as employed or unemployed without further detail of their jobs, and the consumption of alcohol and cigarette smoking were measured as abstinence questions (Yes/No). Whereas, routinely, alcohol consumption is usually measured in terms of units per week (National Institute for Health & Clinical Excellence, 2011) and smoking in terms of number of cigarettes per day (Blank, *et al.,* 2016). Apart from cigarette smoking, information regarding duration of smoking, forms of smoking (e.g. bidi) and consumption of smokeless tobacco was not recorded routinely. This limits the estimation of the exact quantity of total tobacco consumed. It is an inherent limitation of retrospective research methods.

Furthermore, precise dates for the onset of infections was not recorded. Recording of date/s of infection and treatment (if any) would have helped to understand the association between the onset of infection and the occurrence of stroke. The small sample size does not allow for generalisation of the results, but it can generate hypotheses for future research.

7.4.4 Implications

The findings from this case note analysis are expected to draw the attention of healthcare providers and policy makers to the fact that, although the number was small, Bangladeshi patients had risk factors which are unique and distinguish them from other South Asian groups.

Further studies are needed to compare the risk factors and outcomes by first and second-generation migrants among Bangladeshi and other South Asian groups. The WHSS study (Chapter 5) which was conducted among first generation migrants, showed a high prevalence of hypertension and diabetes among South Asians as compared to White Europeans. This study was not classified by generation; it showed transition in risk factor prevalence, for example no significant differences were observed in the prevalence of hypertension by ethnic groups.

The major modifiable risk factors which have not been considered in this case note audit of stroke patients are consuming different forms of tobacco (Bidi) and diet. Exploration of these factors by ethnic group has been inadequate and needs further exploration. For future studies there is a need to collect the data on different forms of tobacco consumption by an accurate method (Abdullah, *et al.*, 2015). This could help to understand the relationship between amount of tobacco consumed and the development of stroke.

The findings from the case note audit warrant the need for prospective study on blood pressure readings at different time points (pre-stroke, at the time of stroke and post-stroke) among all stroke patients. Most of the hypertension studies conducted are among hypertensive or normotensive patients, and there is a need to compare the reading of stroke patients before, at and after stroke irrespective of their hypertensive status.

Future research should concentrate on exploring the relationship between potential risk factors in ethnic groups and outcomes of stroke at different points in time. This information will enable the planning of public health strategies for prevention, control and management of stroke according to ethnic group. Also, this may help to devise risk prediction models for South Asians.

There is a need to study Bangladeshi patients with metabolic syndrome and their risk of stroke, examining what makes them different from other groups with similar risk factors. In this study, all four groups had hypertension and diabetes but what made Bangladeshis different from the other three groups were the severity of comorbidities at and post-stroke, and the type of stroke. This requires a large sample size at different sites to compare the outcomes of stroke by ethnic groups.

7.4.5: Conclusion

In conclusion, the proportion of patients with hypertension and diabetes was similar in all ethnic groups but systolic blood pressure, along with serum glucose, not only differed between subgroups but also differed at different time points. Bangladeshis had lower mean SBP (post-stroke) compared to other ethnic groups. Higher blood pressure and serum glucose are the leading modifiable risk factors for stroke among South Asians (MacMahon, *et al.*, 1990). Along with these traditional risk factors, there is need for the exploration of novel risk factors such as a history of acute infection and passive smoking among South Asians, specifically among Bangladeshis.

The next chapter (Chapter 8) is an audit of the stroke pathway which will summarise important results from the patients' journey with stroke, including the outcome, by ethnic group.

Chapter 8: An Audit of the Acute Stroke pathway at Heart of England NHS Foundation Trust (HEFT) October 2014-April 2017

8.1 Introduction

Even though there has been a decrease in stroke mortality in England and Wales among Caucasians, the stroke mortality among South Asians has remained constant in the United Kingdom (UK) (Harding, *et al.*, 2008; Wasim, *et al.*, 2014). Also, in the past two decades both the disability adjusted life years (DALYs) and the number of stroke survivors have increased (Hankey, 2017).

"Time is brain" is the best way to describe the urgency around the management of stroke (Saver, 2006). It is a time-sensitive emergency; as stroke progresses, nervous tissue is rapidly lost which requires urgent action (Saver, 2006). As mentioned in earlier chapters, each year in the UK, 110,000 people have their first stroke, of whom almost 30-32% have recurrent strokes (Department of health, 2001). The greatest risk of recurrent stroke is in the first 30 days (Liao, 2007), which are more likely to be fatal and more disabling (Kalra, *et al.*, 2010). This makes secondary prevention an important goal in the management of stroke. It is estimated that around 10,000 recurrent strokes can be prevented every year in the UK if transient ischaemic attacks (TIA) and minor strokes are treated on time (Rothwell, *et al.*, 2007).

Stroke is a medical emergency which demands prompt admission to specialised stroke units (Jackson and Millward, 2014). An organised stroke unit, along with the planning of how to deliver specialised care, is an important factor in providing care to each individual patient. The multidisciplinary care plans which detail essential steps in the care of patients with a specific clinical problem are integrated care pathways (Rodgers and Price, 2018), which encourage the translation of national guidelines into local protocols and application to clinical practice. Multidisciplinary care plans are also a means of improving systematic collection and abstraction of clinical data for audit and of promoting change in practice, such as used in this study in a stroke unit (Campbell, *et al.*, 1998). A stroke pathway starts with an assessment of risk factors and continues with the management of stroke and "life after stroke".

In the United States (US) stroke pathways have been implemented since the 1980s in order to improve the efficiency of stroke care and reduce costs of hospitalisation (Huang, *et al.*, 2015), whereas in the UK, stroke pathways have been in practice since the 1990s with mixed results. Some reports suggest that stroke pathways might reduce the length of hospital stay, cost, complications and even mortality (Lanska, 1998). However, others report that their effects on the management of stroke are still unclear (Kwan and Sandercock, 2004). There is a lack of evidence on stroke management among ethnic minority groups (Bourke, *et al.*, 2006).

Specially organised stroke units providing dedicated care to stroke patients have been shown to improve the outcome of stroke patients (Kalra, *et al.*, 2010). Organised care with rapid 24-hour access not only saves lives but also reduces disability. This depends on two important factors: how effective stroke units are and how easily they are accessed by patients (Kalra, *et al.*, 2010). By definition, "a stroke unit is an area and environment of an organised and multidisciplinary care which ensures access to specialist medical, nursing and allied staff and treatment" (Tziotzios., *et al.*, 2011, no pagination).

The National Sentinel Stroke Audit for England, Wales and Northern Ireland reported a substantial increase in dedicated stroke units in hospitals from 79% to 91% from 2004 to 2006 (Kalra, *et al.*, 2010). In London, during 2010, the outcomes of stroke patients improved due to specialised care units and a centralised hyper-acute stroke unit (HASU). NHS England has advocated that this model should be rolled-out on a nationwide basis. (Jackson and Millward, 2014). Birmingham Clinical Commissioning Groups (CCGs) suggested if there is implementation of specialist stroke units in Birmingham, Solihull and the Black Country it will result in improvements in key standards such as CT scanning, access to a multidisciplinary team (MDT) and thrombolysis (Jackson and Millward, 2014).

There have been studies conducted in hospitals showing a specialized stroke unit can reduce mortality, disability and length of hospital stay (Rodgers and Price, 2018). To date there have been no studies conducted in the UK which have compared these outcomes by ethnic groups. In Heartlands Hospital, stroke services were reconfigured with a state-of-the-art specialist

'Hyper Acute Stroke Unit' (HASU) starting in October 2014. The HASU started with the objective of improving the care of stroke patients in the first 72 hours (Rogers, 2018). This remodelling of services has shown improvements in the majority of stroke care areas such length of hospital stay, since length of hospital stay is the single largest determinant of inpatient hospital cost which is 40% of total stroke cost in the UK (Saka, *et al.*, 2009).

Heartlands Hospital manages stroke patients using their acute stroke pathway which has been designed as per national clinical guidelines (Figure 8.1). They implement the standard Sentinel Stroke National Audit Programme (SSNAP) database which includes several variables (George, 2017). This chapter shares the sample population from Heartlands Hospital with Chapter 7. The principle aim of this audit was to understand a stroke patient's journey in the Bangladeshi community and compare them with Indians', Pakistanis' and White Europeans' journeys through the hospital (i.e. location(s), hours/days spent), the management of stroke and to identify if diagnostics errors were made that prolonged the journey. Other aims were to: (1) assess whether the outcome of stroke at discharge differs between Bangladeshi and other ethnic groups (White Europeans, Indian and Pakistani); and (2) to explore whether an organised stroke unit is beneficial in an equal way to patients from different ethnic groups.

The chapter is going to address the following questions:

- Are there differences in the stroke care pathway between patients from Bangladesh and other ethnic groups (White Europeans, Indian, Pakistani) in a stroke unit in Birmingham?
- Are there differences in the outcome from stroke between patients from Bangladesh and other ethnic groups (White Europeans, Indian and Pakistani) in a stroke unit in Birmingham?

The objective is as follows:

- To analyse stroke care pathways of patients of Bangladeshi background and compare them with the other ethnic groups.

8.2 Methods

8.2.1: Design and Sampling: This is a retrospective audit of the Acute Stroke Pathway at HEFT. It includes 96 patients from the 3170 admitted since the start of the new stroke unit in October 2014 up until May 2017. 24 Bangladeshi stroke patients were identified. This audit is a comparison of the 24 Bangladeshi patients with 24 Indian, 24 Pakistani and 24 White Europeans, who were partially matched by age and sex. Full details of the sampling strategy are given in Chapter 7.

The 96 patients were followed up through the care pathway from admission in the Emergency Department (ED) to discharge. The variables reported in Figure 8.1 and Table 8.1 were collected from the stroke data register available at HEFT. The stroke pathway was inserted into the medical notes of each stroke admission at HEFT as a paper document (Appendix 8.1). The data were extracted from the stroke database and case notes.

Ethnicity was established using a mixed approach of self-reported ethnicity from NHS registration data, self-reported ethnicity from case-notes, place of birth, language, religion, name and surname, and going through referral letters from the GP, as described in Chapter 7.

8.2.2: Acute Stroke Pathway: An acute stroke pathway is divided into time intervals, including time in the emergency department (ED), the first 24 hours, the first 72 hours and discharge (Figure 8.1). During each of these periods specific goals and expected progress are planned, together with appropriate investigations and treatment to meet national stroke guidelines such as SSNAP key indicators (Table 8.1).

The Sentinel Stroke National Audit Programme (SSNAP) is a major national healthcare quality improvement programme, which measures the processes of care provided to stroke patients against evidence-based standards including National Clinical Guidelines for Stroke (2016) (Kings Collage London, 2019). SSNAP is the single source of stroke data in England, Wales, and Northern Ireland (Kings Collage London, 2019). Data has been analysed according to the timeline of the pathway by using key indicators from SSNAP guidelines (Table 8.1).

Table 8.1: Summary of key indicators of acute stroke pathway (SSNAP)

Themes covered under pathway timeline
1: Scanning
2: Stroke unit
3: Thrombolysis
4: Specialist assessments
5: Occupational therapy
6: Physiotherapy
7: Speech & language therapy
8: MDT working (Multidisciplinary team)
9: Discharge

Source: SSNAP: Clinical audit August-November 2016 Public Report-March 2017

Figure 8.1– HEFT Flow Chart of the Acute Stroke Pathway

This chapter presents the results of a retrospective audit of the acute stroke pathway from October 2014 to May 2017.

<u>The audit questions that were addressed included:</u>

- How many patients with an acute stroke presented to the stroke unit at Heartlands Hospital?
- What proportion of patients with an acute stroke had a CT scan within the first 24 hours of stroke? Was there any ethnic variation?
- What proportion of patients with an acute stroke were assessed for thrombolysis and what proportion were thrombolysed? Were there any stroke patients not thrombolysed? Why were they not thrombolysed? Was there any ethnic variation?
- How long did it take for the patient to get from A&E to the Hyper-Acute Stroke Unit (HASU)? Did the patients go straight to HASU, or via other wards? Did it vary by ethnic group?
- What proportion of patients with stroke had Occupational Therapist (OT) / Physiotherapist/ Speech and Language Therapist (SLT) assessment within 72 hours of stroke? Did it vary by ethnicity?
- What proportion of patients with stroke had complications during hospital stay such as pneumonia, urinary tract infection, deep vein thrombosis and pressure sores? Did it vary by ethnicity?
- What proportion of patients with stroke had readmission or emergency department attendance? Did it vary by ethnicity?
- What was the range of length of hospital stay (LoS) in A&E and HASU? And was there any ethnic variation in LoS?
- What is the case fatality rate and dependency rate of stroke patients, and do these vary by ethnicity?

8.2.3: Ethical arrangements:

Ethical Approval: Before commencing the study, a research passport was obtained. The proposal was approved by the University of Warwick ethics committee (REGO-2016-1819). HEFT R&D department approval was also obtained before commencing the data collection (Appendix 8.2).

Confidentiality*:* It is imperative to maintain confidentiality. Any personal information about the patients were effectively protected at all times and was kept in a locked filing cabinet within the hospital premises.

8.2.4: Data processing and storage*:* All the data were processed on a HEFT computer located at Devon House at Birmingham Heartlands Hospital. Data were stored securely and anonymised in accordance with the Data Protection Act (1998). A unique participant number was assigned to each patient and then data extracted anonymously without personal identifiers. A list of the patients with their corresponding numbers was stored separately from the database on a drive which will be destroyed once the thesis is submitted and the audit is completed.

8.2.5: Statistical analysis

Statistical analysis was performed using SPSS software (version 25). Percentages were used to describe the proportions of risk factors for stroke and type of stroke. Means and standard deviations (SD) were used for continuous variables, and to summarize categorical data both the number and proportion were used. Pearson's chi-square tests for categorical variables were undertaken to examine the differences in the covariates between ethnic groups.

8.3 Results

Table 8.2 summarises the general characteristics of the 96 patients admitted to the stroke unit during October 2014 to April 2017. The characteristics of patients has been summarised in detail in chapter 7. The number of males were slightly higher compared to females (52:44). The majority of patients were diagnosed with an ischaemic stroke (IS) 87.5% (n=84/96) and 12.5% (n=12/96) had a haemorrhagic stroke (HS). There was a statistically significant difference in the type of stroke by ethnic group. *Post hoc* analysis using z-tests with Bonferroni correction showed that the Bangladeshi patients had a significantly higher proportion of patients with a haemorrhagic stroke (n=9/24) compared to White European (n=0/24), with no other significant differences.

The number of risk factors present at the time of stroke is in Table 8.2. Overall, 7% of patients had no risk factors at the time of stroke. The highest proportion of patients had one or two risk factors (44 %). 39% of patients had 3 to 5 risk factors at the time of stroke. There were higher proportion of White European patients in this category (n=16/24), followed by Bangladeshis and Pakistanis equally (8/24) (Table 8.2).

Table 8.2: Characteristics of patients admitted to HEFT October 2014-April 2017

	White Europeans (n=24)		Indian (n=24)		Pakistani (n=24)		Bangladeshi (n=24)		P value
Mean age at stroke (SD)	76 (9.3)		73 (10.8)		65 (12.6)		67 (13.9)		
Female (n, %)	9	37.5	14	58.3	11	45.8	10	41.7	.
Male (n, %)	15	62	10	41.7	13	54.2	14	58.3	.719
Type of stroke									
Ischaemic (n, %)	24	100	23	95.8	22	91.7	15	62.5	
Haemorrhagic (n, %)	0	0	1	4.2	2	8.3	9	37.5	>0.005
Number of risk factors									
No risk factors	1	4.3	1	4.3	3	12.5	2	8.3	
1 to 2 risk factors	7	29.2	16	66.7	14	58.3	14	58.3	0.081
3 to 5 risk factors	16	66.7	7	29.2	7	29.2	8	33.3	

1: Congestive cardiac failure 2: Hypertension 3: Diabetes mellitus 4: Atrial fibrillation 5: PMH/TIA

8.3.1: First four hours: DOOR TO NEEDLE TIME

The first hours after onset of stroke symptoms until the time to reach hospital is referred to as the 'door-to-needle time'. 40% of patients reached hospital within 4 hours of onset of symptoms. The percentage of Bangladeshi patients who arrived at hospital within 4 hours of symptoms (34%) was lower than White Europeans (50%), Indians (42%) and Pakistanis (42%) (Table 8.3), albeit this was not statistically different. 73% of patients arrived at hospital by ambulance. 79% of patients arrived at a stroke unit within 4 hours of hospital admission. 52% patients had a computerised tomography (CT) scan done within the first hour (Table 8.3) which is as per NICE recommendation (Rudd, 2016). The proportion of

CT scans done within 1 hour was statistically different across the four ethnic groups (chi-squared= 8.515, p=0.036). *Post hoc* analysis showed the White European were more likely to have a CT scan done within 1 hour (75%) compared to the Pakistani group (33.3%, p<0.05), with no other significant differences between the ethnic groups.

Table 8.3: Pathway parameters in first 4 hours by ethnic group in stroke patients admitted at HEFT from October 2014 to April 2017

Emergency Dept	White Europeans (24)		Indian (24)		Pakistani (24)		Bangladeshi (24)		Total (96)		P Value
	n	%	n	%	n	%	N	%	n	%	
Arrive by Ambulance	18	75	18	75	16	66.7	18	75	70	73	.889
Onset within hospital	2	8.3	1	4.0	2	7.4	0	0	5	5.2	.509
First Ward arrived SU	18	75	21	87	18	75	17	71	74	79	.547
Arrive at Hospital within 4hrs of symptoms	12	50	10	42	10	42	8	34	49	40	.590
CT within 1hrs of hospital admission	18	75	12	50	8	33	12	50	50	52	.036
CT within 4hrs of hospital admission	18	75	18	75	19	89	19	89	74	77	.980

Assessment for thrombolysis: The first 4.5 hours are crucial from a treatment point of view. Thrombolysis is a standard medical treatment for stroke within 4.5 hours (Thomalla *et al.*, 2018). In total, seven patients were thrombolysed in the audit. Of thsee seven patients, one was already in hospital prior to the onset of symptoms and one patient experienced complications with thrombolysis sustaining an intracranial haemorrhage (a Pakistani patient). Following stroke classification, haemorrhagic stroke patients were excluded from thrombolysis treatment. Table 8.4 shows the patients who were thrombolysed. It shows 7.3% were thrombolysed and 91.7% were not thrombolysed, either due to being outside the time window (55%) or due to having a haemorrhagic stroke (12.5%). Other reasons for not thrombolysing were listed as ‘co-morbidity’, ‘other medication which contraindicated their use’, ‘improving’ and ‘unknown time’ (Table 8.4).

Swallow Screen: The next test which needs to be done within 4 hours of stroke is a swallow screen (Rudd, 2016). As Table 8.4 shows, 73% of patients were screened for dysphagia within four hours of admission. There was no significant difference between the ethnic groups.

Table 8.4: Pathway parameter in first 4 hours by ethnic group in stroke patient admitted at HEFT from October 2014-April 2017

First 4 Hours	White Europeans (24)		Indian (24)		Pakistani (24)		Bangladeshi (24)		Total		P value
	n	%	n	%	n	%	n	%	N	%	
Type of stroke											
Ischaemic	24	100	23	96	22	92	15	62.5	84	87.5	<0.005
Haemorrhagic	0	0	1	4	2	8	9	37.5	12	12.5	
Thrombolysis	1	4.2	2	8.3	3	12.5	1	4.2	7	7.3	0.588
No thrombolysis BUT											
Haemorrhage	0	0	1	4.2	2	8.3	9	37.5	12	12.5	<0.005
Time window	12	50	12	50	15	62	14	58	53	55.3	.768
Co morbidity	3	12.5	4	16.7	2	8.3	1	4.2	10	10.4	.526
Medication	2	8.3	1	4.2	2	8.3	1	4.2	6	6.3	.871
Improving	4	16.7	5	20.8	2	8.3	2	8.3	13	13.5	.493
Mild severe	5	20.8	7	29.2	6	25.0	4	16.7	22	22,.9	.759
Unknown time	9	37.5	11	45.8	8	33.3	9	37.5	37	38.5	.841
Swallow screen within 4hrs	17	70.8	20	83.6	17	70.8	16	66.7	70	72.9	.594

Table 8.5 shows the NIH (National Institute of Health) stroke scale score at 24 hours (Lyden, 2017). This scale is important in determining the severity of stroke as it "provides a quantitative measure of stroke-related neurologic deficit" (Adams *et al.*, 1999). Although there is no significant difference in the scores between ethnic groups when considered as either a categorical (P=0.424) or a continuous variable (P=0.723) (Table 8.5), the number of

patients in the moderate to severe category was higher in the Bangladeshi group compared to the White Europeans (Figure 8.2).

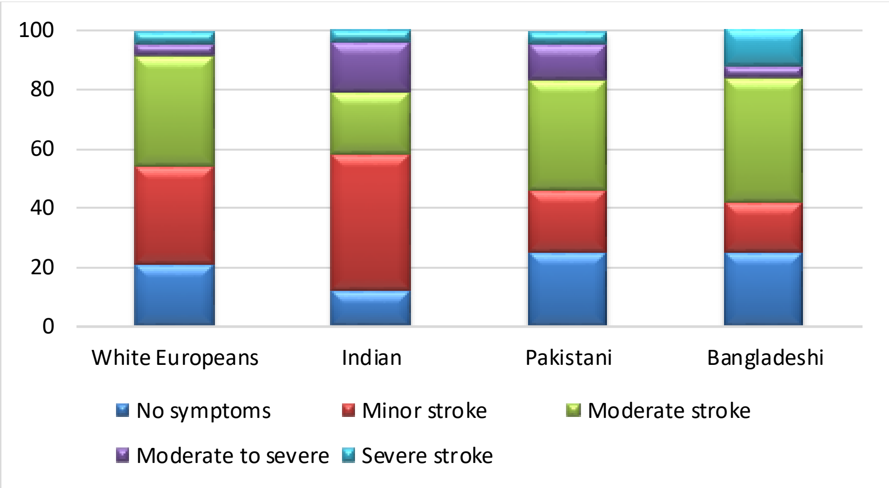

Figure 8.2: First 24hrs NIHSS score of patients admitted to Stroke unit at HEFT from October 2014- April 2017

Table 8.5: NIH Stroke Scale (NIHSS) in first 24 hours by ethnic group in stroke patient admitted at HEFT from October 2014-April 2017

NIHSSS in first 24 hours	White Europeans		Indian		Pakistani		Bangladeshi		Total	
Mean (SD) Median	5.4 (6.0) 3.5		6.7 (6.9) 4.0		6.5 (6.8) 5.5		7.7 (7.7) 6.0		P =0.723	
	n	%	n	%	n	%	n	%	n	%
No symptoms	05	21	03	12	06	25	06	25	20	21
Minor stroke	08	33	11	46	05	21	04	17	28	29
Moderate stroke	09	37	05	21	09	37	10	42	33	34
Moderate to severe	01	04	04	17	03	12	01	04	09	9.4
Severe stroke	01	4.2	01	4.2	01	4.2	03	12.5	06	6.3
									P=0.424	

Assessment by multi-disciplinary specialists (MDT) by 72 hours

More than 90% of patients were assessed by the stroke specialist nurse and consultant within 72 hours of hospital admission (Table 8.6). 82% of patients were assessed by an occupational therapist (OT) and 87% by a physiotherapist (PT) within 72 hours. Only 27% of patients were assessed by a speech and language therapist (SLT) within 72 hours of stroke. The swallow screen is recommended to be repeated within 72 hours for the assessment of dietary modification and instrumental examination (Rudd, 2016). 89% of patients were assessed by a specialist for dysphagia within 72 hours. Only one patient reported a UTI within 7 days of stroke. Antibiotics for pneumonia were administered to 8.3% of patients, of which the

majority were White Europeans (p<0.055). None of the assessments at 72 hours were statistically different between the ethnic groups.

Table 8.6: Pathway parameters in first 72 hours by ethnic group in stroke patients admitted at HEFT from October 2014- April 2017

Assessment at first 72 hours	White Europeans (24)		Indian (24)		Pakistani (24)		Bangladeshi (24)		Total (96)		p-value
	n	%	n	%	n	%	n	%	n	%	
Decision for palliative care	0	0	0	0	0	0	01	4.3	01	01	.387
Assessment by stroke nurse	22	92	22	92	22	92	22	92	88	92	1.00
Assessment by consultant	24	100	23	96	24	100	23	96	94	98	.560
Swallow screen	22	92	22	92	23	96	18	75	85	89	.109
OT assessment	21	87	22	92	19	79	16	67	78	82	.125
PT assessment	21	87	21	87	21	87	20	83	83	87	.966
SLT assessment	06	25	08	33	07	30	05	21	26	27	.788
UTI	01	4.3	00		00		00	00	1	1.1	.437
Antibiotics for Pneumonia	05	21	02	08	01	4.3	00	00	08	8.3	.055

At discharge: In total 92 patients were discharged out of 96 patients. Four patients died within seven days of their admission to the stroke unit (3 Bangladeshis, case fatality rate 12.5%; 1 Indian, case fatality rate 4%). At discharge, 97.8% of patients were assessed by an occupational therapist and a physiotherapist and 80% of patients were assessed by a speech and language therapist (Table 8.7), Almost 40% of patients were on a urinary incontinence plan at discharge, with no statistically significant difference between the ethnic groups (Table 8.7). This finding is consistent with the finding reported by Thomas *et al.* (2008). Dehydration and malnutrition are common after stroke, and dehydration is associated with poor outcomes (Rowat *et al.*, 2012). Malnutrition assessment by a dietitian was reported in 97.8% patients at discharge. Only 13.8% of patients had a mood assessment at discharge, with no significant differences across the ethnic groups (Table 8.7). 67% of patients had cognition screening at discharge, although for Bangladeshis the figure was 57%, and for White Europeans 71% (Table 8.7). Finally, 26% had achieved their rehabilitation goals at discharge. Again, there were no statistical differences observed across the ethnic groups.

Table 8.7: Pathway parameters in first 7 days /discharge hours by ethnic group in stroke patient admitted at HEFT from October 2014-April

	White Europeans (24)		Indian (23/24)		Pakistani (24)		Bangladeshi (21/24)		Total (92/96)		p-value
	n	%	n	%	N	%	n	%	n	%	
OT assessment	24	100	21	91	24	100	21	100	90	97.8	.105
PT assessment	24	100	21	91	24	100	21	100	90	97.8	.105
SLT assessment	19	79.2	21	91	21	87.5	17	80.9	78	84.7	.137
Urinary continence plan	09	37.5	08	34.7	10	41.7	10	47.6	37	40.2	.974
Malnutrition assessment	23	95.8	22	95.6	24	100	21	100	90	97.8	.303
Mood screening	04	16.7	02	8.6	06	25	01	4.2	13	14	.174
Palliative care at discharge	02	8.3	01	4.3	01	4.2	00	00	04	4.3	.575
Cognition screening	17	70.8	16	69.5	17	70.8	12	57	62	67.3	.298
Rehabilitation goals	07	29.2	06	26	03	12.5	08	38	24	26	.374

Length of Stay: Overall the average length of hospital stay was 8.7 days. White Europeans had the shortest length of stay (mean 5.5 days) followed by Bangladeshis and Indians, whereas Pakistanis had the longest length of stay (mean 12.2 days) (Table 8.8). At discharge, out of 92 patients, 35.6% were discharged home, 5.2% were discharged to a care home and 28.1% were discharged to a community team or early supported discharge (ESD). Among Bangladeshi patients, 57.1% were discharged home and 33.3% were discharged to a community team or ESD. The Pakistani patients had the highest proportion discharged to a community team / ESD.

The proportion of patients transferred to another hospital was significantly different between ethnic groups (Table 8.8), with the highest proportion amongst White Europeans (33.3%) compared to the Bangladeshi and Pakistani group (0%). Discharge to care homes was the least common of all discharge options (Table 8.8). 44.5% were discharged with the provision of support for activities of daily living (ADL). ADL help was statistically different between ethnic groups ($p<0.005$), with the highest proportion of patients who required help with ADLs being found in the Pakistani group.

Atrial fibrillation (AF) at discharge was statistically significant between ethnic groups ($p< 0.005$). The highest proportion was in White European patients (33.3%) as compared to Indians (4.3%) and Bangladeshis (9.5%) (Table 8.8). During the study period, 6 patients had recurrent stroke: three were Bangladeshi, two Pakistani and one Indian.

Table 8.8: Pathway parameters at discharge by ethnic group in stroke patients admitted at HEFT from October 2014-April 2017

Discharge	White Europeans (24)		Indian (23)		Pakistani (24)		Bangladeshi (21)		Total (96)		p-value
Length of stay Mean (SD)	5.5 (4.3)		9.7 (11.5)		12.2 (18.3)		7.0 (8.6)		8.7 (12.0)		0.269
	n	%	n	%	n	%	n	%	n	%	
Died within 7 days	0	0	1	4.3	0	0	3	12.5	4	4.2	
Discharge to home	7	30	8	34.7	7	30	12	57.1	34	35.6	
Discharge to care home	2	8.3	2	8.6	1	4.2	0	0	5	5.2	<0.005
Transferred to another hospital	8	33.3	3	13.0	0	0	0	0	11	11.5	
Transferred to another team	5	20.8	5	20.8	2	8.3	2	8.3	14	14.6	
Discharge (ESD)	2	8.3	5	17.9	14	58.3	7	33.3	27	28.1	
ADL help	6	25	8	34.7	17	71	10	47.6	41	44.5	0.001

AF at discharge	8	33.3	1	4.3	6	26.	2	9.5	17	25	<0.005
Recurrent stroke	0	0	1	4.3	2	8.3	3	14.2	6	6.2	

ESD: early supported discharge, ADL: activity of daily living, AF.: atrial fibrillation

Modified Rankin score (mRS) at discharge: mRS was calculated at the time of stroke and at discharge to assess the level of disability post-stroke. mRS at discharge is as important as it is at the start of treatment. At discharge, the proportion of patients in the moderate and severe disability category had increased compared to score at the time of stroke (Table 8.9). At discharge, category 6 was added as it shows the number of deaths. Mortality proportion was higher in Bangladeshis compared to other ethnic groups.

Table 8.9: Modified Rankin score at pre-stroke and at discharge by ethnic group in stroke patients admitted at HEFT from October 2014-April 2017

Modified Rankin score – Pre stroke	**White Europeans (24)**		**Indian (24)**		**Pakistani (24)**		**Bangladeshi (24)**		**Total (96)**	
	n	%	n	%	n	%	n	%	n	%
No symptoms -0	3	12.5	9	37	9	37	11	46	32	33.3
No significant disability-1	6	25	1	4	1	4	2	8	10	10.4
Slight disability-2	8	33	3	12	6	25	6	25	23	24
Moderate disability-3	5	21	8	33	7	29	4	17	24	25
Moderate to severe-4	1	4.2	1	4.2	0	0	1	4.2	3	3
Severe disability-5	1	4	2	8	1	4	0	0	4	4.2
									P=0.253	
Modified Rankin score –at discharge										
No symptoms-0	--		1	5.6	--		2	8.7	3	3.6
No significant disability-1	3	15.8	3	16.7	2	8.7	5	21.7	13	15.7
Slight disability-2	2	10.5	4	22.7	4	17.4	3	13	13	15.7
Moderate disability-3	6	31.6	--		8	35	4	17.4	18	21.7
Moderate to severe-4	2	10.6	6	33	3	13	2	8.7	13	15.7
Severe disability-5	6	31.6	3	16.7	6	26.1	4	17.4	19	23
Dead-6	--		1	5.6	--		3	13.0	4	4.8
									P=0.166	

After seven days, the severity of stroke can be calculated by using NIHSS. The level of consciousness from NIHSS is one of the mandatory components recorded in the SSNAP database. Table 8.10 summarises the worst level of consciousness in the first seven days. It suggests that 75% of patients in the first seven days were alert and responsive; 12.8% were not alert but arousable by stimulation; 4.3% were not alert but required continuous stimulation; and 7.4% responded only with motor reflexes or were totally unresponsive. There was no significant difference in 0-2 category by ethnic group; whereas category 3 had a higher proportion of Bangladeshi patients (p= 0.622).

Table 8.10 below: Worst level of consciousness (NIHSS) in first seven day in stroke patients admitted at HEFT from 2014-2017

Level of consciousness at 7 days	White Europeans (24)		Indian (24)		Pakistani (24)		Bangladeshi (24)		Total (96)		P value
	n	%	n	%	n	%	n	%	n	%	
0	19	79.2	16	72.7	19	79.2	17	70.8	71	75.5	.662
1	3	12.5	3	13.6	4	16.7	2	8.3	12	12.8	
2	1	4.2	2	9.1	0	0	1	4.2	4	4.3	
3	1	4.2	1	4.5	01	4.2	4	16.8	7	7.4	

0-Alert and responsive, 1-not alert but arousable, 2-not alert but require continuous stimulation 3-responded only with reflex motor or were totally unresponsive

8.4: Discussion

8.4.1: Summary

The main focus of this study was to evaluate the stroke care pathway in a stroke unit in Birmingham to find out whether there are differences between patients from Bangladesh and other ethnic groups (White Europeans, Indian, Pakistani). The study is the first to report the results of a stroke audit by ethnic groups in the UK. The study found some differences in stroke care and outcome according to ethnic groups; however, the small numbers prevent generalisation. For the past forty years, several studies have been conducted in industrialised countries to evaluate of stroke pathways in hospitals. To my knowledge, few studies have reported the management of stroke among South Asians in the UK (Bourke, *et al.*, 2006; Hsu *et al.*, 1999).

The secondary aim of the study was to explore the differences in the outcomes from stroke between patients from Bangladesh and other ethnic groups. Overall, the audit against the components of the care pathway mostly showed that it was similar across ethnic groups (i.e. not statistically significant). The study found that Bangladeshi patients had significantly worse outcomes after having a stroke with 13% (n=3) dying within seven days of stroke admission and 13% (n=3) having recurrent strokes during the study period, followed by 8.3%

(n=2) of Pakistanis with recurrent stroke. The outcome is supported by a review mentioned earlier (Gunarathne., *et al.*, 2009), which showed the South Asian stroke survivors reported poor outcomes compared with White Europeans. Another important distinguishing finding among the Bangladeshi patients was the higher proportion of patients with a haemorrhagic stroke (37.5%, n=9), compared to White Europeans, Indians and Pakistanis. Haemorrhagic strokes are associated with a higher mortality than ischaemic stroke (Andersen, *et al.*, 2009). Stroke case fatality within one month is 23% higher for haemorrhage stroke compared to ischaemic stroke (Feigin, *et al.*, 2003). There are three different types of stroke: ischaemic (IS), haemorrhagic (HS) and transient ischemic attacks (TIA) (Stroke Association, 2020). Ischaemic stroke occurs when the blood supply to the brain is cut off due arterial blockage. Haemorrhagic stroke occurs due to bleeding in or around the brain. Transient ischemic attacks (TIAs), often referred as a ‘mini stroke’, is the same as stroke except the duration of symptoms is short (less than 24 hours) (Stroke Association, 2020).

As mentioned earlier the burden of stroke types (ischaemic and haemorrhage) varies by region and over the time (Krishnamurthi, *et al.*, 2013). In this study, type of stroke varied by ethnic group as well. The findings in this study did not match the result of a previous study conducted in London (Bourke, *et al.*, 2006) which found a higher proportion of White patients with haemorrhagic stroke than Bangladeshi patients. A study included in Chapter 4 by Potluri and Natalwala (2009) was conducted in Birmingham; it reported an increased prevalence of haemorrhagic stroke among South Asians although they did not report analyses by individual South Asian grous. The advantage of the current study was the focus on individual South Asian groups which helped understand the true picture of excess haemorrhagic stroke in individual groups.

Others have found that the actual proportion of stroke subtype depends on the population. The management and outcome of stroke also differs for the type of stroke (Bhowmik, *et al.*, 2016). Generally, there is a higher prevalence of ischaemic stroke (80%) than haemorrhagic stroke (20%) in Western countries (Anderson, *et al.*, 2009), hence there are a lack of studies focussing on HS among ethnic minority groups in the UK. There are studies which show that the type of stroke varies not only with population, but also over the time in the same population. For example, the INTERSTROKE study of 22 countries, showed the proportion of IS was 66% and HS was 34% in Africa, whereas in high income countries it was 91% and

9% respectively. In Ghana, a study found a sharp decline in HS with an increasing trend of IS (Donkor, 2018). The reasons for this transition were not clear.

Though the higher proportion of HS among Bangladeshis in this study cannot be generalised due to the small sample size, it is consistent with the findings from studies from South Asian countries. A review by Krishnamurthi *et al.* (2013) supports this finding, reporting a 22% increase in the incidence of haemorrhagic stroke which was significantly high in younger populations in low- and middle-income countries (Krishnamurthi, *et al.*, 2013). Another review from South Asia, which included India, Pakistan, Bangladesh and Sri Lanka, also supports these findings, showing a higher percentage of HS (19-46%) compared to Western Countries (Wasay, *et al.*, 2015). Within South Asia, a higher percentage of HS, and stroke at a younger age, were reported in Bangladesh (Wasay, *et al.*, 2015). A study including European countries reported advanced age (85 years and above) as a risk factor for HS (Aguilar, *at el.*, 2011). As mentioned in chapter 4, cerebrovascular mortality in the Bangladeshi population in the UK is more common among younger age groups as compared to White Europeans (Wild, *et al.*, 2007). Studies from Bangladesh have found higher proportions of patients with IS but with a better prognosis compared to HS (Miah, *et al.*, 2008; Badiuzzaman, *et al.*, 2009).

A review from South Asia reported that uncontrolled hypertension could be an important risk factor for HS (Riaz, *et al.*, 2015). As detailed in chapter 7, beyond traditional risk factors there are some factors which differentiate Bangladeshi patients from Indian and Pakistani patients. There are a few studies which have been conducted in Bangladesh to find risk factors associated with each type of stroke. Factors such as a high salt consumption, low fruit consumption and high waist-to-hip ratio are significant risk factors for both types of stroke (Riaz, *et al.*, 2015). Hypertension, a family history of CVD death and aspirin intake contribute to HS (Riaz, *et al.*, 2015). Findings from the current study, along with the findings from Bangladesh, could help to understand the association of risk factors with the type of stroke among the Bangladeshi population living in the UK. Despite the small sample size in my study, there are no similar studies available which summarise the outcomes of stroke among Bangladeshi patients in the UK. Though the number of Bangladeshis are small, these distinguishing findings along with the findings from chapter 7 (lipid profile, blood pressure difference, glucose profile, low AF) portray a typical stroke profile of Bangladeshi patients compared with White Europeans, Indians and Pakistanis.

For Bangladeshi patients, many had no identified disabilities before the onset of stroke but at discharge had moderate to severe disability, or had died. There could be several possibilities underpinning these untoward outcomes in this group. Firstly, it could be a real effect. Secondly, it could be due to undiagnosed or poorly managed risk factors such as hypertension and diabetes. Thirdly, the severity of stroke could be due to the type of stroke, with the Bangladeshi group experiencing a greater proportion of HS, which has poorer outcomes compared to IS. Fourthly, it could be related to the small sample size or a non-representative sample.

Diabetes, vascular malformations in the brain and/or less explored factors such as betel nut chewing may have a symbiotic effect along with established risk factors for stroke and these would need further research. There are a few other indicators which have shown differences between the groups. Fewer Bangladeshi patients arrived at hospital within 4 hours of symptoms than White Europeans, although this was not statistically different. This could be explained by factors previously studied, such as lack of stroke awareness and language barriers which leads to late presentation of disease (Gerrish, 2001).

Furthermore, fewer Bangladeshi patients had a CT scan performed within one hour of hospital admission than White Europeans. This could significantly impact the management of stroke in accordance with the timeline. This finding is inconsistent with the finding of Bourke *et al.*, (2006) who reported neuroimaging (CT scan) being performed more often in Bangladeshi stroke patients.

Studies conducted on the management of stroke reported that Bangladeshi patients were less likely to receive thrombolysis treatment early compared to Caucasians (Barakat, *et al.*, 2003; Bourke, *et al.*, 2006), which was not found in the current study. Overall, the number of patients in this study who were thrombolysed within 4.5 hours was low, and there was no difference between White Europeans and South Asians. Around 40% of Bangladeshi patients were not eligible for thrombolysis treatment due to having had a haemorrhagic stroke. This was clearly reflected as poor outcomes later with mild to moderate disability or death at seven days in the Bangladeshi group. This diversity in the outcome of stroke is associated with severity and symptoms of stroke in patients, and mRS is the best tool to summarise this diversity (Kennedy *et al.*, 2016). Though there has been no significant difference in mRS scores observed between ethnic groups after stroke, the highest proportion of poor outcomes was observed in Bangladeshi patients. A study supporting this finding pooled data from nine randomized trials assessing the effect of alteplase in thrombolysis treatment on the outcome of stroke, reporting that earlier treatment with intravenous alteplase (within 4.5 hours) has greater benefit in terms of improved level of function (Kennedy, *et al.*, 2016).

There is a need to reduce time from door to needle - it is challenging but not impossible (Wardlaw, *et al.*, 2014). Though delays in door-to-needle times in Bangladeshis are not significant, they could be the explanation for a high proportion of recurrent strokes compared to White Europeans, since early treatment after stroke is associated with an 80% reduction in secondary stroke (Rothwell, *et al.*, 2007). This will reduce the poor outcome after stroke and ultimately reduce the cost associated with stroke. Important factors that could affect outcomes from onset of symptoms to hospital discharge are factors at the individual level and at clinical level (Lachkhem, *et al.*, 2018).

In terms of Bangladeshi patients, individual factors, such as knowledge of stroke, poor recognition of symptoms and unawareness of risk factors could account for the delay in hospital admission which could be due to a low level of education and language barriers. However, a study by Chaturvedi *et al.* (2003) reported there was no difference in perceptions of risk from chest pain in South Asians compared to Whites. This could be explained on the basis of how South Asians were defined. South Asians in this study were classified according to their religion which may not identify the Bangladeshi population precisely.

Apart from the type of stroke, dysphagia is an important independent predictor of mortality (Singh and Hamdy, 2006). Swallow screening is used in acute stroke patients to assess dysphagia which can cause aspiration pneumonia and malnutrition (Odderson, *et al.*, 1995). This could be one of the explanations for high stroke mortality among Bangladeshi men, as dysphagia after stroke results in a poor nutritional state which is certainly associated with increased stroke mortality, and this could be worse for undernourished patients (Teasell and Foley, 2005) . This finding, along with those above, could be important in solving the puzzle of high stroke mortality among Bangladeshi patients. As a group, Bangladeshi patients tend to be from lower socioeconomic groups which could be the reason for poor nutritional status, and this could add 'fuel to the fire' and lead to poor outcomes after stroke. This study showed a high proportion of swallow screens within 4 hours of admission to stroke unit, which increased over 72 hours among all groups with no statistical difference. The data were not available on the number of patients diagnosed with dysphagia following the swallow screen, which is a limitation.

Assessment by a specialist in the stroke unit increases the chances of recovery (Rodgers & Price, 2018). This study showed that a high proportion of patients in each group were assessed by a specialist in the first 24 hours of admission to stroke unit. The number of patients seen by a Speech and Language Therapist (SLT) was low compared to a Physiotherapist (PT) and Occupational Therapist (OT), which could be due to a national shortage of speech and language therapists in the UK (Rogers, 2018).

The average length of stay at stroke unit/ hospital at HEFT was lower compared to data (2006 to 2014) mentioned earlier from HEFT (Chapter 6). This could be because the current study used more recent data from the new hyperacute stroke unit (HASU) which now reflects coordinated multi-specialty team efforts. The length of hospital stay is influenced by the composition of the care team (Morris, *et al.,* 2014). Hence, the new stroke unit could be an explanation for reduced length of hospital stay. Another explanation for the shorter length of stay specifically for the Bangladeshi group could be a higher early stroke mortality or transfer to another hospital after the patient has been stabilised in the stroke unit.

The journey of stroke patients towards recovery and improved quality of life starts with rehabilitation after stroke. In this study, rehabilitation services were excellent in providing therapies to the patient, though mRS scores were poor among Bangladeshis compared to White Europeans. Again, this could be due to a communication barrier or aphasia, especially as the number of patients seen by a speech and language therapist was low. Therapists also contribute to early supported discharge (ESD) which provides rehabilitation to the patient in the community with mild to moderate disability with the help of multidisciplinary team.

8.4.2: Strengths

The main strength of this study was that the data were analysed by individual ethnic group rather than grouping South Asians into one unit, because South Asians (Indian, Pakistani and Bangladeshi) differ significantly in terms of diet, lifestyle and health related behaviours. Another strength of this study was that it used data from a stroke register with more than 40 indicators which allows detailed analysis of the clinical pathway at each timepoint. These indicators are not only included in the CCG outcome indicators but also in NICE standards.

Apart from the indicators, detailed information on outcomes and patient discharge was also available from the hospital dataset. The data were of a high quality as they were checked and signed off by a lead clinician. Though the number of patients were small, each case was explored in detail to gain a clear picture of the stroke pathway from admission to outcome at discharge by ethnic group. The study also analysed mortality data. Apart from data quality, data analysis was unique in producing results for the type of stroke among ethnic groups.

The study site had an advantage, as HEFT received stroke patients from three other hospitals in Birmingham. Rehabilitation data were also available at 72 hours, seven days, and at discharge, analysed by ethnic group, which helped to understand outcomes of stroke and its management by the multidisciplinary team. Including this level of detail in the audit provided further information on the role of ethnicity while considering pathway design.

8.4.3: Limitations

Retrospective case note analysis limits access to data collected by hospital. The reasons for missing data are unclear and cannot be rectified. For example, the swallow screen was reported as whether it was done or not, and not as whether patients had dysphagia, so it was process oriented.

Due to the small sample size, significant differences between important variables could not be demonstrated. Also, analysis by gender was not possible. The sample size was limited by the number of Bangladeshi patients who had been admitted for a stroke during the study period (n=24). The initial plan was to select two White European, two Indian and two Pakistani patients matched to each of the 24 Bangladeshi patients (sample 1:2:2:2), but due to time limitations only one patient from each ethnic group was selected for each Bangladeshi patient (sample 1:1:1:1). There were no audits carried out according to ethnicity before this study, and therefore I cannot compare the findings.

8.4.4: Implications and future recommendations

Implications of the study for stroke services

There are some differences found in Bangladeshi patients when compared to White Europeans but also to Indian and Pakistani groups, making them more prone to a poor outcome after stroke (though not statistically significant). The findings of the study are expected to draw the attention of clinical commissioning groups (CCGs). Perhaps there is a need to focus on recognition of the signs of stroke (e.g. FAST) to increase the proportion who arrive at hospital within 4 hours of symptoms. The West Midlands is an area where more people survive stroke, but with significant morbidity (Knight Jackson & Millward, 2014). Exploration of these outcomes by ethnic group will help to find the exact causes of poor outcomes in Bangladeshis and other ethnic minority groups living in the West Midlands. Extending this type of audit to other hospitals with a high number of Bangladeshi patients may provide a clearer picture of stroke epidemiology in this group.

A report published by the West Midlands Clinical Senate found that the single biggest factor that has the potential to improve patient outcomes following a stroke is the quality of the stroke unit (i.e. having the right skills and equipment). However, there are no specific guidelines for different ethnic groups. The present data may help to change the perception that the service provided by specialised stroke units will be effective for all stroke patients irrespective of their ethnic background. Hospitals are doing well in providing care according to national guidelines, however there is a need to consider stroke patients' age, ethnicity and clinical presentation, among other factors, when preparing stroke pathways. There is an important question that still needs to be explored in detail: do care pathways in an organised hyper acute stroke unit reduce mortality in Bangladeshi patients?

There is a need for further research which explores pre-stroke nutritional status and outcome after stroke. As care pathway data were used, the only relevant variable in this domain was a binary one showing how many patients were *assessed* for dysphagia. It would be helpful in the future to add a variable showing whether or not patients had dysphagia and to assess whether there is an association between dysphagia and stroke mortality among Bangladeshi patients. This finding could be important in understanding the high stroke mortality among Bangladeshis.

Implications for Future Research

Traditionally research has focused on the management of stroke in general, yet there is need for ethnic group-specific studies focusing on pre- and post-stroke pathways to observe the outcome of stroke by ethnic group. In the UK, with an increasing size of ethnic minority groups, a targeted approach to prevention, treatment and management of stroke should be adopted for ethnic groups with a high stroke mortality, such as Bangladeshi men who have a three-fold higher stroke mortality compared to White Europeans (Gunarathanre, *et al.*, 2008).

To find the mechanism of high stroke mortality among Bangladeshis, greater coordination between primary and secondary care could result in better outcome. There is a need for further research which can compare prospective data with previous data (data from before stroke units) to explore the impact of multispecialty acute stroke units on outcomes by ethnic groups. The results of the current study cannot be generalized but it could be the initial step for a larger prospective study.

A higher incidence of haemorrhagic strokes as compared to ischemic strokes, and a higher stroke mortality among Bangladeshis compared to other ethnic groups, need to be explored in detail. Also, there is a need to compare the trends of stroke subtype and excess mortality among them in the UK. At present, there is a paucity of studies on subtype of stroke among Bangladeshis (as mentioned in Chapter 4). This study could give a new direction for research, to find the causes of excess mortality among Bangladeshi, focusing on types of stroke and the risk factors. The situation can be improved for these patients by preventing novel risk factors which lead to worse outcomes after stroke, such as tobacco chewing and smoking.

For future research purposes, each South Asian group needs to be considered individually, rather than combining them which may result in biased outcome.

To conclude, this study shows that the clinical presentation and outcome of stroke differed in some aspects by ethnic group. The findings are consistent with those found in chapter 7. Chen (2013) reported that stroke affects younger and older patients in a different manner; similarly this study shows stroke affects ethnic groups in a different manner. Specifically, the Bangladeshi group showed differences in the underlying risk factors but also for the type of stroke affecting them. The differences found in this study among Bangladeshis and other South Asians have also been noticed in South Asia (Wasay., *et al.*, 2014).

Chapter 9: General Discussion

9.1 Overview

This chapter aims to summarise the key findings of this thesis and consider future implications. It also provides a summary of the overall strengths and weaknesses of the research and gives recommendations for future research in terms of epidemiology, clinical practice and public health interventions.

In this thesis, I have aimed to generate new evidence and to fill the gap in current knowledge on stroke among South Asians, in particular the Bangladeshi population, compared with that of White European, Indian and Pakistani groups in the United Kingdom (UK). The thesis consisted of a systematic review (Chapter 4) followed by a series of studies comprising secondary data analysis of the Wandsworth Heart and Stroke Study (WHSS) (Chapter 5), analysis of hospital data on stroke admissions requested under the Freedom of Information Act (Chapter 6) and finally a retrospective case note analysis and an audit of the acute stroke pathway of stroke patients admitted to Heartlands Hospital in Birmingham (Chapters 7 and 8).

Birmingham has been declared as a ‘super-diverse’ city (Gulliver & Prentice, 2015). In the past 15 years, Birmingham has witnessed a substantial increase in the size of the Bangladeshi community by 50%, thereby making Birmingham the largest home for the Bangladeshi population outside of London (Simpson, 2012). This increase has largely been attributed to increased fertility and a reduction in mortality among Bangladeshis (Simpson, 2012).

The findings in this thesis are consistent with that of previous studies and support the assertion that the South Asian (specifically Bangladeshi) population have significant differences in their cardiovascular and stroke risk profiles compared with White Europeans. These differences were encountered in WHSS (Chapter 5) and the Heartland dataset (Chapter 7). Although the WHSS data is not recent (1994-96), it was conducted in the general population and the data was closer to the time of migration providing a baseline comparator for any subsequent studies. The earlier analysis performed by using WHSS data (Cappuccio, *et al.*, 1998) considered South Asians as a single group, while in this thesis data were analysed for South Asian subgroups. Whilst the WHSS study was conducted in London and the case note analysis (2014-2017) was carried out in Birmingham. The common factor

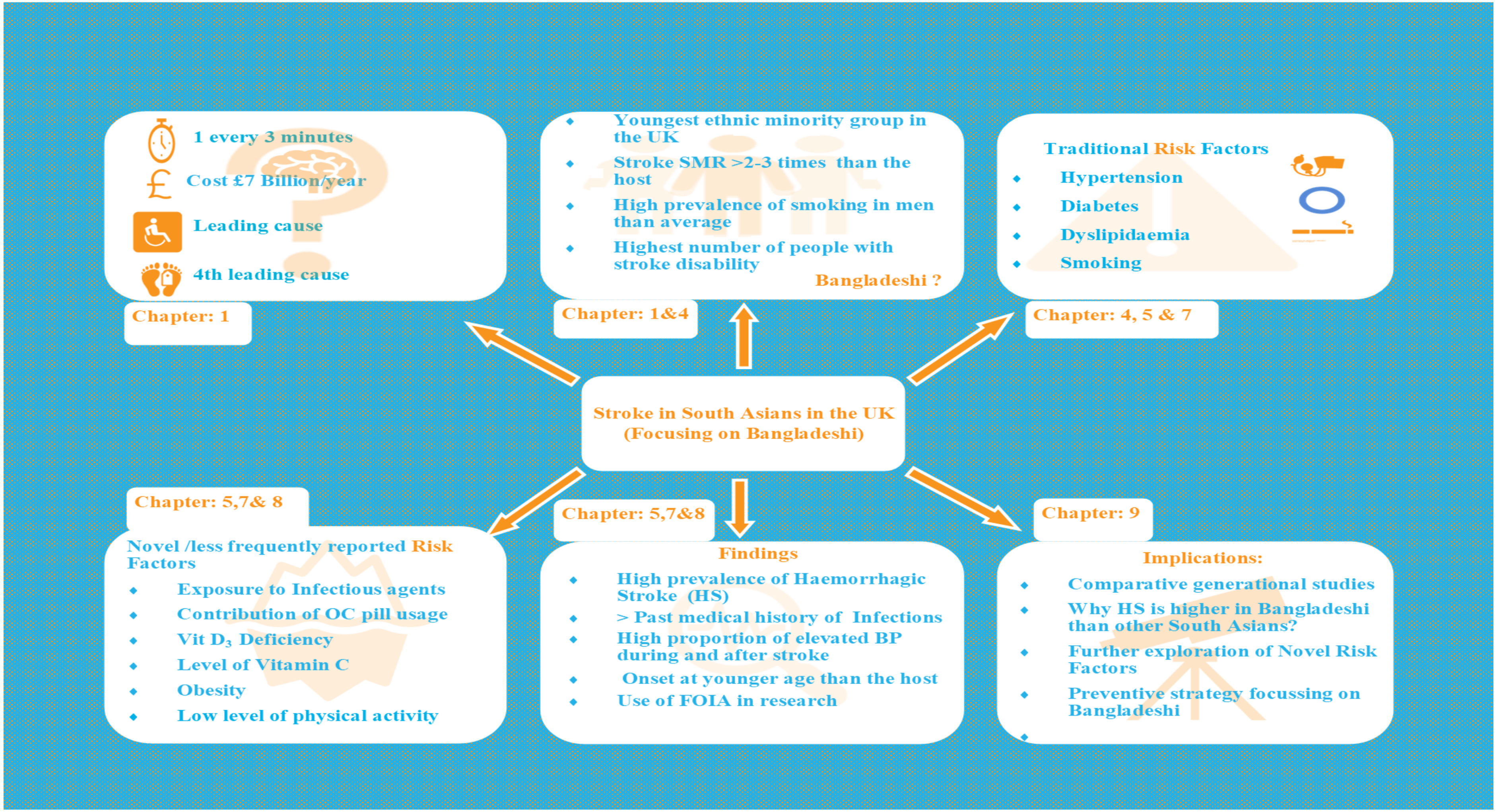

Figure 9.1: Thesis summary infographic

in both studies is the heterogeneity in CVD/stroke risk factors among South Asian sub-groups (whether they have disease or not).

Figure 9.1 visually summarises the main findings from the various studies presented in the chapters, which suggest that there are differences between the South Asian /Bangladeshi and White European groups. However, the differences are not statistically significant for all risk factors, which can be explained by the small sample sizes in this study.

9.2 Emerging findings and implications

The main themes which have emerged from this thesis are as follows:

- Lack of literature: Although the Bangladeshi population has a higher stroke mortality compared to White Europeans, there is a lack of studies on the epidemiology of stroke among Bangladeshi groups in the UK (Chapter 4).

- Traditional risk factors: The studies available in the published literature were mainly focused on traditional risk factors (hypertension, diabetes and hypocholesterolaemia) among South Asians, with a few exceptions (Chapter 4).

- Non-traditional/novel risk factors among stroke patients: There is a similar prevalence of major risk factors for stroke amongst South Asians and White Europeans, but South Asians have some novel risk factors in addition to traditional risk factors (PMH of infection, use of oral contraceptive pills)

- The type of stroke: One of the main new findings of the audit was that the Bangladeshi population had a greater proportion of haemorrhagic strokes versus ischaemic strokes, compared to the White European group, which was statistically significant. This warrants an urgent exploration regarding the type of stroke in large-scale epidemiological studies across different ethnicities.

- Pathophysiology of stroke: There is a need to understand the higher mortality among Bangladeshi men with a detailed exploration of novel risk factors and stroke pathophysiology. Pathophysiology can help to explore the relation between ethnicity and risk factors.

9.2.1 Lack of literature

The systematic review (Chapter 4) confirmed that there is a gap in the knowledge of stroke in the Bangladeshi population in the UK. It showed that in the past three decades researchers have focused on the aetiology of stroke specifically focusing on the prevalence of risk factors and mortality in South Asians (Chaturvedi, 2003) but there are a lack of population-based studies on the incidence and prevalence of stroke specifically in the Bangladeshi population.

The systematic review in this thesis is the first to my knowledge to focus on stroke in the South Asian/Bangladeshi populations living in the UK. Over the last few decades, the UK has vastly contributed to international research in CVD among South Asians with evidence of high cerebrovascular death among Bangladeshi (Cainzos-Achirica *et al.*, 2019). Still, there is a lack of studies conducted in this group specifically, which could explain the previous absence of systematic reviews focussing on stroke in South Asians/Bangladeshis in the UK.

Apart from a lack of research in ethnic minority groups, hospital and GP records lack information on patients from ethnic minority groups suggesting poor or insufficient data collection. Important risk factors which include smoking status among stroke patients, and use of drugs and alcohol consumption, are not always reported completely. While doing the FOIA analysis, it was apparent that hospital data collected by stroke data officers lacks standardisation according to national guidelines. In the FOIA data the coding of ethnicity varied between the hospitals and some outcome variables were incomplete, such as stroke mortality data. If data had been recorded using a standardised format in all hospitals across the nation, then this could have been valuable resource under FOIA to compare the outcomes of stroke between different hospitals.

In the case note analysis and audit, the variables collected were not systematically available except for stroke pathway data, which was collected on the stroke database for SSNAP (Sentinel Stroke National Audit Programme). Still, they were missing some important information such as country of birth, height and weight, BMI, smoking status, lipid profile and CVD risk scores. These are important variables which can help to predict the risk of stroke among South Asians. The quality and completeness of data on ethnicity needs further attention.

In this thesis, along with the aetiology of stroke, emphasis was given to the management of stroke. The published literature is limited on the management of stroke among South Asians in the UK, with only a small number of studies available (Bourke, *et al.*, 2006; Hsu *et al.*, 1999). There is a large national database monitoring stroke services (SSNAP) however it lacks analysis by ethnic group. One of the advantages of the thesis was the initial analysis of data via the FOIA (Chapter 6), which provided an initial picture of stroke management among stroke patients in Birmingham and Solihull. Though the data were aggregate and coding of ethnicity was not uniform between the three hospitals, some important findings were obtained to help understand the management of stroke patients by ethnic group, such as length of hospital stay and the total number of stroke patients admitted and discharged. In chapter 8, detailed analysis of the stroke care pathway was conducted which explored the factors associated with the management of stroke among ethnic groups. In contrast to previous findings, the management of stroke was similar among all stroke patients irrespective of ethnicity. There were a few exceptions, which are not a direct part of hospital management, such as a delay in reaching A&E. This can directly delay access to treatment and could lead to worse stroke outcomes.

9.2.2 Traditional risk factors

An emphasis in this thesis was the exploration of risk factors associated with stroke in the Bangladeshi population due to their persistently high stroke mortality compared to other ethnic groups in the UK. As the prevention of stroke starts with the modification of risk factors, an understanding of these risk factors is one of the fundamental pillars of stroke prevention and treatment (Romero, *et al.*, 2008).

In the systematic review (Chapter 4), the majority of included studies reported a higher prevalence of diabetes and hypertension among South Asians compared to White Europeans (both in the general population, and in the population who have had a stroke or CVD). However, in Chapter 7, the prevalence of hypertension and diabetes was reported to be similar or non-significantly different among stroke patients irrespective of their ethnicity.

This could be because of the changing pattern of risk factors among the general population, as in England the proportion of the population with hypertension increases from 5% in men and 1% in women aged 16 to 24 years, to 58% in men and women aged 65 to 74 years (Public Health England, 2017). The point which needs further exploration is the connection between the duration of risk factors and the incidence of stroke. South Asians are susceptible to CVD risk factors at an earlier age, and therefore a longer duration of these risk factors may impact on the outcome of stroke in South Asians.

Hypertension and diabetes are reported as common risk factors for stroke among all stroke patients irrespective of their ethnicity. However, there is a lack of studies on the association between blood pressure constituents such as SBP and DBP, and its differences among sub-groups of South Asians and White Europeans, before and after stroke. In this thesis, although the sample size was small and statistically insignificant, differences in systolic and diastolic blood pressure were reported. It has been established that there is an association between increased SBP and risk of CHD/stroke among South Asians in the UK and other countries as well (O'Donnell, *et al.*, 2010). The evidence shows that a 2 mmHg rise in systolic BP increases the risk of stroke by 6% (Eastwood, *et al*, 2015). However, further analysis by sub-group shows that Bangladeshis differ from Indians and Pakistanis by having lower mean SBP. This finding is consistent with the finding in this thesis (Chapter 7). Despite low SBP and a low proportion of obesity amongst the Bangladeshi population, they still have a high mortality from stroke. Although blood pressure is an important causative factor for stroke, it still cannot explain excess mortality among Bangladeshis. There are other factors which need consideration among diabetic Bangladeshis, such as the impact of other CVD risk factors including genetics and a family history of CVD.

Diabetes is the second strongest traditional risk factor for CVD and is the most frequently studied among South Asians. It also shows a unique pattern of susceptibility and severity among South Asian subgroups (Gunarathne, *et al.*, 2009). Bangladeshis are reported to have hyperglycaemia and a high prevalence of diabetes, which causes 50-100% more CVD (Bhopal, 2019). However, there is still a lack of studies on the influence of hyperglycaemia on BP before and during stroke among South Asian sub-groups in the UK. In this thesis there were differences reported in glucose levels within South Asian subgroups (Chapter 4). It is established that diabetes is associated with a poor outcome in CVD and contributes to premature mortality (Barnett, *et al.*, 2006). There is progress on evidence-based knowledge of hypertension and diabetes in South Asians (Chapter 4) but there is a lack of evidence on the impact of their constituents (SBP, DBP and glucose level) on individual South Asian groups. Another reason for high mortality among South Asians could be the pathophysiology which has roots in the genetic makeup of South Asians. Other important factors in South Asians which, together with diabetes, increase their excess risk of CVD are abdominal obesity, low physical activity and low consumption of fruit and vegetables. As mentioned earlier (Chapter 7), diabetes and cardiometabolic risk factors contribute to metabolic syndrome in South Asians, which is linked to insulin resistance (Volgman, *et al.*, 2018). There is a need for further research in South Asian subgroups by considering diabetes and its progress to metabolic syndrome.

Insulin resistance and hyperinsulinemia play an important role in developing type 2 diabetes and the increased risk of CHD (Wannamethee, *et al.*, 2000). As mentioned earlier, insulin resistance is a component of the metabolic syndrome, which includes hyperinsulinemia, dyslipidaemia, hypertension and glucose intolerance (Chopra, 2020). It is evident that regular exercise increases insulin sensitivity and reduces hyperinsulinemia (Wannamethee, *et al.*, 2000). Although the metabolic syndrome was not considered during the main data analysis in this thesis due to inadequate information, the importance of metabolic factors among South Asians are highlighted for consideration in future studies. All of the components of the metabolic syndrome are interrelated and may contribute to the higher CHD and diabetes prevalence among South Asians (Misra, *et al.*, 2018). It is therefore important to investigate the role of the metabolic syndrome in the development of CVD in South Asians. Overall, South Asians have a high prevalence of metabolic syndrome (Misra, *et al.*, 2018), but studies are needed to focus on the progression from metabolic syndrome to CVD.

Other traditional risk factors which are less frequently studied are obesity, physical inactivity, metabolic syndrome, and the effect of smoking on individual South Asian subgroups and early age at onset of disease. These risk factors are reported but have not been previously explored in detail. The systematic review summarised all CVD risk factors reported in South Asians in the UK, including both traditional and less commonly reported risk factors. Few studies reported obesity and the level of exercise. There is a strong association between CVD, insulin resistance and physical inactivity. Physical inactivity is an independent risk factor for diabetes among South Asians (Bhatnagar, *et al.*, 2016). It is evident from the systematic review (Chapter 4) and the Wandsworth study (Chapter 5) in this thesis that South Asians are less physically active compared to White Europeans in the UK. Among South Asians, it is reported that Bangladeshi men and women have the lowest proportion who are classified as physically active (Harding, *et al.*, 2008). This is supported by the evidence from the review by Bhatnagar and colleagues (2016), who reported that Bangladeshi men and women had the lowest level of physical activity compared to Indian and Pakistani groups. The lower level of physical activity among South Asians is similar in other countries such as Canada and the USA (Volgman, *et al.*, 2018), as well as in Bangladesh (Fatema, 2014). It is well established that regular physical activity is associated with a reduction in CHD and type 2 diabetes risk (Wannamethee, *et al.*, 2000). Future studies of risk factors need to include the level of physical activity among Bangladeshis due to their high prevalence of CHD and diabetes.

9.2.3 Novel/non-traditional risk profile among stroke patients

The thesis has explored all possible risk factors available in the data used and the published literature to further explore the heterogeneity within the South Asian group. An iceberg best illustrates the current knowledge of known risk factors, and those which are still under consideration among the Bangladeshi population in the UK (Figure 9.2). The tip of the iceberg represents the risk factors which are studied by researchers frequently and the submerged part represents risk factors which are recommended to be explored in further detail.

The risk factors which are marked by a red star in Figure 9.2 have been explored in this thesis and the remaining ones urgently need attention. These include the role of diet, vitamin D deficiency, level of exercise, alcohol consumption, past medical/family history of CVD/CHD, socioeconomic factors and chewing of different forms of tobacco. Chapter 5 (WHSS) reported novel risk factors such as the use of oral contraceptive pills (OCP), vitamin C levels, diet, hormone replacement therapy (HRT) and homocysteine levels. Although not all of them were statistically significant, they add knowledge to the current base evidence. Chapter 7 also reported significantly higher proportions of a PMH of infection among the Bangladeshi group as compared to White Europeans.

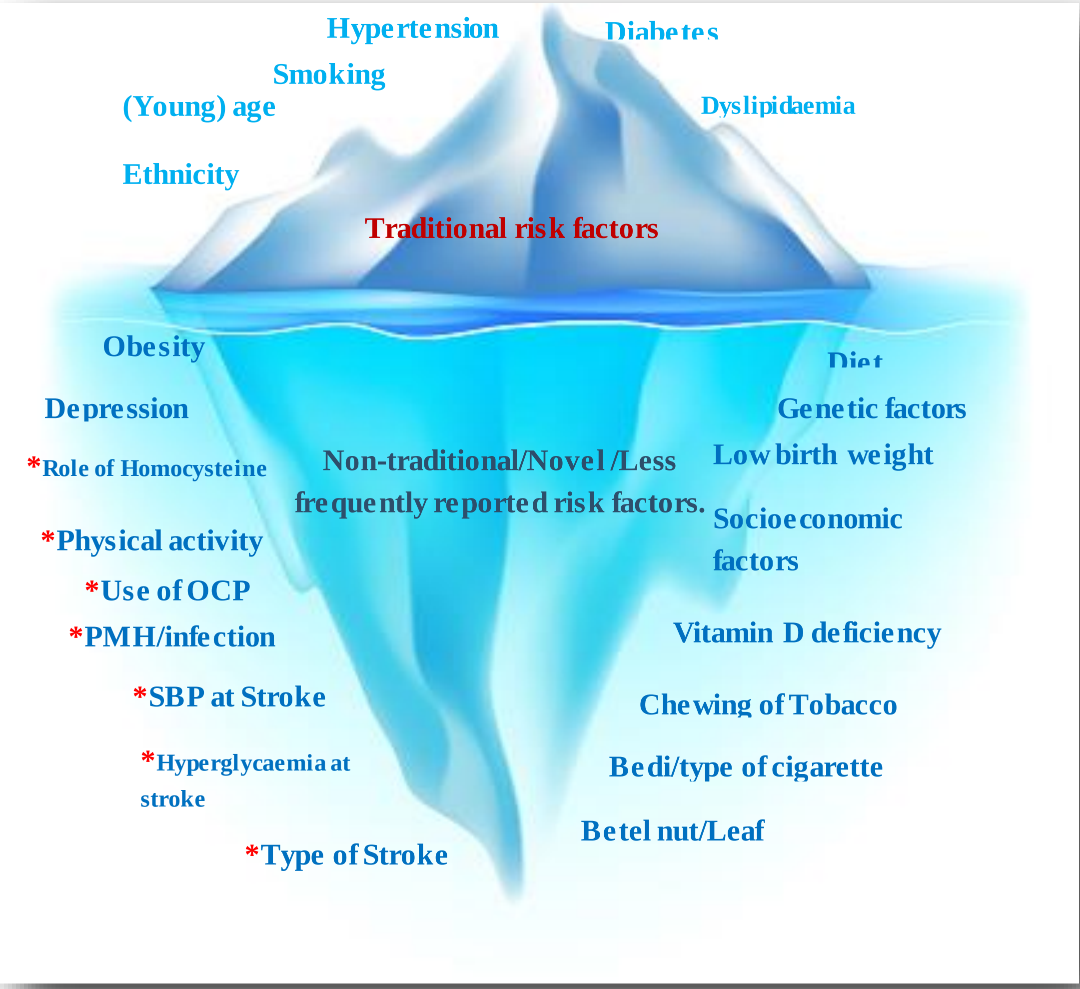

Figure 9.2: Iceberg phenomenon: risk factors associated with stroke amongst the Bangladeshi population.

(The tip of the iceberg represents factors which are the focus of past and current research, and the submerged part represents risk factors which need further research. The red stars represent the risk factors that have been explored in this thesis).

For almost three decades researchers have focused on risk factors previously hypothesised to be associated with stroke. Insufficient evidence including poor data availability, small populations and limited resources may be explanations for the narrow focus. For example, the role of diet and cooking methods need to be explored for individual South Asian subgroups in association with their cultural and religious components. Diet, along with tobacco use and physical inactivity, are the key risk factors for cardiometabolic disease (Khunti, *et al.*, 2017). Diet is heterogeneous among South Asian subgroups (Indian, Pakistani, Bangladeshi). In general, South Asians have diets with higher intakes of carbohydrate, saturated fatty acids, n-6 polyunsaturated fatty acids (PUFA) and trans-fatty acids, and lower intakes of n-3 PUFA and fibre, compared with other populations (Khunti, *et al.*, 2017). This high carbohydrate diet prolongs the period of glycaemia and results in a higher degree of insulinaemia (Shahid, 2013). There are also nutritional biomarkers which are important to consider in terms of South Asians' diets, such as fruit and vegetable consumption and vitamin C/D levels. It is evident that South Asians, specifically Bangladeshis, have a low consumption of fruits and vegetables, not only in the UK but also in Bangladesh as well (Khunti, *et al.*, 2017). The systematic review reported significantly lower levels of plasma vitamin C among South Asians compared to White Europeans. While doing subgroup analyses of South Asians in Chapter 5, I reported low levels of plasma vitamin C in Bangladeshis compared to the Indian and Pakistani groups. Vitamin C level is a useful biomarker for fruit and vegetable consumption.

There is evidence of lower concentrations of vitamin D among South Asians compared to White Europeans (Bhopal, *et al.*, 2005a). The sources of vitamin D are diet (oily fish and dairy products) with 90% synthesised from skin via exposure to sun (Darling, *et al.*, 2018). Vitamin D insufficiency among Bangladeshis is thought to be partly due to low intake of fish and eggs (Bhopal, *et al.*, 2005a). While in the UK, Bangladeshis had on average a higher dietary intake of vitamin D (3.0gµ/d) compared to Indians (1.0gµ/d) and Pakistanis (1.5gµ/d); this is still below the recommendation of 10µg of vitamin D daily ((Kassam-khamis, *et al.*, 2000). However, a recent analysis of the UK Biobank cohort showed consistency with the previous study and reported that 52% of Bangladeshis consume oily fish two to three times per week, whereas Indians and Pakistanis were reported to have lower levels of intake and a higher proportion of Indians were vegetarians (Darling, *et al.*, 2021). Evidence from previous studies found that, apart from low dietary intake of vitamin D, another potential factor among South Asians is their darker skin and lower sun exposure of the skin due to cultural and religious rulings (Darling, *et al.*, 2018). As stipulated by the religious ruling and culture, many South Asian women cover their body to minimise skin exposure. This has been reported as an important factor associated with vitamin D deficiency, as covering the body minimises direct sun exposure for vitamin D synthesis (Lowe and Bhojani, 2017).

There is a lack of studies on the use of vitamin D supplements and associated dietary and lifestyle factors in South Asians in the UK. Low intake of these food items may have been the reality in the early years after migration, when migrants were financially unstable and had limited resources to access traditional diets (Hill, 1990).

Following migration since 1970, there have been changes in the dietary patterns of South Asians, in terms of moving towards eating traditional foods which was not possible in the early years due to the non-availability and cost (Leung and Stanner, 2011). There are a few studies which have been conducted on the consumption of ghee/clarified butter and high-heat cooking among South Asians (Kakde, *et al.*, 2017). As mentioned earlier there is diversity in diet among South Asian subgroups so generalisations should be made cautiously. For example, the consumption of ghee is high in groups from northern India and Bangladesh, but ghee is rarely used by people of South Indian origin, whose risk of atherosclerotic disease is equally high (Khunti, *et al.*, 2017). The other factors associated with South Asians' diets are the methods of cooking, type of diet (vegetarian or non-vegetarian) and the cultural and religious aspects of diet (e.g. Muslims are prohibited to consume alcohol and more are non-vegetarian). These factors need to be explored in association with risk of CVD for subgroups of South Asians.

Another hypothesis mentioned by Bhopal (2019) was that religious practices could be a reason for a low rate of smoking among Indians, whilst there is a high rate of smoking reported among Bangladeshis (Bhopal, 2019). The majority of Bangladeshis are Muslims, with smoking and alcohol strictly prohibited in Islam (Khayat, 2000). Therefore, relating bad habits or lifestyle with religion is not a proper explanation in all circumstances.

Acculturation is a major contributing factor for migration-induced differences in CVD risk factor exposure and its outcome among migrants. Acculturation is defined as a behavioural shift due to cumulative exposure to the host population following migration, with impacts on subsequent generations (Smith, *et al.*, 2011). It impacts the health behaviours among migrants with increasing length of stay in the host country. Migration is associated with psychosocial factors, changes in lifestyle, dietary changes, changes in climate, cultural change and altered living conditions which influence CVD risk profile (Hussain, *et al.*, 2013). Psychosocial factors, such as work-related stress, depression, racial discrimination, and migration issues (resettlement, visa documentation, illegal status) are factors likely to increase stress which can trigger stroke (Hussain, *et al.*, 2013). As mentioned in Chapter 2, in the early days of immigration the majority of Bangladeshi migrants were in unskilled and semi-skilled manual work within a narrow range of employment sectors, mainly garment manufacturing factories. Due to their low level of education and no knowledge of English they were employed in factories and restaurant, where they didn't require knowledge of the English language. It resulted in a low level of understanding of the English language in Bangladeshis. In the 1980s these factories started outsourcing their work and Bangladeshis started to work in the Bangladesh-dominated 'Indian' restaurant sector (Salway, 2008). There was a delay in joining families due to a slow settlement process which also caused serious impacts on physical and mental health. To support families back home, the emigrants worked in jobs where strain and job demands were high, and autonomy and self-control were low. Along with these, there were other psychosocial factors related to employment such as racism at work, low wages and stress of resettlement in new country.

In a recent report by the ONS, the Bangladeshi and Pakistani ethnic group combined had a higher percentage of workers in the distribution, hotels and restaurants sector than any other ethnic group (30.7%) and the lowest percentage in 'professional' jobs (18%) (ONS, 2021). This could be an explanation for their social deprivation. The Bangladeshi population have been significantly more socially deprived within the social hierarchy in the UK in comparison to Indians (Williams, *et al.*, 2010). This degree of deprivation has continued, with recent data from the ONS showing that, in England among the age group 25 to 64 years, the lowest employment rate was in the combined Pakistani and Bangladeshi group (56%) in 2019 (ONS, 2021). However, it also shows that the biggest increase in employment rate from 2004 to 2019 (44% to 56%) was in these groups (Pakistani and Bangladeshi) (Office for National Statistics, 2020). This deprivation has led to poverty, and poverty to psychosocial distress. Poverty and depression has a dominant influence on health and can contribute to stroke.

Depression has known neuroendocrine inflammatory effects, which activate the nervous system and has an immunological/inflammatory effect which could influence the risk of stroke (Pan, *et al.*, 2011). Two meta-analyses of prospective studies conducted to assess the association between depression and the risk of developing stroke found that depression is an important risk factor associated with an increased risk of stroke (Musselman, *et al.*, 1998; Pan, *et al.*, 2011). Depression is also associated with poor health behaviours, such as smoking, poor diet and physical inactivity (Pan, *et al.*, 2011), which ultimately increase the risk of stroke. In addition, depression is correlated with hypertension and diabetes, which are major risk factors for stroke. Lastly, a positive association between medication for depression and the risk of stroke has been reported (Pan, *et al.*, 2011). To understand high rates of CVD among South Asians researchers need to consider the role of psychosocial factors in first-generation migrants living in the UK and compare them with second generation individuals.

To better understand the unique risk profile of South Asians there is a need to consider the differences not only among subgroups but also between first and second generations of South Asians. As compared to the first generation, the second generation has a higher probability of altering their CVD risk in later life, as they experienced a different childhood compared to their parents, influencing their health behaviours, such as exposure to physical education in schools and in their wider social environment (Bhatnagar, *et al.*, 2015).

Second generation South Asians appears to be more active than first generation individuals in the UK (Smith, *et al.*, 2011). This is supported by a review showing generational differences in physical activity levels among South Asians in the UK (Bhatnagar, *et al.*, 2015). This study also reported that second generation Bangladeshis had a more favourable socioeconomic profile compared to the first generation of migrants (Bhatnagar, *et al.*, 2015). Also, there was a higher risk of smoking in first generation Bangladeshis compared to White Europeans, whilst this was non-significant in the second generation (Leung and Stanner, 2011).

Outside of the UK, a study from the Netherlands also found generational differences in CVD risk factors among ethnic minorities, showing a higher prevalence of CVD risk factors in the first generation compared to the second (Hosper, *et al.*, 2011). Another more recent prospective study from Singapore compared the generational differences in CVD incidence and its risk factors between Indian adults. It reported that second-generation Indian individuals had an increased risk of CVD, hyperlipidaemia and chronic kidney disease as compared to first generation immigrants (Gupta, *et al.*, 2018).

There is a lack of population-based studies investigating generational differences among South Asians in the UK. The generational studies in the UK and other countries focus mainly on common risk factors of CVD, such as obesity and physical activity. In this thesis the data from WHSS are over 20 years old (1996-1998) and focused on the general population and reported several traditional and novel CVD risk factors There is a need to compare the results of this study using the WHSS dataset with a new sample of second-generation migrants to compare CVD risk profiles with the focus on generational differences in the Bangladeshi population in the UK.

9.2.4 The type of stroke (ischaemic and haemorrhagic)

It was found that the type of stroke was significantly different among the ethnic groups reported in the case note audit, with a higher proportion of haemorrhagic strokes and a higher mortality rate amongst the Bangladeshi group (Chapter 8). This finding is consistent with previous studies reported in the review by Gunarathne (Gunarathne *et al.*, 2009). Although ischaemic strokes are ten times more frequent than haemorrhagic strokes (Andersen *et al.*, 2009; Mogensen *et al.*, 2013), haemorrhagic strokes are associated with a higher mortality within three months of the stroke. Studies conducted in Europe, the US (Kirshner, 2009) and the UK (Bamford *et al.*, 1990) have explored mortality rates by type of stroke (Gezmu *et al.*, 2014), although none of these studies has focused on South Asians in the UK.

An increased proportion of haemorrhagic strokes could be the reason for the excess stroke mortality amongst the Bangladeshi group (Chapter 8). This could link back to the high prevalence of smoking amongst the Bangladeshi group which has been reported as an important risk factor for haemorrhagic stroke (Andersen *et al.*, 2009). An intervention study reported a high prevalence of smoking amongst Bangladeshi men compared to White men in the UK (Begh *et al.*, 2011). Measures are urgently needed to reduce the burden of stroke and mortality from stroke amongst the Bangladeshi population in the UK.

9.2.5 Pathophysiology of stroke:

Traditional risk factors do not fully explain excess CVD mortality, so there is a need to examine the pathophysiology of stroke and its relationship to novel risk factors (inflammatory mediators due to infection, metabolic factors). Stroke remains an important health issue amongst the Bangladeshi population in the UK. As mentioned earlier it is a disease of old age in general but in South Asians, specifically among Bangladeshis, it is the younger people who warrant targeted health interventions for stroke prevention. Fortunately, the major risk factors for stroke found in this study (chapter 4, chapter 5 and chapter 7) are modifiable risk factors. However, there is lack of data on risk factors by type of stroke. To better understand the clinical outcomes of stroke it is important to know the pathophysiology of stroke. In simple terms, stroke is caused by the disruption of blood flow to the brain. This disruption is caused either by blockage of blood flow and oxygen to the brain, called ischaemic stroke (IS), or by the rupture/leak of blood vessels in the brain, called a haemorrhagic stroke (HS) (Kuriakose and Xiao, 2020). In IS the blood flow to the brain is affected by narrowing of blood vessels due to atherosclerosis, while HS is caused by stress in the brain causing internal injury and the rupture of blood vessels. Better management of stroke depends on treating its pathophysiology (Kuriakose and Xiao, 2020).

Chapter 8 highlighted a high prevalence of haemorrhagic stroke among Bangladeshi as compared to the other ethnic groups. Hypertension is reported as a common risk factor for haemorrhagic stroke which has a higher mortality than IS. The type of stroke could be the missing piece of the unsolved puzzle to explain the higher stroke mortality amongst the Bangladeshi population. Haemorrhagic stroke along with the history of infections and smoking differentiate the Bangladeshi group from stroke patients from the other ethnic groups in this study. To better understand the pathophysiology of stroke among Bangladeshis there is a need to compare the prevalence of risk factors associated with the type of stroke and to apply this understanding to preventive strategies.

Given the high prevalence of risk factors for stroke, the area which needs attention is evidence-based prevention of stroke among the South Asian / Bangladeshi populations. The latest NHS policy, the "Long Term Plan", seeks to reinforce areas such as prevention, population health and health inequalities (Charles, *et al.*, 2019). The prevention plan included improving the detection and care of the people with CVD and improving stroke services (Charles, *et al.*, 2019). The prevention plan aims to maximise the role of the NHS in influencing behaviour change, focussing on the top five modifiable risk factors: high blood pressure, smoking, poor diet and obesity, and alcohol/drug use (Charles, *et al.*, 2019). As reported in this thesis, the majority of the risk factors associated with stroke/CVD are modifiable and preventable. The prevention of stroke risk factors can reduce the burden of disability, improve future health and well-being, and minimise the cost impact of stroke (King, *et al.*, 2020) as well as reduce health inequalities. The Bangladeshi ethnic group have risk factors which differ in profile to other South Asians (Indian and Pakistani). As documented in this thesis, Bangladeshis had highest proportion of smoking (men), the highest proportion reporting a history of infection, a high use of OCP (women) and the lowest physical activity levels. The burden of stroke can be reduced in Bangladeshi/South Asians by eliminating exposure to modifiable risk factors and identifying and treating novel/non-traditional risk factors (explored further in Section 9.2.3). Behavioural modification programmes are required to target modifiable cardiovascular risk factors. Other approaches could include pharmacological interventions (for example, the use of lipid lowering drugs or the treatment for hypertension). The promotion of physical activity and a healthy diet can reduce the risk of type 2 diabetes by 58%, which is an important risk factor for CVD (Khunti, *et al.*, 2017).

This thesis had provided updated information on areas where Bangladeshis are more densely populated. Of the regions in the UK, the West Midlands has the second highest number of Bangladeshis (Khunti, *et al.*, 2017), with a sizeable population in Birmingham where this study took place. Identifying high-risk populations and implementing targeted prevention is cost-effective and helpful in these individuals to reduce the burden of disease (Labarthe, 1999), and this applies to the UK South Asians/Bangladeshis at higher risk of developing CVD/ stroke. Primary prevention of CVD is a significant part of NHS England's and Public Health England's (PHE) ongoing work to tackle CVD (Public Health England, 2018). The largest preventative programme launched in England in 2009 is the NHS Health Check Programme, to improve CVD risk factors by behavioural change (Usher-Smith, *et al.*, 2017). It offers health checks every five years to people aged between 40-74, with uptake reported to be consistently high among women, older people and deprived populations (Usher-Smith, *et al.*, 2017). PHE's latest strategy on the prevention of CVD involved close collaboration with the British Heart Foundation (BHF), NHS England, Stroke Association, NICE and NHS right care (Public Health England, 2018a). There are resources available from these organisations for the prevention of CVD/stroke focused on South Asians/Bangladeshis in the UK. For example, resources focused on the reduction of risk factors such as reducing weight, smoking cessation and dietary advice to minimise the risk of disease. The resources are available in different languages and are helpful to understand the risk of disease and how it can be prevented among specific groups. The focus of the majority of current preventive strategies is mainly on the broad South Asians group, with a focus on traditional risk factors such as blood pressure, diabetes, obesity, smoking and salt intake (Public Health England, 2018a).

Examples of community-based CHD/CVD prevention programmes focused on South Asians in the UK are highlighted below. Project Dil was set up in Leicester in 1998, in which general practices were engaged to promote the awareness of lifestyle risk factors amongst the South Asian community with the aim to reduce CHD (Farooqi and Bhavsar, 2001). Another example of a similar project is the Khush Dil project set up in 2002 in Edinburgh to develop and test CHD prevention and control services for South Asians (Allard, 2007)). QUIT, a health MOT programme delivered at summer community fair, assessed CVD risk factors among Asian families attending the fair (Fox, 2004). The British Heart Foundation has offered several health promotion programmes for the South Asian community. They also offered programmes especially for the Bangladeshi community such as the Bengali Bridge project and Smoke-free Northants, which is a community-based project focused on the Bangladeshi community promoting smoking cessation along with healthy diet and exercise. Another example is the Tower Hamlet's Bangladeshi stop smoking project (Fox, 2004). When developing a prevention programme for CVD/stroke, the Bangladeshi community needs to be considered as an individual group due to their social, cultural, and religious heterogeneity as compared with other South Asian groups. From the thesis it is evident that there is a need for more preventive strategies targeting the Bangladeshi community by focusing on risk factors which are less frequently reported but important in reducing the burden of disease (PMH/infections, use of OCP, HRT). There is a need for follow-up studies in such preventive programmes to measure their impact on the targeted risk factors and to identify whether the interventions and intervention effects have been maintained beyond their initial implementation. For example, the RE-AIM framework was developed to organise reviews of existing literature on health promotion and disease management in different settings. RE-AIM also helps translate research into practice and helps to plan programmes and improve their chances of working effectively in the real world (Glasgow, *et al.*, 2021).

An interesting paradoxical relationship between risk factors and ethnicity was also reported in this thesis; that is a low BMI and high stroke mortality amongst the Bangladeshi group. Another example of a paradoxical relationship was that the Bangladeshi group has a persistently high stroke mortality but a lower systolic blood pressure than the White European group (Chapter 5 and 7).

9.3: Strengths of the thesis

- To start with, ethnicity is considered an important variable in the thesis overall. One of the main strengths was the identification of ethnic groups according to UK census groupings. Bangladeshi were confirmed manually (Chapters 7 and 8) to achieve complete case ascertainment.

- Initially, a comprehensive systematic review was carried out focusing on stroke in South Asians/Bangladeshis in the UK. It is unique in that it is exclusively based on studies conducted on South Asians in the UK.
- South Asian sub-groups (Indian, Pakistani and Bangladeshi) were considered as individual groups in this thesis. This helped to provide a clearer picture about similarities and differences between the groups (Chapters 5, 7 and 8).
- A detailed case note analysis explored risk factors reported in stroke patients. Although some data were missing it still yielded important findings.
- A recent study (Seminog, *et al.*, 2019) published in the BMJ on stroke mortality in England combined data for all types of stroke due to inconsistency in the data, which was reported as one of the study's weaknesses. Instead, in this thesis, I have differentiated between haemorrhagic and ischaemic types of stroke as the data available was robust in terms of stroke classification. This has yielded important information.
- The primary data collection was conducted in the city of Birmingham which has the second largest Bangladeshi population in the UK after London.
- A multi-method research design (systematic review, FOIA analysis, WHSS secondary analysis, retrospective case-note analysis and audit) was used which allowed me to explore the risk factors associated with stroke from all perspectives, starting from aetiology of risk factors to the management of stroke.

9.4: Limitations of thesis

- One of the main limitations was the unavailability of matched case notes for controls (White, Indian and Pakistani) patients. This meant that age and sex matching was not exact.
- Limited information was available in the retrospective case note analysis. Information was missing which could not be accessed for variables such as blood profiles, blood pressure readings and BMI of some patients, leading to an incomplete and variable number of cases being available for analysis of the variables of interest.
- From the systematic review to the main study, information about variables was limited. The systematic review included limited or no studies that addressed

important risk factors for Bangladeshis such as genetics, socioeconomic factors, diet and tobacco chewing.

- Due to the small sample size, the association of risk factors with ethnic groups was not always statistically significant. In the retrospective case note analysis it was not possible to extract some of the data required; for example, smoking status was not categorized as “present” or “previous” smoker. Other variables, such as the level of exercise, could not be categorised as per the standard WHO definition. Furthermore, BMI to assess obesity was not calculated for all patients, due to missing height and weight information.
- Due to small numbers, analysis by sex was not performed to explore whether this factor was associated with stroke mortality.
- These studies were all conducted amongst first generation South Asians, and there is a need for studies comparing first and second generation migrants to find out whether factors related to migration are a major reason for increased risk of stroke in South Asians.

Based on the series of studies in this thesis, the next section will highlight implications and future recommendation for practice and research on CVD/stroke among South Asians focussing on Bangladeshis.

9.5: Implication and future recommendation

9.5.1: Implications for Practice

Despite studies being conducted amongst South Asians since 1970, there is a gap in knowledge which warrants further prospective cohort studies amongst the Bangladeshi group in the UK. Emphasis should be given to ascertain the correct ethnicity of study samples and consider subgroups of South Asians due to their cultural and social heterogeneity. As reported in Chapter 4, some studies have narrowly defined ‘South Asian’, for example a study by Lane *et al.,* (2006) included 90% Punjabi participants with the remainder Bangladeshi in their South Asian sample. India is a multi-cultural country where every state has its own religion, culture, lifestyle, languages and diet (Anjana, *et al.,* 2011). People belonging to a particular state cannot represent Indian ethnicity due their marked diversity; for example, diabetes appears to be more prevalent in the southern states of India, whereas hypertension appears to be more common in the north-eastern states (Anjana, *et al.*, 2011). Thus, involving a particular group from India in a sample means the results cannot be generalised to all Indians or to all South Asians. Similarly, there is a need for equal or enough numbers of Pakistani, Bangladeshi and Sri Lankan individuals in the sample if the result is to be generalised to South Asians.

This series of studies generated several hypotheses to explore the relationship between stroke, ethnicity and its outcome, which need further exploration in future research. The coding of ethnicity in NHS primary care needs a more standardised procedures. There is a need for research guidelines to classify ethnicity correctly, specifically for South Asians. Incorrect classification can impact on the results from the study or bias the results of the study. Additional information is required under the options "other ethnic groups". There is a need for studies on stroke in which ethnicity is confirmed by the researcher by going through their names or confirming ethnicity by a researcher who is from a South Asian background with a sound knowledge of surnames matching them with the history of immigration (country of birth) from case notes. This method is feasible as an alternative in the absence of information on self-ascribed ethnic origin, and it has been used by a number of studies (Cummins, *et al.*, 1999). However, there is some possibility of misclassification of name, specifically people of Pakistani and Indian origin may share the same surname and names due to a common mother tongue (Urdu) and religion. In the case of Bangladeshis they may also share names and surnames with Indian and Pakistani groups due to their religion (names originate from Arabic, Sanskrit or Persian languages) but still they can be recognised as they are written and pronounced according to the Bengali language (Chapter 2). As mentioned in Chapter 2, language and ethnic identity are interrelated, specifically among South Asians in the UK, and so language needs to be considered as an important component when considering ethnicity. For future studies on South Asians, researchers with knowledge of different South Asian languages are needed in order to understand this aspect of ethnic heterogeneity among South Asians. Also, language plays an important role in the recruitment of participants from ethnic minorities. For example, one of the reasons for non-participation in clinical trials or health care research among South Asians/Bangladeshis is a language problem (Khunti, *et al.*, 2017). For instance, in Sylheti (Bengali dialect) there is no agreed written form of the main spoken language, which delays the process of taking informed consent (written form) from non-English speaking participants prior to starting the research.

An important implication from this thesis could be the use of the Sentinel Stroke National Audit Programme (SSNAP) database to carry out a national data analysis of stroke risk factors by ethnic group. Although ethnicity groupings are not 100% correct, it will give an overall picture of stroke epidemiology among South Asians. As the SSNAP is a robust database with a large number of variables (Kings College London, 2019), an analysis could produce important information which may help to explain the excess mortality amongst the Bangladeshi population, such as an analysis of the type of stroke, past medical history (comorbidities) and different treatment options available for stroke patients. The retrospective data analysis conducted in Chapter 7 is a good example of using data which is already collected (although on smaller numbers). It is cost-effective as well as timesaving**.**

The traditional CVD preventive approach focuses on individual traditional risk factors in high-risk groups. It focuses not only on identification of at-risk groups but also on making them aware of their high risk compared to others. In terms of targeted prevention (in Bangladeshis), there is a need to emphasise knowledge of both the risk factors for stroke and the warning signs of stroke. The Bangladeshi population also need to be informed of their excess risk of mortality from stroke in order to promote the better uptake of health improvement interventions. For example, smoking cessation services have poor results with Bangladeshi individuals despite their high smoking rates compared to the national average. Bangladeshis tend to rely on their willpower rather than engage with health services (Zaman and Mangtani, 2007), which needs addressing.

A preventive strategy needs to consider the importance of threshold differences in risk factors among South Asians, including Bangladeshis. For example, they may have a lower BMI and lower SBP, but they can still have a higher stroke mortality. The challenges associated with considering the threshold of these risk factors in minority ethnic groups and comparing them with Caucasian or "general" thresholds, need focus in future research. In chapter 5, obesity and overweight were defined according to specific BMI thresholds for South Asians. By not using the same threshold for BMI for different populations (White Europeans vs. South Asians) it helps to avoid bias in the findings. Similarly, a low SBP in Bangladeshis need to be consider carefully while calculating their CVD risk.

Stroke is not only a burden on an individual's family but also on the community in terms of economic loss (Saka, *et al.*, 2009). There is a need for studies to identify health promotion programmes which are not only cost effective but also have an impact on the burden of stroke in the Bangladeshi community. The findings from this thesis are expected to draw the attention of researchers and healthcare providers. Although the sample size was small in the case note analysis, the findings are consistent with previous studies confirming that Bangladeshis are different from other ethnic groups in terms of their risk factors and pathology of stroke (Chapter 4, 5 and 7).

9.5.2: Implications for research/future recommendations

In terms of the prevention of traditional and non-traditional risk factors, researchers need to understand the heterogeneity of South Asian subgroups in terms of diet and lifestyle patterns. Future research is needed in understanding the determinants of dietary behaviour among subgroups of South Asians and factors that might influence behaviour modification. This warrants studies on the role of diet and CVD risk factors. Studies on the cultural acceptability of different types of exercise and dietary regimens in South Asians are required, as physical activity and diet affect hypertension, diabetes and overweight/obesity. Culture gives the people ethnic belonging and a sense of identity, with diet being one of the cultural factors associated with migration (Khunti, *et al.*, 2017).

One of the important risk factors which is in need of urgent consideration in future research is the use of tobacco and betel nut (Areca catechu) consumption among Bangladeshis. Tobacco use among Bangladeshi groups is part of their culture. There is evidence that Bangladeshi men have higher tobacco smoking rates compared to White Europeans (Khunti, *et al.*, 2017). However, there is a lack of literature on the type of tobacco consumption such as betel nut use, paan (betel leaf) chewing and chewing of tobacco which is an important part of the cultural and social life of the Bangladeshi population (Longman, *et al.*, 2010). There is some evidence of an association of smokeless tobacco use with mortality in the Indian population (Gupta, *et al.*, 2005). Thus, there is a need to study the effects of these smokeless tobacco products among South Asians in the UK specifically focusing on the Bangladeshi population. Use of tobacco, betel nut and pan chewing may be less prevalent among the second generation. If these factors differ between first and second generation migrants it could help to explain the excess mortality among the Bangladeshi population. For example, if these risk factors don't affect the second generation as much as the first generation, but they still have high stroke mortality, then there is need to explore the other novel risk factors mentioned earlier. Some researchers have recommended that poverty, straining at stools, squatting and low birth weight should be taken into the account in future research (Bhopal, *et al.*, 2005a).

A higher level of psychosocial stress is reported to be associated with an increased risk of stroke (Bang, *et al.*, 2015). Therefore, the migration-related psychosocial factors need to be highlighted as potentially important risk factors for future research in stroke epidemiology among South Asians. There is also a need to compare the risk factors of stroke in first and second generation Bangladeshi groups in the UK. This may reveal some new significant findings. For example, depression is common among the first generation which can be due to migration-related factors and homesickness. It is evident that depression is a significant risk factor for stroke ((Pan, *et al.*, 2011), which needs urgent consideration while studying stroke among the Bangladeshi population.

There is a need for studies on the differences in pathogenesis, prognosis and treatment of the subtypes of stroke. The striking finding in this study suggests serious consideration should be given to the pathophysiology of stroke amongst the Bangladeshi population and the type of stroke among other ethnic groups. There is a need for a multicentre comparative study among ethnic groups with high stroke mortality to find if risk factors causing excess mortality are similar in these groups or if there are risk factors which are making them different from each other. An example is a study amongst ethnic groups with a high smoking prevalence or tobacco consumption to find out if they have differences in the type of stroke as compared to groups who have low prevalence of smoking or tobacco consumption. This is relevant because smoking is reported as an important risk factor for haemorrhagic stroke.

There is a need for future studies to examine the impact of stroke units on stroke patients by ethnic group, for example by exploring whether the reductions in length of hospital stay among stroke patients is due to a specialized stroke unit or high stroke mortality. Furthermore, larger management studies could compare ethnic minority groups with White Europeans to examine if the outcome of having a stroke is different between the groups. Along with the clinical management, social and cultural factors need to be considered in providing equitable services to ethnic minorities, including considering personal needs in terms of religion, as religion is an important determinant of South Asian ethnicity. The Bangladeshi community are predominantly Muslim. Islam (Muslim religion) has an influence on the daily lives of followers and it reflects in their culture and behaviour.

South Asian cultural and religious myths about health and disease need special attention to find their role in disease management and treatment. There could be positive impacts on health promotion and intervention if religious and community leaders get involved to clear misconceptions about religion, especially related to health and disease. There is a need to focus on the religious and cultural impact on CVD/stroke in future research studies. Another cultural or religious factor which needs attention is the practice of considering disease as the "will of God", known as religious fatalism (Grace, *et al.,* 2008). It could an important reasons for a delay in symptom recognition and help seeking amongst Bangladeshi patients. One could involve religious leaders (Imams) in CVD/stroke preventive strategies, such as raising the knowledge and awareness of risk factors or behavioural factors which are also prohibited/haram in religion (Fox, 2004). This can help in reducing the burden of disease in the community. Religious leaders have access to large numbers of people and also have a great influence in the Bangladeshi community. Health education through religion was considered by the WHO, with the aim of involving everyone (apart from health professionals) in health promotion and health education (Khayat, 2000). One of the most successful publications on health education through religion is the Islamic ruling on smoking published by the WHO, Eastern Mediterranean region (Khayat, 2000). They have successfully presented a detailed report compiled by prominent Islamic religious scholars who pooled the available scientific evidence on the harmful effects of smoking on health (Khayat, 2000). Based on established facts, strong argument and indisputable findings, they agreed that smoking is prohibited/haram or at least strongly abominable (Khayat, 2000). Therefore, one way in which smoking in Bangladeshis may be addressed is via their religious beliefs. The evidence from the WHO report could help religious leaders to make people aware about the Islamic ruling on smoking being haram, as religious minorities may not be clear about the updated religious rulings. In the first edition of this WHO report, scholars confirmed tobacco in all forms is also totally prohibited in Islam (Khayat, 1996).

The QUIT prevention scheme run by the BHF also runs programmes in conjunction with religious leaders (Fox, 2004). Preventive programmes need to be implemented in mosques across in UK, especially in Bangladeshi mosques, for quitting smoking, which is an important stroke risk factor for stroke among Bangladeshis.

Another important recommendation from this study is the need for a future multicentre study with a large sample of Bangladeshsi to explore the outcome from stroke in men and women.

Although Bangladeshi women have a lower prevalence of smoking and obesity as compared to other women, they still have a high stroke incidence as compared to other ethnic groups. Attention should be given to prospective cohort studies on South Asians specifically focusing on each South Asian subgroup individually due to their heterogeneity.

There is a need for a follow-up study, before and after stroke, to find out the association between the severity of stroke/risk factors before stroke and outcomes at the time and after stroke by ethnic group. A recent population-based study in England concluded positive results reporting a decrease in stroke mortality and case fatality rate but with high stroke events in younger age groups (Seminog, *et al.,* 2019). This needs exploration by ethnic group to find which ethnic groups have more stroke events in the younger age groups. As mentioned earlier, Bangladeshis had the highest number of strokes in the youngest age categories compared to other ethnic groups. Although the data in Seminog, *et al.* (2019) was from 2001-2010, it still suggests some important recommendations for future research and targeted health promotion planning (Seminog, *et al.*, 2019).

Finally, risk prediction assessment tools should be designed for South Asians specifically focusing on the Bangladeshi group in the UK and including novel risk factors. Novel risk factor variables (such as use of OCP, tobacco consumption, HRT, and a history of infection) should be incorporated into current risk algorithms to provide an accurate estimate of CVD risk among South Asians. Recent and current strategies for stroke prevention and treatment need to consider the importance of heterogeneity among South Asian groups while focussing on health inequalities.

9.6: Bangladeshis in Bangladesh

This section briefly compares the results in this thesis from the Bangladeshi population who now live in the UK with findings from studies on the Bangladeshi population who still live in Bangladesh.

In Chapter 1, I mentioned that stroke is the third leading cause of death in Bangladesh. The INTERHEART study also reported that Bangladesh has the highest prevalence of CVD risk factors as compared to other South Asian countries (Joshi, *et al.*, 2007). The important major contributing risk factors are hypertension, diabetes, hyperlipidaemia and smoking, which are consistent with the findings from the systematic review in this thesis (Chapter 4). Apart from traditional CVD risk factors, other risk factors such as the use of oral contraceptive pills, tobacco consumption, low physical activity and low consumption of fruits and vegetables, have also been reported among Bangladeshis in Bangladesh (Bhowmik, *et al.*, 2016).

A recent study has reported an increased prevalence of CVD in Bangladesh in recent decades due to the epidemiological transition and industrialisation (Chowdhury, *et al.*, 2018). When compared with the other South Asian countries, the highest prevalence of stroke was reported in Bangladesh, even though the lowest rate of uncontrolled hypertension was observed among Bangladeshis (Jafar, *et al.*, 2015). This increasing prevalence of stroke could be due to factors such as rapid urbanisation, changes to dietary habits, a decline in communicable disease and low birth weight in Bangladesh (Mamin, *et al.*, 2017). Low birthweight (LBW) is major public health challenge in Bangladesh. It was reported that 20% of children in Bangladesh were born as LBW babies (Khan, *et al.*, 2018). LBW is more common among South Asians babies compared to White Europeans and it has been consistently found in second generation South Asians in the UK (Oldroyd, 2005). In the UK, Indian, Pakistani and Bangladeshi infants are 280-350gm lighter and 2.5 times more likely to be LBW compared with White infants (Kelly, *et al.*, 2009). LBW has also been associated with an increased risk of stroke in adult life and this inverse association was strong among heavier women who were born small (Rich-Edwards, *et al.*, 2005). Evidence from a recent study is consistent with this finding, suggesting that birth weight in the lowest tertile (0.90-3.38kg) followed by overweight at the age of 20 years was associated with an 81% increased risk of stroke as compared to birth weight in the middle tertile (3.38-3.80kg) followed by normal weight at age of 20 years (Lilja, *et al.*, 2021).

An interesting study from Bangladesh reported the prevalence of CVD risk factors among school children and found alarming levels of risk factors such as smoking and tobacco chewing, albeit no significant findings for obesity (Islam, *et al.*, 2020). They mentioned that the habit of tobacco chewing among children is greatly influenced by their parents (Islam, *et al.*, 2020). As smoking is associated with atherosclerosis, which is a major underlying mechanism for CVD (Islam, *et al.*, 2020), there is a need for a similar study to examine the association of duration of smoking with the occurrence of stroke in the adult UK Bangladeshi population. There is also a need for a study including participants from Bangladesh and Bangladeshis in Europe to identify similarities and differences in risk factors associated with

CVD/stroke. Specifically, this will help in understanding the role of genetics, migration, and socioeconomic status in stroke epidemiology amongst the Bangladeshi population.

9.7: Concluding remarks

This thesis has provided some important insights into high stroke rate amongst the Bangladeshi population despite various limitations. Because of a paucity of information, there is need to undertake more detailed studies with bigger sample sizes to explore the associations and risk factors of stroke among Bangladeshis.

The persistent high stroke mortality among Bangladeshis reflects health and socioeconomic inequalities, poor research in this group and a lack of ethnicity-specific national guidance on the management of stroke. This reflects poorly on the public health system as the most important risk factors are modifiable and can be prevented. The high susceptibility of South Asians/Bangladeshis to stroke cannot be fully explained by known risk factors. The journey to find other co-factors that solve this puzzle continues. The epidemiology of stroke among South Asians, specifically Bangladeshis, is limited to traditional risk factors, and the pathophysiology of stroke in terms of its types (IS and HS) remains elusive. Further studies are recommended to explore and confirm all risk factors and outcomes by type of stroke amongst the Bangladeshi population, to strengthen the preventive strategy in the UK. There is a need for further studies to provide evidence on current epidemiology and management of stroke among South Asians, specifically in Bangladeshis in the UK.

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Appendices

Appendix 4.1: Search Strategy Medline

1. South Asian.mp. or Asian Continental Ancestry Group/
2. Bangladesh/ or Bangladeshi.mp.
3. Indian.mp.
4. Pakistan/ or Pakistani.mp.
5. 1 or 2 or 3 or 4
6. Stroke/ or stroke.mp.
7. Cardiovascular Diseases/ or cardiovascular.mp.
8. Cerebrovascular Disorders/ or Cerebrovascular disease.mp. or Ischemic Attack, Transient/
9. 6 or 7 or 8
10. 5 and 9
11. limit 10 to (English language and "all adult (19 plus years)")
12. England/ or England.mp.
13. Wales/ or wales.mp.
14. Scotland.mp. or Scotland/
15. United Kingdom.mp. or Great Britain/
16. 12 or 13 or 14 or 15
17. 11 and 16

Appendix: 4.2 Search Strategy CINAHL

#	Query	Limiters/Expanders	Last Run Via	Results	Action
S15	S10 AND S14	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database – CINAHL	68	Edit S15
S14	S11 OR S12 OR S13	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL	227,336	Edit S14
S13	(MH "Wales") OR "wales"	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL	16,487	Edit S13
S12	(MH "Scotland") OR "scotland" OR (MH "United Kingdom") OR (MH "Great Britain")	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL	179,515	Edit S12
S11	(MH "United Kingdom") OR (MH "Great Britain") OR "England"	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL	204,688	Edit S11
S10	S5 AND S9	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL	706	Edit S10
S9	S6 OR S7 OR S8	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL	79,958	Edit S9
S8	(MH "Cerebrovascular Disorders") OR "cerebrovascular disease"	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL	4,498	Edit S8
S7	(MH "Cardiovascular Diseases") OR "cardiovascular disease"	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL	30,599	Edit S7
S6	(MH "Stroke") OR "Stroke"	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL	50,194	Edit S6
S5	S1 OR S2 OR S3 OR S4	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL	15,112	Edit S5
S4	"Bangladeshi"	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases	363	Edit S4

			Search Screen - Advanced Search Database - CINAHL		
S3	"Pakistani"	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL	475	Edit S3
S2	"Indian"	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL	4,438	Edit S2
S1	(MH "Asians") OR "South Asian"	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search	10,508	Edit S1

Appendix: 4.3 Search Strategy Embase

1. South Asian.mp. or South Asian/
2. Bangladeshi.mp. or Bangladesh/ or Bangladeshi/
3. Indian/ or Indian.mp.
4. Pakistani.mp. or Pakistan/ or Pakistani/
5. 1 or 2 or 3 or 4
6. stroke.mp.
7. Cardiovascular.mp. or cardiovascular disease/
8. Cerebrovascular disease.mp. or cerebrovascular disease/
9. 6 or 7 or 8
10. 5 and 9
11. limit 10 to (english and adult <18 to 64 years>)
12. England.mp. or United Kingdom/
13. wales.mp. or United Kingdom/
14. Scotland.mp.
15. Great Britain.mp. or United Kingdom/
16. 12 or 13 or 14 or 15
17. 11 and 16

Appendix 4.4: Decision tool

Stroke in Bangladeshi migrants in the UK
A systematic review
Full text decision tool – eligibility criteria

Author …….....
Title
……...

1. Study **Design** ……………………………………………………………………………………….
2. **Sample**: Age, ………………………,Gender ………………………………Size……………………….
   Bangladeshi-only ☐ or South Asians ☐
   Study Location ……………………………………………………………………………

4. **Outcome**: Stroke ☐ / Cardiovascular disease ☐ / Cerebrovascular disease☐
   as primary ☐ or secondary ☐ outcome.

Decision by (circle): RS JS
INCLUDE paper☐ Not Sure☐
EXCLUDE paper☐ [Symbol] Reason:……………………………………………………………………………………...

Stroke in Bangladeshi Immigrants in the UK
A systematic review
Full text decision tool – eligibility criteria

Author …….....
Title
……...

1. Study **Design** ……………………………………………………………………………………….
2. **Sample**: Age, ………………………, Gender………………………………Size……………………….
   Bangladeshi-only ☐ or South Asians ☐
3. **Study Location** ……………………………………………………………………………

4. **Outcome**: Stroke ☐ / Cardiovascular disease ☐ / Cerebrovascular disease☐
   as primary ☐ or secondary ☐ outcome.

Decision by (circle): RS JS INCLUDE paper☐ Not Sure☐
EXCLUDE paper☐ [Symbol] Reason:……………………………………………………………………………………...

Appendix Table: 5.1

Table: Smoking habit * Ethnic group * sex Crosstabulation WHSS 1994-96								
Sex		Ethnic group						Total
		White European (n=523)		Indian (n=380)	Pakistani (n=77)	Bangladeshi (n=48)		
Female	Current	Count	94	5	0	2		101
		%	32.4%	2.7%	0.0%	6.7%		18.6%
	Ex	Count	81	3	2	0		86
		%	27.9%	1.6%	5.4%	0.0%		15.2%
	'Never'	Count	115	177	35	28		355
		%	39.7%	95.7%	94.6%	93.3%		65.8%
Total		Count	290	185	37	30		542
		%	53.5%	34.1%	6.8%	5.5%		100.0%
Male	Current	Count	91	46	13	3		153
		%	39.2%	23.6%	32.5%	16.7%		31.5%
	Ex	Count	90	41	3	6		140
		%	38.8%	21.0%	7.5%	33.3%		28.8%
	'Never'	Count	51	108	24	9		192
		%	22.0%	55.4%	60.0%	50.0%		39.6%
Total		Count	232	195	40	18		485
		%	47.8%	40.2%	8.2%	3.7%		100.0%
Total	Current	Count	185	51	13	5		254
		%	35.4%	13.4%	16.9%	10.4%		24.7%
	Ex	Count	171	44	5	6		226
		%	32.8%	11.6%	6.5%	12.5%		22.0%
	'Never'	Count	166	285	59	37		547
		%	31.8%	75.0%	76.0%	77.1%		53.3%
Total		Count	522	380	77	48		1027
		%	100.0%	100.0%	100.0%	100.0%		100.0%

Appendix table 5.2

Table: Level of Vitamin C by ethnic group WHSS 1994-96								
Vitamin C								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White	335	45.8	22.5	1.23	43.4	48.2	5.0	136.0
Indian	253	37.4	20.1	1.26	34.9	39.9	3.0	87.0
Pakistani	48	36.5	22.4	3.23	30.0	43.0	7.0	103.0
Bangladeshi	27	26.4	17.0	3.27	19.6	33.1	5.0	68.0
Total	663	41.1	22.0	.85	39.5	42.8	3.0	136.0

Appendix Table: 5.3

Table: Hormone replacement therapy (HRT) Ethnic group by Female Crosstabulation WHSS 1994-96							
			Ethnic group				Total
			White	Indian	Pakistani	Bangladeshi	
H.R.T.	Yes	Count	75	18	6	1	100
		% within H.R.T.	25.7%	9.4%	15.4%	3.2%	18.1%
	No	Count	215	167	31	29	442
		% within H.R.T.	74.3%	90.6%	84.6%	96.8%	81.9%
Total		Count	290	185	37	30	542
		% within H.R.T.	100%	100%	100%	100%	100.0%

Appendix Table 5.4

Table: Multiple Comparisons								
Dependent Variable		(I) Ethnic group	(J) Ethnic group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
height	LSD	White	Indian	4.33239*	.64014	.000	3.0762	5.5885
			Pakistani	3.34815*	1.16460	.004	1.0629	5.6334
			Bangladeshi	9.03017*	1.43071	.000	6.2227	11.8376
		Indian	White	-4.33239*	.64014	.000	-5.5885	-3.0762
			Pakistani	-.98424	1.19220	.409	-3.3237	1.3552
			Bangladeshi	4.69778*	1.45326	.001	1.8461	7.5495
		Pakistani	White	-3.34815*	1.16460	.004	-5.6334	-1.0629
			Indian	.98424	1.19220	.409	-1.3552	3.3237
			Bangladeshi	5.68202*	1.74885	.001	2.2503	9.1138
		Bangladeshi	White	-9.03017*	1.43071	.000	-11.8376	-6.2227
			Indian	-4.69778*	1.45326	.001	-7.5495	-1.8461
			Pakistani	-5.68202*	1.74885	.001	-9.1138	-2.2503
weight	LSD	White	Indian	4.46780*	.89987	.000	2.7020	6.2336

			Pakistani	-.77167	1.63838	.638	-3.9866	2.4433
			Bangladeshi	9.30826*	2.01274	.000	5.3587	13.2578
		Indian	White	-4.46780*	.89987	.000	-6.2336	-2.7020
			Pakistani	-5.23947*	1.67683	.002	-8.5299	-1.9490
			Bangladeshi	4.84046*	2.04416	.018	.8292	8.8517
		Pakistani	White	.77167	1.63838	.638	-2.4433	3.9866
			Indian	5.23947*	1.67683	.002	1.9490	8.5299
			Bangladeshi	10.07993*	2.46031	.000	5.2521	14.9078
		Bangladeshi	White	-9.30826*	2.01274	.000	-13.2578	-5.3587
			Indian	-4.84046*	2.04416	.018	-8.8517	-.8292
			Pakistani	-10.07993*	2.46031	.000	-14.9078	-5.2521
Waist circumference	LSD	White	Indian	-1.26602	.79226	.110	-2.8207	.2886
			Pakistani	-6.88341*	1.43424	.000	-9.6978	-4.0690
			Bangladeshi	.23685	1.77203	.894	-3.2404	3.7141
		Indian	White	1.26602	.79226	.110	-.2886	2.8207
			Pakistani	-5.61739*	1.46829	.000	-8.4986	-2.7362
			Bangladeshi	1.50287	1.79970	.404	-2.0286	5.0344
		Pakistani	White	6.88341*	1.43424	.000	4.0690	9.6978
			Indian	5.61739*	1.46829	.000	2.7362	8.4986
			Bangladeshi	7.12027*	2.16062	.001	2.8805	11.3600
		Bangladeshi	White	-.23685	1.77203	.894	-3.7141	3.2404
			Indian	-1.50287	1.79970	.404	-5.0344	2.0286
			Pakistani	-7.12027*	2.16062	.001	-11.3600	-2.8805
Hip circumference	LSD	White	Indian	2.38631*	.58075	.000	1.2467	3.5259
			Pakistani	-.35024	1.05135	.739	-2.4133	1.7128
			Bangladeshi	5.71767*	1.29896	.000	3.1687	8.2666
		Indian	White	-2.38631*	.58075	.000	-3.5259	-1.2467
			Pakistani	-2.73655*	1.07630	.011	-4.8486	-.6245
			Bangladeshi	3.33136*	1.31924	.012	.7426	5.9201
		Pakistani	White	.35024	1.05135	.739	-1.7128	2.4133
			Indian	2.73655*	1.07630	.011	.6245	4.8486
			Bangladeshi	6.06791*	1.58381	.000	2.9600	9.1758

		Bangladeshi	White	-5.71767*	1.29896	.000	-8.2666	-3.1687
			Indian	-3.33136*	1.31924	.012	-5.9201	-.7426
			Pakistani	-6.06791*	1.58381	.000	-9.1758	-2.9600
Waist-to-Hip Ratio	LSD	White	Indian	-.03501*	.00606	.000	-.0469	-.0231
			Pakistani	-.06541*	.01096	.000	-.0869	-.0439
			Bangladeshi	-.04967*	.01354	.000	-.0763	-.0231
		Indian	White	.03501*	.00606	.000	.0231	.0469
			Pakistani	-.03040*	.01122	.007	-.0524	-.0084
			Bangladeshi	-.01466	.01376	.287	-.0417	.0123
		Pakistani	White	.06541*	.01096	.000	.0439	.0869
			Indian	.03040*	.01122	.007	.0084	.0524
			Bangladeshi	.01574	.01651	.341	-.0167	.0481
		Bangladeshi	White	.04967*	.01354	.000	.0231	.0763
			Indian	.01466	.01376	.287	-.0123	.0417
			Pakistani	-.01574	.01651	.341	-.0481	.0167
Heart rate	LSD	White	Indian	-2.62831*	.70732	.000	-4.0163	-1.2403
			Pakistani	-7.39767*	1.28311	.000	-9.9156	-4.8798
			Bangladeshi	-4.44590*	1.58200	.005	-7.5503	-1.3415
		Indian	White	2.62831*	.70732	.000	1.2403	4.0163
			Pakistani	-4.76937*	1.31484	.000	-7.3495	-2.1892
			Bangladeshi	-1.81760	1.60784	.259	-4.9727	1.3375
		Pakistani	White	7.39767*	1.28311	.000	4.8798	9.9156
			Indian	4.76937*	1.31484	.000	2.1892	7.3495
			Bangladeshi	2.95177	1.93164	.127	-.8387	6.7423
		Bangladeshi	White	4.44590*	1.58200	.005	1.3415	7.5503
			Indian	1.81760	1.60784	.259	-1.3375	4.9727
			Pakistani	-2.95177	1.93164	.127	-6.7423	.8387
Systolic BP	LSD	White	Indian	-4.04730*	1.25636	.001	-6.5126	-1.5819
			Pakistani	-2.19063	2.27159	.335	-6.6481	2.2669
			Bangladeshi	-1.86988	2.80670	.505	-7.3774	3.6377
		Indian	White	4.04730*	1.25636	.001	1.5819	6.5126
			Pakistani	1.85666	2.32683	.425	-2.7092	6.4226
			Bangladeshi	2.17741	2.85160	.445	-3.4182	7.7731
		Pakistani	White	2.19063	2.27159	.335	-2.2669	6.6481

			Indian	-1.85666	2.32683	.425	-6.4226	2.7092
			Bangladeshi	.32075	3.42246	.925	-6.3951	7.0366
		Bangladeshi	White	1.86988	2.80670	.505	-3.6377	7.3774
			Indian	-2.17741	2.85160	.445	-7.7731	3.4182
			Pakistani	-.32075	3.42246	.925	-7.0366	6.3951
Diastolic BP	LSD	White	Indian	-3.44240*	.69907	.000	-4.8142	-2.0706
			Pakistani	-2.53691*	1.26396	.045	-5.0172	-.0567
			Bangladeshi	-2.23307	1.56171	.153	-5.2976	.8315
		Indian	White	3.44240*	.69907	.000	2.0706	4.8142
			Pakistani	.90548	1.29470	.484	-1.6351	3.4461
			Bangladeshi	1.20933	1.58669	.446	-1.9042	4.3229
		Pakistani	White	2.53691*	1.26396	.045	.0567	5.0172
			Indian	-.90548	1.29470	.484	-3.4461	1.6351
			Bangladeshi	.30384	1.90434	.873	-3.4330	4.0407
		Bangladeshi	White	2.23307	1.56171	.153	-.8315	5.2976
			Indian	-1.20933	1.58669	.446	-4.3229	1.9042
			Pakistani	-.30384	1.90434	.873	-4.0407	3.4330
Body Mass Index	LSD	White	Indian	.25505	.30714	.407	-.3477	.8577
			Pakistani	-1.50983*	.55878	.007	-2.6063	-.4133
			Bangladeshi	.65876	.68646	.337	-.6883	2.0058
		Indian	White	-.25505	.30714	.407	-.8577	.3477
			Pakistani	-1.76488*	.57202	.002	-2.8873	-.6424
			Bangladeshi	.40371	.69728	.563	-.9646	1.7720
		Pakistani	White	1.50983*	.55878	.007	.4133	2.6063
			Indian	1.76488*	.57202	.002	.6424	2.8873
			Bangladeshi	2.16859*	.83910	.010	.5220	3.8152
		Bangladeshi	White	-.65876	.68646	.337	-2.0058	.6883
			Indian	-.40371	.69728	.563	-1.7720	.9646
			Pakistani	-2.16859*	.83910	.010	-3.8152	-.5220

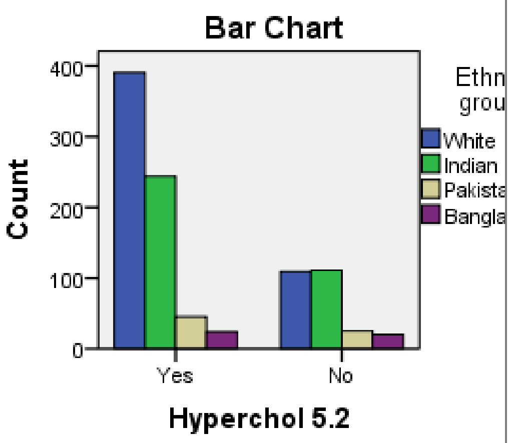
*. The mean difference is significant at the 0.05 level.

Appendix Table 5.5

WHO criteria for Moderate Exercise (150min/wk)				
	White Europeans (n=523)	**Indian (n=380)**	**Pakistani (n=77)**	**Bangladeshi (n=48)**
<150min/wk n (%)	380 (72.6)	318 (83.6)	64 (83.1)	45 (93.7)
≥150min/wk n (%)	143 (27.3)	62 (16.3)	13 (16.8)	3 (6.2)
	523 (100)	380 (100)	77 (100)	48 (100)
WHO criteria for Heavy Exercise (75min/wk)				
<75min/wk n (%)	451 (86.2)	362 (95.3)	74 (96.1)	46 (95.8)
≥75min/wk n (%)	72 (13.8)	18 (4.7)	3 (3.9)	2 (4.2)
	523 (100)	380 (100)	77 (100)	48 (100)

Appendix Table 5.6

Table Hypercholesterolemia by Ethnic group WHSS 1994-96						
Cholesterol> 5.2		Ethnic group				Graph presentation
		White	Indian	Pakistani	Bangladeshi	
Yes	Count	391	244	45	24	
	%	78.2	68.7	54.3	54.4	
No	Count	109	111	25	20	
	%	21.8	31.3	35.7	45.5	
Total	Count	500	355	70	44	
	%	100	100	100	100	



Appendix Table 5.7: Biochemical analysis of blood- WHSS 1994-96

		N	Mean	95% Confidence Interval for Mean	
				Lower Bound	Upper Bound
Serum creatinine	White	220	91.0367	89.6336	92.4397
	Indian	183	94.2800	92.7023	95.8578
	Pakistani	36	91.2769	87.5777	94.9761
	Bangladeshi	16	98.1201	89.6434	106.5967
	Total	455	92.6092	91.5925	93.6260
Total cholesterol	White	226	6.2093	6.0633	6.3553
	Indian	187	5.7987	5.6572	5.9403
	Pakistani	36	5.5428	5.1351	5.9506
	Bangladeshi	16	5.5276	5.0171	6.0382
	Total	465	5.9691	5.8698	6.0684
HDL-cholesterol	White	226	1.2610	1.2161	1.3058
	Indian	187	1.1089	1.0681	1.1496
	Pakistani	36	1.0188	.9148	1.1228
	Bangladeshi	16	.8971	.7795	1.0148
	Total	465	1.1685	1.1387	1.1984
Serum triglycerides	White	226	1.4975	1.3857	1.6093
	Indian	187	1.6989	1.5696	1.8282
	Pakistani	36	1.6969	1.4354	1.9583
	Bangladeshi	16	2.0772	1.5149	2.6395
	Total	465	1.6139	1.5337	1.6940
Haematocrit	White	226	.4384	.4349	.4419
	Indian	191	.4379	.4330	.4428
	Pakistani	39	.4457	.4340	.4575
	Bangladeshi	18	.4351	.4214	.4487
	Total	474	.4387	.4359	.4414
Serum glucose	White	224	5.2076	5.0576	5.3576
	Indian	188	5.9074	5.6044	6.2105
	Pakistani	37	5.7216	5.0284	6.4149
	Bangladeshi	17	5.7471	5.0351	6.4591
	Total	466	5.5504	5.3949	5.7060
Total homocysteine (uM)	White	143	11.0762	10.6725	11.4800
	Indian	95	13.5432	12.5225	14.5638
	Pakistani	19	11.4000	10.4323	12.3677
	Bangladeshi	8	9.2125	8.2128	10.2122
	Total	265	11.9275	11.4744	12.3807

Appendix Table 5.8

Crosstab: PMH of Stroke among Ethnic groups in WHSS 1994-96					
			PMH Stroke		Total
			Yes	No	
Ethnic group	White	Count	5	518	523
		% within Ethnic group	1.0%	99.0%	100.0%
	Indian	Count	3	377	380
		% within Ethnic group	0.8%	99.2%	100.0%
	Pakistani	Count	2	75	77
		% within Ethnic group	2.6%	97.4%	100.0%
	Bangladeshi	Count	1	47	48
		% within Ethnic group	2.1%	97.9%	100.0%
Total		Count	11	1017	1028
		% within Ethnic group	1.1%	98.9%	100.0%

Appendix 6.1: Request to FOIA

Dear **FOI Lead**
I am writing to make an open government request for all the information to which I am entitled under the Freedom of Information Act 2000.

Please send me:
Q. How many patients presented with stroke to A&E by ethnic origin for the period from 01 Jan 2006 to 31 Dec 2014?
Example Answer: abcdef no of patients presented with stroke to A&E. Of this jklm were White British, xyx were (British or Non British) Indians, bcde were Pakistani, abx were Bangladeshi, hijk were Africans and xyz were others

Q. What was the length of hospital stay of patients with stroke by ethnic origin for the period from 01 Jan 2006 to 31 Dec 2014?
Example Answer: White British hospital stay was xx days, Indians abc days, Pakistani defg days, Bangladeshi had abcd days of hospital stay etc.

Q. What was the age range and average age of patients presented with stroke by ethnic origin for the period from 01 Jan 2006 to 31 Dec 2014?
Example Answer: White British e.g 29 years to 102 years with avg 70 years.
Indians: 40 years to 90 years with avg 60 years,
Pakistani: 45 years to 80 years with avg 50 years,
Bangladeshi : 30 years to 80 years with avg 55 years,

Q. How many patients presented with stroke to A&E by ethnic origin were re-admissions for the period from 01 Jan 2006 to 31 Dec 2014?
Example Answer: out of 1000 admissions 300 were readmissions
According to their ethnicity 111 were White British , 123 were Indians: 124 readmissions were Pakistani: 444 were Bangladeshi .

I would like the above information to be provided to me as ***electronic copies.***

If this request is too wide or unclear, I would be grateful if you could contact me as I understand that under the Act, you are required to advise and assist requesters. If any of this information is already in the public domain, please can you direct me to it, with page references and URLs (if necessary?)

If the release of any of this information is prohibited on the grounds of breach of confidence, I ask that you supply me with copies of the confidentiality agreement and remind you that information should not be treated as confidential if such an agreement has not been signed.

I understand that you are required to respond to my request within the 20 working days after you receive this letter. I would be grateful if you could confirm in writing that you have received this request.
I look forward to hearing from you.

Yours faithfully
Raheela B Shaikh

Appendix 7.1

PRIVATE
Mrs Raheela Shaikh 82 Fentham Road Aston

Dear Mrs Shaikh,

Study Title and BSREC Reference: *An audit of the Acute Stroke Pathway at the HEFT during November 2014 to the present*, REGO-2016-1819

Thank you for submitting your revisions to the above-named study to the University of Warwick's Biomedical and Scientific Research Ethics Sub-Committee for approval.

I am pleased to confirm that approval is granted and that your study may commence.

In undertaking your study, you are required to comply with the University of

Warwick's
Research Data Management Policy, details of which may be found on the Research and

Impact Services' webpages, under "Codes of Practice & Policies" » "Research Code of Practice" » "Data & Records" » "Research Data Management Policy", at: http://www2.warwick.ac.uk/services/ris/research_integrity/code_of_practice_and_policies/res earch_code_of_practice/datacollection_retention/research_data_mgt_policy

You are also required to comply with the University of Warwick's *Information Classification and Handling Procedure*, details of which may be found on the University's Governance webpages, under "Governance" » "Information Security" » "Information Classification and Handling Procedure", at: http://www2.warwick.ac.uk/services/gov/informationsecurity/handling.
Investigators should familiarise themselves with the classifications of information defined therein, and the requirements for the storage and transportation of information within the different classifications:

> *Information Classifications:*
> http://www2.warwick.ac.uk/services/gov/informationsecurity/handling/classifications *Handling Electronic Information:*
> http://www2.warwick.ac.uk/services/gov/informationsecurity/handling/electronic/
> *Handling Paper or other media*
> http://www2.warwick.ac.uk/services/gov/informationsecurity/handling/paper/.

Please also be aware that BSREC grants **ethical approval** for studies. **The seeking and obtaining of *all* other necessary approvals is the responsibility of the investigator.**
These other approvals may include, but are not limited to:

1. Any necessary agreements, approvals, or permissions required in order to comply with the University of Warwick's Financial Regulations and Procedures.
2. Any necessary approval or permission required in order to comply with the University of Warwick's Quality Management System and Standard Operating Procedures for the governance, acquisition, storage, use, and disposal of human samples for research.
3. All relevant University, Faculty, and Divisional/Departmental approvals, if an employee or student of the University of Warwick.
4. Approval from the applicant's academic supervisor and course/module leader (as appropriate), if a student of the University of Warwick.
5. NHS Trust R&D Management Approval, for research studies undertaken in NHS Trusts.
6. NHS Trust Clinical Audit Approval, for clinical audit studies undertaken in NHS Trusts.
7. Approval from Departmental or Divisional Heads, as required under local procedures, within Health and Social Care organisations hosting the study.
8. Local ethical approval for studies undertaken overseas, or in other HE institutions in the UK.
9. Approval from Heads (or delegates thereof) of UK Medical Schools, for studies involving medical students as participants.
10. Permission from Warwick Medical School to access medical students or medical student data for research or evaluation purposes.
11. NHS Trust Caldicott Guardian Approval, for studies where identifiable data is being transferred outside of the direct clinical care team. Individual NHS Trust procedures vary in their implementation of Caldicott guidance, and local guidance must be sought.
12. Any other approval required by the institution hosting the study, or by the applicant's employer.

There is no requirement to supply documentary evidence of any of the above to BSREC, but applicants should hold such evidence in their Study Master File for University of Warwick auditing and monitoring purposes. You may be required to supply evidence of any necessary approvals to other University functions, e.g. The Finance Office, Research & Impact Services (RIS), or your Department/School.

May I take this opportunity to wish you success with your study, and to remind you that any Substantial Amendments to your study require approval from BSREC before they may be implemented.

Yours sincerely

E Dight

Professor John Davey Chair

Biomedical and Scientific Research Ethics Sub-Committee **Biomedical and Scientific Research Ethics Sub-Committee** Research & Impact Services University of Warwick. Coventry, CV4 8UW E: BSREC@Warwick.ac.uk

Appendix 7.2 Honorary Contract

Heart of England NHS

NHS Foundation Trust

HONORARY CONTRACT

HEART OF ENGLAND NHS FOUNDATION TRUST

and

Raheela Begum Shaikh

BETWEEN:

(1) Heart of England NHS Foundation Trust (the "Trust") of Bordesley Green East, Birmingham, B9 SSS; and Raheela Begum Shaikh.

(2) Raheela Begum Shaikh of 82, Fentham Road, Aston, Birmingham B6 6AU. ("you", "your")

1. INTRODUCTION

Your job title under this honorary contract is Phd Researcher in Care of the Elderly/Stroke Department.

Your substantive employer is N/ A.

You are hereby appointed in an honorary (unpaid) capacity as a Phd Researcher in Care of the Elderly/Stroke at Birmingham Heartlands Hospital.

Should your substantive contract of employment be terminated, your honorary employment with us will also be terminated.

1.1 This Agreement sets out the terms and conditions of your Honorary appointment with the Trust and are together referred to as "the Appointment".

1.2 This Agreement should be read in conjunction with your contract of employment with your substantive employer.

1.3 This Appointment does not give rise to any other relationship between you and the Trust, in particular that of a contract of employment.

1.4 The Trust reserves the right to review, revise, replace or amend any term of this Agreement and any Schedule which may form part of your Appointment from time to time by agreement with you and in conjunction with your substantive employer.

1.5 The Appointment is made subject to the Trust conducting acceptable security checks, health checks and receiving satisfactory references and to your not being prohibited from working for the Trust. If, after commencement of the Appointment, the Trust receives information which it deems in its absolute discretion to be unsatisfactory or if the Trust becomes aware of any restrictions preventing or prohibiting you from carrying out the Appointment, you agree that the Trust will be entitled to terminate the Appointment without notice. The Trust will notify your substantive employer for the reason for the termination of the Appointment.

2. PERIOD OF APPOINTMENT

2.1 Your employment under this honorary contract begins on 20th February, 2017 and will end on 19th February, 2018.

2.2 The Honorary Appointment will terminate on the completion of the duties {"Duties") set out in Schedule 1. This may be varied by agreement between you, the Trust and your substantive employer according to the requirements of the Appointment.

3. TITLE FOR POST AND DUTIES

3.1 The title for this Honorary Appointment is Phd Researcher.

3.2 Your activities will be overseen by David Sandler, Consultant Stroke Physician.

3.3 At all times during the Appointment you will act in the Trust's best interests. You must observe the same standards of care in dealing with patients, staff, visitors, suppliers, equipment and the premises as is expected of a member of the Trust's employees. You agree that you are under a continuing duty to disclose to the Trust all acts of misconduct, breaches of contract or wrong doing committed by any employee and your own.

3.4 You must not at any time give the impression that you are an employee of the Trust, or in any way as having authority to bind the Trust. Any breach of this provision could lead to your removal from the Trust.

4. PLACE OF WORK

4.1 Your principal place of work for the purposes of this honorary contract is Care of the Elderly/Stroke Department at Birmingham Heartlands Hospital. Other work locations including off site working may be agreed where appropriate

5. HOURS OF WORK

5.1 Your normal hours and days of work will be 37.5 hours per week over 5 days or as agreed with David Sandler.

5.2 Rest breaks are to be taken in accordance with the Trust's rules relating to rest breaks as notified to you from time to time.

5.3 The Trust reserves the right to vary your Normal Hours of Work, as are necessary to meet the requirements of the Honorary Appointment. If this is necessary the Trust will give you reasonable notice. Any variation will be by agreement with you and in conjunction with your substantive employer.

6. REMUNERATION

The Appointment is Honorary and therefore is unpaid.

7. EXPENSES

If you wish to claim expenses you will need to discuss this matter with your substantive employer to confirm whether or not they will reimburse you for all expenses reasonably and properly incurred by you in the performance of this Appointment.

8. HOLIDAYS

8.1 Your leave entitlement will be determined and paid by your substantive employer. Any leave that may prevent you from delivering your duties under this honorary contract must be agreed with us in advance in accordance with our procedures. You are obliged to notify your substantive employer of holidays arranged and agreed with the Trust during the Appointment

9. POLICIES AND PROCEDURES

9.1 You are required to comply with the Trust policies and procedures as may from time to time be in force in connection with your duties under this honorary contract.

9.2 Your substantive employer will retain overall responsibility and employment liability for implementing your terms and conditions of employment and any contractual policies and procedures

10. NOTIFICATION OF ABSENCE

10.1 If you are unable to come to work for any reason and your absence has not been authorised by your substantive employer, you must inform David Sandler personally by 9.00am on the first day of absence and keep the above named informed of the reason for the absence and the anticipated length of absence. You must keep your substantive employer notified of any period of absence, the reason for the absence and the anticipated length of absence.

10.2 You are not entitled to sick pay under this Contract. Fit notes from your GP should be provided to your substantive employer. The management of your sickness absence will be undertaken by your substantive employer.

11 GRIEVANCE PROCEDURES

1.1 The Trust has a non contractual grievance procedure which will apply to your duties under this honorary contract, a copy can be obtained from the Trust Intranet.

1.2 The Trust has a non-contractual disciplinary policy and procedure which may be amended from time to time. A copy can be obtained from the Trust Intranet. This policy may be applied to you in instances where you may be required to provide evidence or assist in part of an investigation.

1.3 Should action against you be contemplated for reasons relating to discipline or competence, we will advise you and your substantive employer of our concerns and your substantive employer will invoke the Disciplinary Procedure governed by your substantive employment.

1.4 As a part of any disciplinary proceedings involving you, the Trust reserves the right to restrict your Duties or suspend you from the Honorary Appointment

2. INSURANCE

For the purposes of employment insurance (and for no other purpose) you will be regarded as a Trust employee during the Appointment, provided that at all times you exercise all reasonable skill and judgement and act in good faith.

3. CONFIDENTIALITY

3.1 You must not at any time during or after the Appointment directly or indirectly disclose, use or exploit for your own purposes or those of any other third party any confidential information belonging to the Trust ("Confidential Information") or your knowledge of that Confidential Information.

3.2 For the purposes of the Appointment and this Agreement, Confidential Information includes all information about patients, staff, policies or finances of the Trust. You must not discuss such matters with, or release such information to unauthorised persons.

3.3 You must not remove any hospital or related documents from any of the Trust's premise without prior consent from Davis Sandler.

3.4 The obligations in this clause shall not apply:

14.4.1 To any information or knowledge which may subsequently come into the public domain other than by way of an unauthorised disclosure {whether by you or a third party); or

14.4.2 To any act of yours in the proper performance of the Appointment;

14.4.3 Where such use or disclosure has been properly authorised by the Trust; or

14.4.4 To any information which you are required to disclose by law or in accordance with a Court order.

14.5 A breach of confidentiality during the Appointment will result in its termination.

4. DATA PROTECTION

4.1 For the purposes of the Data Protection Act 1998 you give your consent to the Trust holding and processing personal data relating to you for all purposes relating to the performance of this Agreement including, but not limited to:

15.1.1 undertaking joint performance appraisals and reviews with your substantive employer;

15.1.2 maintaining sickness and other absence records to inform your substantive employer;

15.1.3 The lawful monitoring of communications via the Trust's systems.

5. TERMINATION OF APPOINTMENT AND POST TERMINATION OBLIGATIONS

5.1 The Trust and you are able to terminate the Honorary Appointment with 4 weeks notice.

5.2 The Trust will terminate the Appointment should your substantive contract of employment with your substantive employer be terminated for any reason.

5.3 The Honorary Appointment may be terminated by agreement between the Trust and your substantive employer.

5.4 At the end of the Honorary Appointment or on demand during the course of the Appointment, you must return all the Trust's property, documents, computer hard and software (including discs), tapes and all other tangible items (including but not limited to security pass, office/desk/cupboard keys, stationery, protective clothing) in your possession or control belonging to the Trust or containing any Confidential Information.

6. EQUAL OPPORTUNITIES

The Trust regards harassment or any other form of discrimination as unacceptable conduct, which will be subject to the disciplinary proceedings.

Details of the Trust's equal opportunities policy are available from the Trust Intranet. You are expected to comply with the Trust's policies relating to equal opportunities and harassment and to report any breach you may become aware of.

7 HEALTH & SAFETY

1.1 The Trust will take all reasonably practicable steps to ensure your health, safety and welfare during the Appointment. You must familiarise yourself with any Health and Safety notices posted at your Normal Place

of Work or where you are working from time to time. It is also your legal duty to take care for your own health and safety and that of any person who may be affected by your actions or omissions. You will also be required to attend the Trust induction programme.

1.2 It is expected that you will co-operate with the Trust in complying with any relevant statutory requirements imposed by the Trust including any Regulations and Codes of Practice issued.

8 OTHER CONDITIONS OF EMPLOYMENT-REGISTRATION REQUIREMENTS

It is a condition of your honorary employment that you are, and remain a registered member of the N/A.

9 INTELLECTUAL PROPERTY

For your duties under this honorary contract you will comply with the Trust procedures for intellectual property which are in line with 'The NHS as an Innovative Organisation, Framework and Guidance on the Management of Intellectual Property in the NHS'. For intellectual property generated under this contract we will where necessary seek to agree with your substantive employer how it should be treated if that organisation has an interest.

3. MISCELLANEOUS

7 The Trust cannot accept responsibility for articles of personal property lost or damaged by burglary, fire, theft or otherwise. You are therefore advised to arrange insurance cover for yourself in this respect against all risks.

8 Each paragraph and sub-paragraph of this Agreement is separate and severable. In the event that a paragraph of this Agreement shall be found to be void, if the paragraph would be valid if a sub-paragraph was deleted or if some part of the offending paragraph was deleted, such paragraph or sub-paragraph will apply with such modifications as may be necessary to make the Agreement valid.

9 This Agreement refers to various policies which are contained which are

available from the Trust Intranet site. These policies are non-contractual but you are expected to observe their principles and guidelines.

It is your responsibility to familiarise yourself with these policies. If you fail to comply with these policies you may be subject to disciplinary action. The Trust may make amendments or variations to or introduce new policies from time to time.

Any amendments to the Honorary Appointment will be communicated in writing by the Trust to you and your substantive employer. The Trust will seek agreement from you and your substantive employer to these amendments.

Issued by Barbara Bennett, Faculty of Education, Faculty Administrator, on Behalf of Recruitment team.

CC: David Sandler

21.5 This Honorary Agreement is the whole agreement between you and the Trust and supersedes all previous agreements whether oral or in writing.

I, Raheela Begum Shaikh, agree and accept the terms and conditions of the Honorary Appointment

Signed by Waqas Azam, for and on behalf of Trust

Signed: ....

Dated: ...1f.. /i./.L3.. ......:...

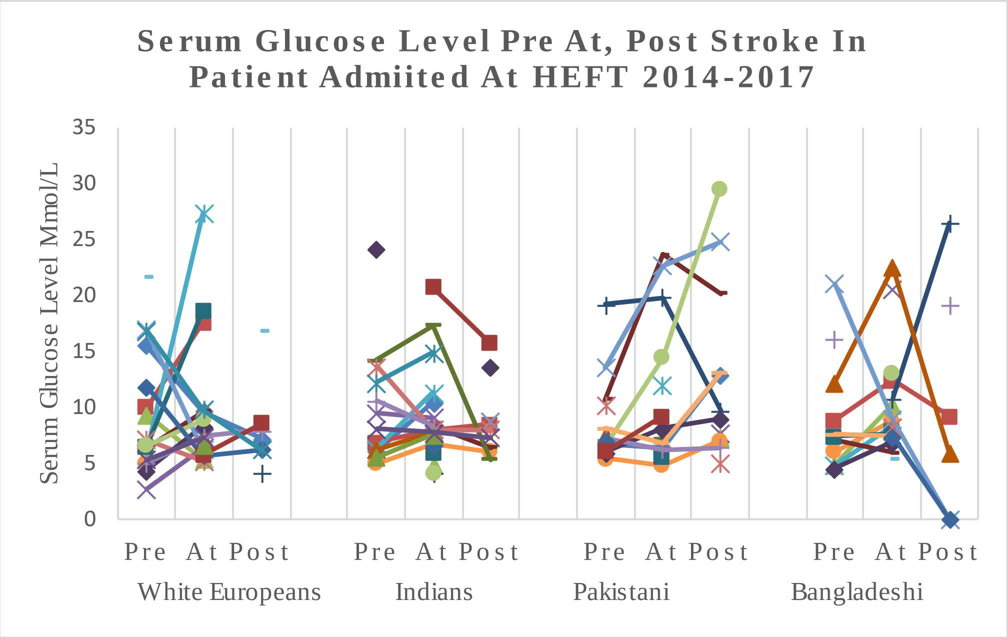
Issued by Barbara Bennett, Faculty of Education, Faculty Administrator, on Behalf of Recruitment team.

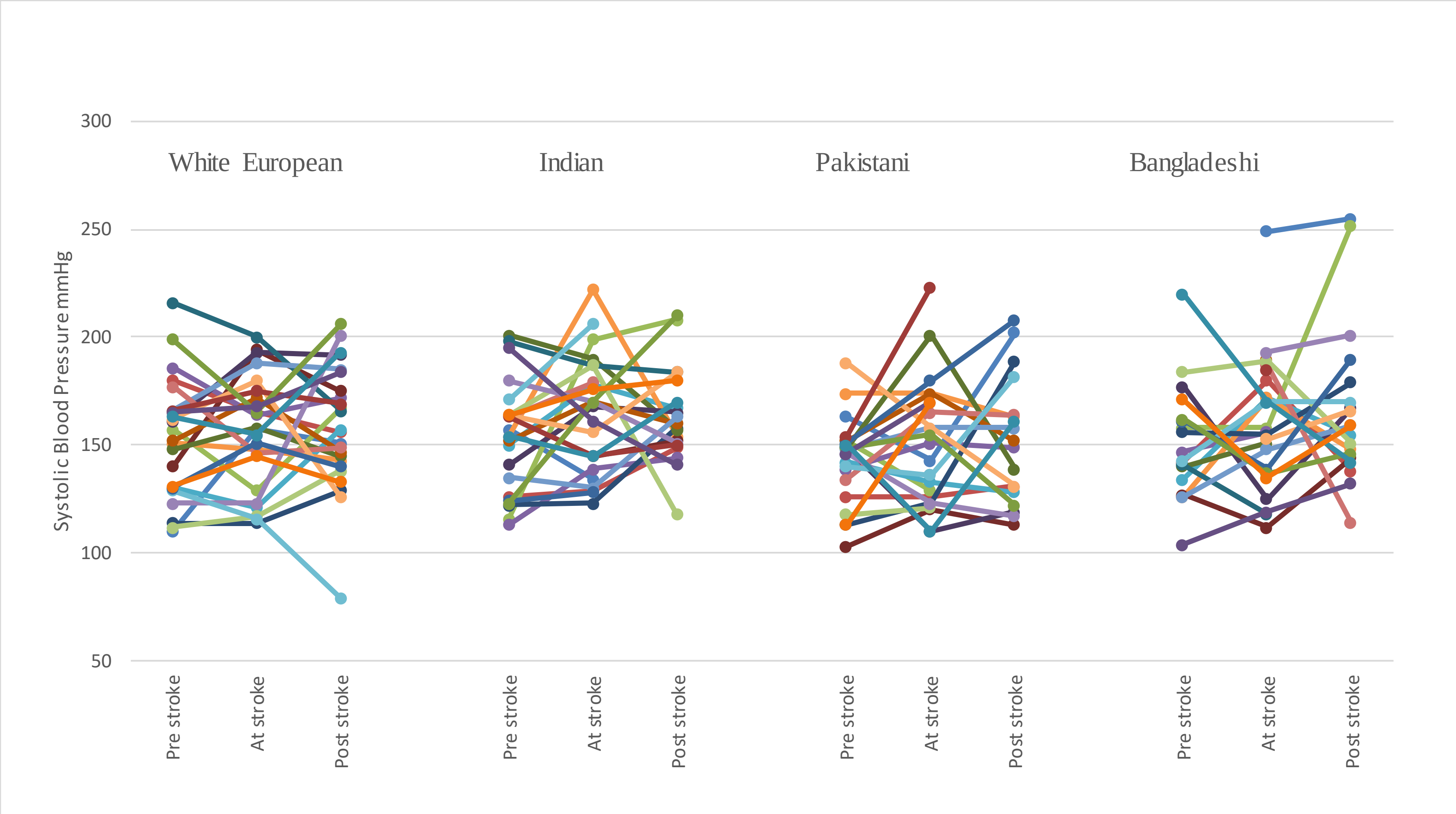
CC: David Sandler

Appendix 7.3 Case notes data extraction sheet

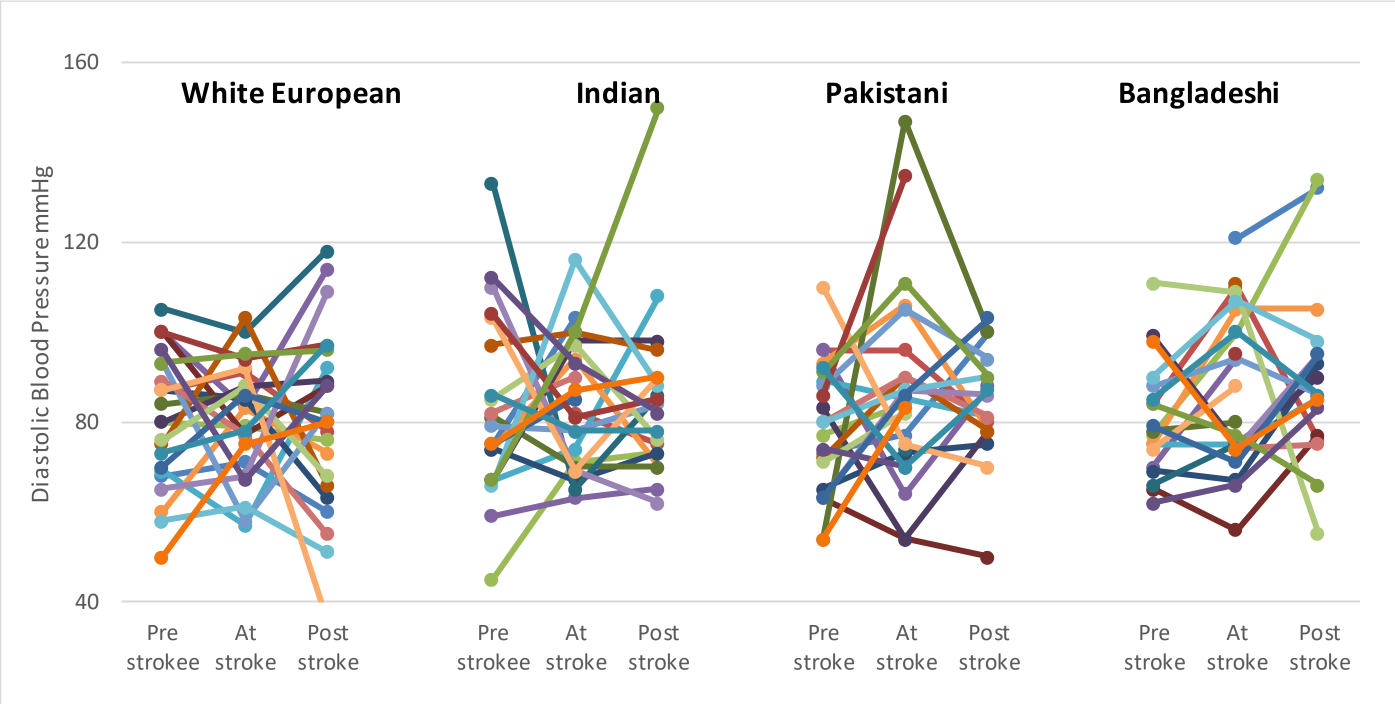
List of Data Required			
Stage 1: This is a retrospective case control study of risk factors associated with stroke in:			
Group A: include patients with stroke and are of Bangladeshi origin.			
Group B: include patients with stroke and are of other South Asian origin.			
Group C: includes White Europeans.			
Variables	GROUPS		
	Bangladeshi	Other South Asian	White European
Age			
Gender			
Ethnicity			
Level of education			
Occupation (if available)			
Post code (for deprivation index)			
Birth weight (If available)			
Genetic factor (Family History of stroke)			
Beetle nut use			
Smoking (present/past)			
Alcohol intake/day			
Diabetes			
Hypertension			
Atrial fibrillation			
Dyslipidaemia			
Carotid artery stenosis			
Sickle cell disease			
Postmenopausal hormonal therapy			
Dietary habits			
Physical activity level			
Obesity (BMI)			
Central body fat distribution (in inches)			
Sleep disordered breathing			
Metabolic syndrome			
Drug abuse			
Oral contraceptive use			
History of Migraine headache			
Elevated gamma-glutamyl transferase			
Hyperhomocysteinemia			
Elevated lipoprotein			
Elevated lipoprotein phospholipase			
Hypercoagulability			
any specific Inflammation and infection			
Any other factors			

Appendix 7.4: serum glucose level of stroke patients at HEFT Oct 2014-April 2017 at three points (Pre, at and post stroke)



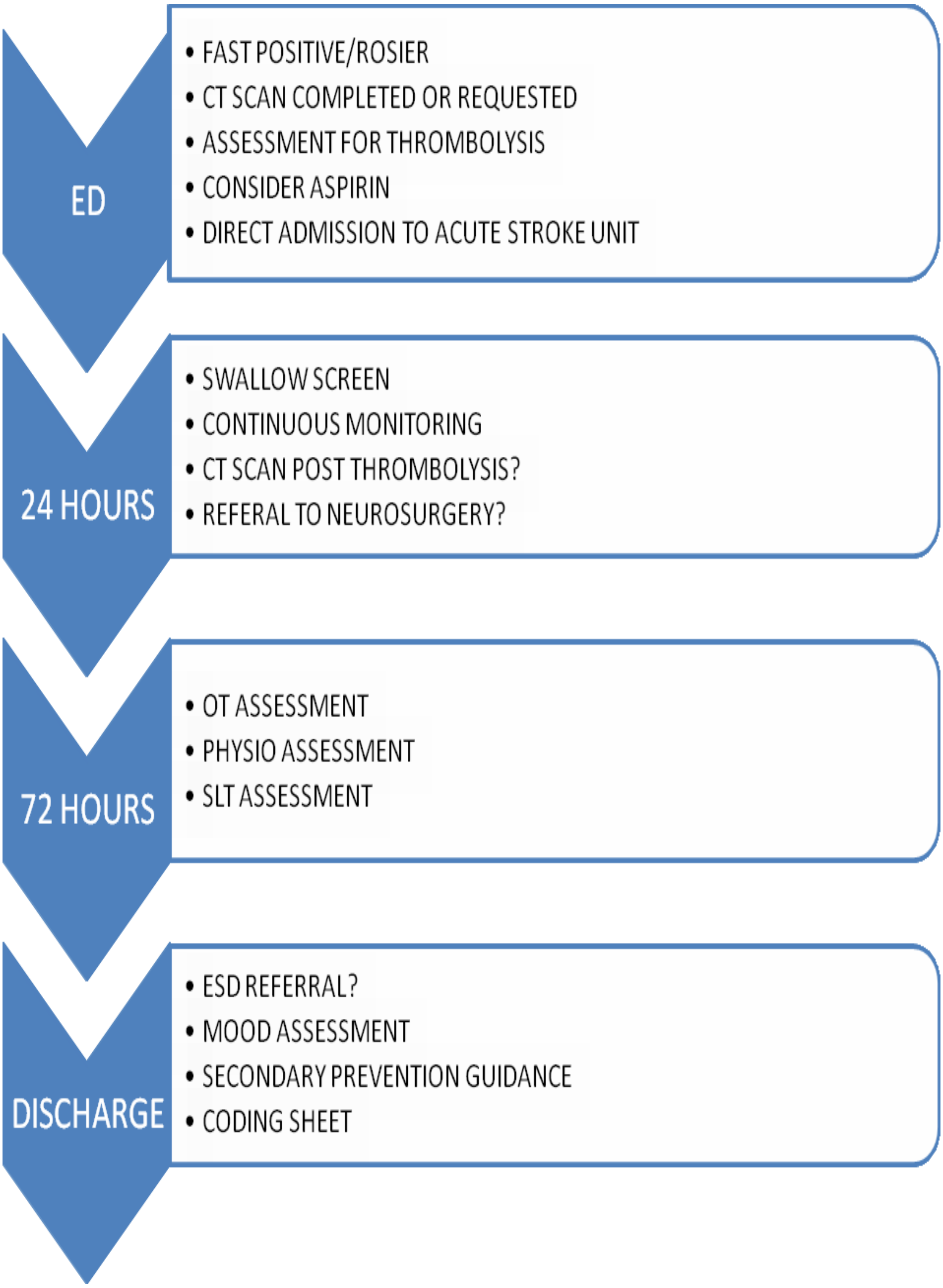


Appendix 7.5: Time trend analysis of systolic BP among stroke patient by ethnic group admitted at HEFT October 2014-April 2017



Appendix 7.6: Time trend analysis of Diastolic BP among stroke patient by ethnic group admitted at HEFT October 2014-April 2017

Appendix 8.1 GUIDANCE FOR THE ACUTE STROKE PATHWAY



Appendix 8.2 R & D Department Approval at HEFT – Audit

Audit Details

Audit Summary

Audit No	342	Date Created	24/05/2016
Status	Approved		
Proposed By	HEARTSOL/AsmarS	Site	Heartlands
Directorate	Elderly - BHH	Audit Lead	Khalid Azhar
Approved By	HEARTSOL/AzharK	Approved	25/05/2016
Audit	KHALID AZHAR	Supervisor	01214243768
Completed		Signed-Off	
Audit Title	AN AUDIT OF QUALITY OF DISCHARGE SUMMARIES FOR STROKE PATIENTS		
Comments	In recent years there have been great strides in the provision of hospital care for patients with a diagnosis of stroke. This has been prompted by the creation of acute stroke units and centralisation		

Audit Members

Audit Details

Audit Standard	Standards created from generic guidelines avaialable from Academy of royal colleges and consultant stroke physician input

Audit Type	Local	Rationale Type	Local Interests
Proposed Start Date	24/05/2016	Proposed Presentation	10/06/2016

Improve Patient Care	Ensure appropriate handover to GP of crucial information for hospital admission. Provide colleagues crucial information that will aid in patient care in future outpatient appoitnments and hospital admissions.
Improve Service	
Ensure compliance against guidelines Compliant	Ensure driving advice given to stroke patient (legal requirement)
Set local guidelines	May lead to generation of stroke discharge summary proforma to

Affected Members

Audit Details Audit Methodology

Data	Retrospective
Data Type	Computer Search
Data Type - Other	
Who is going to collect the data	If possible ask for all patients ID numbers for those discharged within the month of january 2016 with a coded primary diagnosis of stroke from HASU/A
Estimated Sample Size	50
Estimated Collection Period	1 MONTH
Require Honary Contract/Confidentional	No
Access Required to Medical Records	Yes

Where are the findings going to be

☑ Audit Meeting ☐ Directorate Meeting

☐ Governance Meeting ☐ Morbidity /Mortality

Audit Start Date	24/05/2016
Audit Stage	Proforma Submitted
Decline Comments (if	
Comments	
Delay Reason	
Comments	