SOCIAL NETWORKS, NUTRIENT INTAKE, NUTRITIONAL STATUS, AND PHYSICAL FUNCTION OF ETHNICALLY DIVERSE OLDER ADULTS: A LONGITUDINAL MIXED METHODS STUDY

By

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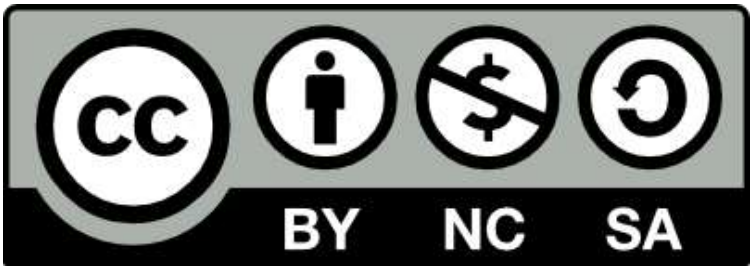
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ABSTRACT

The United Kingdom (UK) population is ageing and becoming more ethnically diverse. Ethnic minorities experience higher health inequalities and increased prevalence of diet-related diseases as compared to the general population. Social networks (SN), nutrition and physical function are essential components of healthy ageing. Despite this, little is known about these components of healthy ageing within ethnic minority older adults. In this PhD thesis, using a longitudinal mixed-methods design, the profile and changes in social networks, nutrient intake and physical function were explored in 100 community-dwelling, ethnically diverse older adults living in a super-diverse city (Birmingham, UK). Additionally, how these variables were related over time, and factors influencing these variables were examined. In study 1, most participants experiencing changes in SN transitioned from an integrated SN to non-integrated SN (63%), and more importantly, these changes occurred over a relatively short period of eight months. These changes were identified by participants as having influenced their eating behaviours and physical function. In study 2, it was observed that the intakes of most micronutrients across the sample over time was lower than the UK Recommended Nutrient Intakes (RNI), suggesting a potentially prolonged nutrient deficiency in this population. In study 3, changes in the factors influencing eating behaviours and physical function were intriguing and differed significantly by socio-demographic characteristics; more men reported negative changes as compared to women at follow-up. Furthermore, most participants considered healthy eating and physical function as separate entities with no relationship. Overall, the findings of this thesis indicate that ethnic minority older adults may experience rapid declines in SN, nutrition and physical function, which could inhibit healthy ageing. Steps towards developing and implementing community and faith-based culturally acceptable interventions to support healthy ageing are urgently needed.

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DEDICATION

I dedicate this work to my loving wife, Comfort Ayamga, my adorable daughter, Somdolma Asamane and to the newest addition to the family, my son, Anabila, for their love and support during the challenging times of my PhD study.

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7. Rodrigues, B., **Asamane E.A**, Greig C.A, Thompson, J.L, Sousa N, Santos, N (*In preparation*). Impact of dietary patterns on the age-related cognitive decline: A systematic review and meta-analysis.

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5. **Asamane, E.A**., C.A. Greig, and J.L. Thompson. Dietary intake, eating behaviours and physical function in community-dwelling ethnically diverse older adults: cultural tailoring of assessment methods and identification of key social influences. *1st PANINI Advanced training meeting. University of Jyvaskyla, Finland. April 2017*. Oral presentation.

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LIST OF ABBREVIATIONS

BME	**Black and Minority Ethnic**
BMI	**Body Mass Index**
CAG	**Carolyn A. Greig**
CI	**Confidence Interval**
DWP	**Department for Work and Pensions**
EU	**European Union**
FFQ	**Food Frequency Questionnaire**
GP	**General practitioner**
HGS	**Handgrip strength**
HSE	**Health Survey for England**
IMD	**Index of multiple deprivation**
JLT	**Janice L. Thompson**
MNA-SF	**Mini-Nutritional Assessment-Short Form**
ONS	**Office for National Statistics**
OR	**Odds ratio**
SD	**Standard deviation**
SN	**Social Networks**
SportExR	**Sport, Exercise & Rehabilitation Sciences**

SPPB	**Short Physical Performance Battery**
UK	**United Kingdom**
UN	**United Nations**
US	**United States of America**
WC	**Waist circumference**
WHO	**World Health Organization**

DEFINING CONCEPTS

In this PhD study, community-dwelling, ethnically diverse older adults refer to free-living ethnic minority older adults aged 60 years and older living in any setting within the community, excluding those living in care homes/institutions or hospitals. The concept of 'ethnic minority older adults' as used in this PhD refers mainly to migrant-origin groups, mainly first-generation migrant groups that have settled in the UK or other parts of Europe and the US. Eating behaviours refers to behaviours or habits that relate to grocery shopping, meal planning, cooking, eating and all other behaviours and habits pertaining to food intake. Social Network (SN) denotes all of the self-reported perceived/actual support received through the interpersonal ties shared by participants and their families, friends and the wider community. Nutrient intake throughout this thesis refers to the estimated amount of energy and nutrients calculated from the assessment of diet carried out using multiple-pass 24-hour recalls with the addition of an in-depth interview.

CHAPTER 1

GENERAL INTRODUCTION AND LITERATURE REVIEW

This chapter provides an overview of the background and literature review underpinning this PhD research. The chapter begins by providing a background summary of the research, followed by a narrative review of literature, highlighting the gaps in the literature and the need to examine the profile of social networks, nutrient intake, nutritional status, physical function and eating behaviours of community-dwelling ethnically diverse older adults over time, which has yet to be examined using a longitudinal design and mixed-method approach. The chapter concludes by summarising the rationale for this PhD research.

1.0 General Background

Globally, the world population is increasing and ageing rapidly, with developed nations having the greatest degree of ageing (Organization, 2018; United Nations, 2015). The increasing life expectancy and low fertility rate are contributing substantially to the ageing of the world's population (He, Goodkind, & Kowal, 2016; United Nations, 2015). Considering the available projections, the population of older adults aged 60 years and older will increase by 56% for the period of 2015 to 2030. This will give rise to a population of 1.4 billion older adults aged 60 years and older by 2030, and a further increase to 2.1 billion by the year 2050 (United Nations, 2015). Interestingly, the subgroup of older adults often termed the oldest-old (80 years and older) are the major drivers of this growth as their proportion have increased rapidly, and are projected to continue to increase as compared to any other subgroup of older adults globally (United Nations, 2015).

In the United Kingdom (UK), the population growth and ageing effect are no different from the rest of the world. The current population of 64.6 million (as of mid-2014) is projected to

increase by 9.7 million in 25 years' time (ONS, 2015). Specifically, the older adult population in the UK has also increased tremendously in recent years and is forecast to increase further in the coming decades (ONS, 2015; ONS, 2018). For example, in 2016, there was a total of 11.2 million people aged 65 years and older, representing 18% of the population (ONS, 2018). It is projected that by 2030, one in five people in the UK will be aged 65 years and older, comprising 21.8% of the population, and with the proportion of those aged 75 years and older and 85 years and older comprising 6.8% and 3.2% of the population, respectively (ONS, 2017). Although life expectancy is increasing, the majority of older adults in the UK and other parts of the world spend the last decades of their life in poor health with increased dependency (HSE, 2005; Thompson, 2014; WHO, 2018). The added number of years versus the number of healthy years contribute not only to reducing quality of life for these individuals, it also impacts significantly on health and social care systems, the economy and the lives of family members (Age UK, 2017).

Another vital component directly increasing along with population growth and life expectancy in the UK is the increasing super-diversified nature of the population (Lievesley, 2013; Vertovec, 2007). Super-diversity refers to the unprecedented collection of different nationalities, faiths, languages, cultures and ethnicities in the society (Vertovec, 2007). Currently, the population of black and ethnic minorities in England forms 12% of the entire population (ONS, 2012). In England and Wales, the population of ethnic minorities (non-white) has increased from 14% (7 million) in 2001 to about 20% (11 million) in 2011, with further projections of 30% by 2050 (Jivraj, 2012; ONS, 2012; Rees *et al.*, 2012). Specifically, older ethnic minorities aged 50 years and older has increased from 1.3 million in 2001 to 1.7 million in 2007 and 2.4 million by 2016, and is projected to reach 3.8 million and 7.4 million by 2026 and 2051, respectively (Lievesley, 2013).

Specifically, within the Birmingham area, census data indicate that the population of ethnic minority groups has increased from 30% in 2001 to 42.1% in 2011, whereby 2 of every 5 people identify themselves with an ethnic group (Birmingham City Council, 2011b). Birmingham has been defined as one of the youngest super-diverse cities in the UK, with the greatest collection of nationalities, faiths, languages, cultures and ethnicities of migrants from over 170 countries (Birmingham City Council, 2011a; Phillimore, 2013). Recent projections predict that by 2021, more than 50% of the population in Birmingham will be comprised of ethnic minorities (Birmingham City Council, 2018). Figure 1 illustrates the various ethnic groups residing in Birmingham, and the projected changes in the population of these groups in the super-diverse city of Birmingham, UK.

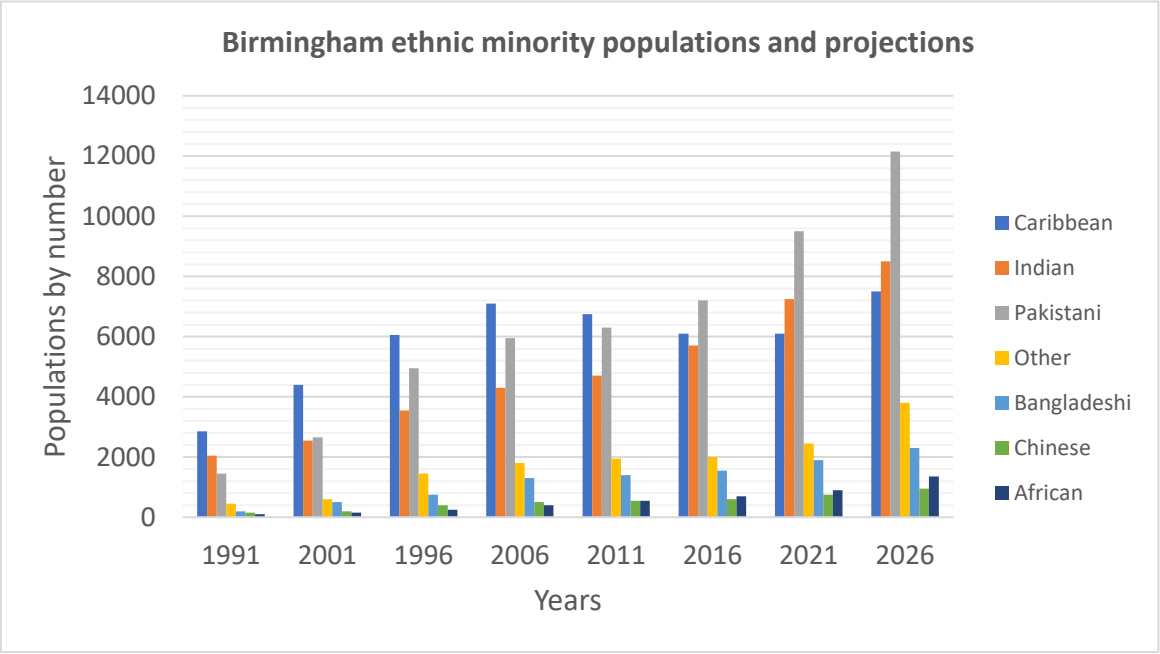


Figure 1: Changes in the population of ethnic minorities and future projections within Birmingham, UK
(Source: Population forecasts for Birmingham, with an ethnic group dimension population forecasts for Birmingham; Population forecasts for Birmingham CCSR Report.doc http://hummedia.manchester.ac.uk/institutes/cmist/archive-publications/working-papers/2007/2007-12-population-forecasts-for-birmingham.pdf)

The increasing super-diversity and the rise in the size of the older population are two important factors that will affect the general health of the population in the 21st century and beyond (Simpson, 2007; Vertovec, 2007). Given such growth, it is necessary for research to focus on understanding the complexities and modalities that influence the ability of community-dwelling, ethnically diverse older adults to age more healthily. This will improve the quality of life and reduce the personal, social, and financial burdens on individuals, families, communities and society.

1.1 Health and Diet profiles in Community-dwelling, ethnically diverse older adults

Ethnicity as a multi-faceted fluid model and subjective concept (ONS, 2012), comes from the Greek word 'Ethnos' which means belonging to a nation. Ethnicity is sometimes used as a synonym to mean the cultural grouping of people (Betancourt & López, 1993). By definition, an ethnic population could be referred to a group of people that share similar language, customs, values and race and are distinct from the rest of the population (Carlson, Kipps, & Thomson, 1984).

In the UK, many ethnic minority groups are often faced with low levels of economic status and disproportionate health inequalities, predisposing them to lower quality of life and poorer health than the white British population (Department for Work and Pensions, 2015; Evandrou, 2000; Nazroo, 1997; Sproston & Mindell, 2006). Also, the high prevalence of sedentary behaviour and low physical activity levels have been highlighted among older ethnic minorities in the UK (Babakus & Thompson, 2012; Castaneda-Gameros, Redwood, & Thompson, 2018b). This is evident in the higher trends of obesity, diabetes and other non-communicable diseases among older minorities as compared to the white British population (Eastwood *et al.*, 2015; Gilbert & Khokhar, 2008; Leung & Stanner, 2011; Misra & Ganda, 2007; Sproston & Mindell, 2006).

Furthermore, there have been possible differences reported in dietary intakes which may account for the higher incidence of diet-related diseases among ethnic minority groups compared with their counterparts in the UK (Anderson *et al.*, 2005; Leung & Stanner, 2011). More so, accumulating evidence suggests that dietary habits of ethnic minority groups are becoming unhealthy mainly due to food acculturation, age and years spent in the host country (Gilbert & Khokhar, 2008; Leung & Stanner, 2011; Talegawkar *et al.*, 2016). While recognising the changes in dietary profiles and the ultimate role diet and food behaviours play in the overall health of older adults, there are limited data on the factors affecting dietary changes (barriers), specifically exploring the association of Social Networks (SN) and other key influences on diet and physical function among this population over time.

There is a growing body of evidence that shows that adequate dietary intake, social networks and physical function could remarkably influence morbidity, quality of life and mortality in later life (Fiori & Jager, 2012; Gopinath *et al.*, 2014; Hammond, 2010; Millen *et al.*, 2005; Milte & Mcnaughton, 2016; Munoz *et al.*, 2008; Santini *et al.*, 2015). For example, a double-blind, randomised controlled trial, discovered that adequate dietary intake mainly focusing intakes of whey protein, essential amino acids, and vitamin D, coupled with the right amount of exercise improves muscle mass, strength and functional abilities of sarcopenic older adults in a 12-week study (Rondanelli *et al.*, 2016). Similarly, in the EPIC study of 74,607 of adults aged 60 years or older, it was established that the stronger an individual's adherence to the Mediterranean diet, the lower the risk of mortality (Trichopoulou *et al.*, 2005). Another study exploring the adherence to Mediterranean diet also found that self-perceived mental and physical health was directly associated with high adherence to Mediterranean diet (Munoz et al., 2008).

In addition to the role of optimal nutrition for healthy ageing, evidence suggest that strong social networks (including household size, the frequency of non-household contact with family/friends and active involvement with the community) could have a significant influence on healthy ageing. Community-dwelling older adults with strong social networks often have good support to adapt comfortably to healthy lifestyles, leading to improved functionality and quality of life (Barnett & Praetorius, 2015; Escobar-Bravo, Puga-González, & Martín-Baranera, 2012; Fiori & Jager, 2012; Park, Smith, & Dunkle, 2014; Santini et al., 2015). In the EPIC study, it was found that older adults with strong social networks were more likely to adapt to healthier eating habits of increased fruits and vegetables consumption compared with those having weaker social network ties (Conklin *et al.*, 2014). Another significant influence of social networks (family ties) was found in a group of 50 older adults. In this study, it was discovered that homebound older adults ate well (adequate calories) when mealtimes were with family members (Locher *et al.*, 2005). Additionally, a study examining the influence of social networks on health outcomes among 4,170 Korean adults aged 65 years and older found that individuals with more extensive social networks had higher levels of life satisfaction and lower depressive symptoms than those with restricted networks (Park et al., 2014).

Given the above evidence, assessing dietary intake and social network influences among the population forms an important asset to informing nutritional policies/interventions and consequently improving healthy dietary intake, physical function and reduction in the trends of non-communicable diseases. The current data are limited, and further research is needed to enhance our understanding of dietary behaviour and nutrient intakes of community-dwelling ethnically diverse older adults to ensure the provision of the necessary support for older adults to adopt healthy lifestyle activities for healthy ageing. A well-conducted screening and assessment of diets of older adults could improve our ability to detect risks of malnutrition

much earlier in older populations (Crombie *et al.*, 2004). Also, Sharma (2011) highlighted the need for an appropriate and timely screening and assessment of dietary intake and eating behaviours, which could help to identify the link between certain foods and disease causation (Sharma, 2011). Such vital information could inform policies, create network specific interventions and monitor the progress of existing interventions.

To date, the assessment of diet in older adults have often been poorly conducted, and most of the research has been done within predominately white populations. Even though there is evidence that ethnic minorities are willing to participate in relevant research, they are often underrepresented in both clinical and community health research (Gill *et al.*, 2012; Redwood & Gill, 2013). More so, the few researchers that explored dietary research into multicultural and super diverse communities often fail to use culturally sensitive assessment methods, leading to reduced participation and inaccurate results (Birmingham Policy Commission on Healthy Ageing, 2013). As such, there is still a great deal to be learned about the influences on dietary intake and how these impact on physical function and healthy ageing among ethnic minorities living in super-diverse communities in the UK. Also, there is limited evidence examining the effect of social networks typology (type, size and composition) and their changes on dietary behaviours and physical function among community-dwelling, ethnically diverse older adults living in a super-diverse city in the UK.

1.2 Aims and Research Questions

This section discusses the aims and the research questions of the PhD study.

1.2.1 Research Aim

This longitudinal mixed-methods PhD research sought to measure the profile of social networks, nutrient intake, nutritional status and physical function, and explore the extent to

which these variables change over a period of eight months among community-dwelling, ethnically diverse older adults. Also, this PhD research aimed to identify and contextualize the influence of social networks and other key factors on nutrient intake, eating behaviours, and physical function over time in ethnically diverse older adults in the super-diverse city of Birmingham, UK. These aims were achieved by adapting already existing tools to ensure they were culturally appropriate, more accurate and less burdensome for participants.

1.2.2 Research Questions

To achieve the aims of the study, the following research questions were developed. Table 1 shows the primary and secondary research questions and the corresponding methods to address each, under the three main empirical chapters of this PhD research.

Primary questions

1. What is the profile of the social networks (SN) of community-dwelling ethnically, diverse older adults living in a super-diverse city, and what are the influences of SN on nutrient intake, nutritional status and physical function?
2. What are the changes in SN and do changes in SN influence dietary intake, eating behaviours and physical function in ethnically diverse older adults over an 8-month period? And if so, how?
3. What is the current nutrient intake, nutritional status, eating behaviours and physical function of ethnically diverse older adults living in a super-diverse city? Is their nutrient intake and nutritional status related to their physical function?

Table 1: The research questions addressed in each empirical chapter and the methods used

Empirical chapter	**Research questions addressed**	**Methods**
Chapter 3: Social networks and its influence on nutrient intake, nutritional status and physical function of community-dwelling ethnically diverse older adults: A mixed methods longitudinal study	1. What are the social network (SN) typologies of community-dwelling ethnically diverse older adults living in a super-diverse city? 2. Are there SN changes over the period of 8-months in this population? To what extent do social networks, and any changes in these networks, influence nutrient intake, nutritional status and physical function over 8-months?	Longitudinal concurrent mixed methods
Chapter 4: The association between nutrient intake, nutritional status and physical function of community-dwelling ethnically diverse older adults: A longitudinal study	1. What is the profile of energy, macro- and micronutrient intakes, and nutritional status in community-dwelling ethnically diverse older adults? 2. What are the changes in nutrient intakes and nutritional status over an 8-month period? 3. What are the changes in physical function over an 8-month period? 4. How is nutritional status related to their physical function over time?	Longitudinal quantitative design
Chapter 5: Eating behaviours and factors influencing dietary and physical function behaviours of community-dwelling ethnically diverse older adults living in the United Kingdom: A qualitative prospective.	1. What are the eating behaviours of community-dwelling ethnically diverse older adults? 2. What are the main factors influencing dietary and physical function behaviours?	Longitudinal qualitative design Analysis

1.3 Literature Review

Search strategy

Literature was searched using several databases during the study period. These included Scopus, Medline, Pubmed, PsychInfo, Web of Science, CINHAL and Google Scholar. Books and additional references were sought through FindIt@Birmingham, the University of Birmingham library search tool. Other reports, books and papers were obtained from the relevant government websites such as Office for the National Statistics (ONS), World Health Organisation (WHO), Birmingham City Council, Age UK, and the United Nations. Also, references of identified material were explored to find related articles to the subject area.

The search was divided into 4 main categories using years of published work as a guide. These categories included:

- Ageing and super-diversity
- Diets and dietary assessment
- Social networks and healthy ageing
- Physical function

With a combination of keywords and phrases, literature within each category was sought (as listed in table 2).

Table 2: Categories and keywords for the literature search for this PhD thesis.

Category	**Keywords or phrases**
Ageing and super-diversity	Age, old, elderly, super-diversity, diversity, ethnicity, older, 'ageing', 'ageing well' 'healthy ageing', 'successful ageing'
Diets and dietary assessment	'diets' 'ethnic food', 'nutrient intake', 'dietary assessment', 'dietary assessment method', 'ethnic group', 'ethnic food', 'immigrant food', 'minority group' 'dietary need' 'physiological'
Social networks and healthy ageing	'social', 'networks' 'ties', 'social ties', 'family ties', 'friends' ties', 'social support', 'health'
Physical function	'physical capacity', 'physical function', 'fitness', 'functional capacity', 'functional decline'

1.3.1 Ageing and the Concept of Healthy Ageing

Ageing occurs as a result of the life-long biological changes, damages to the genome and the inability of the body to adapt/repair these changes with time (Steves, Spector, & Jackson, 2012). As this molecular damage occurs, it has the ability to cause cells and organs to malfunction, hence the failure to produce energy and maintain other functional abilities with time (Steves et al., 2012). This gradual decline in functionality predisposes the body to an increased risk of diseases and subsequently death. The process of ageing is influenced significantly by many factors such as genes, nutrition and the environment (Kirkwood, 2006; Steves et al., 2012).
The multi-dimensional impact on ageing explains the age and health disparities often noticed within the same population irrespective of the chronological ageing spectrum (Marmot & Bell, 2012; Steves et al., 2012). Older adults that live in different environments with different socio-economic status and dietary intake will age and die differently (Marmot & Bell, 2012; Trichopoulou et al., 2005).

Over decades, there has been substantial debate on what and how to describe healthy ageing,

what constitutes it, or even how it can be measured (Bowling, 2006; Romo *et al.*, 2013; WHO, 2015). There has also been considerable debate on the terms or phrases used to describe healthy ageing. Some refer to it as active ageing, healthy ageing, ageing well, positive ageing or successful ageing (Bowling, 2006; Romo et al., 2013; WHO, 2015). Given the current and projected demographic changes, research into healthy ageing is becoming vital, with numerous researchers looking at ways to effectively promote and sustain healthy ageing in both community and institutionalised settings (WHO, 2015; World Health Organization, 2015). This has led to the formation of working groups and commissions on healthy ageing globally, aimed at generating feasible regulations and recommendations that will support older adults to age healthily in safe and healthy communities (Birmingham Policy Commission on Healthy Ageing, 2013; CFHD, 2006; WHO, 2015).

The definitions of healthy ageing continue to evolve and become more comprehensive, taking a multi-dimensional approach to describing healthy ageing. Some of these definitions have been based solely on two distinct theories, namely the biomedical perspective and that of the psychosocial perspective of healthy ageing (Cosco *et al.*, 2014). The dimension of an individual's physical health, functional and cognitive capacity and social activity forms the biomedical aspect of healthy ageing, while that of the dimensions of social networks, psychological well-being and the community support for healthy ageing forms the psychosocial domain of healthy ageing. Following the earlier work of Rowe and Khan, they defined healthy ageing as "the state of no disease and disease-related disability-free life with high functional capacity and active life involvement" (Rowe & Kahn, 1997). While this definition comes with many limitations, it has led to the unearthing of several definitions with a comprehensive approach to healthy ageing. In a systematic review exploring the various descriptions of healthy

ageing, it was found that there are 105 operational definitions of healthy or successful ageing currently in existence (Cosco et al., 2014).

The latest of these definitions is contained in the WHO recent report, "Ageing and Health Report (2015).'' WHO defined healthy ageing as "the process of building and sustaining the functional ability that enables an individual's well-being in older age'' (WHO, 2015). While examining this definition, the Birmingham Commission on Healthy Ageing found that the feeling of how old one is, is not necessarily determined by chronological age or health status, but rather a holistic array of many other factors surrounding the individual. This leads to a description of healthy ageing as the components of daily activities one undertakes, the environment in which one lives, the services one has access to, how valued and valuable one feels and, importantly, the social networks of an individual (Birmingham Policy Commission on Healthy Ageing, 2013). Besides these definitions, the Community and Family Health Division (CFHD) (2006) working group on ageing also defined healthy ageing as the development and maintenance of optimal mental, social and physical well-being and function in older adults through safe communities, accessible health services and programmes to prevent or reduce the burden of diseases. It has been suggested that the absence of uniformities in these definitions impedes the progress of research, making adoption and comparison of policies across populations difficult (Cosco et al., 2014).

1.3.2 Cultural understanding of Healthy Ageing in a Super-diverse community

After several decades of research into healthy ageing, evidence suggests that healthy ageing is complex and very subjective to different individuals in different populations (Birmingham Policy Commission on Healthy Ageing, 2013; Bowling, 2006; Cosco et al., 2014). This is manifested by the differences within and across various cultures and individuals, the differing

approaches and interpretations by researchers, and the way we define and promote healthy ageing (Cosco et al., 2014; Hung, Kempen, & De Vries, 2010).

As such, there is a great deal that still needs to be learned about the cultural perspective of healthy ageing, especially within super-diverse communities (Uotinen, Suutama, & Ruoppila, 2003). Accumulating evidence suggests that lay people's understanding of healthy ageing is more holistic with components of healthy ageing outside the already existing theoretical models of healthy ageing (Bergstrom & Holmes, 2000; Bowling, 2006; Guse & Masesar, 1999; Phelan *et al.*, 2004; Tate, Lah, & Cuddy, 2003; Von Faber *et al.*, 2001). Bowling (2006), found that lay older people's understanding of healthy ageing was all-inclusive and varied across age groups and social-demographic characteristics. For example, it was found that respondents who were in 'good' health, rather than 'not good' health, had a significantly increased odds of defining successful ageing in terms of social relationships, social activity, and psychological factors, rather than defining it with regards to health (Bowling, 2006). While older adults that were married, as opposed to unmarried, responded with an increased odds of mentioning financial circumstances as part of successful ageing (Bowling, 2006). These findings are further supported by Hung and colleagues (2010). In their study, it was found that lay views of healthy ageing varied considerably within and between various cultures or ethnic groups (Hung et al., 2010).

Given this, many studies have argued that the understanding of healthy ageing from the lay views of older adults could help not only to understand how and what constitutes healthy ageing, but also to design and implement a network-specific intervention to promote healthy ageing (Bowling, 2006; Phelan & Larson, 2002). As the UK is becoming ethnically diverse, there are limited data on how specific minority groups understand and experience ageing

especially in super-diverse communities (Fenton & Draper, 2014; Sin, 2007). The Birmingham Commission for Healthy Ageing (2013) found that there existed many differences within and between ethnic minority groups. This has led to calls for more research to explore how healthy ageing is culturally understood and what influences healthy ageing in different populations (Fenton & Draper, 2014). In light of this, this PhD research seeks to contribute to the understanding of healthy ageing in super-diverse communities in Birmingham by identifying key influences to the adoption of healthy lifestyle behaviours among community-dwelling, ethnically diverse older adults.

1.3.3 Diets and Dietary needs of the Ageing Population

Physiological, physical and social changes occur as an individual age. These changes impact on dietary behaviour (food intake), nutrient needs, nutritional status and sedentary behaviours (WHO, 2015). More so, these changes are not uniform, as food intake, nutrient needs and requirements, and the entire ageing process occur distinctive from person to person as they age. For example, some overweight older adults might require less energy to avoid weight gain but need to ensure adequate intake of micronutrients, while those older adults who are at risk of underweight (including other diseases and concomitant infections) will require more energy and nutrients to combat malnutrition (Houwing *et al.*, 2003).

From a physiological perspective, the ageing process impacts on the body in many dimensions that can impair the body's ability to ingest, digest, absorb, process, distribute and store nutrients over time (Morley, 1997). These changes have the tendency to affect the dietary behaviours and nutritional status of older adults. Morley and Silver (1988) describe these changes with age that could impair dietary behaviour and nutritional status as "the anorexia of ageing.''

Additionally, the loss of dentition, sight, hearing and taste with age are considered to be the primary drivers that can impact on food intake, nutritional status, prevalence of other diseases and subsequently the quality of life among older adults (Boyce & Shone, 2006; De Marchi *et al.*, 2012; Petersen & Yamamoto, 2005; WHO, 2015). For example, the loss of teeth with age affects the amount and quality of food consumed. This usually occurs as mealtimes are not pleasurable, which results in the inability to eat a variety of nutritious meals due to chewing difficulties encountered during mealtimes (N'gom & Woda, 2002). Specifically, most older adults with impaired dentition are likely to avoid meat, fruits, vegetables and meals that require proper use of the teeth, which will eventually lead to poor nutritional status (Hutton, Feine, & Morais, 2002). In a study exploring dentition and nutrient intake (fat), De Marchi et al. (2012) found that in 471 community-dwelling older adults, being toothless had higher odds for inadequate body fat as compared to increased dentition. In a similar study, using the Mini Nutritional Assessment (MNA), it was discovered that older adults that were edentulous (lacking natural teeth) and wearing only one denture were more likely to have less adequate food intake, thus presenting higher risks of malnutrition when assessed (De Marchi *et al.*, 2008).

Similar results have been found with the loss of sight, hearing, taste and smell impacting on dietary intake with age (Bautista *et al.*, 2013; Rolls, 1986). Bautista and colleagues (2013) demonstrated in a two-month cross-over intervention study that enhanced flavour foods led to better nutritional status of nursing home older adults aged 60 years and older. In this study, the addition of either 0.5g of monosodium glutamate or 0.5g of iodized salt, as compared to no intervention, led to an increase in energy intake, most nutrients and body mass index (Bautista et al., 2013). Other physiological changes that might influence food intake and nutrient needs in older adults include impaired gastrointestinal function, increases in leptin levels which

decreases appetite, having the overall effect of decreasing the desire to eat as one ages (Chapman, 2007; Landi *et al.*, 2016).

Furthermore, the occurrence of low-grade chronic inflammation becomes more common as the individual ages, and this eventually leads to a high oxidative stress, and subsequently increases the risk of diseases such as atherosclerosis, chronic heart diseases, cancers etc. (Franceschi *et al.*, 2007). These diseases have the potential to impact on nutrient intake and needs of older adults. Likewise, ageing is accompanied by decreased metabolic activity and decline in energy expenditure due to the loss of muscle mass and proportional increase of fat mass (Kyle *et al.*, 2001). This decline in metabolic activity and energy expenditure could also be attributed to the decline of physical activity with age (Caspersen, Pereira, & Curran, 2000; Elia, Ritz, & Stubbs, 2000). Given this, the amount of food intake reduces with time, leading to a low nutrient intake (especially micronutrients) consequently causing malnutrition that could lead to a further impact on metabolic rate and energy expenditure (Donini, Savina, & Cannella, 2003; Landi et al., 2016).

Moreover, it has been shown that bone mineral mass declines faster with advancing age, thus exposing older adults to a greater risk of osteoporosis (Eastell and Lambert, 2002). The onset of osteoporosis also has the effect of destabilising energy expenditure, thus affecting food intake and prompting a further loss of muscle mass with age (Morley, 1997).

In addition to these obligatory impacts of ageing on dietary behaviour, older people's dietary behaviour is influenced by a multi-dimensional array of factors such as gender, educational level, socio-economic status, culture, food shopping environment and social support (social networks) (Bloom *et al.*, 2017; Conklin et al., 2014; Kamphuis, De Bekker-Grob, & Van Lenthe, 2015; Locher et al., 2005). For example, there is accumulating evidence suggesting that

poor dietary behaviours and nutritional status are as a result of limited social networks in old age (Conklin et al., 2014; Locher et al., 2005; Mcintosh, Shifflett, & Picou, 1989). In earlier research, it was found that older adults in the USA that had extensive friendship networks had good appetites, adequate dietary intake and good nutritional status as compared to their counterparts with weaker social networks (Mcintosh et al., 1989). Similarly, Locher and colleagues explored the diets of 50 homebound older adults and found that food intake was significantly and positively influenced by the presence of family ties (Locher et al., 2005). Also, it has been shown that the presence of good social networks increases the consumption of fruits and vegetables among community-dwelling older adults (Conklin et al., 2014).

Even though current and past research studies have delved into the factors impacting on poor dietary behaviours, adequate nutrient intake, and subsequently malnutrition, nutritional health is still a major problem in old age. In Canada, a study exploring dietary profiles of older minority groups found that 72.5% were at moderate to high risk of malnutrition (Johnson & Garcia, 2003). In the UK, poor nutritional status in older adults often goes unnoticed, unaccounted for, and hence untreated (Elia & Russell, 2009). Even with this assumption, malnutrition still affects 3 million people of which 93% are community-dwelling individuals (Elia & Russell, 2009). Older adults in the UK are faced with a double burden of malnutrition. The double burden of malnutrition refers to the coexistence of undernutrition, overweight/obesity, or diet-related non-communicable diseases among a population across all spectrums of ages (WHO, 2016). In the UK, national statistics indicate that 0.3% and 1% of older adults aged 65-74 years and >75 years, respectively, are underweight. While obesity, a form of overnutrition, affects 35% of women and 52% of men aged 65 years and older (Bates *et al.*, 2014; Health and Social Care Information Centre, 2013).

1.3.4 Dietary assessment in ethnic minority older adults

As outlined earlier, dietary intake and behaviours of ethnic minorities have changed considerably over time (Leung & Stanner, 2011). However, there is a paucity of data illustrating the trend of dietary information in super-diverse communities. Dietary assessment in ethnically diverse communities is limited, and the few assessments that are often done fail to use culturally appropriate and sensitive tools, thus leading to incomplete and inaccurate nutritional data.

Dietary intake assessment refers to the assessment of food intake at either the national, household and individual level for the purposes of research and interventions. The aim of dietary assessment is to ascertain the habitual dietary intake of individuals or populations that are being investigated at each point in time. For example, adequate nutritional data of patients enables clinicians to assess the efficacy of treatment and tailor existing interventions. Information at the population level could also be used to design policies and redefine the focus of health care services, thus crafting new interventions to curb nutritional problems.

Similarly, at the country level, nutritional assessment could be used to ascertain food and nutrition security that could aid in the formation of policies. As such, the choice of dietary assessment method to be used at each level depends on a multitude of factors. For example, the objective of the study, resources available and subjects in the study could determine the type of dietary assessment to be used (Biro *et al.*, 2002).

There is no perfect measurement tool for dietary assessment as all the tools come with inherent merits and demerits, for example, some assessment tools at the individual or population level are either cumbersome with high participant burden, inaccurate, or culturally inappropriate for participants (Bingham, 1991). These challenges are more prominent among ethnic minority

groups, as most researchers have insufficient information about ethnic minority foods, recipes or even how to estimate portion sizes (Garduño-Diaz *et al.*, 2014).

In the assessment of diets among ethnic minority populations, food frequency questionnaires (FFQs) have been commonly used (Earland, Campbell, & Srivastava, 2010; Kassam-Khamis *et al.*, 1999; Sharma *et al.*, 1999). FFQs capture an individual's acute or long-term dietary intake through the format of asking participants to provide the frequency of dietary intake from an already provided list of foods (Thompson & Byers, 1994). FFQs are relatively inexpensive, quick to use and can be tailored for a group of people (Sharma *et al.*, 1996). However, FFQs may not be able to estimate true nutrient intakes, cooking method or even portion sizes, and may not be appropriate to provide details of food combination among ethnic minority older adults in a multi-ethnic community (Garduño-Diaz et al., 2014). Also, the level of English literacy varies widely across ethnically diverse populations, and as such this limits the accuracy and reliability of using FFQs in these populations (Garduño-Diaz et al., 2014). Lastly, FFQs have been found to overestimate consumption levels when used with older adults. For example, in the Newcastle 85+ study, it was found that the FFQ used in the study overestimated energy and nutrient intakes in white British older adults when compared with the multiple pass 24-hour recall method (Adamson *et al.*, 2009).

In addition to FFQs, food records are also commonly used to assess diet among community-dwelling older adults. Food records refer to the collection of dietary intake using food diaries (Thompson & Byers, 1994). Food records are usually completed over 3 to 7 days. Even though this method is considered the most accurate among dietary assessment methods, it shares similar difficulties like the FFQ, and can lead to participant fatigue and reducing the adherence of participants to the entire study (Brunner, Juneja, & Marmot, 2001; Thompson & Byers, 1994).

Khokhar *et al.* (2013) worked with South Asian populations, and found this method to be more demanding, invasive and due to the literacy level of participants, was not well understood.

Multiple-pass 24-hour dietary recalls have by far been considered as the most accurate tool to measure dietary information among community-dwelling ethnically diverse older adults (Garduño-Diaz et al., 2014; Ngo *et al.*, 2009). It is rapid and user-friendly with less participant burden while ensuring participants' interest in the process. It also requires less reliance on an individual's longer-term memory as the participant only has to recall all foods and drinks consumed in the past 24-hours (Thompson and Byers, 1994). In the validation of the 24-hour recalls as compared to the FFQ in older adults, it was found to be more appropriate as it yielded more realistic energy and nutrient intakes with fewer errors (Adamson et al., 2009). A study exploring the challenges in conducting dietary assessments among ethnic minority groups concluded that multiple-pass 24-hour recall on two non-consecutive days was the most appropriate method to measure habitual dietary intake and reduce the challenges accompanied with dietary assessments within this group (Garduño-Diaz et al., 2014).

However, the use of 24-hour recalls also comes with some limitations such relying on participant's memory to recall all foods and drinks consumed in the past 24 hours (Thompson and Byers, 1994; Adamson et al., 2009). Also, this method requires the researcher to have a good knowledge of foods, recipes and dietary styles of the targeted population to enable him/her to make appropriate prompts to capture all foods and drinks eaten in the past 24-hour period (Garduño-Diaz et al., 2014; Thompson, 2014).

To estimate dietary intake of community-dwelling ethnically diverse older adults more precisely, there is the need for these assessment methods to be tailored to make them culturally sensitive and ensure a low participant burden (Ngo et al., 2009). This will give not only a more

accurate view of the diets of this population but will help to understand the wide variation of factors that affect ethnic minority older adults from making healthy food choices. To augment this knowledge gap, this PhD research tailored the multiple-pass 24-hour dietary recall and coupled it with qualitative interviews to serve this purpose.

1.3.5 Social Network typologies: size, density and composition of Ethnic older minorities living in Super-diverse communities

The inter-personal ties and relationship shared among a group of inhabitants in an environment are termed social networks (Kahn, 1980; Mitchell, 1969). These ties offer a sense of identity, support/solidarity and the feelings of belongingness to the people sharing it (House & Kahn, 1985; Walker, Macbride, & Vachon, 1977). As explored by Wenger, these networks could either be supportive or non-supportive networks (Wenger, 1994), but in research, the emphasis is mostly on the capacities of these networks to provide functional support and their consequent influences on healthy ageing. In other words, the aspect of social support derived from any network denotes the functional component of that network. Furthermore, older adults sometimes value the content of their social networks with the majority perceiving stronger social networks to be better signs of healthy ageing than merely their physical health (Depp & Jeste, 2006).

In understanding social networks, the term ‘network typology’ is often used. This term refers to the different characterization of the types of interpersonal ties that exist within a population with regards to size, density and composition of each network group (Litwin, 2001). The typology of social networks is not only unique but enables easy classifications to ascertain its support capabilities and contribution to health. Below depicts the structural representation that forms any social network.

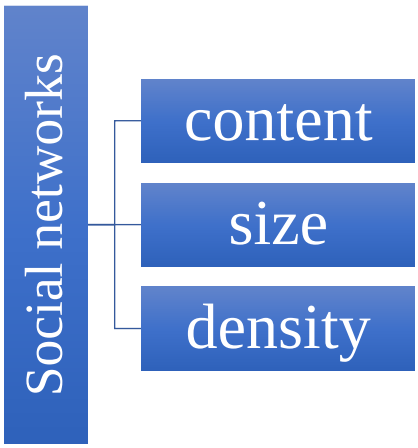


Figure 2: The structural illustration of the make-up of every social network (Source: Mitchell, 1969; House and Kahn, 1985).

The use of network typologies started decades ago, with scientists describing different versions under which an older adult's social networks could be classified (Adams, 1986; Litwin, 1995; Mugford, Kendig, & Kendig, 1986; Wenger, 1984; Wenger, 1989). Early work on network typology used friendship ties to classify social networks of unmarried elderly women (Adams, 1986). Following this, Wenger (1989) developed a distinctive network typology for measuring social networks of older adults, using three distinct criteria namely availability of local close kin, the frequency of contact with family, friends and neighbours and the levels of social integration of community and other voluntary groups. With further work, Wenger systematically generated five different social networks for older adults representing different lifestyles and varying degrees of support. (Wenger, 1991; Wenger, 1994). These include the family dependent, locally integrated, local self-contained, wider community focussed, and private restricted networks. The characteristics of these networks are detailed in table 2.

Table 3: Characteristics of social network types (Wenger, 1994)

Characteristics	**Local Integrated**	**Wider Community focussed**	**Family dependent**	**Local self-contained**	**Private restricted**
Local Kin	Yes	No	Yes	Yes	No
Children	Most times yes	Most times yes	Most times yes	Most times no	Most times no
Network size	Larger (8+)	Larger (8+)	Small (1-4)	Medium (5-6)	Smallest
Marital Status	Mostly married	Mostly Married	Sometimes widowed	Single or widowed	Mostly single or widowed
Family members contact	Regular and active	Irregular but active	Very regular	Irregular and not active	Irregular not active
Community/Voluntary Involvement	Highest	High	Low	Low	Lowest
Risk of institutionalisation, frailty and mortality	Fewer	fewer	Few	High	Highest
Isolation, loneliness and depression	Very low/absent	Low	Present but low	High	Highest
Representation in UK	Common/ majority of older people	Small older population	Not common	Small/ minority of the population	Small

Considering these characteristics, the five social networks can easily be grouped under two main domains; integrated social network and non-integrated social network. The locally integrated and wider community focussed social networks forms the integrated social network. While the remaining three, the family dependent, the local self-contained and the private restricted forms the non-integrated social networks.

Further to Wenger's network typology, Litwin (1995) created a version of network typology using data of 259 elderly Russian-Jewish immigrants living in Israel. In this typology construction, six variables were used to generate four distinct networks called the kin networks, family-intensive networks, friend focused networks, and diffused networks. Most of these typologies are often presented with challenges such as a high degree of inconclusiveness of network type and misclassifications.

In the quest to address these challenges and increase the sensitivity of network typologies, especially among ethnic minorities older adults living in multigenerational households, Burholt and Dobbs (2014), developed a four-network typology. The establishment of this network typology used data from 590 older South Asians living in multigenerational households in the UK. The creation of these networks using nine network generation variables yielded the following types: 1) multigenerational household-older integrated networks; 2) multigenerational household-younger family networks; 3) family and friends networks; and 4) non-kin restricted networks.

The categorisation of older adults into these social network typologies is predictable on socio-demographic characteristics, physical health and other socio-economic factors (Knipscheer *et al.*, 1995; Wenger, 1994). For example, Fischer (1982) established that people with high incomes and higher educational status tended to have large social networks compared to their

lower income, lower educated counterparts. Also, the prediction of individuals belonging to these social networks could be linked to their marital status. Married older adults often have larger social networks, while single older adults have small social networks (Knipscheer et al., 1995). For physical health as a predictor in network typology classification, it has been illustrated that reduction in physical health led to a reduction of network size (Newsom & Schulz, 1996).

In order to aid in the classification of older adults into various social network types, specific network measurement instruments have been created. Among these is the commonly used Wenger Practitioners Assessment of Network Type (PANT) (Wenger, 1991; Wenger, 1994). This was first developed in rural Wales in 1989 and validated in urban areas (Wenger, 1984). Further modifications led to a simpler version comprising of eight distinct questions based on the availability of close local kin (3 questions), the geographical closeness of family, friends and neighbours (3 questions), and level of interaction with community, voluntary and religious groups (2 questions) (Wenger, 1991; Wenger & Tucker, 2002).

1.3.5.1 The use of the Wenger PANT

The Wenger typology tool has been used extensively in both clinical and public health studies. For example, it was used to identify network types of 51 older adults living in Sylhet, Bangladesh, and Gwynedd, Wales (Burholt *et al.*, 2000). The tool has also been used in India, Nepal and China to identify older adults social network types (Burholt *et al.*, 2003; Wenger & Liu, 1999). Also, in the classification of migrant groups living in the UK, the tool has been used to score network categorization of ethnic minority older adults. For example, the Wenger typology tool was used to identify network types of 98 Bangladeshis living in London and Liverpool (Burholt et al., 2000). In Dublin, Golden *et al.* (2009a), used the Wenger typology to

grade social networks of 1299 elderly men over the age of 65 years. In all these studies, the Wenger typology produced a lower proportion of inconclusiveness of social networks of older adults as compared to other network typologies. Additionally, the Wenger PANT has been validated in many different populations (Burholt et al., 2000; Stephens *et al.*, 2011; Szabo *et al.*, 2016; Thiyagarajan Jotheeswaran A., 2014; Wenger & Liu, 1999). The ease of use of the Wenger typology in different geographical locations and ethnic groups, suggest its appropriateness in the application of ethnic minority older adults living in the super diverse city of Birmingham.

Besides the Wenger PANT, other commonly used tools include the Litwin support network typology, Burholt network typology questions and the Lubben support network scale (Burholt & Dobbs, 2014; Lubben *et al.*, 2006; Lubben & Gironda, 2004). The Lubben support network scale is similar to the Wenger tool, as it contains easy-to-answer questions and thus could be used to generate networks easily. Even though the Litwin support networks tool and the Burholt support networks tool are specific to ethnic minority older adults, they require a complex analysis of responses (e.g. Latent class analysis) to classify older adults network types (Burholt & Dobbs, 2014; Litwin, 1995).

Despite the appropriateness and broad use of the Wenger typology in super-diverse communities, Burholt and Dobbs (2014) suggested that the use of the Wenger typology tool in older ethnic minorities living in multigenerational household fails to gauge the extent of social support for individuals in these living arrangements. Studies have supported this, emphasising that staying together in a multigenerational household or proximity of kin does not necessarily mean social support is provided to the older members of the family (Berkman *et al.*, 2000; Burholt & Dobbs, 2014). Additionally, the Wenger PANT is limited in the assessment of

support received within a network as it fails to account for phone, internet and other modes of communication either than the face-to-face contact. Hence it is appropriate for this tool to be supplemented with additional questions (qualitative interviews) to account for these modes of contact that might be providing informational support for older adults.

1.3.5.2 Social Networks on Health of Minority older adults

As previously stated, there are a limited number of studies exploring social network influences on various components of the health of ethnic minority older adults living in the UK. The few studies that have examined ethnic minority communities have found significant benefits to health and wellbeing (Burholt, Dobbs, & Victor, 2018; Cook & Weigel, 1983; Kuo & Tsai, 1986; Prager, 1985). For instance, in Australia, it was found that social support networks improved elderly Italians 'help'-seeking behaviours (Roy & Hamilton, 1992). Similarly, English minorities in Israel coped well with relocation as a result of social support networks (Prager, 1985). Studies exploring the impact of social networks on specifically dietary behaviours and physical function in ethnic minority older adults are rare.

Additionally, the abrupt and severely disruptive changes in social networks of older adults as compared to younger individuals makes this an important area to explore. Older adults network size is more likely to rapidly shrink than flourish, leading to the loss of support and consequently negative impact on healthy ageing. These changes in network size might occur as older adults undergo massive life course changes. These changes, as explained by the convoy model of social networks, are mainly caused by situational and personal characteristics such as retirement, ill-health, loss of a spouse, residential changes and other life events primarily associated with ageing (Antonucci, Ajrouch, & Birditt, 2013; Cornwell, Laumann, & Schumm, 2008).

The social network profiles of community-dwelling ethnically diverse older adults vary considerably to their white European counterparts. Studies have shown that the characteristics of most ethnic minority groups are likely to have locally integrated or family support networks or other network types with greater network size as opposed to their counterparts (Burholt & Dobbs, 2014; Burholt et al., 2000; Litwin, 1995; Wenger, 1995). Burholt and colleagues' study of support networks of older Bangladeshis in London and Sylhet, reported that 54% and 34 % of respondents in London and Sylhet, respectively, belonged to the locally integrated support network, which had a higher network size and frequent contact with family, friends and neighbours (Burholt et al., 2000).They also found that very few participants in these two locations belonged to non-kin or private restricted network (A network with higher risk of loneliness) Similarly, in the generation of a new network typology for multigenerational households, Burholt and Dobbs found that only 18.1% of older adults belonged to the restricted non-kin network (similar to Wenger's private restricted network) (Burholt & Dobbs, 2014). While this may be the case, other studies have also shown high prevalence of non-kin or restricted networks among minority ethnic older adults, thus debunking the fact that all ethnic minority older adults have robust networks and substantial informal support as compared to their counterparts (Ajrouch, Antonucci, & Janevic, 2001; Barnes *et al.*, 2004). For example, a longitudinal study exploring social networks and engagement between black older adults and white older adults aged 65 years and older in the United States (US) found that Blacks had smaller social networks and engagements as compared to Whites over the study period (Barnes et al., 2004). As such, it is important to explore the social networks of community-dwelling ethnically diverse older adults and examine the influences of different social network typology on healthy ageing.

1.3.6 Association of Nutrition and Social Networks on Physical Function

Healthy ageing is a multi-dimensional concept with a broad array of factors influencing it. As depicted in figure 3, dietary intake influences physical function and vice versa in older adults (Kimura *et al.*, 2009; Kumagai *et al.*, 2003; Rondanelli *et al.*, 2016). Physical function declines with age and so impacts on the quality of life, medical service use, institutionalisation and mortality of older adults (Age UK, 2017; Beckett *et al.*, 1996; Chou, Hwang, & Wu, 2012). As demographic trends suggest an increase in the older population, it is necessary for studies to explore factors influencing physical function and thus find interventions to curb the decline in physical function with age. Given this, there has been little published evidence on the risk factors of physical function decline in community-dwelling ethnically diverse older adults. The limited studies published suggest that ethnic minority groups and older adults living in low socio-economic environment often have low physical function as compared to their counterparts in the same country (Louie & Ward, 2011; Williams *et al.*, 2012).

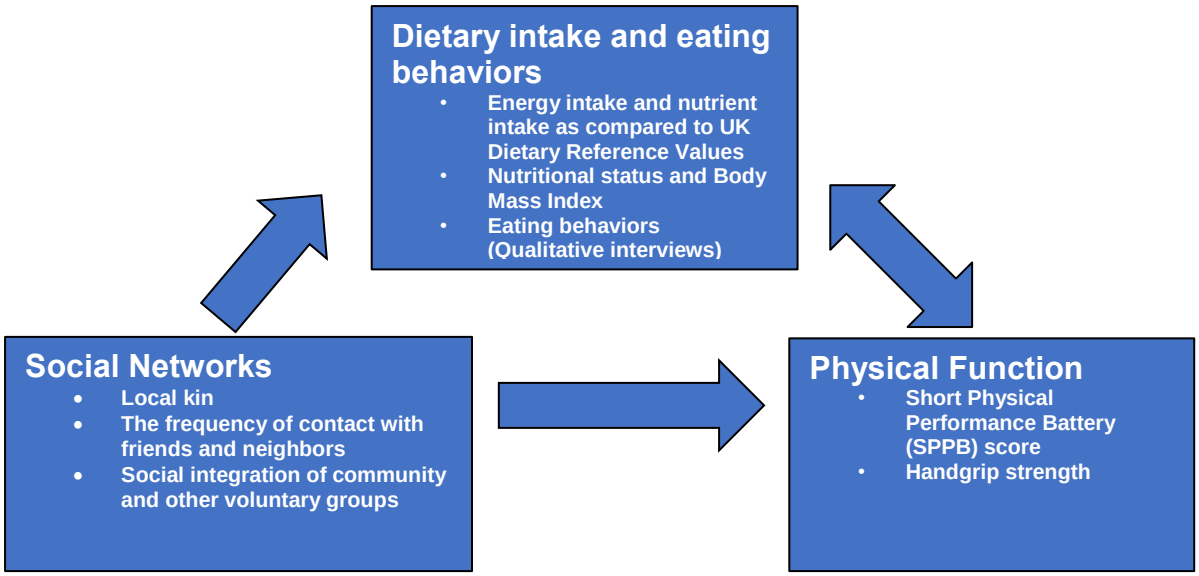


Figure 3: Potential relationship between social networks, nutrition and physical function

Furthermore, some studies exploring nutritional influences on physical function found positive results suggesting that good nutritional health significantly improves the physical function of community-dwelling older adults (Danielewicz, Barbosa, & Del Duca, 2014; Kimura et al., 2009; Kumagai et al., 2003; Rondanelli et al., 2016). For example, Rondanelli and colleagues (2016) in a double-blind, randomized controlled trial found that an individual dietary intake coupled with exercise correlated with improved strength and functional abilities of sarcopenic older adults. In addition, a 5-year longitudinal study (from 1992 to 1997) of 608 community-dwelling older adults, found that adequate dietary intake (dietary variety) was associated with a reduction in the risk of functional decline (Kumagai et al., 2003). To further support the importance of good nutrition on physical function and quality of life, Kimura et al. (2009) found that dietary diversity was closely linked to activities of daily living (functional capacity) in 689 community-dwelling older adults (65+ years). In summary, these studies suggest that the improvement of dietary intake could significantly improve not only nutritional health, but can consequently improve the physical function of community-dwelling older adults.

Besides the impact of nutrition on physical function, there are several studies that indicate that good social networks are protective against physical functional decline, and at the same time enhances adequate nutrition in later life (Avlund *et al.*, 2004; Escobar-Bravo et al., 2012; Mendes De Leon, Glass, & Berkman, 2003; Seeman, 2000). For instance, Escobar-Bravo, and colleagues (2012) in a study of 1244 elderly Spanish individuals found that social networks (active social life, the emotional support provided by friends and confidants) were protective against the incidence and progression of disability. In a related study, it was discovered that the social networks of 651 non-disabled community-dwelling older adults (75 years and older) were highly associated with functional decline (disability) and mortality (Avlund et al., 2004). In

addition, this same study found that individuals with poorer social support networks had the fastest decline in physical function and higher rates of mortality over time.

1.3.7 The interplay of nutrition, social networks, and physical heath on healthy ageing

While the argument surrounding the definitions and components of healthy or successful ageing continue to linger, there is epidemiological evidence that supports the potential role of nutrition, physical health and social networks as predictors of healthy ageing and mortality (Robinson *et al.*, 2013; Södergren, 2015; Sowa *et al.*, 2016; Wannamethee *et al.*, 2005). Healthy lifestyle such as cessation of smoking, optimal nutrition and physical activity have been shown to promote early recovery from diseases, higher quality of life and longevity in general (Robinson et al., 2013; Vetter, 1999; Wannamethee et al., 2005).

Dietary intake and eating behaviours as independent variables have also been shown to influence healthy ageing and mortality (Gopinath et al., 2014; Millen et al., 2005; Milte & Mcnaughton, 2016; Trichopoulou et al., 2005). Adequate nutrition can also reduce the occurrence of non-communicable diseases that are more prevalent in older age (Eriksen *et al.*, 2015; Lopez *et al.*, 2006). In addition to this, physical activity behaviours have also been found to influence the quality of life and longevity. The right amount of physical activity could be protective against mental and non-communicable diseases, mobility and mortality. (Haveman-Nies, De Groot, & Van Staveren, 2003; Sieverdes *et al.*, 2012; Södergren, 2015). For example, a multi-ethnic longitudinal study with 21 years of follow-up, found that poorer adherence to a combination of healthy life choices (non-smoker, moderate alcohol intake, physically active and frequent fruit and vegetable intake) was associated with an increased risk of cardiovascular disease and coronary heart disease among 1090 Europeans and 1006 South Asians (40–69 years) (Eriksen et al., 2015). In addition to the findings of this study, the population attributable

fraction for CVD and CHD was almost twice as high in South Asians as compared to the European cohort (Eriksen et al., 2015).

Besides these findings, the creation and maintenance of good social networks have been similarly shown to improve healthy ageing and mortality (Fratiglioni, Paillard-Borg, & Winblad, 2004; Hammond, 2010; Litwin, 1998). Good social networks do not only improve the quality of life at this stage, but are often stated to have a continuous impact and significantly predict health outcomes and mortality in later life (Fratiglioni et al., 2004; Hammond, 2010; Litwin, 1998). Litwin and Shiovitz-Ezra (2006) in an analysis of 1997 national survey of adults aged 60 and older (N=5,055), found that survival in later life is dependent on network type. This study found that individuals with a poor social network type (restricted network) had a high mortality rate as compared with individuals from the friend-focussed network or the community-clan networks that had a lower risk of mortality. In a longitudinal study of 15-years follow-up, a similar result was reported in that network type and size were protective against the risk of premature mortality (Shye *et al.*, 1995). Additionally, an international study of 13,891 older adults in eight developing countries discovered that individuals with integrated social networks were more protected against premature all-cause mortality over three and half years of follow-up as compared to those in restricted social networks (Santini et al., 2015).

Having emphasised the importance of nutrition, social networks, and physical function on healthy ageing, there is the need to explore how these inter-relate in super-diverse communities with different cultural views of healthy ageing. This study moves in this direction to create a greater understanding of how these factors influence healthy ageing of community-dwelling, ethnically diverse older adults living in Birmingham, UK.

1.4 The Study Rationale

As identified in this review, there is accumulating amount of evidence that suggests that social networks, healthy dietary behaviours and physical function are potential indicators of an individual's overall health. There is also appropriate amount of evidence that demonstrates that good social networks are associated with proper nutrition and the maintenance of optimum physical function. Despite this, there is a paucity of literature examining the profile and relationship of social networks, nutrition and physical function, particularly among ethnic minority older adults. The increasing health inequalities and higher prevalence of diet related-related non-communicable diseases in this group warrants a deeper understanding of the extent to which each or the association of SN, nutritional intake and status and physical function influences healthy ageing in super-diverse communities in the UK.

Considering the few studies that have explored social networks, diet and physical function in community-dwelling older adults in the UK, this present study shares similar features with them. For example, Castaneda-Gameros, Redwood, and Thompson (2018a) explored the impact of dietary intake on frailty among 76 ethnically diverse older women living in super-diverse communities in Birmingham. In this study, using a single 24-hour dietary recall, it was found that physical function (frailty) was associated with the level of energy and nutrient intake. Castaneda-Gameros and colleagues pointed out that among other things, dietary intake within this sample was influenced by their cultural perceptions.

Besides this study, Bulholt and colleagues (2018) exploring the use of a new network typology among 514 ethnic older minorities aged 55+ years living Birmingham reported that ethnic older minorities with restricted Non-Kin networks were more prone to poorer health and loneliness as compared to integrated networks (Burholt et al., 2018). Another study reported nutrients intakes above the UK RNI in a sample of 39 African-Caribbean adults aged 19-65 years

(Earland et al., 2010). In the US, a study among ethnic minority populations aged 60 years and older found that church attendance (frequency of contact with community members) was associated with higher total energy intake, fibre intake and obesity levels of participants (Phillips, 2006).

These studies share a common limitation of using a cross-sectional study design, which prohibits a deeper insight to the extent to which social networks, nutrient intake and physical function change overtime, and how these could have been related. In addition, some of these studies had samples that were, on average, young to middle-aged, and were in some cases studied as single ethnic minority group or gender, which makes it difficult to comprehensively compare and understand how these factors differ among a heterogeneous older ethnic minority population living in a super-diverse city like Birmingham.

Hence, unlike existing studies, this PhD research contributes to addressing these literature gaps, by providing a more detailed longitudinal profile of dietary intake and eating behaviours over an 8-month period by using a longitudinal concurrent mixed methods design. It also uniquely explored the changes in social networks of community-dwelling ethnically diverse older adults over the study period, and how these changes influenced their nutrient intake, eating behaviours and physical function over the 8-month follow-up.

Furthermore, this study differed significantly from past research, by including both male and female participants from the major ethnic minority groups living in super-diverse communities to understand the potential differences in nutrient profiles by ethnicity and gender and ascertain how these may influence healthy ageing in a super-diverse community. Also, as gender/sexuality is reported as having a significant influence in behaviour modelling and a key role in the success of health interventions, a good understanding of healthy ageing could help

design not only network specific interventions but gender-specific interventions within these network groups (Liu *et al.*, 2015).

As the population of ethnic minority groups continues to increase, so will the increase in diversity of eating habits, food cultures and other lifestyle components among ethnic groups and the general population (Khokhar et al., 2013). In view of this, it has become crucial for diet assessment methods to be tailored to capture accurate data from ethnic minority groups (Garduño-Diaz et al., 2014; Ngo et al., 2009). As such, this study modified existing assessment tools to make them culturally sensitive and less burdensome for participants. An already validated 24-hour recall method was improved by using culturally recognised terms and using a portion size booklet that contained clearer pictorial descriptions of many ethnic minority foods consumed in the UK (Cheyette & Balolia, 2010). In addition to the generation of valuable data from ethnic minorities, this study included strategies around building confidence with participants and maintaining regular communication to improve on data quality and retention of participants in the study (Garduño-Diaz et al., 2014).

In summary, the increasing ethnic diversity, health inequalities, and the non-communicable diseases among ethnic minority groups in the UK is concerning. It is therefore imperative to explore in-depth the modifiers of choices of healthy lifestyle behaviours. That is, looking at the barriers and facilitators that will enable the adoption of healthy lifestyle practices for healthy ageing in these super-diverse communities. The findings reported in this PhD research will contribute to a deeper understanding of the longitudinal patterns of social networks, dietary intake and physical function among community-dwelling ethnically older adults living in super-diverse communities. This information will aid the development of social network specific interventions and policies to improve the ability of community ethnically diverse older adults

to make better lifestyle choices and promote healthy ageing.

CHAPTER 2

METHODOLOGY

The methodological approach of this longitudinal mixed methods study is described in this chapter. First, the underpinning research philosophy of the methodology adopted to address the research questions is discussed. This is followed by the description of the mixed research design and the mixed methods approach. The rationale for the choices of methods utilised to collect and analyse data to address the research questions are also described.

2.1 Philosophy of Research

A research paradigm simply refers to "the consensual set of beliefs and practice that guide a field of study" (Morgan, 2007, p. 49). As beliefs and practices within the field of social science, paradigms are essential to structure the research and can influence the belief of the nature of reality (ontology), the nature of knowledge (epistemology), and lastly the manner in which knowledge will be gathered (methodology) (Doyle, Brady, & Byrne, 2009; Teddlie & Tashakkori, 2009). The research philosophy adopted plays a key role in influencing the ontology, the epistemology and the methodology, thus influencing how the knowledge will be generated (Gray, 2013; Neuman & Kreuger, 2003).

Mainly, there are three main philosophical positions adapted in the field of social and behavioural sciences. These include the positivist, the anti-positivist and the pragmatic positions (Doyle et al., 2009; Teddlie & Tashakkori, 2009). The next few sections will describe these positions and the rationale for choosing the position that best fits the present PhD research.

2.1.1 Positivism

The positivist, as the foundation of quantitative research, believes that "facts speak for

themselves" (Bowling & Ebrahim, 2009). These thinkers believe true knowledge is based on experience of senses and can be obtained either by observation or experiment. The approaches associated with this paradigm are usually deductive and theory-driven (Teddlie & Tashakkori, 2009). As a means of knowledge generation for positivist, these thinkers are often associated with realism (Flick, 2014). "the consequence of such a position is that social research is often committed to ideas of measurement and objectivity, rather than reconstruction and interpretation, thus the research situation is conceived as independent and separate from the known and the knower, so that the "facts" can be collected in an objective way" (Flick, 2014). To this end, these thinkers use only quantitative approaches to collect, analyse and present findings (Doyle et al., 2009; Gelo, Braakmann, & Benetka, 2008). The positivist mode of knowledge generation is often criticized as an impropriate/inadequate form to derive conclusive findings as it often considers human behaviour to be influenced by only external factors without considering the actions of the human beings themselves. They often see the human behaviour as passive and controlled, which is far from reality (Doyle et al., 2009; Teddlie & Tashakkori, 2009).

2.1.2 Anti-positivism, Constructivist or the Naturalist ideology

Contrary to the positivist form of thinking is the anti-positivist, constructivist or the naturalist ideology. As a foundation for qualitative research, they believe that social reality could only be viewed and interpreted by the individual in that position (Doyle et al., 2009; Gelo et al., 2008). They further argue that reality is seen as a multiple of complex layers and cannot be objectively deduced (Cohen, Manion, & Morrison, 2013). Hence, the research conceived is dependent and inseparable from the known and the knower (Doyle et al., 2009; Gelo et al., 2008). To this end, this group of thinkers use qualitative approaches as the best means to collect, analyse and present findings (Gelo et al., 2008). These thinkers are often criticized mainly on the fact that

it is not generalizable and subjected to research bias, and, coupled with the fact that qualitative research are less likely to be reproducible, as a different researcher could draw a different conclusion on the same study (Mays & Pope, 1995).

2.1.3 Pragmatism

In order to explore and create a more holistic view of participants that will help address the research questions of this PhD study, it is essential that we understand and make use of both the positivist and naturalistic constructs to arrive at a more accurate evaluation of the knowledge acquisition. To achieve this, the pragmatic paradigm was chosen. Unlike the positivist or the naturalist paradigms, the pragmatic paradigm makes use of both quantitative and qualitative approaches to answer research questions, thus forming the basis for the use of mixed methods study design (Doyle et al., 2009; Morgan, 2007). The use of these underpinning constructs at the same time in a study has been described as mixed methods study design (Creswell, 2009; Creswell & Clark, 2007). This is defined as:

"a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches in many phases in the research process. As a method, it focuses on collecting, analysing, and mixing both quantitative and qualitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone" (Creswell & Clark, 2007 p.5).

Qualitative and quantitative methods individually have their strengths and weaknesses as described above, but in order to compliment the strengths of the research design and reduce the weaknesses of these methods used individually, a combination of both within one study is

desirable as it allows for a holistic evaluation of all the research questions of the study, allowing for the strengths of one to compliment the weaknesses of the other (Bryman, 2015; Creswell, 2009).

In this current research, a quantitative approach was chosen to examine the nutrient intake, physical function and social networks of ethnically diverse older adults. This will partly address some of the secondary research questions in this study:

- What is the profile of energy, macro- and micronutrient intakes in community-dwelling ethnically diverse older adults?
- What are the changes in nutrient intakes, nutritional status and physical function over an 8-month period?
- What are the social networks of ethnically diverse older adults over an 8-month period?

The qualitative approach was also chosen to explore eating behaviours, the influence of social networks, and other key influences on dietary intake and physical function concurrently with the quantitative evaluation. The qualitative approach at this stage will furthermore address the remaining secondary research questions in the study:

- What are the perceptions of healthy eating and physical function among community-dwelling, ethnically diverse older adults?
- What are the factors influencing eating behaviours and physical function in population?
- How do community-dwelling, ethnically diverse older adults perceive changes in factors influencing eating behaviours and physical function over a period of 8-months?
- How do community-dwelling, ethnically diverse older adults perceive the influence of variations in social networks on dietary intake, eating behaviours and physical function

over an 8-month period?

2.2 Study Design: Longitudinal Concurrent triangulation mixed methods design

This PhD research employed a longitudinal mixed method study design. The approach included adapting already existing assessment methods to enable the measurement of dietary intake and eating behaviours of community-dwelling ethnically diverse older adults at baseline and after an 8-months follow-up. The rationale for choosing a longitudinal design was to enable the exploration of any changes in dietary behaviours, physical function and social networks over time, and their interactive effects. As a novel study, it was important to understand the possible changes in dietary intake and physical function over time and most especially monitor the changes in social networks and how this might influence eating behaviours and physical function over time.

Given this longitudinal design, a mixed method concurrent triangulation approach was adopted and considered appropriate, as it enabled the use of both quantitative and qualitative data to more accurately explain the relationships of the variables of interest within the study (Castro *et al.*, 2010; Cresswell, 2003). The concurrent triangulation mixed method refers to the collection of both quantitative and qualitative data at the same time point, which makes it possible to compare, contrast, and potentially validate the findings generated from the quantitative approach using the evidence from the qualitative approach, or vice-versa. This concurrent triangulation mixed method was also appropriate as it allowed the researcher to explore at one phase of data collection the findings from both quantitative and qualitative data to understand the research questions adequately. Unlike concurrent nested designs, in this design, both quantitative and qualitative data collection were given equal priority and resources (Cresswell, 2003). Given the uniqueness of the PhD study population, data collection techniques were

adapted to make the data collection process more culturally appropriate and less burdensome on participants (Garduño-Diaz et al., 2014). The research design is illustrated in figure 5 below, detailing the qualitative and quantitative measures and how the results were triangulated.

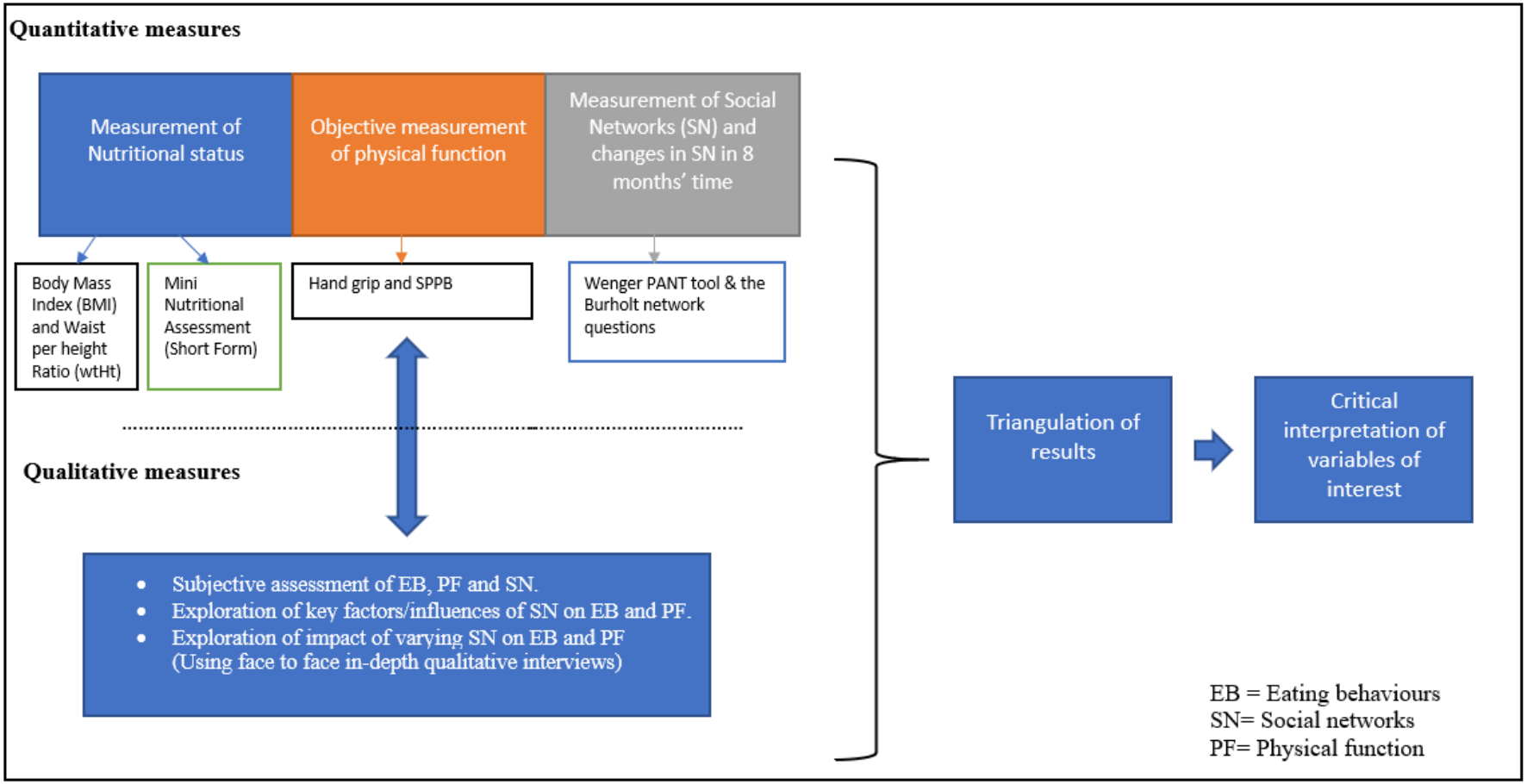


Figure 4: Integration of concurrent quantitative and qualitative methods (Mixed methods concurrent design concept)

2.3 Participants, Data collection and Analysis

The following sections will describe in detail the study participants, recruitment methods, data collection procedures, and how data were analysed.

2.3.1 Participants and Recruitment

Recruitment was on a rolling basis and was designed to include participants that are ethnically diverse, representing the major ethnic minorities in Birmingham: South Asians, Caribbean and Africans. Recruitment was limited to these groups as they are well represented in Birmingham and projected to rise substantially in the population in the coming years (Birmingham City Council, 2011a; ONS, 2011; Simpson, 2007).

In this study, the age of 60 years and above was used to denote older adults in accordance with previous studies that explored characteristics of migrants in the UK (Burholt, 2004b). The rationale for choosing this age as a representation of older migrants in the UK within this study stems from evidence that migrants in the UK have a lower life expectancy coupled with the youthful age structure of ethnic minority population (Simpson, 2007; Burholt, 2004a, 2004b, ONS, 2011; World Bank Group 2001). In addition to agreeing with this age range, Sin (2004), argued that adult migrants are considered "older" at younger ages as compared to white populations, since migrants are often faced with a combination of low socio-economic status, poor living environments and health throughout life, which significantly contributes to premature ageing.

To add to the age inclusion criteria, the study included community-dwelling older adults identifying themselves as either being Black Caribbean, Black African, Indian, Pakistani or Bangladeshi. Participants were permanent residents in the Birmingham area throughout the

duration of the study. Lastly, participants with no known diagnosis of dementia or any cognitive disabilities which might affect their participation in the study were included.

Older adults who were institutionalized or hospitalised at the start of the study were excluded. Also, individuals that were younger than 60 years, or were institutionalized during the study or had medically diagnosed mental conditions such as dementia were excluded from partaking in, or continuing with, the study.

As it is nearly impossible to recruit a representative sample of older adults via probability sampling (Boneham *et al.*, 1997), the study employed a number of non-probability sampling techniques such as maximum variation and chain referral sampling to recruit participants across the range of age, ethnicity, sex, religion/faith and socio-economic groups as reflective of the ethnic minority population characteristics in Birmingham (Patton, 2002; Penrod *et al.*, 2003; Teddlie & Yu, 2007). This was guided by recent Birmingham census data and other relevant literature (Birmingham City Council, 2011a; Simpson, 2007). Maximum variation sampling is a form of purposive sampling where participants are selected across a wide spectrum relating to the research questions the study seeks to answer (Patton; Teddlie & Yu, 2007). In addition to that, the use of chain referral sampling which is sometimes called multiple snow balls, expands beyond the scope of the traditional snow ball technique, such that several networks are accessed concurrently, allowing different participants in each network to make referrals of potential participants known within their network.

The objective of using this technique was to create a more heterogeneous sample that will be characteristic of community-dwelling ethnically diverse older adults living in Birmingham, UK (Birmingham City Council, 2011a; Simpson, 2007). The traditional snowball technique was not used as it has reported likelihood of recruiting participants within the same network, thus

preventing the exploration of meaningful data from a wide range of social networks (Penrod et al., 2003).

In contrast to snowballing technique, chain referral sampling was used to gather data from participants from varied social networks, hence expanding the scope of investigation and enabling the researcher to test the relationships of variables of interest in different social networks (Penrod et al., 2003; Teddlie & Yu, 2007). This type of sampling is often used in qualitative studies involving hard to reach populations (Penrod et al., 2003; Suen, Huang, & Lee, 2014).

Using these techniques, potential eligible participants were invited to take part in the study by word of mouth. After the initial contact, participants were given the participant information sheet detailing the purpose of the study and their involvement. Interested participants were contacted after two weeks of receiving the participant information, to confirm interest and provide informed consent before beginning participation in the study. All consented participants were engaged in both the quantitative and qualitative data collection process. Considering the expected heterogeneity among minority ethnic groups, this was necessary to ensure a more robust comparative analysis using data from both quantitative and qualitative aspects of the study. Socio-demographic characteristics of initial recruited participants (30 participants) were used to inform the maximum variation strategy.

Participants were initially recruited through old age societies (Halesowen Asian Elders, Ward End Asian Elders Welfare Association), faith/religious centres (churches, mosques and Gurdwaras), community centres (West Bromwich Afro-Caribbean Centre, Kings Heath Community Centre, Balsall Heath Community Centre), and other informal places. These places of recruitment have been successful in recruiting ethnically diverse older adults in previous

studies (Burholt, 2004a; Burholt, Dobbs, & Victor, 2016; Castaneda-Gameros, Redwood, & Thompson, 2017). These avenues of recruitment as compared to recruitment from General Practice (GP) lists is reported to be more prudent and produces a closer representative sample of ethnic groups than GP lists (Saunders *et al.*, 1993; Sin, 2004).

2.3.2 Ethical Considerations

The study received approval of protocols by the University of Birmingham STEM committee (ERN_17_1364). At the point of contact, participants had the opportunity to clarify anything on the participant information sheet before agreeing to either take part in the study or not. All participants signed a written informed consent sheet before the study could commence. Recruited participants were also informed of the right to withdraw at any point from the study without any reason or penalty. All data gathered from the participants within this study were used to write up the thesis, with selected anonymised data shared with the research partners within the Physical Activity and Nutrition INfluences In ageing (PANINI) research group, within which the study was funded and sponsored.

2.3.3 Data Protection and Confidentiality

All data (questionnaires, 24-hr dietary recall data collection forms, interview transcripts and audio-recordings) were kept in a locked filing cabinet in a locked office in the School of Sport, Exercise and Rehabilitation Sciences (SportExR). In addition, the signed consent forms and form linking the participant numeric ID with his/her personal information were stored in a separate locked filing cabinet so that participants could not be identified.

With regards to electronic data (such as audio recordings, interview transcripts, databases, and dietary intake data), all data were stored in a password-protected University computer and also on an encrypted laptop. These documents were only accessible to the researcher and

supervisors. For confidentiality, all participants were immediately assigned a unique numeric participant ID on the first day of contact (visit 1), and they were provided with details of how the data would be protected and how their confidentially would be maintained.

2.4 Procedure and Phases of Data Collection

As one of the core components of this PhD was to make assessment tools and data collection culturally sensitive and less participant burdensome, data collection visits were carried out at times and places of convenience to participants, to make participants more comfortable and to involve them more actively in the entire data collection process (Bassett, 2006; Bowling & Ebrahim, 2009). After providing enough information about the study through the participant information sheet and going through eligibility, most participants preferred their homes to community centres or the University as places of meetings/assessments. At homes, most interviews and assessments were done with the participant in a quiet space with little interruption from family members. At the community centres, interviews were done in a private room with the participant, separate from the community group activities. When data were collected at the University, interviews and assessments were done in one of the quiet laboratories and afterwards, participants were provided with hot drinks. The University's lone worker policy was adhered to during visits where the PhD researcher was alone; however, on a number of occasions a second female researcher accompanied the PhD researcher to assist with translation and to build rapport with female participants. Participant recruitment and subsequent data collection took place from March 2017 to November 2018.

These data collection visits were structured into 2 phases scheduled 8 months apart, with each phase having 2 visits. This was to provide time to gather sufficient data while also reducing the burden of data collection on the participants. As most studies suggest a minimum of 14 days apart for capturing consistent and habitual dietary intake (Dodd *et al.*, 2006; Hoffmann *et al.*,

2002), a schedule of 14 days (2 weeks) between each visit within each phase was followed. Figure 5 illustrates the details of the phases of data collection and the timelines within the study.

2.4.1 Phase 1 (Quantitative and Qualitative data)

In phase 1, visit 1 involved collection of demographic data using a questionnaire, dietary assessment using multiple pass 24-hour recall, measurement of social networks using the Wenger Practitioner Assessment of Network Type (PANT) and measurement of physical function, and other anthropometric measurements. Additional questionnaires such as Mini-Nutritional Assessment-Short Form (MNA-SF) and Katz Activities of Daily Living (ADL) were also administered at this visit.

The second visit within phase 1 involved the second dietary assessment, again using the multiple pass 24-hour recall plus an in-depth qualitative interview exploring eating behaviours, physical function and the influences of social networks on eating behaviours and physical function.

2.4.2 Phase 2 (Quantitative and Qualitative data)

In phase 2, the 3rd visit was similar to visit 2 of phase 1 as dietary intake was assessed again using the multiple pass 24-hour recall, and afterwards an in-depth qualitative interview was conducted to understanding eating behaviours and the changes in eating behaviours over the 8-month period. This interview also explored the influences of social networks over time and the changes in social networks over this time. The last visit in phase 2 and in the entire data collection visits was the visit 4. Unlike any other visit, cognitive function was assessed in visit 4 using the Standardized Mini-Mental State Examination (SMMSE). Again, dietary assessment, anthropometric and other physical function measures as carried out in visit 1 were repeated at this visit.

Visit 1 and 4 lasted approximately 120 minutes while visit 2 and 3 lasted approximately 90 minutes. Considering the mixed literacy/educational levels within this population, all questionnaires were administered by the researcher to enhance the quality of responses and to avoid skipping questions.

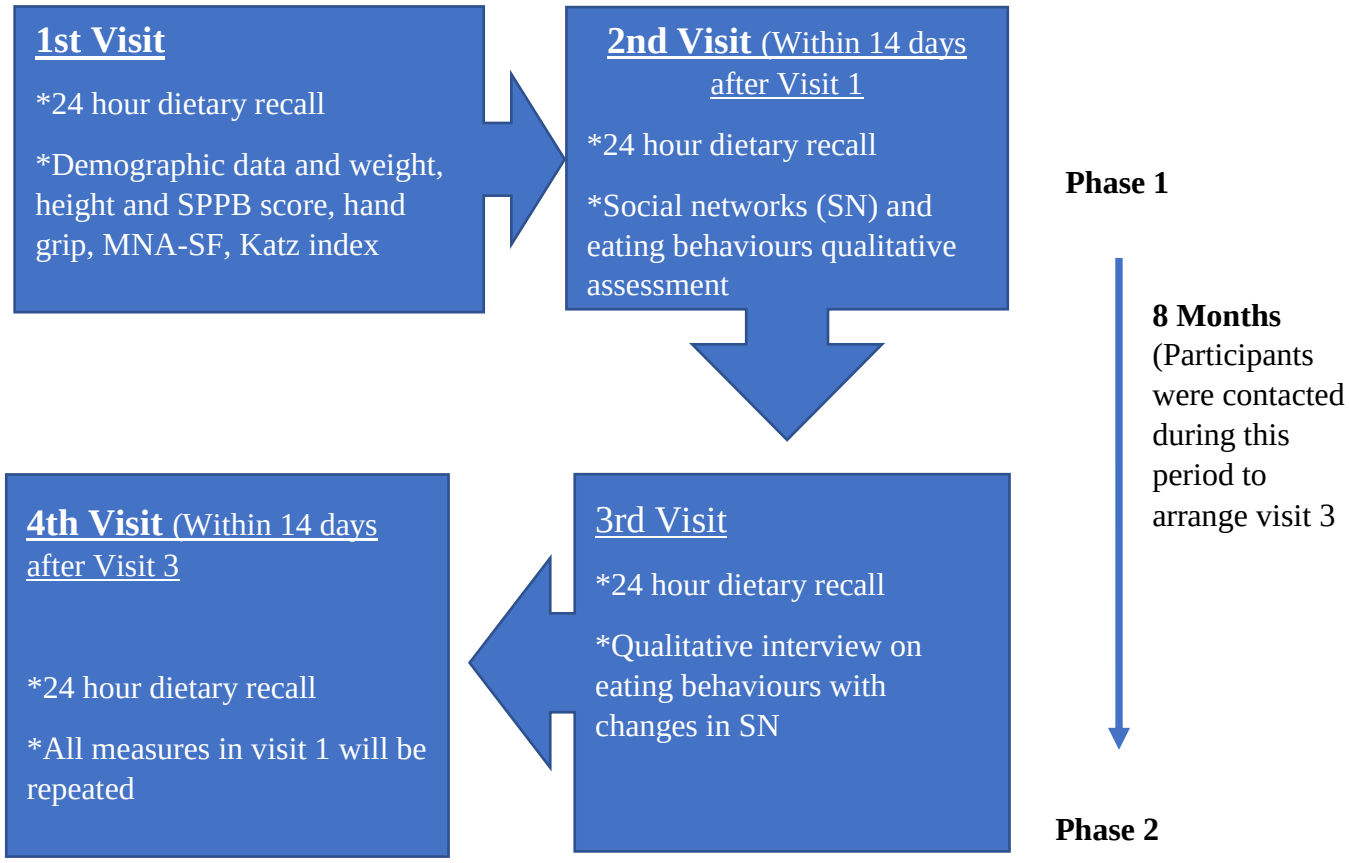


Figure 5: Flow chart summarising the data collection phases and visits over the 8-month period.

A participant tracker was also designed to track the amount of data collected per each participant at each time point and for data completeness check to ensure all necessary data were collected from all participants at the right time.

2.5 **Measures and tools of data collection for phase 1 and phase 2**

This section describes all the measurements and tools used in data collection for the entire study.

2.5.1 Socio-demographic and Socio-economic questionnaire

Using a simplified questionnaire, all demographic data were collected via self-report. Demographic data included sex, religion, ethnicity, living arrangements, age, country of birth, length of stay in the UK, alcohol intake, smoking and marital status. This questionnaire also captured participants' postcodes which were used to generate the Index of Multiple Deprivation (IMD), an indicator of the level of deprivation across all of England (Communities and Local Government, 2015). In addition, all diagnosed medical conditions and current medications used were collected using this form. This questionnaire was denoted as form 1 (Appendix D3).

2.5.2 Dietary Assessment

As illustrated above, each participant's dietary information including food intake and eating behaviours were collected at 4 different time points using the multiple pass 24-hour recall, and supplemented with an interview to capture additional information on eating behaviours at each of these visits to ensure the accuracy of the 24-hour recall.

The multiple pass 24-hour dietary recall was chosen as a preferred form of dietary assessment as it has by far been considered the most accurate and often used tool to measure dietary information among community-dwelling ethnically diverse populations (Garduño-Diaz et al., 2014; Holmes, Dick, & Nelson, 2008; Ngo et al., 2009). It is rapid and user-friendly with less participant burden while ensuring keen participant interest in the process (Efsa, 2009; Thompson & Byers, 1994). It also requires less reliance on individual's memory, as the participant only recalls all foods and drinks consumed in the immediate past 24 hours (Thompson & Byers, 1994). In the validation of the 24-hour recall as compared to the FFQ in

older adults aged 85 years and older, the 24-hour recall was found to be more appropriate as it yielded more realistic energy and nutrient intakes with fewer errors (Adamson et al., 2009).

At each of the visits, the multiple pass 24-hour recall was performed using standard procedures (Adamson et al., 2009). To improve data accuracy and also to allow prompts to capture food behaviours and meal preparations, all 24-hour recalls were conducted face-to-face and audio recorded. In addition, as the primary aim of this study was to modify methods to be culturally appropriate, a full-colour food portion booklet that contains over 1,700 ethnically diverse foods eaten in the UK was used in the portion size estimations (Cheyette & Balolia, 2010). As this portion size booklet contained traditional foods that are mostly eaten together, it provided useful insights for the researcher to make relevant prompts to capture most commonly forgotten foods during the multiple pass 24-hour recall interviews.

To finish up the multiple pass 24-hour recall interviews, participants were asked to describe how different that day's food and drink consumption was from the rest of the days of the week. This was done to determine how close the captured dietary intake was from the rest of the days of the given week. In instances that a participant indicated that they had fasted or had eaten substantially differently than usual, that day's dietary record was discarded, and a new 24-hour recall interview was scheduled. Also, the use and rationale for the use of supplements were captured during the multiple pass 24-hour recall. Brand names, dosage and frequency of use of these supplements were also gathered (See Appendix D8).

The four multiple pass 24-hour recalls per participant were conducted on four non-consecutive days, most including one weekend day (Sunday) and three (3) weekdays (see Figure 5). Following the recommendation of the European Food Safety Authority (EFSA) on assessing dietary intakes, it is recommended that dietary assessments done on 2 non-consecutive days is

more reflective of participants' habitual dietary intake, thus reducing day-day variability in dietary intake (EFSA, 2009; Garduño-Diaz et al., 2014). A review of dietary statistics also argued that at least 2 non-consecutive days of multiple pass 24-hour recall is needed to estimate habitual dietary intakes (Dodd et al., 2006). Additionally, Hoffman and colleagues provided evidence that shows that multiple pass 24-hour recalls collected on 2 non-consecutive days can represent an individual's habitual dietary intake (Hoffmann et al., 2002). Given this evidence, 2 non-consecutive days of multiple pass 24-hour recalls were collected each in phase 1 and phase 2. These 2 non-consecutive days of dietary assessments were carried out within a 2-week period (within 14 days).

After each visit, the multiple pass 24-hour recall data was checked for accuracy using the audio information taken during dietary assessment before entering these data into a dietary software analysis package, Dietplan 7.0 (Forestfield Software Ltd. Horsham, UK) for processing.

2.5.3 Measurement of Social Networks

The Wenger Practitioner Assessment of Network Type (PANT) was used to measure social networks as it is easy to administer and has been used in previous studies within ethnic minority populations to measure social networks (Burholt et al., 2000; Burholt et al., 2003; Wenger & Liu, 1999). This tool was adapted by incorporating some questions from the Burhort network typology tool for multigenerational households (Burholt & Dobbs, 2014).

Using the PANT and these supplementary questions, participants were classified into 5 distinct typologies of social networks based mainly on the availability of close local kin (3 questions), closeness of family, friends and neighbours (3 questions), and level of interaction with community, voluntary and religious groups (2 questions) (Wenger, 1991). This tool has been widely used and is well-validated (Szabo et al., 2016; Thiyagarajan Jotheeswaran A., 2014;

Wenger, 1994). It has also been used in previous studies in the UK, Bangladesh and other parts of Europe and has yielded successful outcomes in the assessment of social networks (Burholt et al., 2000; Burholt et al., 2003; Golden et al., 2009a; Golden, Conroy, & Lawlor, 2009).

The tool identifies 5 network types: the family dependent, the local integrated, the local self-contained, the wider community focussed, and the private restricted networks. This form was represented as form 5 (see Appendix D7).

2.5.4 Anthropometric Data

The weight and height of each participant were measured to the nearest 0.01kg and 0.1cm, respectively, at two separate visits, visits 1 and 4 (see figure 5 above). Weight was measured using the Secca 899 digital scale following standard techniques with participants wearing light clothing and no shoes (Lee & Nieman, 1993). Height was measured using a Seca 213 portable stadiometer and following standard techniques, with participants wearing no shoes and with minimal headgear (Lee & Nieman, 1993).

The scales were standardised at baseline and at regular intervals throughout data collection using a known weight. The body mass index (BMI) was calculated using the values obtained for height and weight per the standard equation: weight by height squared to the nearest 0.1 kg/m.^{2} Pakistani, Indian and Bangladeshi participants' BMI were classified using the WHO BMI cut-points for Asian populations, while the standard WHO BMI cut-points were used for African and Caribbean participants (WHO, 2004).

Table 4: BMI cut-off for ethnic minority populations

Classification	**BMI(kg/m^2)**	
	Standard cut-off points	Additional cut-off points (e.g. South Asian population)
Underweight	<18.5	<18.5
Normal	18.5-24.99	18.5-22.99

Overweight	≥25.00	≥23

Source: Adapted from WHO, 2004

Waist circumference was measured and recorded to the nearest 0.01cm using a flexible retractable non-elastic tape, following standard techniques (Gibson, 2005) at two-time points as indicated in figure 5 above. The tape was placed between the iliac crest and the lowest rib margin and readings were taken after the end of expiration.

At each measurement time point, all measurements were taken two times to reduce measurement error. In some cases, where these two readings were more than 0.5 cm or kg different, a third reading was taken and the average of the two closest measures was used as the final data point.

2.5.5 Nutritional Status

Participants' nutritional status was assessed using the Mini-Nutritional Assessment-Short Form (MNA-SF) (Appendix D5). This is a simple to use, sensitive and reliably validated tool for rapid assessment of nutritional status of older adults (Vellas *et al.*, 1999). Unlike the full MNA, the short form has proved to be more rapid and equally reliable to the full MNA (Cuervo *et al.*, 2009; Rubenstein *et al.*, 2001).

The MNA-SF is composed of six major items and has a scoring of 0-14 points, with 0-7 classified as malnourished, 8-11 classified as at risk of malnutrition, and 12-14 classified as normal (Rubenstein et al., 2001). The MNA-SF can be completed within 10 minutes; hence it was the preferred option to assess nutritional status as it reduces participant burden in the entire data collection procedure. Besides this, most of the information on the full MNA such as dietary information was being collected using the multiple pass 24-hour recall, hence the need for the short version.

To complement the MNA-SF in assessing nutritional status, waist-to-height ratio was calculated as waist circumference in cm divided by height in cm. As an accurate proxy indicator of central adiposity, it has been proven to be a better indicator of nutritional status than BMI alone across different populations (Ashwell & Hsieh, 2005; Gibson, 2005).

2.5.6 Physical Function

In this study, functional tests were performed either via self-report or by objective measures using validated tools. Three different measures of physical function were carried out, the Short Physical Performance Battery (SPPB), Hand Grip Strength (HGS) and the Katz Activities of Daily Living (ADL). The SPPB and HGS formed the two objective measures of physical function, and the Katz-ADL was the subjective measure of physical function. These are shown in figure 6 below.

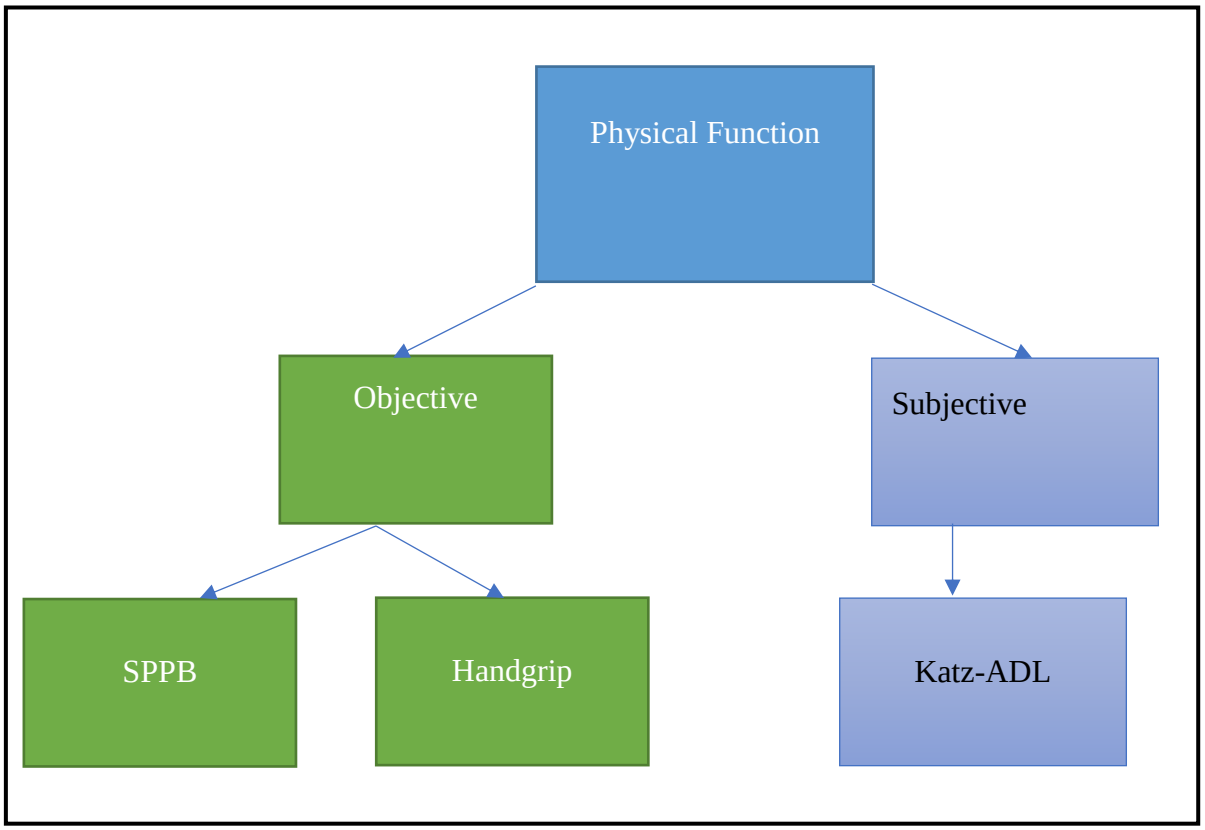


Figure 6: Perceived and measured physical functional status

2.5.6.1 Short Physical Performance Battery (SPPB)

Short Physical Performance Battery (SPPB) is a validated and reliable tool comprising a group of measures used to ascertain and monitor older adults' lower body extremity function (Gómez *et al.*, 2013; Guralnik *et al.*, 2000; Guralnik *et al.*, 1994). These measures include gait speed, balance and the time taken to perform repeated chair rises (Guralnik et al., 1994). The gait speed involves the measurement of the time taken for the participant to walk 4 metres on a straight line unaided. The balance test includes the ability of the participant to maintain balance in 3 separate standing positions lasting 10 seconds each, the side-by-side, the semi-tandem and the tandem positions. Lastly, the repeated chair rise involves the ability of the participant to sit up and return to the chair 5 times as quickly as possible (Guralnik et al., 1994) (Figure 7). The total achievable score is 12, a score 0 indicates worst performance while a score 12 indicates best performance. A score of less than 7 indicates high risk for frailty and poor health outcomes.

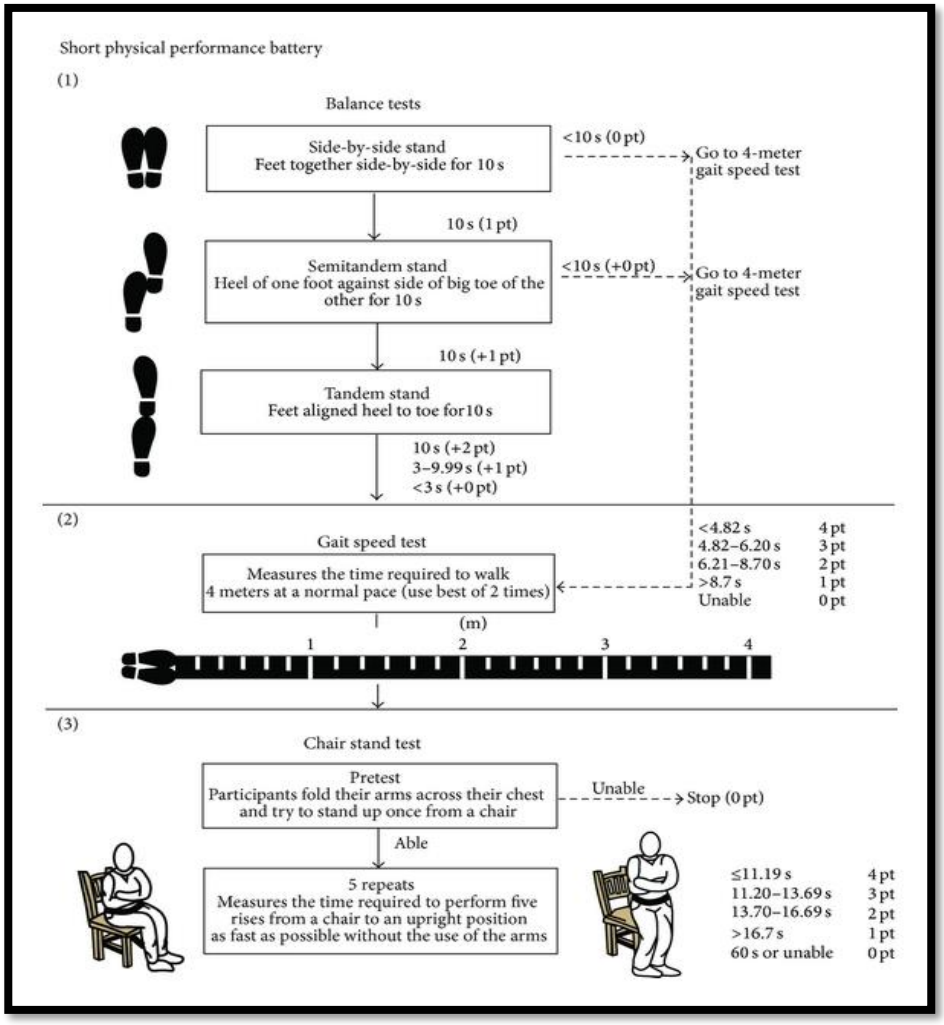


Figure 7: Image of the measures of SPPB assessing lower body physical function (Guralnik et al., 1994).

2.5.6.2 Handgrip Strength (HGS)

HGS was measured in kilogram (Kg) using a Jamar hand dynamometer per the NHANES protocol for measuring handgrip in the standing position (CDC, 2011). Using this protocol, handgrip strength was measured using participants' dominant hand in a standing position, with the elbow straight and fully extended at the side, and with head straight and participant looking forward. Each measurement was done three times, with the highest value used for analyses. The standing position was chosen as it has been shown to produce maximal grip strengths as compared to the other positions in measuring HGS (El-Sais & Mohammad, 2014). During all measurements, the Jamar handgrip dynamometer was adjusted to the second handle as this has

also been shown to produced maximal handgrip strengths with consistent and reliable results (Roberts *et al.*, 2011).

HGS measurements were done at baseline and repeated at the 8-months follow up. The hand used during baseline measurement was noted and participants were reminded to use that same hand again at the 8-month follow period to ensure consistency in measurement.

2.5.6.3 Activities of Daily Living (ADL)

Activities of Daily Living (ADL) was undertaken using a self-administered questionnaire, the Katz Activities of Daily Living (ADL) questionnaire at baseline and at the 8-month follow-up visit (See Appendix D6). This is a simple and quick functional tool used to assess the ability to carry out basic activities of daily living among the elderly population. It is often used as a screening tool to pave the way for a detailed physical function assessment of older adults who are beginning to lose their physical ability. This tool scores ability of independence to perform daily activities in 6 separate functions, including bathing, dressing, toileting, transferring, continence and feeding (Katz et al., 1970). Each of these questions is answered yes or no, and a total score of 6 designates full function, a score of 4 implies moderate impairment and a score less than 2 implies severe functional impairment (Wallace & Shelkey, 2007).

As some of the questions within this form were very personal and might be uncomfortable for some participants to answer, a culturally sensitive approach was used to make this process less uncomfortable. This was done by engaging participants in a form of conversation and the answers derived from these questions in the conversation and then use to complete this form. This made it more comfortable as the participants described their activities that they could carry out in a day with or without help.

2.5.7 Semi-structured interviews and the use of interpreters

As described above, two different face-to-face qualitative interviews were conducted throughout the study, one at the second visit of phase 1 and the other at the last visit of phase 2 (see figure 5). Responsive interviewing techniques were used to enhance adequate participation and trust of participants in the interviewing process. Rubin and Rubin described responsive interviewing as:

"*a style of qualitative interviewing that emphasises the importance of building a relationship of trust between the interviewer and the interviewee that leads to more give and take in a conversation. The pattern of questioning is flexible; questions evolve in response to what the interviewees have just said, and new questions are designed to tap the experience and knowledge of each interviewee.*'' (Rubin and Rubin, 2012, p.37).

Using a semi-structured questionnaire, the interview was divided into 4 different sections, introduction, eating behaviour, physical function and social network questions (See appendix D9). All these sections aimed at exploring current and past dietary and physical activity behaviours, and also the social networks and other key influences on these behaviours. A semi-structured questionnaire was determined to be the most appropriate tool as compared to the other forms of interviewing, as it allows the researcher to guide the interviews and steer the discussion towards relevant areas that will yield responses geared towards answering the research questions (Bryman, 2015).

During interviews, an open-ended guide was used to start up the discussion on the participant's perceptions of healthy eating and physical function, and influences of social networks and other key influences on eating behaviours and physical function. The use of this guide allowed for flexibility, providing participants with the opportunity to contribute to the discussion naturally (Gill et al., 2008). To facilitate comprehensive discussion of these topics, relevant probes were

used along the interview while bearing in mind culturally sensitive areas. Interviews range from 20-110 minutes in duration. All interviews were transcribed verbatim.

As described in section 2.7, participants were asked to choose the place and time of convenience for interviews and assessments, ensuring participants felt comfortable and safe to engage fully in the interviews (Bowling and Ebrahim, 2009; Bassett, 2006). Most interviews and all other assessments were carried out at a participant's home. Participants that were recruited from age-well societies at community centres preferred the community centres to their homes, as these places were their weekly meeting place. At the community centre, a separate room or private area of a larger room was designated for assessments and interviews, giving privacy to participants. Only 4 participants chose to come to the University for both assessments and interviews. At the University, a quiet laboratory space was used.

Considering the poor English literacy levels of the some of the targeted participants and the under-representation of these group of participants in research (Murray & Wynne, 2001), the services of trained interpreters were employed to enable us to gather valuable data from these participants. These trained interpreters were initially taken through the scope of the questionnaires and the major sections of the qualitative interview guide to become familiarised with the questions to be ask before the interviews and assessments. In doing this, some of the words/ phrases that did not have direct translations in the local language were then rephrased in the local language to allow participants to understand the concepts being explored, while keeping the meaning of the word/phrase intact. Also, some of these interpreters also supported recruitment of participants from the community and faith centres.

During interviews involving participants with limited English literacy, these interpreters translated the questions in either Twi, Punjabi, Urdu, Gujarati or Bengali to the participants,

and the responses from participants were translated again from these languages back to English for the PhD student researcher. All interviews were audio-recorded.

2.5.8 The Conceptual model guiding Qualitative interviews

A theory is defined as a "set of interrelated constructs (concepts), definitions, and propositions that present a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting phenomena" (Kerlinger, 1986, p. 9). An accumulative amount of evidence has helped us to understand that healthy lifestyle activities such as healthy eating and physical activity behaviours are influenced by a wide range of factors, including the influence of the external environmental factors and that of personal factors (French, And, & Jeffery, 2001). To aid in understanding more about these factors and their influences in relation to healthy eating among ethnically diverse older adults, the PhD researcher adopted the model of Story and colleagues (2008) to conceptualize and explore how these factors play a role in influencing dietary and physical activity choices among ethnically diverse older adults living within the Birmingham area (Story *et al.*, 2008). Using this model, an enhanced understanding could be gained particularly about the relationships between social networks and nutrient intake and physical function within this population.

This model best fits this study as it explores multiple factors influencing eating behaviours, that is from the personal level, to the social networks level, to the level of the immediate environment and lastly to the macro-level environmental influences consisting of policies and interventions (Story et al., 2008). Figure 8 depicts the adapted ecological framework of influences to an individual eating behaviours and physical function.

According to Story and colleagues (2008), the first level of influence is attributed to personal-level factors mainly the individual cognition, biological and demographic factors and other

behaviours. These could be manifested through the individual food attitudes, beliefs, motivations and knowledge. The second level of influence within this model has to do with the impact of social networks. This involves the social ties of the individual including family, friends and the community social ties and how these intend influence the individual's food choices, norms, beliefs and knowledge over time (Story et al., 2008).

Beyond this social environment is that of the physical environment that plays a crucial role in shaping the eating and physical function behaviours of an individual. This physical environment is comprised of the settings where the individual purchases food or where the individual eats (eating out), that is the barriers and opportunities within the community that can either promote or hinder healthy eating or good physical activity behaviours. One example of this as described in figure 8 is the availability and proximity of fast foods, local/traditional food stores or other grocery stores. After the physical environment is that of the macro-environment, sometimes described as 'upstream' factors. These factors, even though often labelled to play a distal and indirect role, can have significant influences on an individual's eating behaviours and physical function. These factors may include policies and interventions regarding the marketing and pricing of certain foods (Story et al., 2008).

This model, coupled with the use of relevant literature, was used to design the semi-structured schedule for the interviews (Babakus & Thompson, 2012; Castaneda-Gameros et al., 2017; Emadian & Thompson, 2017). The developed semi-structured interview schedule was pilot-tested with eight participants, with revisions made based on this pilot-testing. Via an iterative process, this interview schedule was further amended during the data collection process to make it more suitable to capture relevant responses to address the research questions.

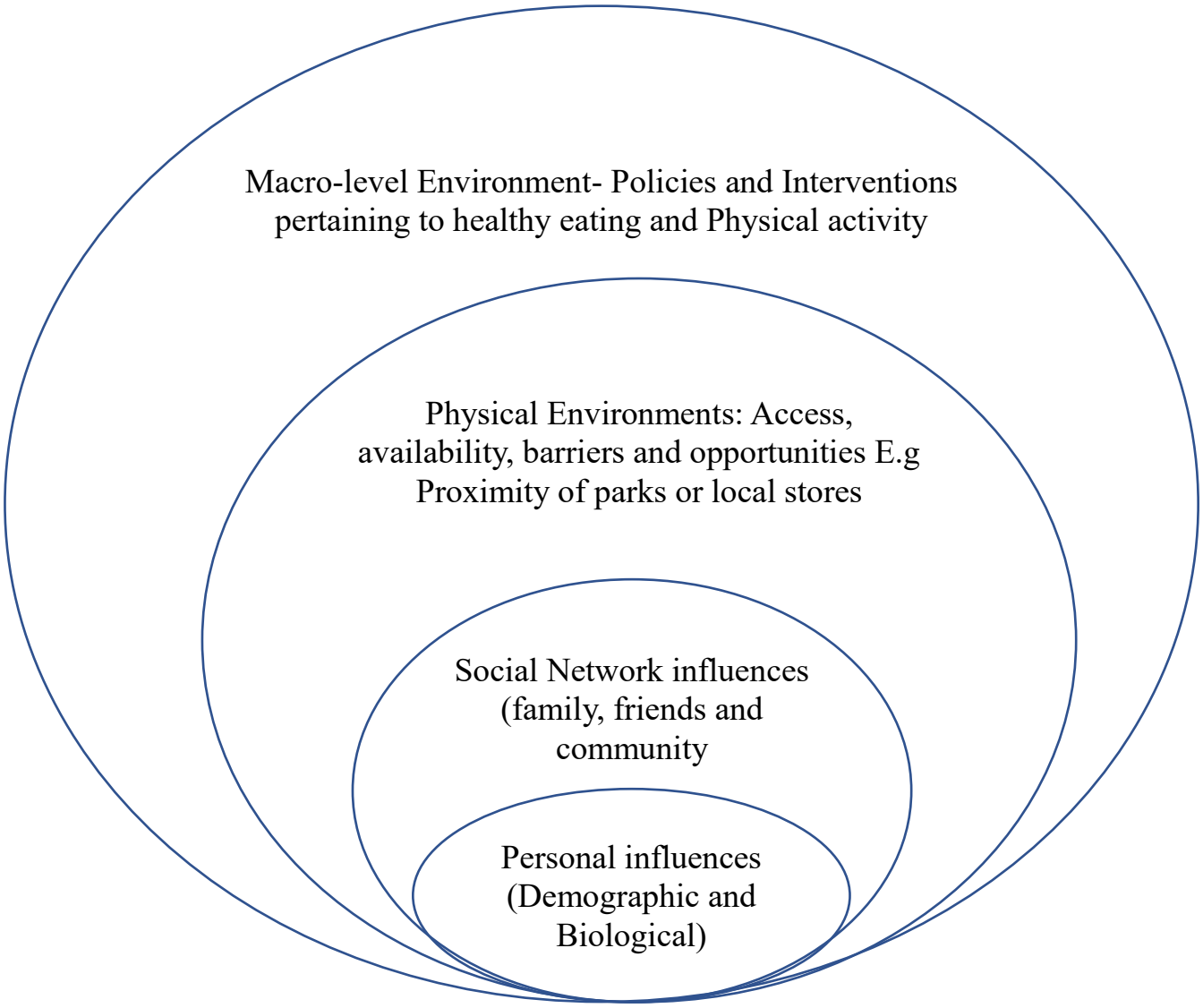


Figure 8: Adapted Ecological model depicting the influences of eating behaviours among minority older adults (Story et al., 2008).

2.6 **Techniques employed to increase Participant Commitment, Data accuracy and reduce drop out**

Considering the complexity of the targeted population, several techniques were employed to recruit and obtain quality data, and also to reduce the drop-outs across the follow-up period. Firstly, adopting insights from (Garduño-Diaz et al., 2014), the PhD researcher established an initial contact with community leaders and potential participants prior to the start of the study.

This involved attending church services and other faith organization's public events to get to know potential participants and vice-versa. This was to build strong rapport and to increase trust.

Secondly, during the initial meetings with community leaders asking for permission to recruit from their organizations, the researcher encouraged the leaders who met the inclusion criteria to partake in the study. The participation of these leaders was an encouragement for other members to join the study, acting as role models. Again, the participation of the leaders also served as a message that the study was genuine with all data collected solely for research purposes.

Thirdly, like other studies within this population, it is found that constant communication and incentives improve data collection (Garduño-Diaz et al., 2014). As such, the researcher maintained constant communication coupled with incentives by sending out research branded seasonal greeting cards (birthdays, Ramadan, Christmas cards etc.). Participants were also invited for two PANINI public engagement events at the University, where other researchers working under the PANINI research network showcased their work to the public. At this event, participants were given souvenirs such as branded shopping bags, pens and stress balls. Also, to show gratitude at the end of the study (at the final visit of data collection), all participants received PANINI branded shopping bags and mugs. All these factors may have increased participant's commitment, quality of data and reduced the drop-out rate.

2.7 **Data synthesis and analysis**

In this study, data synthesis and analysis were done concurrently with data collection. This allows the improvement of the data collection process, tools and approach in subsequent interviews (Pope, Ziebland, & Mays, 2000). It also allows the researcher to modify strategies

of gathering useful data in subsequent interviews that might have been omitted in previous interviews to help answer all relevant research questions (Pope et al., 2000). Details of both quantitative and qualitative data synthesis and analysis are described below.

2.7.1 Quantitative data analysis

Dietary information collected using the 24-hour recall was entered into Dietplan 7 (Forestfield software Ltd. Horsham, UK). This software contains databases of single foods (e.g. Weetabix) or information on complete dishes (e.g. Pakistani chicken curry) that could be easily selected and entered using the estimated portion sizes described by the participant from the food portion booklet.

Foods were entered using the already existing databases contained within the software. Also, the ethnic minority food databases such as the South Asian foods were selected to give a wide database of foods for complete data entry and analyses. This software allows for the addition of other foods to the database, hence, some foods that were not found in all list of databases contained within the software were manually entered using the nutritional information found on the nutritional labelling of the package of the product. As each food item on the databases could have different versions within the same software, a collection of all single or complete dishes previously entered were kept in an Excel document and used for future data entries to maintain consistency throughout the data entry process.

After entering all data, analyses were done within Dietplan 7 to calculate the energy, macro- and micro-nutrient intakes of reported foods eaten by participants. These were then exported to Statistical Package for the Social Sciences (SPSS) software for further analyses.

All other quantitative data including anthropometric and physical function data were entered into an Excel worksheet after each data collection session. After completion of data collection,

all information on this worksheet were imported into SPSS for statistical analyses.

Descriptive statistics (means, standard deviations, and percentages) were carried out for the socio-demographic variables. Using multiple logistic regression analysis, the association between varying physical function, social networks and nutritional status compared with various socio-demographic variables were tested. Independent t-test was used to compare any differences of demographic variables in the main sample. Also, t-test was used to compare significant differences in social network typology and nutritional status of baseline data and the 8-month follow up visits. Similarly, using t-test, differences between social networks and physical function of participants was generated at these two-time points. Linear and multinomial regression were also performed to ascertain the associations between variables of interest. All statistical analyses were conducted using a statistical software package IBM SPSS version 23 (IBM Corp, Armonk, NY, 2012). The p-value for significance was set at $p<0.05$.

2.7.2 Qualitative data analysis

As stated earlier, qualitative interviews were transcribed verbatim during the course of the data collection. These interviews were then transported to QSR NVivo 12 Plus software for reorganising and coding using the directed content analysis approach (Elo & Kyngäs, 2008; Hsieh & Shannon, 2005; Qsr International, 2012).

Content analysis involves subjective interpretation of data using a systematic process of coding and organising codes into categories or concepts (Hsieh & Shannon, 2005). As this form of analysis focuses on the contextual meaning of the text (Budd, Thorp, & Donohew, 1967; Lindkvist, 1981; McTavish & Pirro, 1990; Tesch, 1990) and the flexibility of use (Harwood & Garry, 2003), it was considered the most appropriate method to analyse the detailed key

influences to eating behaviours and the impact of social networks on eating behaviours and physical function within this population. Also, the use of directed content analysis has been described to be the best fit for studies that have pre-existing research on the phenomenon that is being tested (Hsieh & Shannon, 2005). In this case, there have been previous research studies examining various influences on physical activity and dietary behaviours among ethnic minority women (Babakus & Thompson, 2012) and men (Emadian & Thompson, 2017).

The process of directed content analysis as described by Hsieh and Shannon, (2005) is similar to that of deductive content analysis described by Elo & Kyngas (2000). Using the process of content analysis described by Elo & Kyngas (2000), the first step is the preparation phase. In this phase, the main purpose was to become familiar with the data by reading and re-reading the transcripts and field notes. This was to gain an initial understanding of the direction of the content of the transcripts (Elo & Kyngas 2000) and the field notes. After this process, two main coding matrices were developed, one on the social network and other key influences to eating behaviours and the other on physical function (See figure 9 and 11). These coding matrices were developed using existing relevant literature and insights from Story and colleagues (2008) model that focuses on the key influences to eating behaviours and physical function (Babakus & Thompson, 2012; Castaneda-Gameros et al., 2017; Emadian & Thompson, 2017).

The next step was to categorise the data deductively using the developed coding matrices as a guide (Elo & Kyngäs, 2008). Acting as a translational device or scheme, the coding matrices helped to systematically sort (code) all the transcripts into the identified categories on the matrices (Elo & Kyngäs, 2008; Poole & Folger, 1981). As an iterative process, new categories were assigned to emerging data that did not fit into the existing categories within the matrices and other categories without data were also taken out in the process.

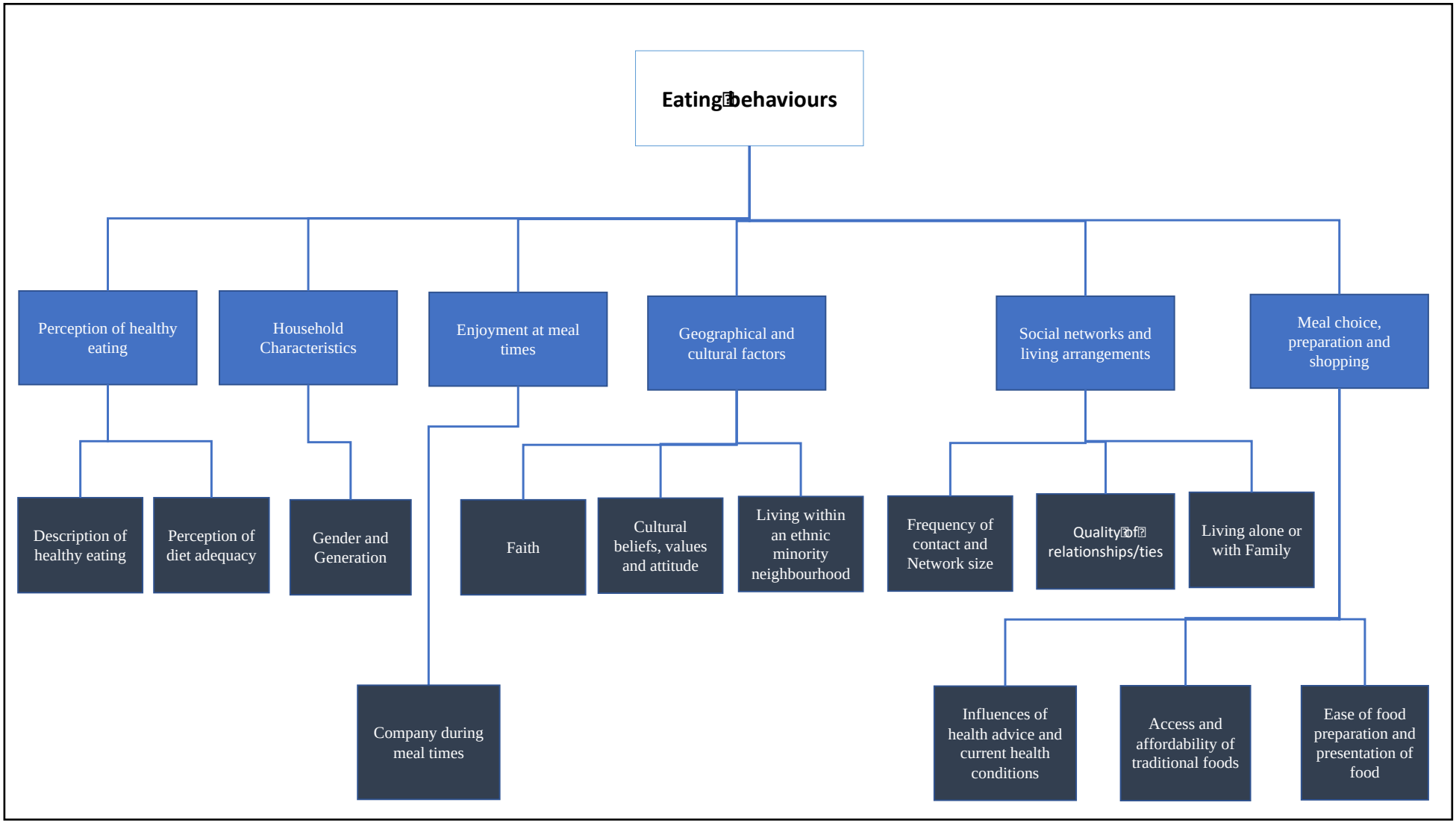


Figure 9: Complete coding matrix on eating behaviours

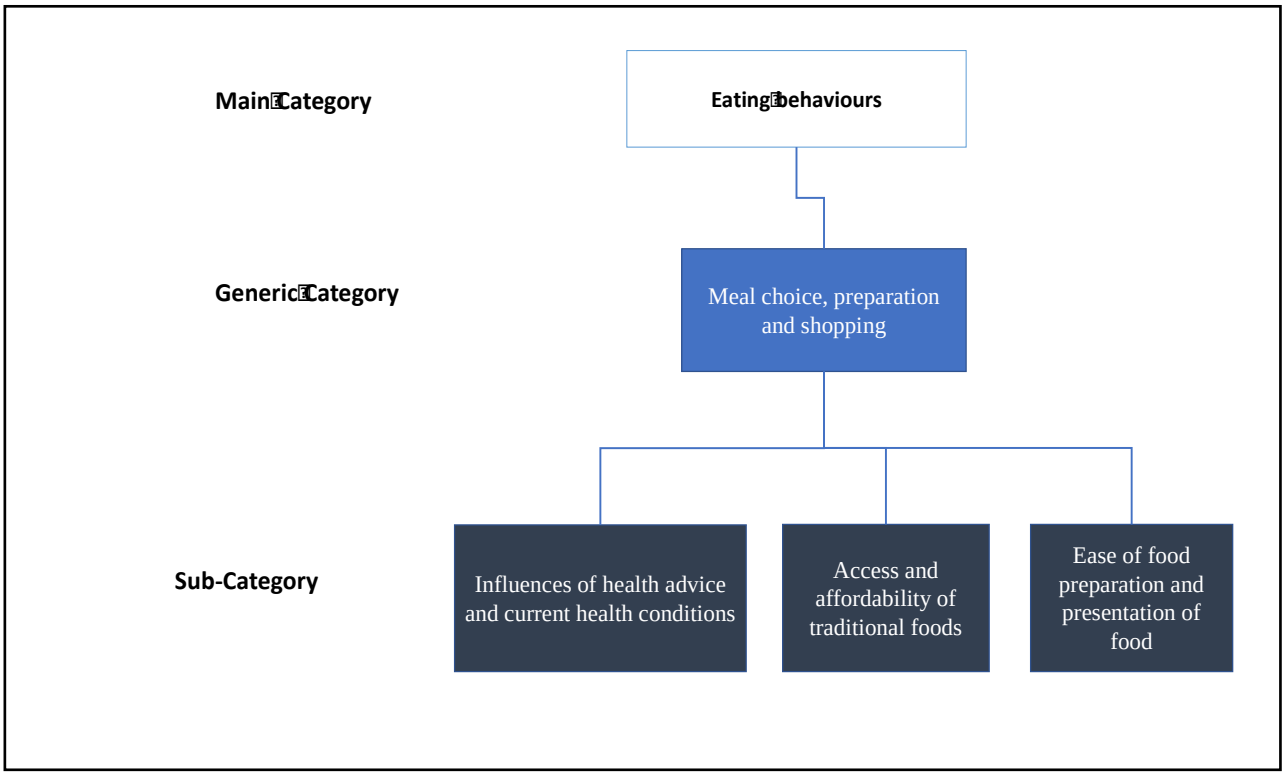


Figure 10: Section of coding matrix on eating behaviours

Once the final coding matrices were revised and agreed by the research and academic team, all data were revisited and coded appropriately under the main and sub-categories within each matrix (Elo & Kyngäs, 2008). Reporting the data within these categories in a manner that will answer the research questions of the study was the final step in the directed content analysis (Elo & Kyngäs, 2008).

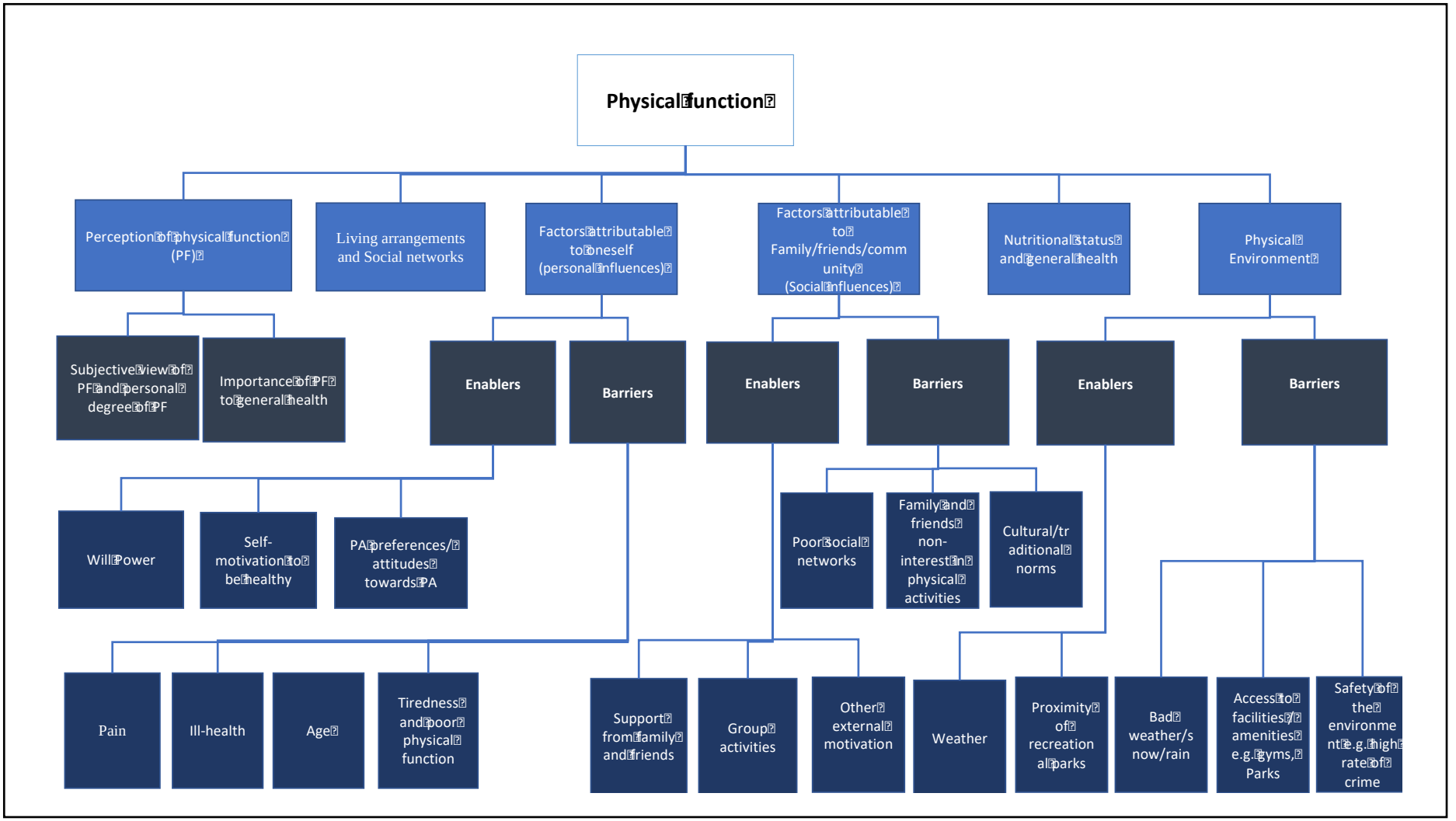


Figure 11: Coding matrix on Physical Function

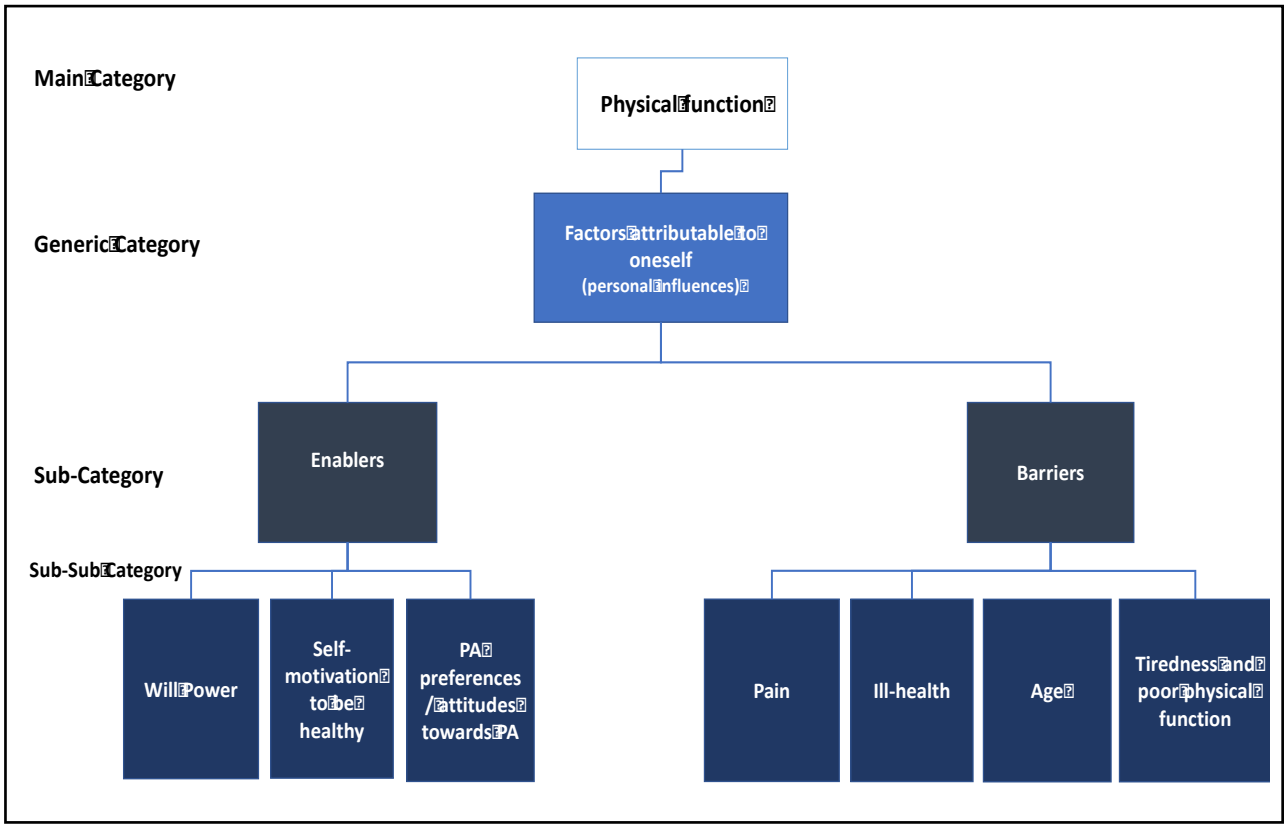


Figure 12: Section of coding matrix on physical function

2.8 **Reflexivity**

Having explored the research paradigm, the key objectives of this PhD research, and what and how the data collection was carried out, it is important to discuss my background, perspectives and assumptions that might have influenced knowledge generation and the arrival of key findings in this study (Pope & Mays, 2009). As such, this section of the thesis is written in first person.

I am a trained nutritionist, with experience in community health management of maternal and child health nutrition. In the past, I have worked as a District Nutrition Officer (DNO) with the Ghana Health Service (GHS), as part of a District Health Management Team (DHMT). In this role, I led the design, implementation and evaluation of community nutrition interventions geared towards reducing maternal and child health nutrition. I was also part of a United Nation

Child's Fund (UNICEF) funded regional longitudinal survey team, the nutrition surveillance system. This surveillance system assessed maternal and child health nutrition along the 2 major seasons in Northern Ghana. Within this survey, using both quantitative and qualitative measures, the main aim was to understand the major factors influencing the uptake and impact of our current nutritional interventions. That is to understand how these interventions yielded results at the household level and also to understand the major role family members and other care-givers played in the nutrition rehabilitation process. In these surveys, the role of cultural beliefs and the influence of other family members were major factors affecting the smooth implementation of these programmes.

Afterwards, I worked in Zambia as part of my Masters' programme research to explore the nutritional and social importance of meat consumption among urban and rural young men. This was a mixed method study that gave me the opportunity to interact with participants at homes, work, and social places to understand the basic meanings they attached to the consumption of meat and the main drivers of increase in meat consumption. One of the key findings from this study was the strong influence of cultural or social factors that predicted dietary patterns within this population.

Given these two research exposures in different populations, I had a strong opinion of how traditional and cultural beliefs could impact on healthy lifestyles. With this in mind, I was keener to understand how different this might be with community-dwelling ethnic older minorities in Birmingham, hence the decision to conduct this research. Notwithstanding my previous knowledge and my exposure to different populations, I had to consciously set aside my assumptions and views to ensure I kept an open mind, and approached the participants and

the research as a unique scenario without allowing my previous knowledge to influence my data collection, interpretation and reporting of the findings.

In the present study, I could easily relate to some of the cultural/traditional influences to dietary intake to my personal life. Growing up in a community that upholds strong cultural and traditional connotations to our traditional foods, I have been raised to appreciate the value of traditional meals in the context of their health, moral and spiritual importance. I remember my grandfather used to say I could not have chicken because I was the first born of my parents. This was also applicable to all women with regards to chicken. This played a huge influence on the amount of meat eaten by first born children and women in my rural community (Bongo-Soe). Given this experience, I could easily relate when participants wanted me to understand the importance of their traditional foods, with some strongly emphasising that their traditional foods were like an identity and gave them strength as compared to any other food, and they do not feel right if they fail to eat their traditional foods.

As an ethnic minority and a migrant myself, most of the participants' stories of how their dietary patterns have changed were very similar to what I have experienced over the years. Having spent a few years in a western country, the UK, my dietary behaviours have been slightly altered, thus resulting in the inclusion of some western foods in my dietary choices. With this close relationship in mind during data collection, I used it to my advantage, by encouraging participants to explore their eating behaviours, and the social networks and other influences to their eating behaviours. My experience gave me a platform to relate and contribute to the discussion, to build rapport, thus helping participants to feel more comfortable and to express openly relevant information that will help me address my research questions. Even though this served as an advantage, I was conscious throughout the interviews to bracket my assumptions

and opinions and to be as objective as possible during the interviews, to prevent leading participants in their responses.

Furthermore, having a good knowledge of the foods/recipes within the African and Caribbean homes was very helpful in assisting me with prompting participants for forgotten foods that were eaten along with these foods, and I could show them the exact food item from the food portion booklet for the right portion size estimation. There was also a limitation with this, as most participants presumed, as being African (Ghanaian), I knew the food/the recipe, hence they just mentioned the main food without its constituents. In order to address this, I avoided making any assumptions and further prompted participants for every detail of a recipe or complete dish even though I might be familiar with it.

Additionally, my identity as an ethnic minority, Ghanaian and a Christian might have accounted for the high numbers of Christians and Caribbean (especially Jamaicans) within this present study. There is a historical belief that Jamaicans originated (trace their roots) from present-day Ghana in West African (Agorsah, 1993; Sarfo, 2010). This may help explain why most of the Jamaicans I contacted were willing to take part in the study, with some stating that they see me as one of them ('an Insider') and as such, they were willing to do everything in their power to support my data collection (Mullings, 1999). So, this could explain the high numbers from this ethnicity and the low rate of drop out from this population. Given this, using a maximum variation approach, I targeted and recruited other participants that were different in ethnicity, age, sex and religion from this group to achieve a closer representative sample of the characteristics of ethnic older minorities living in Birmingham.

Besides my identity, I also took into consideration the fact that English is not my first language, hence I made sure I rephrased questions or gave examples during times that participants could

not understand me due to my accent. Also, during data synthesis and analysis, I sought help from other native English-speaking researchers when I had difficulty in interpreting information correctly from the transcripts what some participants were expressing during the interviews. I also contacted a South Asian female researcher fluent in Urdu during the times I was in doubt of certain combinations of South Asian foods or gestures made by participants from this background.

Lastly, considering the role of gender in qualitative interviews, it has been argued that interviews might produce high quality, reliable and valid data when both the interviewee and interviewer are of the same gender (Finch, 1993; Oakley, 1981). Interviewee and interviewer being of the same gender allows them to feel more comfortable to share their experiences and to have a lengthy and deep conversation about the subject without restrictions (Finch, 1993; Oakley, 1981). Given these assumptions, to ensure gender balance, especially in the Muslim communities with female participants, I employed the services of a female researcher or chaperone to aid in this process. This assisted the female participants in feeling more comfortable to share views and issues with regards to the research.

2.9 **Rigour and Trustworthiness**

Rigour refers to the process of being thorough and accurate, and without this research becomes meaningless and valueless ("Oxford English Dictionary", 2013; Morse et al., 2002). While that of trustworthiness has to do with the degree readers could judge truthfulness of the findings (Schmidt and Brown, 2015). As both rigour and trustworthiness ascertain the reliability and validity of the research, these should be incorporated in the design, data collection and analysis of the results of the study (Patton, 2002; Morse et al., 2002).Within this section, all strategies adopted to ensure the trustworthiness of my data are discussed. Firstly, after the initial development of the coding matrices, these were reviewed by the student's research team using

the research questions, relevant literature, and the conceptual model adopted for the qualitative interviews (Babakus & Thompson, 2012; Castaneda-Gameros et al., 2017; Emadian & Thompson, 2017; Story et al., 2008). This allowed them to make minor adjustments to these matrices. After the amendments, the coding matrices were subsequently reviewed by the academic team (supervisor) and again further edits were made. Ten percent of random transcripts from phase 1 (9) and phase 2 (8) were independently reviewed and coded using the matrices developed by the researcher and two other PhD student researchers. As discussed by Mays and Pope (1995), the level of agreement in reviewing and coding these transcripts enhances the reliability of the research. Discussing the level of agreement by the researcher and the student research team led to further adjustments to the coding matrices until consensus was reached. All these processes were aimed at achieving triangulation of evidence from both the research student and supervisory teams (Morse *et al.*, 2002).

Besides triangulation of evidence, the role, assumptions, position and possible biases of the researcher were thoroughly explored, and strategies implemented to reduce biases were discussed within the reflexivity section above (Mays & Pope, 1995). All other information related to these aspects were recorded throughout the study using reflective field journals.

There was also regular peer-debriefing from my supervisors, Prof. Janice L. Thompson and Dr. Carolyn A. Greig, at all stages of this research. They provided relevant feedback and comments that guided the data collection, analysis and findings in this study (Creswell & Miller, 2000).

Lastly, following the recommendations of Mays and Pope (1995), the rigour and trustworthiness of the data was ensured by providing a rich and in-depth description of the methodology, that is, the data collection procedures, data management and analysis explored within the study to arrive at these findings. This allows the study to arrive at similar conclusions,

if conducted by a different researcher, and also, allows readers to make judgements of the transferability of the study findings to other similar settings/population (Creswell & Miller, 2000; Mays & Pope, 1995).

2.10 **Summary of Chapter**

In this chapter, a detailed description and justification for the use of a mixed method design have been provided, allowing for an exploration of the research questions that will be answered by the quantitative and qualitative designs. This chapter further explored measures employed to improve rigour and trustworthiness of the findings in this study. The findings from study 1, 2 and 3 of this PhD research are presented as chapter 3, 4 and 5 respectively.

CHAPTER 3

SOCIAL NETWORKS AND THEIR INFLUENCES ON NUTRIENT INTAKE, NUTRITIONAL STATUS AND PHYSICAL FUNCTION IN COMMUNITY-DWELLING ETHNICALLY DIVERSE OLDER ADULTS: A MIXED-METHODS LONGITUDINAL STUDY

This paper forms part of the first study of this PhD and is currently under review for publication with the journal *BMC Public Health* as **Asamane E.A**, Greig C.A, Thompson, J.L. Social networks and their influences on nutrient intake, nutritional status and physical function in community-dwelling ethnically diverse older adults: A mixed-methods longitudinal study.

The chapter seeks to answers the following research questions:

1. What is the profile of social networks among community-dwelling ethnically diverse older adults?
2. To what extent do social networks change over time, and what accounts for these changes among this population?
3. To what extent does social networks and their changes influence nutrient intake, nutritional status and physical function within this population?

3.0 Abstract

Background: The United Kingdom population is ageing and becoming increasingly diverse; thus, it is vital to develop and implement interventions supporting this population shift. Social networks (SN) significantly impact health outcomes in later life, however relatively little is known about SN of community-dwelling ethnically diverse older adults. This study aimed to: 1) profile SN and changes in SN in this population over eight months; 2) examine associations between SN, dietary intake, nutritional status, and physical function.

Methods: SN were assessed using the Wenger Practitioner Assessment of Network Type. Energy and nutrient intakes were measured using multiple-pass 24-hour recalls. The Mini Nutritional Assessment-Short Form (MNA-SF) assessed nutritional status. Physical function was measured using the Short Physical Performance Battery (SPPB) and handgrip strength. Data were collected at baseline and 8-months. Correlation and regression analyses examined relationships between SN, physical function, nutrient intake and nutritional status. Semi-structured interviews were conducted at baseline (n=92) and follow-up (n=81) to identify potential influences of SN. Interviews were transcribed verbatim and analysed using directed content analysis.

Results: Quantitative data were obtained from 100 participants at baseline and 81 at follow-up. Mean (SD) age was 70.8 (8.1) years (59% male), comprising African/Caribbean (60%), South Asian (34%), and other ethnicities (6%). Five SN typologies were identified under two broad areas: integrated-SN consisting of locally integrated (44%) and wider community (7%); and non-integrated-SN consisting of family dependent (25%), local self-contained (18%), and private restricted (6%). At follow-up, 37% remained in non-integrated networks, 19% transitioned to non-integrated networks, 11% transitioned to, and 33% remained in, integrated networks. Participants within integrated networks at baseline had higher SPPB scores at follow-

up. Compared to the private restricted, local self-contained SN significantly predicted zinc, riboflavin and vitamin B6 intakes. Participants remaining in, or transitioning to, non-integrated networks had low MNA-SF scores. Qualitative findings indicate that participants with reductions in SN perceived it as causing poorer physical function and eating behaviours.

Conclusion: Relatively to non-integrated SN, integrated SN were associated with better maintenance of physical function and nutritional status. These results can inform the design of interventions to improve social networks, physical function and healthy nutrition within this population.

3.1 Background

Social networks are described as inter-personal ties and relationships shared among a group of inhabitants in an environment (1, 2). These ties often offer a sense of identity, support, solidarity and feelings of belonging (3, 4). During later life, social networks are unstable, often with severe disruptive changes such as bereavement, and are more likely to become smaller as compared to middle life (5). These disruptions, as explained by the convoy model of social networks, are mainly caused by situational and personal characteristics such as retirement, ill-health, loss of a spouse, residential changes and other life events primarily associated with ageing (5, 6). Evidence suggests that stronger social networks positively influence quality of life, morbidity and mortality in later life (7-10). A study examining the influence of social networks on health outcomes among 4,170 Korean adults aged 65 years and older found that individuals with more extensive social networks had higher levels of life satisfaction and lower depressive symptoms than those with restricted networks (11). Additionally, an international study of 13,891 older adults in eight developing countries discovered that individuals with integrated social networks were more protected against premature all-cause mortality over three and half years of follow-up as compared to those in restricted social networks (9). Given this,

it is necessary to understand the types of social networks among diverse populations living in diverse communities, and how these social networks influence healthy lifestyle choices over time.

The UK population is ageing and becoming more ethnically diverse (12). Ethnic minorities account substantially for the recent population growth, and are estimated to constitute over 30% of the population by 2050 (12, 13). The majority of ethnic minorities live in areas of higher deprivation and experience disproportionate health inequalities, predisposing them to a lower quality of life and poorer health than the white British population (14, 15). Even though policies and interventions have been implemented to try to address this gap, much still needs to be done to support this rapidly growing portion of the population to age more healthily (16). A more in-depth enquiry of social networks in this population could contribute to a wider understanding of the relationship between social networks and health, and thus help in developing more culturally sensitive community-based interventions with the potential to improve social networks, and thereby help address the health disparities among this population.

It is often assumed that ethnic minorities live in multigenerational households that offer continuous informal support for their older members, and hence have stronger social networks than white older adults. However, this is often not the case, as growing evidence suggests that multigenerational households do not translate into a continuous pool of support (17). Additionally, there is evidence that ethnic minorities do not have extensive social networks or a lower risk of loneliness as previously reported (18-21). For example, a longitudinal study exploring social networks and engagement between Blacks and Whites aged 65 years and older in the United States (US) found that Blacks had smaller social networks and engagements as compared to Whites over the study period (21). While recognising these disparities between ethnic minorities and the predominately white population, there is also evidence pointing to

differences in social networks among ethnic minorities themselves. For instance, a recent study of social networks of immigrants aged 55 years and older in England and Wales found that Black Caribbean and Chinese older immigrants had a higher proportion of restricted non-kin social networks, at 30% and 22.3%, respectively, as compared to Pakistanis (12.1%), Bangladeshis (6.7%), Indians (16.3%) and Black Africans (16.8%) (22). These differences within and between ethnic minorities and white populations further cast doubt on the assumptions that the majority of ethnic minorities have extensive social networks. These studies also provide a rationale to explore and compare the social networks of older adults living in a super-diverse city, with that of previous studies of ethnic minorities elsewhere. This could be useful in broadening our understanding of social networks of ethnic minorities living in different environmental contexts, and subsequently aid in the design and implementation of tailored interventions to improve social networks.

There are relatively few studies that have explored the role of social networks on health outcomes of ethnic minorities in later life (22-25). These studies have highlighted the critical relationship between social networks and health outcomes. For example, in the US, a cross-sectional study involving 700 South Asians aged 44-84 years found that increases in emotional closeness of network members was associated with better self-rated health (23). Similarly, in the UK, a study involving six ethnic minority groups (aged 55+ years) using quantitative measures within a cross-sectional study design, found that older ethnic migrants with more extensive family-oriented networks reported lower loneliness and higher quality of life than those in restricted networks (22). Even though these studies have advanced our understanding of the relationship of social networks and some health outcomes within ethnic minorities, they are often cross-sectional in design, thus making it difficult to monitor changes in social networks, and how these changes may subsequently influence health outcomes.

A longitudinal study design enables the disentangling of the temporality of associations and helps to unravel the influence of changes in social networks on health outcomes over time. Furthermore, considering the potential complex mechanisms of how social networks exert influence, the use of only quantitative techniques, as done in previous studies, limits us from understanding why these changes occur or how they might be influencing health. To address these gaps in the literature, the present study uses a longitudinal concurrent mixed method approach aimed to: 1) categorise and assess any changes in the social network profiles of community-dwelling ethnically diverse older adults over 8-months; and 2) examine the extent to which social networks, and any changes in these networks, influence nutrient intake, nutritional status and physical function over 8-months.

3.2 Methods

3.2.1 Study design and study setting

A longitudinal concurrent mixed method approach was used to explore social networks and their associations with nutrient intake, nutritional status and physical function at baseline and 8-month follow-up (26). Data were collected on four different occasions: two visits at baseline (T1) and two visits at follow-up (T2) (see figure 13). The two visits within each time point were carried out across a 14-day period to capture a closer representation of habitual intake of food (27). All baseline data were collected from March 2017 to February 2018, and follow-up data collection occurred approximately eight months later, from November 2017 to February 2019. The study was conducted in Birmingham, UK, which is the second most populated city in the UK. Recent projections predict that by 2021, more than 50% of the population in Birmingham will be comprised of ethnic minorities (28). Given this, the present study setting was appropriate to answer the research questions in this study.

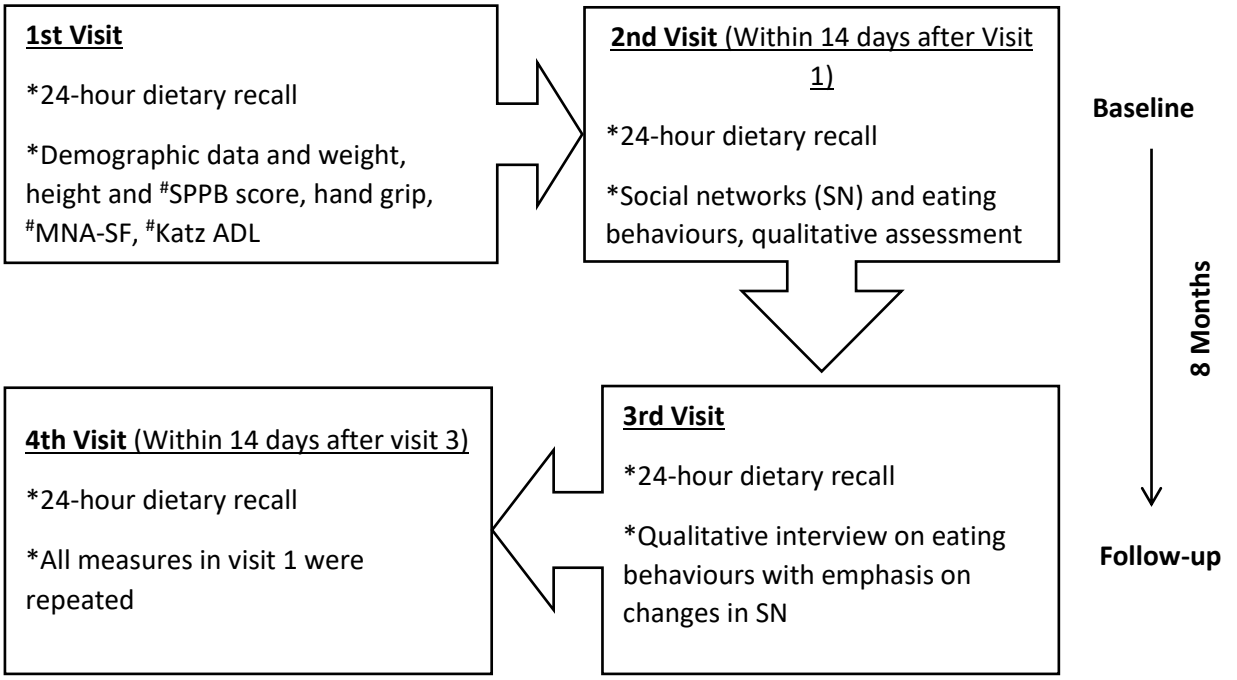


Figure 13: Flow chart summarising the data collection phases and visits over the 8-month period.

#SPPB= Short Performance physical battery; MNA-SF =Mini Nutritional Status-Short Form; Katz-ADL=Katz Activity of Daily Living.

3.2.2 Participants and recruitment

Community-dwelling ethnically diverse older adults (≥60 years), living in Birmingham, and self-identifying as African, Indian, Pakistani, Bangladeshi or Caribbean, took part in the study. Potential participants were identified and approached at age-well societies, community centres, faith centres and other informal social events across Birmingham. A total of 100 participants were conveniently and purposively recruited to take part in the study.

3.2.2.1 Inclusion criteria

1. Participants aged 60 years and older

2. Permanent resident in the Birmingham area

3. Self-identifying as African, Indian, Pakistani, Bangladeshi or Caribbean

3.2.2.2 Exclusion criteria

1. Older adults with a diagnosis of dementia or any cognitive disabilities that might affect their participation. Using the Standard Mini Mental State Examination (SMMSE) test, a score of <19 was considered moderately cognitively impaired and hence not eligible to take part in the study (29, 30).

2. Older adults that were institutionalised or hospitalised.

3.2.2.3 Recruitment and ethics

Maximum variation sampling and chain referrals were employed during the recruitment process to ensure broad representation across older age groups, ethnicities, sexes, religions/faiths and socio-economic groups (31-33). Several techniques were incorporated to increase recruitment, improve data quality and increase participant retention in the study. The authors established initial contact with community leaders and potential participants prior to the start of the study. In addition, EAA attended church services and public events held at faith centres to develop rapport with community leaders and potential participants. This may have enhanced trust between EAA and potential participants, which has been shown to improve the quality of data collection (34). Community leaders who met the inclusion criteria were also encouraged to take part in the study. By recruiting those serving as role models, more trust and credibility was given to the study (34).

The study received ethical approval from the University of Birmingham Science, Technology, Engineering, and Mathematics (STEM) ethical review committee (ERN_17_1364). All participants provided written informed consent before data were collected.

3.2.3 Data collection

3.2.3.1 Social networks

Among the different social network typologies, two social network generation tools were considered appropriate for this study: the Burholt et al. social network typology for people living in multigenerational households and the Wenger Practitioner Assessment of Network Type (PANT) (35-37). Although somewhat similar, these network typologies differ in the number of network groups, the composition of typology and the ease of applicability (35). For instance, the Burholt typology uses nine 'network generator' questions to derive four network groups and has been tested and validated to more accurately identify restricted social networks among people living in multigenerational households than the Wenger PANT (35). The Wenger PANT includes five network groups, is easy to administer, and has been validated and used in many populations in different countries, including ethnic minority populations in the UK (38-41). Although data were collected using these two network typologies in the present study, the Wenger PANT was used to categorise older adults' social networks because of the low proportion (5%) of multigenerational households in the study sample and its ease of administration.

The Wenger PANT is composed of eight distinct questions based on the availability of close local kin (3 questions), the closeness of family, friends and neighbours (3 questions), and level of interaction with community, voluntary and religious groups (2 questions) (36, 37). This scoring tool generates five social network types that describe the size, composition and function of the social network. These five social networks include: locally integrated; wider community focussed; family dependent; local self-contained; and the private restricted networks. These are summarised below under two broad categories, integrated and non-integrated social networks:

Integrated social networks

1. The locally integrated social network is considered more robust and integrated, providing an optimal level of support as compared to the other network types. It is often larger than average (network size more than 8 members) and involves active involvement with family, friends, neighbours and the wider community. This is the most common network found in the UK (39, 42).
2. The wider community focussed network is also large (more than 8 members within the network). It is characterised by high community involvement and no local kin (42). Family members are always a distance from the individual but might visit occasionally. There is a high dependence on friends and neighbours, and with low levels of isolation (42).

Non-integrated social networks

3. The family dependent network is typically characterised by a small network size (1-4 members). It has high family involvement and low involvement with the community. Individuals are usually living with an adult child or relative and are often widowed. The family dependent social network has a high dependence on family members (39, 42).
4. The local self-contained network is characterised by low community involvement, and family members might be present locally with low involvement. Individuals within this network are generally reliant on neighbours for support. This network size tends to be smaller than average (5-6 members), and presents high levels of isolation (39, 42).
5. The private restricted social network is less common in the UK as compared to the other social networks; it is characterised by very low involvement with family, friends, and the wider community (42). There are usually no local kin, and individuals within this network are at high risk of isolation, loneliness, depression and low quality of life in

general (42).

3.2.3.2 Energy and nutrient intake

Repeated multiple pass 24-hour dietary recalls coupled with qualitative interviews were used to assess energy and nutrient intakes on four different occasions (2 non-consecutive days each at baseline and follow-up), including at least one weekend day following standard procedures (43). EAA, a trained nutritionist with relevant expertise in conducting dietary assessments, conducted all assessments with oversight from JLT, a Professor of Public Health Nutrition and Exercise, who has extensive experience in dietary assessment among different populations. A culturally sensitive full-colour food portion booklet containing over 1,700 ethnically diverse foods eaten in the UK was used to aid in portion size estimations (44). The use of dietary supplements was captured during the multiple pass 24-hour recalls. 24-hour recall records were discarded when participants indicated that the previous day was not habitual, or they had fasted (N=17), and an additional data collection session was completed to obtain the record. Before data entry, recalls were cross-checked for accuracy using the digital audio-recorded interviews before entering data into the Dietplan 7.0 dietary software analysis package (Forestfield Software Ltd. Horsham, UK) for processing. West African food composition tables, food manufacturing websites, and recipe books for ethnic minority groups were employed when a food item could not be identified in the Dietplan 7.0 database (45).

3.2.3.3 Nutritional status

Participants' nutritional status were assessed using the Mini-Nutritional Assessment-Short Form (MNA-SF). This is a simple to use, sensitive, reliable and valid tool for rapid assessment of the nutritional status of older adults (46). Unlike the full MNA, the short form is faster to complete and equally reliable when compared to the full MNA (47, 48). Considering its ease of administration, this was the preferred tool to assess nutritional status in the present study as

it reduces participant burden. Furthermore, most of the information on the full MNA (such as dietary information) was collected using the multiple pass 24-hour recall, further justifying the use of the short version. The MNA-SF is composed of six major questions and was administered at visits 1 and 3 (see figure 13). The MNA-SF has a scoring of 0-14 points, with as score of 0-7 classified as the malnourished group, 8-11 classified as at-risk-of malnutrition group, and 12-14 classified as normal group (48).

3.2.3.4 Anthropometrics and physical function

Body weight was measured using a Seca 899 digital scale to the nearest 0.1kg, with participants wearing light clothing and no shoes. Height was measured using a Seca 213 portable stadiometer to the nearest 0.1cm, with participants wearing no shoes/minimal headwear. Body Mass Index (BMI) was calculated using the standard equation, weight (kg)/height $(m)^2$. Waist circumference was measured using a flexible retractable non-elastic tape and recorded to the nearest 0.01cm.

The Short Physical Performance Battery (SPPB) was used to measure participants' lower body extremity physical function (49-51). These measures include gait speed, balance and time taken to perform five repeated chair rises (51). Handgrip strength was measured using a Jamar hand dynamometer in the standing position (52). The standing position was chosen as it has been shown to produce maximal grip strength as compared to other body positions (53). During all measurements, the Jamar handgrip dynamometer was adjusted to the second handle as this has also been shown to produce consistent and reliable maximal handgrip strength results (54). Each measurement was completed three times and the highest recording used for analysis.

3.2.4 Quantitative analysis

SPSS version 25 (IBM Corp, Armonk, NY, 2017) was used to carry out all statistical analyses, with significance set at a p-value set of 0.05. Bivariate analyses were conducted to ascertain the

difference between the baseline sample and the sample lost to follow-up (n=18). Descriptive analyses were conducted to explore the frequencies and percentages of variables of interest by social networks. Paired t-tests and chi-square tests were used to test for differences between continuous variables and categorical variables, respectively. In instances where normality was violated, the Wilcoxon signed-rank test was used instead of the paired t-test. One-way ANOVA, with the addition of the Bonferroni multiple comparisons test, was used to test the differences in continuous variables between social networks. Multiple logistic regressions were used to assess the association of social networks with nutritional status, nutrients intake and physical function (SPPB and handgrip strength). Change in physical function was computed as the mean difference between baseline and follow-up scores and categorised as stable (SPPB score at baseline same as SPPB score at follow-up), declined (SPPB score at baseline was higher than SPPB score at follow-up) or improved (SPPB score at follow-up was higher than SPPB score at baseline). Also, the change in nutritional status was calculated. First, the malnourished group was combined with the at-risk-of malnutrition group forming the malnourished/at-risk-of malnutrition group. Second, the changes in nutritional status at follow-up was calculated as: 1) those that remained in the malnourished/at-risk-of malnutrition group at follow-up; 2) those that changed from the normal nutrition group to the malnourished/at-risk-of malnutrition group; 3) those that remained in normal nutrition status group; 4) those that changed from the malnourished/at-risk-of malnutrition group to the normal nutritional status group.

Social network typologies were first treated as categorical variables, where dummy variables were created for locally integrated, wider community, family dependent, local self-contained and private restricted networks. The private restricted network was used as the reference category for cross-sectional associations, while the remainder of the four dummy social networks served as predictor variables in unadjusted and adjusted regression models to predict:

a) baseline SPPB scores (physical function); b) baseline nutritional status; and c) baseline nutrient intake (including dietary supplements).

Considering previous literature (36, 55) and as described above, the locally integrated and wider community social networks formed the integrated social network type, while family dependent, local self-contained and private restricted social networks formed the non-integrated social network type. Change in social networks was computed as maintenance or change of social network group membership at follow-up in reference to the non-integrated social network group. Four groups were formed: 1) those that remained in the non-integrated social network group; 2) those that changed to the non-integrated social network group; 3) those that changed to the integrated social network group; and 4) those that remained in the integrated social network group. For longitudinal analyses, the baseline social network groups (the integrated and non-integrated groups) served as independent predictors in multinomial regression analyses to predict the changes in physical function and nutritional status at follow-up while controlling for age, sex, IMD, self-rated health, number of diseases and educational attainment.

3.2.4 Qualitative interviews and analysis

A semi-structured interview schedule was used to guide in-depth qualitative interviews at baseline and follow-up, using open-ended questions and following up with relevant probes. At baseline, the interviews were focused on the perceived impact of social networks on eating behaviours and physical function. At the 8-month follow-up, the interview guide was revised to incorporate areas capturing perceived changes in social networks and their potential influences on eating behaviours and physical function. Trained translators were employed in instances where the participant had limited ability to communicate in English (n=19). All interviews were digitally recorded and were 25-110 minutes in duration. Interviews were

transcribed verbatim, then entered into QSR NVivo 12 Plus software for reorganising and coding (56).

Directed content analysis was used to analyse the qualitative data (57, 58). The directed content analysis approach includes three main steps: preparation, organisation and reporting phases. The preparation phase involved immersion in the data, where transcripts and field notes were read several times to understand the pattern of the data. During the organisation phase, two categorisation matrices were developed: 1) the influence of social networks and other key factors on eating behaviours; and 2) the influence of social networks and other key factors on physical function. Relevant literature and an ecological model of creating healthy environments were used in the initial formation of these matrices (59-61).

Using an iterative process, the matrices were further restructured inductively based on the findings arising (data-driven). To ensure rigour, trustworthiness and the ease of use of the matrices, two independent researchers pre-tested the matrices using preliminary data (57). Afterwards, discussions around the difficulty of use of the matrices and interpretations of the categories were resolved by consensus, and the matrices further restructured. Following this step, the remaining transcripts were coded by EAA using the updated categorisation matrices. All findings were systematically presented in the reporting phase.

3.3 Results

At baseline, 100 community-dwelling ethnically diverse older adults took part in the study, with a mean (SD) age of 70.8 (8.1) years (59% males). This sample comprised Africans/Caribbean (60%), South Asians (34%) and other ethnicities (6%). More men were married (47%) as compared to women (19%). Seven percent and 9% of men and women respectively were widowed. At follow-up, data were available for 81% of the sample, with a mean (SD) age of

70.9 (8.1) years (62% males). Figure 14 displays the breakdown of recruitment and drop-outs throughout the phases of data collection.

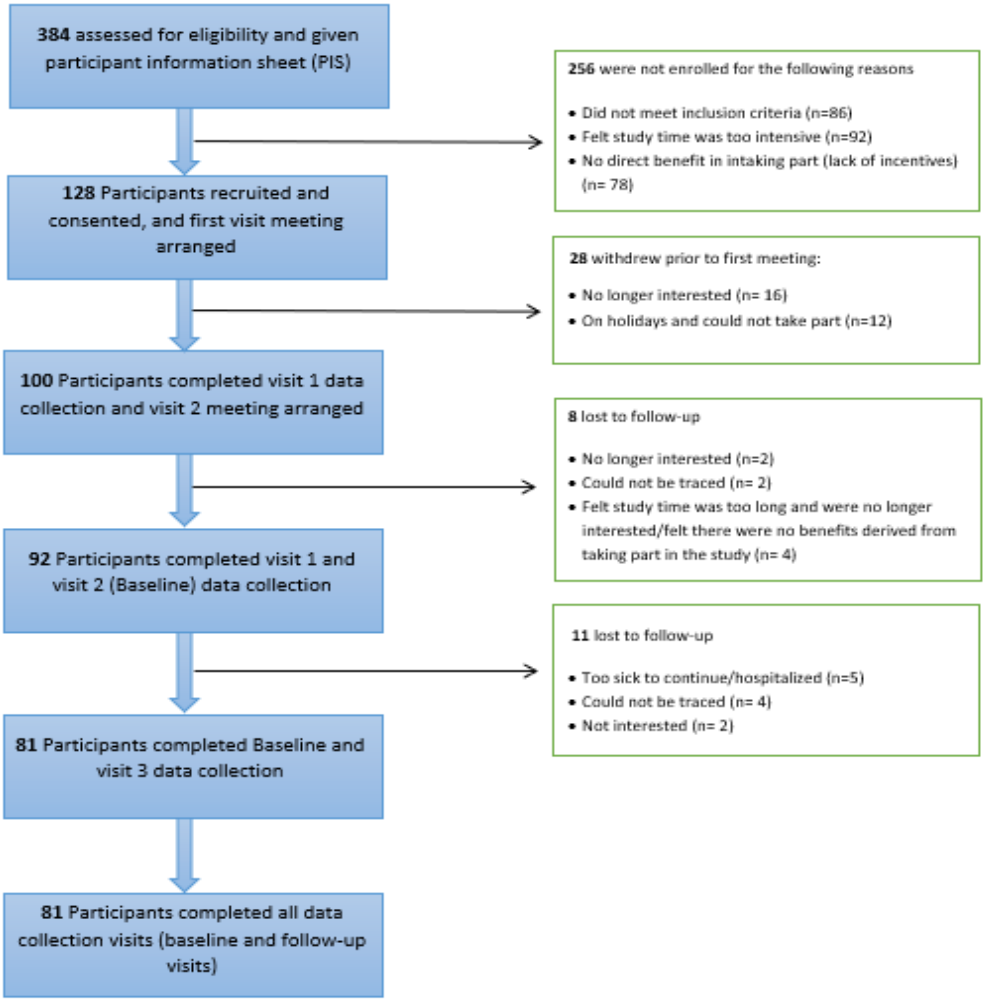


Figure 14: Flow chart of recruitment, data collection and reasons for dropouts.

Five different social networks (SN) were identified at baseline and follow-up visit: locally integrated (44% vs 37%), wider community (8% vs 9.9%), family dependent (25% vs 35.8%), local self-contained (17% vs 9.9%), and private restricted (6% vs 7.4%). Participants belonging to private restricted as compared to locally integrated networks had significantly lower SPPB scores (p=0.014). There was a statistically significant association between living arrangements and social networks, with those living alone having weaker social networks (p=0.001).

Furthermore, as compared to the private restricted network, locally integrated social networks were associated with better self-rated health (p=0.02) (Table 5).

Table 5: Socio-demographic characteristics and other variables by social networks at baseline (N=100)

		Integrated SN (n=52)		Non-integrated SN (n=48)			
Variable		**Locally integrated (N= 44)**	**Wider community (N= 7)**	**Family dependent (N= 25)**	**Local self-contained (N=18)**	**Private restricted (N=6)**	**P-value[α]**
Age Mean (SD)		70.5 (7.6)	75.3 (7.6)	68.5 (8.2)	71.4 (7.6)	74.3 (11.8)	0.218
Sex N (%)	Male	28 (63.6)	3 (37.5)	19 (76.0)	6 (29.4)	4 (66.7)	0.045
	Female	16 (36.4)	5 (62.5)	6 (24.0)	12 (70.6)	2 (33.3)	
Marital Status[¥]	Married	34 (79.1)	4(50.0)	20 (80.0)	6 (33.3)	2 (33.3)	0.001
	Not married	9 (20.9)	4 (50.0)	5 (20.0)	12 (66.7)	4 (66.7)	
Ethnicity N (%)	Caribbean	15 (34.1)	4 (50.0)	6 (24.0)	13 (76.5)	3 (50.0)	0.466
	Pakistani	13 (29.5)	2 (25.0)	6 (24.0)	2 (11.8)	0 (0.0)	
	African	7 (15.9)	1 (12.5)	7 (28.0)	1 (5.9)	3 (50.0)	
	Indian	3 (6.8)	1 (12.5)	2 (8.0)	1 (5.9)	0 (0.0)	
	Bangladeshi	2 (4.5)	0 (0.0)	2 (8.0)	0 (0.0)	0 (0.0)	
	Others[β]	4 (9.1)	0 (0.0)	2 (8.0)	0 (0.0)	0 (0.0)	
Faith/ Religion N (%)	Christian	21 (47.7)	5 (62.5)	13 (52.0)	12 (70.6)	5 (83.3)	0.698
	Muslim	19 (43.2)	2 (25.0)	9 (35.0)	3 (17.6)	1 (16.7)	
	Sikh	3 (6.8)	1 (12.5)	2 (8.0)	1 (5.9)	0 (0.0)	
	Hindu	1 (2.3)	0 (0.0)	1 (4.0)	0 (0.0)	0 (0.0)	
	No religion	0 (0.0)	0 (0.0)	0 (0.0)	1 (5.9)	0 (0.0)	
Self-R health mean (SD)	Excellent/good	34 (79.1)	4 (50.0)	16 (64.0)	8 (44.4)	1 (16.7)	0.02
	Fair/poor	9 (20.9)	4 (50.0)	9 (36.0)	10 (55.6)	5 (83.3)	
IMD Quintile N (%)	1 (Most deprived)	16 (37.2)	2 (25.0)	5 (20.0)	5 (27.8)	5 (83.3)	0.137
	2	7 (16.3)	1 (12.5)	8 (32.0)	3 (16.7)	0 (0.0)	
	3	9 (20.9)	1 (12.5)	5 (20.0)	6 (33.3)	1 (16.7)	
	4 (least deprived)	11 (25.6)	4 (50.0)	7 (28.0)	4 (22.2)	0 (0.0)	

SPPB Mean (SD)		10 (2.0)	9 (3.0)	10 (3.0)	8 (4.0)	6 (5.0)	0.014
HGS Mean (SD)		27.7 (8.9)	24 (5.4)	29.1 (9.9)	22.8 (9.4)	26.3(14.3)	0.231
MNA-SF Mean (SD)		13 (2.0)	13 (1.0)	13 (1.0)	12 (2.0)	12 (3.0)	0.296
BMI	Underweight	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.852
categories* N	Normal	2 (4.5)	1 (12.5)	2 (8.0)	2 (11.8)	0 (0.0)	
(%)	overweight	13 (29.5)	3 (37.5)	9 (36.0)	4 (23.5)	2 (33.3)	
	Obese	29 (65.9)	4 (50.0)	14 (56.0)	11 (64.7)	4 (66.7)	
Number of Disease Mean (SD)		2 (1.0)	2.0 (2.0)	2 (1.0)	3 (2.0)	3 (2.0)	0.344
Length of stay in UK		47.7 (11.9)	50.6 (6.2)	34.7 (20.1)	45.7 (11.3)	20.5 (10.6)	0.001
Living alone %		11.6	50.0	8.0	55.6	66.7	0.001
Supplement use	Yes	16 (37.2)	3 (37.5)	8 (32.0)	11 (61.1)	1 (16.7)	0.236
	No	27 (62.8)	5 (62.5)	17 (68.0)	7 (38.9)	5 (83.3)	

SD= Standard deviation; IMD= Index of Multiple Deprivation; MNA-SF= Mini-Nutritional Assessment-Short Form; SPPB= Short Physical Performance Battery HGS= Handgrip strength; BMI= Body Mass Index

*WHO guidance on BMI thresholds for Asian populations (World Health Organization, 2004) was used to categorise BMI of South Asian participants, and the standard BMI categories were used for Caribbean and African participants.

Note age is in years.

¥ This includes all those that are single, separated, divorced and widowed.

α Significant differences between social networks.

β 'Others' referring to mixed ethnicities e.g. African Asians.

3.3.1 Profile of social networks and their changes over eight months

The total proportion of participants reporting locally integrated and local self-contained networks was reduced by 8.7% and 6.1%, respectively, at follow-up (Table 6). However, participants reporting private restricted, wider community and family dependent social networks increased by 1.2%, 3.7% and 9.9%, respectively, at follow-up. The most dominant social network was the locally integrated social network, and the least common was the private restricted social network at both time points. Comparing the two time points, locally integrated and family dependent networks were more stable with 62.2% and 66.7%, respectively, at follow-up. At follow-up, 2.7% of those in the locally integrated social network at baseline declined to the local self-contained network, with 27% in the locally integrated social network declining to the family-dependent network. The most unstable network group was the local self-contained, with only 23.1% retaining this category at follow-up. Additionally, 30% of those in the local self-contained network at baseline changed to the private restricted social network at follow-up.

Table 6: Profile of social networks and transition over time (N=81)

		Social networks, follow-up					
Social networks, baseline N (%)		Locally integrated	Wider community	Family dependent	Local self-contained	Private restricted	Total
	Locally integrated	23 (62.2)	3 (8.1)	10 (27.0)	1 (2.7)	0 (0.0)	37 (45.7)
	Wider community	1 (20.0)	2 (40.0)	1 (20.0)	1 (20.0)	0 (0.0)	5 (6.2)
	Family dependent	5 (23.8)	0 (0.0)	14 (66.7)	2 (9.5)	0 (0.0)	21 (25.9)
	Local self-contained	1 (7.7)	2 (15.4)	3 (23.1)	3 (23.1)	4 (30.8)	13 (16.0)
	Private restricted	0 (0.0)	1 (20.0)	1 (20.0)	1 (20.0)	2 (40.0)	5 (6.2)
Total		30 (37.0)	8 (9.9)	29 (35.8)	8 (9.9)	6 (7.4)	81 (100.0)

Table 7 shows the differences in demographic characteristics and outcome variables between those who remained in the integrated network group, those who changed to the integrated network group, those who remained in the non-integrated network group, and those who changed to the non-integrated network group. The groups were not significantly different with respect to age, sex, marital status, number of diseases, handgrip strength or waist circumference. However, the groups differed in MNA-SF scores, SPPB scores, self-rated health and length of stay in the UK. Those who remained in the non-integrated network group had significantly lower SPPB scores at baseline (P=0.039) and follow-up (p=0.018), as compared with participants who remained in the integrated network group. Similarly, at follow-up, participants who changed to the non-integrated network group had the lowest MNA-SF scores (p=0.018). Participants who remained in the non-integrated network group had lower self-rated health as compared to those who remained in the integrated network (P=0.05).

One-way analysis of variance was conducted to ascertain the difference in energy and nutrient intakes between the changes in social network groups at follow-up. The groups differed in the intakes of folate, potassium, sodium, and percentage total energy (%TE) from saturated fat (Figure 15). Compared to those who changed to the non-integrated network group, those who remained in the integrated network group had lower intakes of %TE from saturated fat (P=0.009) that were within the UK Recommended Nutrient Intakes (RNI) for %TE saturated fat. Similarly, those who remained in the integrated network group had significantly higher intakes of folate (133.3 $\mu g.day^{-1}$) as compared to those who changed to the non-integrated network group (94.8 $\mu g.day^{-1}$) (P=0.045). Potassium intakes also differed significantly between the groups (p=0.015). Those who changed to the integrated network group had higher intakes (1959.5$mg.day^{-1}$) as compared to those who changed to the non-integrated network group (1412.1$mg.day^{-1}$) and who remained in the non-integrated network group (1501.2$mg.day^{-1}$)

(P=0.015). As compared with the age specific UK RNI for folate, 200 µg.day^{-1}, and potassium 3500mg.day^{-1}, the intakes of folate and potassium for all changes in social network groups as shown in figure 15 were below the recommended intakes. Sodium intakes for all groups were also below the UK RNI of 2400mg.day^{-1}. However, those who changed to the integrated network group had significantly higher intakes of sodium (1536mg.day^{-1}) as compared to those who changed to the non-integrated network group (895.3mg.day^{-1}) and those who remained in the integrated network group (1006.3mg.day^{-1}) [see Supplementary file A1 for details].

Table 7: Socio-demographic characteristics, nutritional status and physical function of the changes in social networks groups in community-dwelling ethnically diverse older adults (N=81)

Variable		Total at follow-up (N=81)	Remained integrated (N=27)	Changed to integrated (N=9)	Remained non-integrated (N=30)	Changed to non-integrated (N=15)	P-value*
Age Mean (SD)		70.9 (8.1)	71.3 (7.7)	72.4 (9.1)	69.8 (8.8)	71.3 (7.5)	0.808
Sex N (%)	Male	50 (61.7)	16 (59.3)	6 (66.7)	19 (63.3)	9 (60.0)	0.975
	Female	31 (38.3)	11 (40.7)	3 (33.3)	11 (36.7)	6 (40.0)	
Marital status	Married	55 (67.9)	23 (85.2)	5 (55.6)	18 (60.0)	9 (60.0)	0.137
	Not married	26 (32.1)	4 (14.8)	4 (44.4)	12 (40.0)	6 (40.0)	
Self-rated health	Excellent	10 (12.3)	4 (14.8)	2 (22.2)	3 (10.0)	1 (6.7)	0.05
	Good	42 (51.9)	21 (77.8)	4 (44.8)	11 (36.7)	6 (40.0)	
	Fair	18 (22.2)	2 (7.4)	2 (22.2)	8 (26.7)	6 (40.0)	
	Poor	11 (13.6)	0 (0.0)	1 (11.1)	8 (26.7)	2 (13.3)	
Number of diseases Mean (SD)		2 (1.4)	1.7 (1.2)	1.6 (0.7)	2.3 (1.7)	2.1 (1.0)	0.303
MNA-SF Mean (SD)	T1	12.6 (1.6)	12.7 (1.4)	13.0 (0.7)	12.5 (2.0)	12.1 (1.0)	0.572
	T2	12.0 (1.8)	12.6 (1.6)	13.1 (0.9)	11.7 (1.9)	11.1 (1.9)	0.018
SPPB Mean (SD)	T1	9.5 (3.2)	10.2 (2.1)	10.4 (2.6)	8.2 (4.1)	10.2 (2.2)	0.039
	T2	8.6 (3.3)	9.7 (2.6)	9.8 (2.3)	7.1 (4.2)	9.0 (2.2)	0.018
HGS Mean (SD)	T1	27.9 (9.6)	27.7 (8.6)	32.3 (9.1)	26.1 (11.3)	28.8 (7.3)	0.386
	T2	27.2 (8.6)	28.5 (8.4)	29.9 (8.9)	24.4 (9.2)	28.8 (6.9)	0.171
WC Mean (SD)	T1	100.2 (10.5)	99.5 (10.1)	98.6 (11.5)	100.2 (12.0)	102.3 (7.9)	0.822
	T2	100.9 (10.7)	99 (7.7)	98.1 (12.3)	101.7 (13.6)	104.4 (6.6)	0.382
Length of stay in the UK mean (SD) years		43.3 (16.3)	51.2 (10.4)	43.8 (17.9)	34.5 (17.6)	46.1 (14.4)	0.001

SD= Standard deviation; MNA-SF= Mini-Nutritional Assessment-Short Form; SPPB= Short Physical Performance Battery; HGS= Handgrip strength; WC= Waist circumference; *Mean difference between changes in social networks groups.

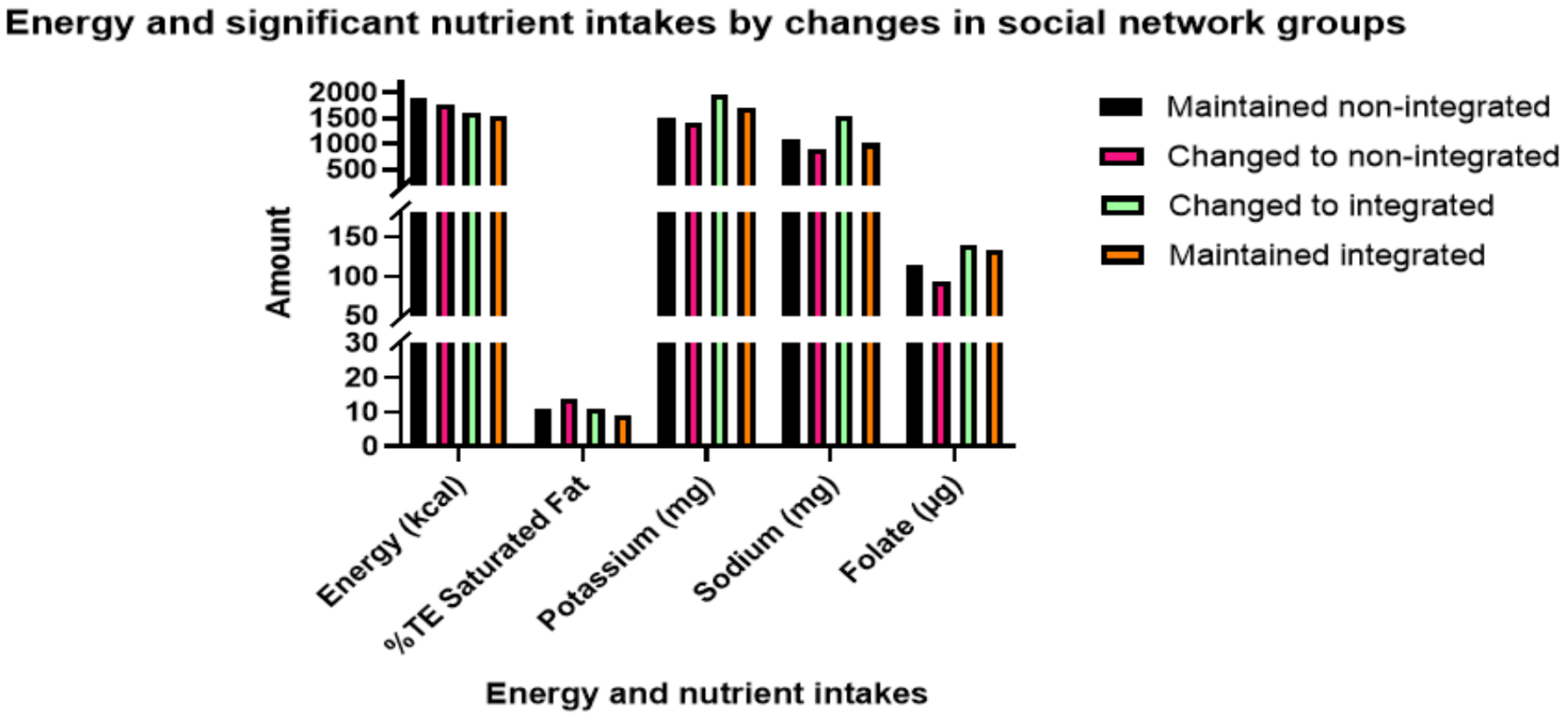


Figure 15: The distribution of energy and nutrient intakes by changes in social networks over 8-months in community-dwelling ethnically diverse older adults (N= 81).

3.3.2 Perceived social changes and reasons for social network changes

Almost one-third (28%) of participants reported perceived changes in their social networks during follow-up. Of those perceiving changes, the quantitative data supported these changes in 18 (22%), indicating changes to non-integrated or integrated social network groups, as shown in table 7. The majority (12; 67%) of those that changed to the non-integrated network, reported perceived declines in their social networks. These participants cited changes in living arrangements, and reduced frequency of contact from children, other relatives and friends as the main reasons for the decline in network size and density. For instance, a woman living alone and belonging to the 'changed to the non-integrated social network group' at follow-up attributed the reduction in network size to the sudden, infrequent visits from her children as compared to baseline:

"No, there's no increases [in social networks], it has decreased since we met. I don't know why, but my children…. because some of them [children], when they have the partner, the partner doesn't like them to come and visit mum, I said to them it's up to you, don't let anybody tell you, "oh you can't go by your mum". You should go by your mother, your mother gave birth to you, but I can't force someone to come… (P72, 68 years, Caribbean, Female).

Another participant explained that her network size had stayed the same over the study period, however, the frequency of contact of network members (family and friends) had reduced.

"The network has stayed the same, but the frequency of contact has reduced" (P100, 64 years, female, Caribbean).

Participants listed Illnesses that made them less mobile as one reason for experiencing declines in their social networks. The decrease in physical function resulting from illness prevented them from visiting their social groups as regularly as they used to. A participant recounted how his

ill-health during the study period kept her housebound, hence the reason she no longer sees some of his friends.

"Yes, because I'm getting more immobile in my legs. My hip and my legs, I don't know what is causing it, maybe the sickness in this couple of months….that has made me not able to go there again [community centre]…I don't see my friends again as I used to" (P77, 68 years, female, Caribbean).

Participants who remained in the non-integrated social network at follow-up described no improvement in their social networks. In some cases, participants described their social networks as poorer than before. For instance, a male participant reported that he is alone most of the time, and the few friends that he used to spend time with are unwell.

"It is the same if not bad now, I don't have my family here as I said, I am alone here……. I have a few friends that I used to see from time to time, they are sick now, I am by myself most times" (P18, 64 years, African, male).

Participants that remained in the integrated group were more likely to describe a stronger social network, attributing it to the increase in family network size, for example, the presence of grandchildren or the relocation of their children back to Birmingham. As explained by a male participant living with his spouse and youngest daughter, he outlines how his network size has improved over the study period.

"Oh, the size is increasing because the other one [son] has got two children now. Yeah, and the relationship is getting even tighter because the children come here, their mum comes here almost every day. So, the relationship is tight" (P37, 63 years, African, male).

3.3.2 Associations of social networks with physical function, nutrient intake and nutritional status at baseline

Hierarchical multiple linear regressions were performed to determine the relationship of social network types with physical function (SPPB), nutritional status, BMI, waist circumference and nutrient intakes. Table 8 shows statistically significant predictors of fully adjusted models for the outcome variables: SPPB, zinc, riboflavin, vitamin B6 and manganese. Models of social networks and other independent variables predicting BMI, waist circumference, handgrip strength, nutritional status and all other nutrients as outcome variables were not statistically significant [See supplementary file A2].

With respect to physical function (as indicated by SPPB), the fully adjusted model shows that age, sex, IMD, self-rated health, number of diseases, education and social networks were significant predictors [$F (10, 89)= 5.11$, $p<0.001$], contributing to 36.5% of the variance in SPPB scores. Older adults who belonged to the integrated network, wider community network and family-dependent social networks had SPPB scores that were 3.06, 3.47 and 2.97 points higher, respectively, than those in private restricted network (the reference group), social networks explained an additional of 5.5% of the variance in SPPB. Also, within the fully adjusted model, participants who were older and who self-reported poorer health were more likely to have lower SPPB scores than the younger old with good self-reported health.

For zinc, the fully adjusted model was significant [$F(10, 89)=2.302$, $p= 0.19$], and the variables age, sex, IMD, self-rated health, number of diseases, education and social networks explained 20.5% of the variance of zinc. Participants belonging to the local self-contained network reported a 2.27mg/day higher zinc intake as compared to participants in private restricted network, and this contributed to an additional 10.15% of the variance of zinc intake. Similarly, for riboflavin intake, the model was significant, [$F (10, 89)=2.668$, $p=0.07$ and the variables

age, sex, IMD, self-rated health, education and social networks contributed a total of 23.1% of the variance of riboflavin intake. Older adults belonging to the local self-contained network reported a 0.51 mg/day higher riboflavin intake than the private restricted network, explaining 8.6% of the variance in riboflavin intake. A similar result was found for the fully adjusted model for vitamin B6 [F(10, 89)=2.67, p=0.007], with age, sex, IMD, self-rated health, number of diseases, education and social networks accounting for 23.1% of the variance in vitamin B6 intake. Older adults belonging to the local self-contained network as compared to the private restricted network consumed 0.54 mg/day more vitamin B6, accounting for an additional 8.6% of the variance.

For manganese intake, results differed in that the fully adjusted model was significant, [F(10, 89)=2.04, p=0.038], and the variables age, sex, IMD, self-rated health, number of diseases, education and social networks explained 18.6% of the variance of manganese intake. Older adults belonging to the wider community network had 1.64mg/day higher intakes of manganese than the private restricted network, and this explained an additional of 11.4% of the variance of manganese intake.

Table 8: Hierarchical multiple linear regression predicting SPPB, zinc, riboflavin, vitamin B6, manganese and folate intakes in community-dwelling ethnic diverse older minorities at baseline (N=100)

	SPPB		Zinc		Riboflavin		Vitamin B6		Manganese	
Sociodemographic variables	**B (95%CI)**	**SE**	**B (95%CI)**	**SE**	**B (95%CI)**	**SE**	**B (95%CI)**	**SE**	**B (95%CI)**	**SE**
(Constant)	17.33 (10.8, 23.85)**	3.28	1.01 (-3.45, 5.47)	2.25	-0.34 (-1.54, 0.85)	0.60	0.09 (-1.07, 1.24)	0.58	0.99 (-2.03, 4.01)	1.52
Sex	-0.36 (-1.50, 0.78)	0.57	0.26 (-0.51,1.04)	0.39	0.12 (-0.09, 0.33)	0.10	0.10 (-0.11, 0.30)	0.10	-0.04 (-0.57, 0.48)	0.27
Age	-0.09 (-0.16, -0.02)*	0.03	-0.02 (-0.03, 0.06)	0.02	0.10 (-0.01, 0.02)	0.01	0.01(-0.01, 0.01)	0.01	0.01 (-0.02, 0.05)	0.02
IMD	0.05 (-0.23, 0.32)	0.14	0.01 (-0.19, 0.18)	0.09	0.10 (-0.05, 0.05)	0.03	-0.03 (-0.08, 0.02)	0.02	-0.04 (-0.16, 0.09)	0.06
Education	-0.09 (-0.60, 0.43)	0.26	0.10 (-0.25, 0.46)	0.18	0.16 (0.06, 0.25)**	0.05	0.17 (0.07,0.26)**	0.05	0.11 (-0.13, 0.35)	0.12
Self-rated health	-1.57 (-2.29, -0.84)*	0.37	0.11(-0.39, 0.61)	0.25	0.04 (-0.09, 0.18)	0.07	0.01 (-0.14, 0.12)	0.07	0.10 (-0.24, 0.44)	0.17
Number of diseases	-0.10 (-0.57, 0.37)	0.24	0.31 (-0.01, 0.63)	0.16	0.04 (-0.05, 0.12)	0.04	0.03 (-0.05, 0.12)	0.04	-0.12 (-0.33, 1.36)	0.11
Social networks										
Locally integrated (n=44)	3.06 (0.69, 5.44)*	1.20	1.29 (-0.33, 2.92)	0.82	0.14 (-0.30, 0.57)	0.22	0.16 (-0.29, 0.59)	0.21	0.26 (-0.84, 1.36)	0.55
Wider community (n=7)	3.47 (0.45, 6.48)*	1.52	1.72 (-0.35,3.78)	1.04	0.12 (-0.43, 0.68)	0.28	0.13 (-0.40, 0.67)	0.27	1.67 (0.27, 3.06)*	0.70
Family dependent (n=25)	2.97 (0.49, 5.45)*	1.25	0.56 (-1.14, 2.26)	0.85	0.07 (-0.38, 0.53)	0.23	0.22 (-0.22, 0.66)	0.22	-0.23 (-1.38, 0.92)	0.58
Local self-contained (n=18)	2.25 (-0.30, 4.81)	1.29	2.27 (0.52, 4.02)*	0.88	0.50 (0.03, 0.96)*	0.24	0.54 (0.09, 0.99)*	0.23	0.38 (-0.81, 1.56)	0.60
Private restricted (n=6)	Ref		Ref		Ref		Ref		Ref	
R^2 *for the final model*	0.365		0.205		0.231		0.231		0.186	
R^2 *change for SN addition*	0.055		0.101		0.080		0.086		0.114	
F for change	1.942		2.829		2.324		2.477*		3.131*	

Sex was coded as male=1, female=2; Education was coded no education, primary=2, secondary=3, college/university=4; self-rated health was coded as excellent=1, good=2, fair=3 and poor= 4. IMD=Index of multiple deprivation. 1 is least deprived and 4 is most deprived. B =Unstandardized regression coefficient; SE= Standard error of the coefficient; CI= Confidence interval; *P value <0.05; **P value <0.01.

3.3.3 Perceptions of the impact of social networks on eating behaviours and physical function at baseline

It emerged that some participants (28%) perceived their current social networks ties to be influencing their physical function and eating behaviours. Many of them expressed the changes in living arrangements, especially the absence of children in the household as compared to baseline, to be the key influence on their eating behaviours.

"As the children, all moved out, my diet has changed, yes, at that time, you know, there was more salad, and yes, I usually did a little bit more extra…there was always more food, so I ate more may be better but now...[shaking her head] no" (P19, 81 years, Caribbean, Female).

"Um, I wouldn't say my eating habits have improved, because like when the children were at home, we used to have a lot of eating times, but now I think it's reduced cos we are alone now. Also, I tend to be eating more now (laughs), because the excuse is, there's more to eat, and I don't wanna waste it (laughs)" (P24, 81 years, Caribbean, Female).

A few (15%) also identified that changes in living arrangements and social networks impacted on their physical function. They felt that the presence of the children or other social ties served as motivation to be more physically active, as they used to do activities together.

"Well, we used to have exercises a lot when they [children] were home, you know, especially when my daughter was at home because I used to have an exercise bike that we shared together. I still got a few exercise equipment thrown in the cupboard in there, no motivation to bring them out" (P28, 83 years, Caribbean, Female)

The social support received during commensality was mixed, with the majority (62%) of males living with spouses preferring it, describing it as helping them to eat more healthily. Even though females also preferred the act of commensality, some said it led them to consume larger

portion sizes than they would normally eat. However, a few women (6%) said it had no influence on their portion sizes. These views are supported by the quotes presented below:

"Yeah, my, my wife supports me to eat healthily. Always reminding you about what you have to eat especially when we eat together and even the times to eat and then, with exercises, exercise also, she says "Oh, I haven't seen you step on this treadmill for some time." she will [be] saying it till you do it (laughs)" (P30, 64, African, Male).

"He's [Husband] always telling me that I'm not eating enough carbohydrates, like this morning he decided he was going to do egg and toast for us, and you should have seen the slice of the bread he cut! ……Yes, it does influence as sometimes I tend to eat too much, just like this morning" (P63, 62 years, Caribbean, Female).

Five percent of men living with their spouse preferred to eat alone and explained that eating alone allowed them to eat what and when they wanted, without interference from their spouse or other family members. As explained by a 60-year-old man:

"My wife is the one who jumps up and about, "Shouldn't be eating this, this is not good." I don't like it…I stubbornly still put it [the food] on my plate regardless and I say, "Look, I'm going to die one day, let me die in style, at least you can say I went after eating what I enjoyed best (laughs)" (P14, 60 years, Other, Male).

3.3.4 The impact of social networks on changes in physical function (SPPB) and nutritional status over time

Multinomial logistic regression was conducted to ascertain the impact of baseline social networks on changes in physical function (SPPB) and nutritional status. These analyses were controlled for sex, age, IMD, self-reported health, educational status and number of diseases.

In table 9, sex, IMD, level of education and self-rated health had no effect on changes in physical function. However, participants belonging to integrated social networks at baseline were more likely to experience no decline in physical function as compared to participants belonging to the non-integrated social network (OR=3.50 95% CI 1.02, 12.07). Additionally, with every unit increase in age, participants were more likely to experience declines in physical function (OR=0.88 95% CI 0.81, 0.96). There were no other statistically significant results found in the analysis. The multinomial regression to determine the predictors of changes in nutritional status showed no statistical significance (Results shown in supplementary file A3).

Table 9: Predictors of changes in physical function of community-dwelling ethnically diverse older adults (N=81)

	Stable (n=31)			**Improved (n=14)**		
Variable	**B**	**SE**	**OR (95% CI)**	**B**	**SE**	**OR (95% CI)**
Intercept	8.442	3.064		1.13	3.64	
Social networks						
Integrated	1.25	0.63	3.5 (1.02, 12.07)*	-1.04	0.93	0.35 (0.06, 2.16)
Non-integrated	1			1		
Age	-0.12	0.04	0.88 (0.81, 0.96)*	-0.02	0.05	0.99 (0.89, 1.09)
IMD	0.05	0.16	1.05 (0.77, 1.43)	0.13	0.17	1.14 (0.83, 1.59)
Sex						
Male	-0.67	0.61	0.51 (0.16, 1.70)	-0.10	0.76	0.9 (0.21, 3.96)
Female	1			1		
Education						
No education	-1.42	0.95	0.24 (0.04, 1.55)	-0.96	1.28	0.38 (0.03, 4.67)
Primary	0.45	0.86	1.57 (0.29, 8.51)	-0.39	1.30	0.68 (0.05, 8.57)
Secondary	-0.64	0.86	0.53 (0.10, 2.85)	1.08	0.85	2.94 (0.56, 12.55)
University/College	1			1		
Self-rated health						
Excellent	-0.363	1.15	0.70 (0.07, 6.64)	-0.53	1.59	0.59 (0.03, 13.12)
Good	-0.40	1.01	0.67 (0.09, 4.85)	-2.07	1.62	0.13 (0.01, 3/02)
Fair	0.03	1.25	1.03 (0.09, 11.85)	-0.53	1.69	0.59 (0.02, 16.31)
Poor	1			1		

The reference category is: Declined (n=36). OR= Odds ratio. SE= Standard error. 95% CI= Confidence interval. *P<0.05, R^2=0.38 (Nagelkerke). Model X^2 (20) =32.66, p= 0.037; Stable group refers to the maintenance of SPPB score over time, Declined group refers to a higher score of SPPB at baseline as compared to follow-up; Improved group refers to a low score of SPPB at baseline as compared to follow-up.

3.3.5 Perceived influences of social network changes on eating behaviours and physical function

At follow-up, participants' perceptions of the impact of changes in social networks on their eating behaviours and physical function were explored. Out of the 28% of participants perceiving changes to their social networks, men were more likely to describe these changes as unfavourable as compared to women. Most men highlighted the decline in social networks to be directly influencing their shopping, cooking and physical function. A male participant described the loss of his spouse during the study period as impacting on his eating behaviours. He highlighted that he now chooses to eat 'ready to eat' meals opposed to traditional meals, citing a lack of cooking skills and a lengthy amount of time required to cook his traditional foods.

"Well, it [eating behaviours] has changed quite a lot, to be honest. Because as I said, I used to have my wife…my wife used to cook, but now I have to do all that myself and it is not easy mainly because it's me, shopping it myself is not easy…. I don't know how to cook it [traditional foods] myself and it takes long. So, I don't eat them [traditional foods] like l used to….I just go for the easy packaged ones [ready to-eat foods]" (P58, 65 years, Caribbean, Male).

Over the study period, participants that perceived a decline in social network attributed it as part of the reasons for a decrease in their regular physical activities, eventually leading to a reduction in physical function. One participant described how the recent decline in the frequency of meeting with her friends is making her "lazy" and less likely to engage in her regular physical activities as before.

It [social networks] has reduced. E and Z used to come around. They are my only friends now. We used to visit the park or go for a meal. Things have changed, E is caring for her sick husband

now, and for Z I don't know what is wrong with her. If I don't ring, she will not ring. Well, I don't know much but I think that has probably made me a bit lazy…I don't want to walk on my own (P74, 61 years, African, female).

Contrary to participants expressing the decline in social networks influencing their eating behaviours and physical function, a few participants (12%) reported a perceived increase in social networks during follow-up. They described it to be positively influencing them to eat well and to maintain their physical function. A participant recounted that during the follow-up period, she had made new friends who motivated her to join cycling and other physical activity groups in the community.

"More of an increase, really because I made new friends, this friend that came from London, she's like this [slim]. So, she'll say, "Come on, we're doing a bike ride." And she'll say, "Come on, we're going yoga." And she's very much active, because of her I have joined this evening group in the last eight months, that we all do this walking" (P68, 60 years, Caribbean, female).

Within this group expressing improvement in social networks at follow-up, some discussed how the improvement of social networks was linked to some improvements in their eating behaviours, as expressed by a female participant below:

"Friends are maybe more now as compared to before, and when I'm saying 'friends,' I'm thinking about church, especially my local church. We eat a lot at church this time [within the 8-months] and again, sometimes there is a swapping of ideas around food" (P51, 72 years, Caribbean, Female).

Regular engagement in religious and community group meetings were perceived to be influencing eating behaviours and physical function. These participants highlighted the

importance of these regular meetings, stating that it allowed them to meet with friends, share food and other healthy eating tips. Participants also cited the regular group exercises at some of these meeting centres to be important in maintaining their physical function, as explained by a female participant below:

"Well coming here [community centre], you get to [do] your exercise, and then you can see your friends as well, that's very important. This motivates me to come. I mean, otherwise, you won't see them. And they keep your mind occupied as well. And you do, like, the exercise, you lose one stone or two, you become fitter, it's like killing two birds with one stone" (P88, 73 years, Indian, female).

3.4 Discussion

This is the first study to explore changes in social networks, and their association with nutritional status, nutrient intake and objectively measured physical function monitored longitudinally among community-dwelling ethnically diverse older adults in the UK. Considering the growing population of ethnic minorities in the UK and the existing health inequalities faced by these groups, the present findings form part of an essential process of advancing our understanding of social network dynamics and their implications for a healthier ageing trajectory in this population (12, 62). A clearer understanding of social networks could help design and implement culturally sensitive community interventions to improve social networks and promote healthy ageing.

We identified five social networks grouped under two major categories: 1) the integrated social network, consisting of the locally integrated social network and the wider community network; and 2) the non-integrated network, consisting of the family-dependent, the local self-contained and the private restricted networks. While most participants at baseline (45.7%) and follow-up

(37.0%) belonged to the locally integrated social network, only a few at baseline (6.2%) and follow-up (7.4%) belonged to the private restricted social network. This is consistent with previous studies of social networks in the UK using similar network generation typologies (39, 55, 63). Even though there seemed to be high proportions of non-integrated social networks among Caribbean and African participants, there were no significant differences in social networks between ethnicities as reported by previous studies in ethnic minority populations in the UK and elsewhere (22, 63). However, social networks differed by sex; despite the high proportion of men being married, they had the significantly higher proportion of restricted social networks than women. The present findings are not consistent with other studies which reported that older married men had more extensive networks as compared to women that were unmarried or widowed (64). As explained by our qualitative findings, women (both married and widowed) expressed high community involvements with faith groups and other community activities, thus accounting for a higher proportion of integrated social networks than their male counterparts.

Furthermore, in contrast to previous findings, our findings indicated a small proportion of restricted social networks at baseline and follow-up (6.2% and 7.4%, respectively) (22, 63, 65). One possible explanation could be the different social network typologies used, that is, the use of latent class, cluster analysis or name generation of network groups as compared with the Wenger PANT tool. For instance, a study of changes in social networks among older Koreans using latent class analysis to categorise older adults into groups found that at both study points, the most prevalent social network group was the restricted social network [62]. In addition, the recruitment strategy used in the present study could be accounting for these differences. Participants in the presented study were recruited from community centres, faith groups and other social events, while other published studies analysed large national or international

datasets of participants who were recruited using postal addresses, hospital registers or directly from national records (65, 66).

Despite the small number of participants reporting restricted social networks, the present study provides novel findings of the dynamics across social networks over time in ethnic minority older adults. Within a relatively brief follow-up period, quantitative findings indicated that 24 (29.6%) participants reported changes in social networks. As compared to many studies with longer follow-up periods, the finding of changes in social networks within eight months is unique, providing valuable insights on the stability of social networks within this population even over brief periods. Even though the direction of change was not always towards the non-integrated social networks as anticipated, the majority of those that changed, 15 (62.5%), moved from an integrated social network to a non-integrated social network.

This sharply contrasts with a study of social network changes among older Europeans, where over a 4-year period, Europeans aged 65 years and older experienced an expansion of network ties (66). Explained through the qualitative results, participants within the present study noticed the changes to a more restrictive type, describing a reduction in network size and frequency being due to less interaction with their children and friends. A striking finding was that sex, age, marital status and IMD scores were not associated with changes in social network groups at follow-up, which contrasts with previous studies (65, 66). For instance, a 2-year longitudinal study exploring social network changes among adults aged 60 years and older found that sex, age and self-rated health were significant predictors of changes in social networks at follow-up [65] This study observed that participants who remained in the poorer social networks at follow-up were typically females, older, having poorer socio-economic status and self-rated health [65]. Also, unlike the present study, a recent 4-year longitudinal study of Europeans aged 65 years and older also found that women had relatively larger social networks at follow-up (66).

One possible explanation accounting for these differences in findings across studies is the relatively small sample size (for quantitative analysis) of the present study as compared to the other studies. However, in the present study, social network changes did differ significantly by the length of stay in the UK, SPPB and MNA-SF scores. The maintained integrated group had been living in the UK longer than the changed or maintained non-integrated groups. Length of stay in the UK has been previously shown to vary among migrants in the UK, with Black Caribbean people showing the longest stay in the UK as compared to other ethnicities (22). In the present study, it is likely that the increased length of stay enabled older adults to form stronger and more stable integrated networks as compared to those with shorter stays. This is supported by studies elsewhere that found longer residence in the UK was associated with more stable integrated social networks than in those with shorter stays (67, 68).

As explained by our qualitative findings, good health in terms of stronger physical function and better nutritional status was essential to maintaining a stronger social network. This evidence supports the theory of constraint of social networks, which explains that structural constraints such as a decline in physical health and other changes associated with ageing cause a decline in personal social networks. Hence, it was not surprising that participants remaining in, or transitioning to, integrated networks had significantly higher SPPB and MNA-SF scores than the participants who were in, or who transitioned to, non-integrated social networks. Nevertheless, given the limited follow-up period of 8 months, further investigations are required to confirm these factors associated with declines of social networks within this population over time.

3.4.1 The association of social networks and health outcomes

The findings of the present study indicated that the locally integrated social network was associated with increased SPPB scores when compared to the private restricted network, even

after adjusting for age, sex, IMD, self-rated health, number of diseases and education. During the qualitative interviews, participants described poor social networks at baseline to be affecting their eating behaviours and physical function. As expected and consistent with previous findings, at follow-up, participants who remained in, or transitioned into, non-integrated networks had significantly lower physical function scores as compared to those that maintained, or transitioned to, integrated social networks (69). In the adjusted model, belonging to a non-integrated social network at baseline and increased age were associated with lower physical function. Participants perceiving declines in social networks at follow-up mentioned the decline as contributing to poorer physical function and eating behaviours. These longitudinal mixed methods findings suggest that integrated social networks might be protective against physical function declines over time among community-dwelling ethnically diverse older adults. The protective effect of large social networks on physical function has also been reported in predominately white populations, with similar profile of non-communicable diseases (70).

In the UK, ethnic minorities report lower self-rated health as compared to the rest of the population (71). For instance, in the 2004 Health Survey for England (HSE), 15% of Bangladeshi men, 14% of Bangladeshi women, 10% of Pakistani men, and 15% of Pakistani women reported poor health as compared to the 6% men and 7% women in general population (71). In the present study, there were no differences in self-rated health among ethnic minorities, with approximately one-third reporting fair or poor health. However, self-related health differed by social networks. We found that social networks and changes in social networks were significantly associated with self-rated health. Older ethnic minorities belonging to the non-integrated social networks, as compared to integrated social networks, reported significantly higher proportions of poor or fair health. Similarly, participants that transitioned from an integrated social network to a non-integrated social network were more likely to report fair or

poor health as compared to the maintained integrated group. These findings are consistent with studies in indigenous populations reported elsewhere (72).

Findings from the present study are consistent with the model of 'social control' on healthy behaviours in old age (73). Participants with integrated social networks recounted the importance of their spouse and the wider relationships on their eating behaviours and physical function. The findings enlighten the direct path of 'social control' played by their spouses in either providing healthy food or healthy eating messages as described in the 'social control' model (73). Outside the family, some participants that attended community centres or other faith groups saw it as a valuable contribution to improving their eating behaviours and physical function. As previously reported (74), the activities of these centres provide at least one of the three broad components of social support: informational (the dietary advice received); emotional (providing a sense of empathy); and instrumental support (exercise classes or free medical assessment received). These findings further broaden understanding of the mechanism related to how increased social ties might impact the health of older adults. The benefits of these social groups as purported in this present study have also been reported by older Asian adults living in the United States (23). Anecdotally, it was observed that even though these centres provided this level of support, most of these centres were either closed or reduced their opening days during the study period due to budget cuts, threatening the sustainability of these support groups.

The lack of statistically significant differences in nutrient intakes between the most and least robust social network groups within this study was unexpected and in contrast to existing literature showing that more robust social networks were associated with healthier nutrient intake (75, 76). However, the two least robust social networks (local self-contained compared with private restricted) were found to be significant predictors of zinc, riboflavin and vitamin

B6 intakes. These two non-integrated networks are defined by having relatively reduced frequency of contact and the absence of local kin (36, 42). Additionally, participants in the present study reported less company during meals and minimal or no influence of family and friends during mealtimes. One possible explanation for this unexpected finding could be the higher intake of nutrient supplements reported among older adults in the local self-contained social network (61%) as compared to the private restricted social network (16.7%).

Intakes of sodium, potassium, folate and %TE from saturated fat differed significantly by changes in social network groups at follow-up. Older adults who remained in, or transitioned to, the integrated network had significantly higher intakes of these nutrients (except sodium). Despite the consumption of potassium and folate being below the UK RNI, these older adults within the integrated networks could have been influenced by the 'informational support' at their regular community meetings and even at home as evidenced by the qualitative findings. Even though awareness does not necessarily translate into behaviour change, it is possible that older adults attending these meetings that offer dietary advice and many times provide meals benefit from this attendance, which could contribute to the difference in nutrient intakes observed. Given the relatively small sample size (in relation to the quantitative analyses) and limited follow-up time of eight months, these findings should be viewed with caution, and we recommend that future studies should be designed with a longer follow-up period to carefully examine these findings.

3.5 Strengths and limitations of the study

The study was conducted in an under-represented research population which is a significant strength. Additionally, the longitudinal mixed methods element made it possible to explore the changes in social networks, the participants' perspectives of their social networks, and the influence of these changes of social networks on physical function and nutritional status. The

sample size, although relatively small from a quantitative perspective, was large for a qualitative study. Compared to previous studies using subjective measure of physical function, the inclusion of objectively measured physical function (SPPB and handgrip test) provided a more accurate representation of the relationship between social networks and physical function in the present study. However, this study had limitations. Firstly, by design, the eight months duration of follow-up was relatively short. This length of time was chosen due to the practicality of the data collection within the timeframe of the project. Secondly, although the study employed a maximum variation sampling technique to ensure a wider representation of the sample, it was difficult to recruit South Asian women, particularly women of Bangladeshi origin. Thirdly, this study shares a common limitation encountered within many studies exploring dietary intake, which is the inherent limitations of self-reported nutrient intake. Even though measures were put in place to enhance accurate self-recalls, it is still possible that some participants under-reported or over-reported their nutrient intakes. Lastly, as most of the recruitment was done through social gatherings, this made it difficult to recruit highly socially isolated participants. This could have accounted for the high representation of integrated social networks. It is recommended that future studies employ various recruitment approaches that can enhance the recruitment of more isolated participants across diverse populations of older ethnic minorities.

3.6 Conclusion

This longitudinal mixed methods study produced unique findings regarding the changes in social networks among community-dwelling ethnic minority older adults over eight months. Even though the direction of change was not always towards the non-integrated social networks as expected, the majority moved from integrated to non-integrated social networks. Overall, the findings indicated that integrated social networks at baseline were protective against declines

in physical function at follow-up and were associated with better self-rated health. These findings further demonstrate the important role of stronger social networks in healthy ageing, and the need to develop community-based interventions to support older ethnic minorities embedded in restricted social networks to age more healthfully. Given the benefits of social support derived from attending community groups found in this study, improving the access of these centres and providing long-term financial support from interested organisations and public funding sources could improve the sustainability of these ethnic and religious centres. This could, in turn, support the maintenance of integrated social networks among community-dwelling older adults. Additionally, the findings of this study could be used to tailor community interventions to make them more culturally sensitive to support community-dwelling older adults to age more healthily. Future studies with an extended follow-up within this population are recommended to further elucidate the temporality and quality of changes in social networks and their relationship with dietary intake and physical function in this population.

3.7 References

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CHAPTER 4:

THE ASSOCIATION BETWEEN NUTRIENT INTAKE, NUTRITIONAL STATUS AND PHYSICAL FUNCTION OF COMMUNITY-DWELLING ETHNICALLY DIVERSE OLDER ADULTS: A LONGITUDINAL STUDY

This paper forms part of the second study of this PhD research and is currently under review for publication with the journal *BMC Nutrition* as **Asamane E.A**, Greig C.A, Thompson, J.L. The association between nutrient intake, nutritional status and physical function: A longitudinal study.

The chapter seeks to address the following research questions:

1. What is the dietary intake, nutritional status and physical function of community-dwelling older adults over time?
2. Is there a relationship between physical function, nutritional status and nutrient intake among community-dwelling ethnically diverse older adults?

4.1 Abstract

There is limited longitudinal data regarding nutrient intake, nutritional status and physical function in community-dwelling ethnically diverse older adults. This study explored these variables and their relationship at baseline (n=100) and 8-months' follow-up (n=81) among community-dwelling ethnically diverse older adults (≥60 years) in Birmingham, United Kingdom. Multiple pass 24-hour dietary recalls and the Mini Nutritional Assessment-Short Form assessed nutritional intake and status, respectively. Short Physical Performance Battery (SPPB) and handgrip strength measured physical function. Linear and multinomial regressions were used to predict relationships between physical function, nutritional status and nutrient intake. Mean (SD) age was 70 (8.1) years (60% male), with 62% being obese. Significant decreases in intakes of vitamin B6 (0.88-0.77mg/day, p=0.014); vitamin B1 (0.73-0.63mg/day, p=0.029); iron (6.16-5.85mg/d, p=0.045); folate (113.23-106.66µg/d, p=0.043); and magnesium (154.54-144.59mg/d, p=0.031) occurred over time. At both time points, across sexes, daily intake of all micronutrients except vitamin B12, phosphorus and manganese were below the Recommended Nutrient Intakes (RNI). SPPB scores (Z=-4.01, p<0.001) and nutritional status (Z=-2.37,p=0.018) significantly declined over time. At baseline, younger age, better nutritional status, and higher vitamin D and fibre intakes were associated with higher SPPB scores. At follow-up, higher SPPB scores (OR=0.61 95% CI 0.40, 0.94) were associated with a slower decline in nutritional status. The observed declines in nutritional status and physical function, and the inadequate nutrient intakes in the absence of weight loss within an 8-month period pose serious challenges to healthy ageing, identifying an urgent need to re-evaluate and tailor appropriate dietary advice for this population.

4.2 Introduction

The world population is increasing and ageing rapidly, with developed countries having the highest proportion of ageing populations compared to developing countries[1]. In the United Kingdom (UK), there was a total of 11.2 million people aged 65+ years, representing 18% of the population in 2016 [2]. It is projected that by 2030, one in five people will be aged 65+ years, comprising 21.8% of the population [3]. Furthermore, the UK population is becoming increasingly ethnically diverse, with ethnic minorities significantly ageing alongside the white population[4]. According to the findings from the 2011 Office for National Statistics (ONS), it is projected that by 2051, there will be 3.8 million BME people aged 65+ years and 2.8 million BME aged 70+ years [4]. The ageing and increasing ethnic diversity of the UK population has implications not only to the quality of life of the individual but significantly impacts on health and social care systems, the economy and the lives of family members [2, 5, 6].

Furthermore, many BMEs are often faced with lower socio-economic status and disproportionate health inequalities, which accounts for the differences in health outcomes among ethnic minorities and the white European population [7-9]. For instance, as evident in the findings of the Health Survey England (HSE), the prevalence of obesity among Black African women is 38% (risk ratio 2.0), and 32.1% among Black Caribbean women (risk ratio 1.43) compared to 23% in the general white British population of women [10]. While recognising these differences in health outcomes, dietary habits of BMEs have been shown to become unhealthy mainly due to financial constraints, language barriers, age, availability of traditional foods, and years spent in the host country [11-13]. A study in the UK found that older BME women with a mean age of 70.5 years had inadequate intakes of vitamin D, selenium, magnesium and potassium, and attributed reasons such as age, reduced physical activity and dietary restrictions to be influencing dietary intake [11]. Considering the ultimate

role of diet as a modifiable factor in obesity and related chronic diseases, and the limited literature regarding it, it is essential to study the trends in nutrient intake particularly in this population with a relatively high prevalence of obesity and diet-related chronic diseases [10]. Most studies exploring nutrient intakes in ethnic minorities have focused only on south Asian population, single ethnic groups, or mainly one sex limiting a clearer understanding of the differences shared within and between ethnic minorities [11, 14, 15]. The present study is an initial step towards increasing knowledge on the heterogeneity and gender differences in nutrient intakes over time among ethnic minority older adults living in the super-diverse communities.

Besides nutrition, the promotion and maintenance of good physical function are crucial in improving quality of life, nutrient intake and reducing institutionalisation, hospitalisation and mortality among older adults [16-18]. Ethnic minority groups and older adults living in lower socio-economic environments often have a lower physical function as compared to the general population [19, 20]. Despite this, few studies have explored the risk factors, specifically the impact of nutrient intake and nutritional status on the maintenance of physical function in this population. Published findings from non-ethnic minority community-dwelling older adults have shown that good nutrition can improve and maintain higher physical function such as keeping up with activities of daily living and preventing falls [21, 22]. For instance, a study of 689 community-dwelling older adults with a mean age of 75.7 years, found that an increased dietary diversity was closely associated with better scores activities of daily living, lower depression scores and increased quality of life [21]. Considering these and the relatively higher risk of physical function limitations within this population, it has become more pertinent to explore the profile of nutrition and physical function, and their association over time among community-dwelling, ethnically diverse older adults.

The few studies that have examined these variables within this population are usually cross-sectional, with many employing a subjective measure of physical function and providing limited information on dietary intake and nutritional status. Additionally, the cross-sectional nature of these studies also hinders a deeper understanding of the impact of the time element on the relationships between diet, nutritional status, and objectively measured physical function. The present study aimed to: 1) provide a clearer understanding of the profile of nutrient intake, nutritional status and objectively measured physical function over time; and 2) explore how nutrient intake and nutritional status are associated with physical function over time in this population.

4.3 Methods

4.3.1 Study Design and Setting

An observational longitudinal quantitative approach was used to examine nutrition and physical function over eight months. The study was conducted in the Birmingham area, West Midlands, UK. In this geographical location, ethnic minorities (non-white) comprise 46.9% of the population, with the largest group being South Asians (comprising 22.5% of the total population), and it is projected that ethnic minorities will become the majority of the population by 2021 [23, 24].

4.3.2 Participants and Recruitment

The sample included community-dwelling, ethnically diverse older adults aged 60 years and older, and self-identifying as Pakistani, Indian, Bangladeshi, Caribbean and/or African. In addition to these, other inclusion criteria encompassed residing in the Birmingham area, non-institutionalised and with no known diagnosis of dementia or any mental illness that will impair participation. A convenience sample of 100 participants were recruited through community centres, age-well societies, faith/religious centres and other informal social events by word of

mouth. The rationale was to recruit a more representative sample, thus maximum variation technique was introduced after recruiting 60 participants [25].

4.3.3 Measures

There were four different contact points for data collection, two completed within 14 days at baseline and repeated in the same format after eight months of follow-up. Socio-demographic data including date of birth, sex, marital status, educational status, faith, ethnicity, and years residing in the UK were collected using a bespoke questionnaire, at baseline and at follow-up. The Index of Multiple Deprivation (IMD) was computed as an indicator of deprivation using the participant's postcode [26]. Weight was measured to the nearest 0.1kg and height to the nearest 0.1 cm, using a Seca 899 digital scale and Seca 213 portable stadiometer, respectively. Body Mass Index (BMI) was calculated using the standard equation; weight (kg)/height^2 (m^2). Waist circumference (WC) was measured and recorded to the nearest 0.01cm using a flexible retractable non-elastic tape.

4.3.4 Dietary Assessment

Dietary intake was assessed using the multiple-pass 24-hour recall, following standard procedures [27]. EAA, a trained nutritionist with relevant expertise in conducting dietary assessments, conducted all assessments with regular data checks from JLT, a Professor of Public Health Nutrition and Exercise, with extensive experience in dietary assessments in diverse populations. A culturally-appropriate food portion booklet containing ethnic minority foods, accompanied by standard household food measures, were used to estimate portion sizes [28]. In total, four 24-hour recalls were collected, two non-consecutive days each at baseline and follow-up. In instances where participants had fasted within the previous 24 hours, the record was discarded, and a new day assigned to retake the record (n=17). All 24-hour recall interviews were digitally recorded to enhance the quality of the data during data entry. Detailed

recipes were gathered for home-cooked meals, and brand names and cooking methods were recorded during interviews. In addition, nutrient supplement usage was collected during dietary assessments. After each visit, the multiple-pass 24-hour recall data were checked for accuracy using the interviews before entering these data for processing into a dietary software analysis package, Dietplan 7.0 (Forestfield Software Ltd, Horsham, West Sussex, UK). Dietplan 7 was appropriate as it utilises UK-specific databases such as McCance and Widdowson, as well as relevant ethnic minority food databases. In instances that a food item could not be found in the software databases, these were added to the database using food manufacturing websites and other food composition tables. Nutrient data obtained from the analysis were compared with the age and sex-specific UK Dietary Reference Values (DRV) [29].

4.3.5 Nutritional Status

Nutritional status was assessed using the Mini-Nutritional Assessment-Short Form (MNA-SF). This is a simple to use, sensitive, reliable, and valid tool for rapid assessment of nutritional status of older adults [30]. Unlike the full MNA, the short form is more rapid (can be completed within 10 minutes) and equally reliable to the full MNA [31, 32]. Given the validity and quick administration, it was the preferred option to assess nutritional status as it reduces participant burden during data collection. Additionally, as this study was part of a larger study, MNA was the tool chosen to measure nutritional status [33]. The MNA-SF is composed of six major items and has a scoring of 0-14 points, with 0-7 classified as malnourished, 8-11 classified as at risk of malnutrition, and 12-14 classified as normal [32].

4.3.6 Physical Function

The Short Physical Performance Battery (SPPB) was used to measure participants' lower body extremity function [17, 34]. SPPB has been widely validated to measure accurate physical function and serves as a prediction of mobility, disability and mortality in older adults [16].

SPPB includes a balance test conducted in side by side, semi-tandem, and tandem positions, as well as 4-metre walk test at one's self-selected 'natural' pace, and a test of their ability to rise five times from a chair as quickly as possible. The maximum score from these three components makes up a total score of 12 on the SPPB; a score of 0 indicates the worst performance, while a score of 12 indicates the best performance.

Handgrip Strength (HGS) was also used to measure physical function. HGS was measured in kilogram (Kg) using a Jamar hand dynamometer (Sammons Preston, Inc., Bolingbrook, IL) per the NHANES protocol for measuring HGS in the standing position, with arms by the side [35]. Handle width was adjusted to hand size, and each measurement performed three times [36]. The standing position was chosen as it has been shown to produce maximal grip strength as compared to the other positions in measuring HGS [37].

4.3.7 Statistical Analysis

Nutrient density was computed by dividing the nutrient intake by the total energy intake and multiplying it by 1000kcal/day [38]. Independent T-test and chi-square test were conducted to test for differences in continuous and categorical variables, respectively, at both time points. The Wilcoxon signed-rank test was used to test for median differences in instances where the continuous variables failed to meet the assumptions for a t-test. Prior to conducting the above analyses, normality was tested using the Shapiro-Wilk test and Q-Q plots. Marital status was later regrouped as married and not married, educational status was regrouped as educated and not educated, the number of diseases grouped as number of diseases ≤ 2 and number of diseases >2, and ethnicities regrouped as South Asian (Pakistanis, Indians and Bangladeshis), African-Caribbean (Africans and Caribbean), and 'other ethnicity,' (mixed ethnicities). Given the smaller numbers in each group, these regroupings were done to satisfy the assumptions needed to run some of the analyses.

For energy and macronutrient intakes, both mean (SD) and median (IQR) were presented. Micronutrient intakes and all other variables that satisfied normally distributed characteristics were presented as mean (SD), while those that were not normally distributed were presented as median (IQR). Categorical variables were presented as number (N) and percentages. The percentage of nutrient intake of the RNI defined for that nutrient was computed to ascertain whether the participant met the recommendations [39]. One-way ANOVA and Kruskal Wallis were performed to examine any differences in nutrient intake by ethnicities and other socio-demographic characteristics.

A pairwise correlation was conducted, and the variables correlated with physical function (p <0.05), were built into a hierarchical model to test the predictors of physical function (SPPB and HGS) while controlling for variables of interest. For longitudinal analysis regarding physical function, the difference in physical function between both time points was computed and classified into the following groups: improved, declined and stable. In logistic regression, the improved/stable and declined groups were used as outcome variables to test factors predicting changes in physical function at follow-up. Regarding nutritional status, the at-risk of malnutrition and the malnourished groups were combined to form malnourished/at-risk of malnutrition group, while the normal nutritional status group was maintained as originally defined. Changes in nutritional status were 1) those who remained in the malnourished/at-risk of malnutrition; 2) those who declined from the normal to the malnourished/at-risk of malnutrition group; 3) those who improved from malnourished/at-risk of malnutrition to the normal group; and 4) those who remained in the normal group. Multinomial regression was used to predict the membership of these four nutritional status groups. A sensitivity analysis was conducted to ascertain differences in nutrient intakes with or without supplement intakes

at both time points. All statistical analyses were conducted using IBM SPSS version 25 (IBM Corp, Armonk, NY, 2012) with significance set at $p < 0.05$.

4.4 Results

Sociodemographic and other health-related data for participants at baseline and after 8 months of follow-up are presented in table 10. Data were collected for 100 participants at baseline and 81 participants at follow-up. Of the 19 of participants who did not complete the study, 5 did not continue due to sickness, 8 were no longer interested, and the remaining 6 could not be reached during follow-up. At baseline the mean (SD) age was 70.8 (8.1), with 59% male. Most of the participants were married and had a University or college degree.

Older adults that completed the study had a significantly higher SPPB (P=0.007), HGS (p=0.027) and lower WC (p=0.036) as compared to those lost to follow-up (n=19). All other variables of interest were not significantly different (See supplementary file B1).

Table 10: Socio-demographic characteristics and other health-related information at baseline and 8-months' follow-up.

Variables		**Baseline (n=100)**	**Follow-up (n=81)**
Age, years Mean (SD)		70.8 (8.1)	70.7 (8.2)
Male N (%)		59 (59.0)	50 (62.0)
Ethnicity N (%)	Pakistani	23 (23.0)	15 (18.5)
	Indian	7 (7.0)	5 (6.2)
	Bangladeshi	4 (4.0)	2 (2.5)
	Caribbean	41 (41.0)	38 (46.9)
	African	19 (19.0)	15 (18.5)
	Others	6 (6.0)	6 (7.4)
Marital status N (%)	Single	4 (4.0)	3 (3.7)
	Married	66 (66.0)	55 (67.9)
	Divorced	14 (14.0)	12 (14.8)
	Widowed	16 (16.0)	11 (13.6)
Faith/Religion N (%)	No religion	1 (1.0)	1 (1.2)
	Hindu	2 (2.0)	2 (2.5)
	Sikh	7 (7.0)	4 (5.0)
	Muslim	34 (34.0)	24 (29.6)
	Christian	56 (56.0)	50 (61.7)
Education N (%)	No education	16 (16.0)	11 (13.6)
	Primary	16 (16.0)	14 (17.3)
	Secondary	21 (21.0)	15 (18.5)
	College/University	47 (47.0)	41 (50.6)
Self-rated health N (%)	Excellent	18 (18.0)	16 (19.7)
	Good	55 (55.0)	45 (55.6)
	Fair	16 (16.0)	11 (13.6)
	Poor	11 (11.0)	9 (11.1)
No. of diseases Mean (SD)		2.0 (1.4)	2.1 (1.4)
IMD Decile N (%)	1 (Most deprived)	33 (33.0)	29 (35.8)
	2	19 (19.0)	19 (23.4)
	3	22 (22.0)	11 (13.6)
	4 (least deprived)	26 (26.0)	22 (27.2)
BMI categories* N (%)	Normal	7 (7.0)	9 (11.1)
	Overweight	31 (31.0)	21 (25.9)
	Obese	62 (62.0)	51 (63.0)
[a]Nutritional status by MNA-SF N(%)**	Malnourished	2 (2.0)	1 (1.2)
	At- risk of malnutrition	22 (22.0)	29 (35.8)
	Normal	76 (76.0)	51 (63.0)

[a]SPPB score Median (IQR) **	11.1 (4.0)	10.0 (4.0)
HGS Mean (SD)	27.6 (9.8)	26.5 (9.5)
WC Mean (SD)	100.3 (10.6)	100.8 (10.6)

SD= Standard deviation; IQR= Interquartile range; IMD= Index of Multiple Deprivation; BMI= Body Mass Index; MNA-SF= Mini-Nutritional Assessment-Short Form; HGS= Handgrip Strength; WC= Waist circumference

*WHO guidance on BMI thresholds for Asian populations (World Health Organization, 2004) was used to categorise BMI of South Asian participants, and the standard BMI categories were used for Caribbean and African participants.

** $p<0.05$

[a] Wilcoxon Rank test used to examine median differences.

4.41 Energy and nutrient intakes

The Mean (SD) and median (IQR) values for energy and nutrient intakes are reported in table 11. There was no significant difference in energy intake over time (p=0.393 for males and p=0.656 for females). In addition, the intakes for both sexes at both time points were below the estimated average requirement based on the population with low physical activity levels. There was a significant decrease in polyunsaturated fatty acids intakes for females only at 8-months' follow-up (P=0.04) (Table 11). There were statistical median decreases for the following micronutrients: vitamin B6 (0.88-0.77 mg/day, z=-2.45, p= 0.014); vitamin B1 (0.73-0.63 mg/day, z= -2.19, p= 0.029); iron (6.16-5.85 mg/day, z=-2.01, p=0.045); folate (113.23-106.66 µg/day, z=-2.01, p=0.043); and magnesium (154.54-144.59 mg/day, z=-2.16, p=0.031). All other nutrient intakes were not significantly different over time. Macronutrient intakes at both time points were compared with the UK Dietary Reference Values (DRVs). As shown in table 11, the mean percentage Total Energy (%TE) from carbohydrates at baseline and follow-up for both sexes were slightly above the DRV. However, fibre intakes at both time points for both sexes were below the DRV. At both time points, regardless of the sex, mean %TE from protein was well above the DRV. Also, the %TE from fat at both time points for females were below the DRV (31.3% and 32.3%, respectively, vs 35%). However, the %TE from fat for males at

baseline was below the DRV (34.3% vs 35%), and at follow-up was above the DRV (38.2% vs 35%).

Table 11: Energy and macronutrient intake of community-dwelling, ethnically diverse older adults at baseline and follow-up (N=81)

		Baseline		Follow-up			
Nutrient intake	**Sex**	**Mean (SD)**	**Median (IQR)**	**Mean (SD)**	**Median (IQR)**	**RNI ****	**P-values***
Energy Kcal/day	Male	1884.6 (518.2)	1853.8 (609.6)	1965.0 (686.5)	1822 (797.8)	2103.3-2366.2	0.393
	Female	1514.5 (428.3)	1358.5 (526.5)	1354.5 (498.5)	1243.5 (676.0)	1673.0-1888.1	0.065
Carbs g	Male	230.2 (61.9)	223.8 (60.9)	248.9 (72.1)	234.8 (83.0)	-	0.104
	Female	195.4 (60.9)	201.1 (95.3)	178.2 (74.0)	161.8 (84.5)		0.189
%TE Carbs	Male	50.2 (11.6)	48.2 (17.7)	53.5 (10.8)	52.7 (16.4)	50	0.101
	Female	51.8 (8.9)	50.2 (9.2)	52.1 (9.2)	52.3 (14.5)		0.883
Fibre g/day	Male	18.3 (7.3)	17.2 (10.0)	20.3 (10.8)	19.1 (10.5)	30	0.192
	Female	17.1 (7.9)	15.0 (10.7)	14.1 (7.5)	12.8 (9.5)		0.084
Protein g	Male	79.1 (25.3)	74.2 (28.7)	77.6 (34.4)	73.9 (41.5)		0.736
	Female	68.0 (23.0)	57.5 (36.6)	58.6 (23.4)	53.2 (28.2)		0.070
Protein g/kg/day	Male	1.02 (0.40)	0.94 (0.44)	0.98 (0.48)	0.90 (0.51)	1.0-1.2g/kg[40]	0.754
	Female	0.93 (0.33)	0.86 (0.50)	0.80 (0.37)	0.76 (0.38)		0.183
%TE Protein	Male	17.0 (3.9)	16.8 (5.3)	15.8 (4.2)	15.3 (3.9)	15	0.127
	Female	18.1 (4.4)	17.7 (4.8)	18.0 (5.9)	18.0 (6.7)		0.912
Fats g	Male	75.3 (40.8)	73.6 (49.2)	73.5 (44.7)	66.6 (39.5)	-	0.816
	Female	53.3 (20.2)	53.0 (33.7)	48.8 (22.4)	41.6 (29.9)		0.319
%TE Fats	Male	34.3 (10.8)	36.3 (16.5)	38.1 (37.6)	32.4 (12.8)	35	0.453
	Female	31.6 (8.6)	31.3 (14.4)	32.3 (7.0)	31.1 (10.3)		0.724
Saturated fats g	Male	24.2 (14.5)	22.2 (17.5)	28.9 (28.0)	23.6 (17.2)	-	0.203
	Female	17.5 (8.9)	16.9 (12.4)	17.2 (10.7)	14.0 (8.5)		0.885
%TE Saturated fats	Male	11.2 (4.8)	11.0 (6.7)	11.3 (4.3)	11.1 (6.0)	11	0.885
	Female	10.4 (4.6)	9.7 (4.8)	11.2 (4.2)	10.8 (6.7)		0.445

MUFA g	Male	24 (14.0)	22.8 (17.2)	24.8 (16.9)	20.6 (15.2)	-	0.742
	Female	17.6 (8.3)	17.9 (12.1)	16.1 (9.2)	14.6 (8.8)		0.385
%TE MUFA	Male	11.1 (4.6)	11.3 (6.1)	10.3 (3.8)	10.6 (6.0)	12	0.310
	Female	10.4 (3.9)	10.4 (4.8)	10.5 (36)	10.4 (3.6)		0.889
PUFA g	Male	13.9 (10.2)	10.5 (8.8)	15.4 (14.6)	10.9 (13.5)		0.460
	Female	8.9 (4.1)	9.7 (7.1)	7.2 (3.7)	6.2 (3.6)		0.040
% TE PUFA	Male	6.3 (3.4)	5.7 (3.2)	6.7 (5.9)	5.5 (5.1)		0.626
	Female	5.2 (2.0)	4.9 (3.0)	4.8 (1.7)	4.8 (2.5)		0.292

%TE= Percentage of Total Energy; RNI = reference nutrient intake SD = Standard deviation; IQR =interquartile Range; g= gram
*P values showing significant difference in nutrient intake for the two time points; ** Department of Health (1991) and Scientific Advisory Committee on Nutrition (2012).

Additionally, one-way ANOVA and Kruskal Wallis for normally and non-normal distributed data, respectively, were performed to determine the intakes of energy and macronutrients by ethnicities. The ethnicities within the study were combined to form three main ethnicities: South Asian, comprised of Pakistanis, Indians and Bangladeshis; African-Caribbean, comprised of African and Caribbean; and 'other,' comprised of mixed ethnicities. As shown in table 12, at both time points, South Asians reported significantly higher intakes of energy ($p=0.003$) and %TE PUFA ($p<0.001$). Also, South Asians reported significantly higher intakes of %TE total fat at follow-up ($p=0.048$).

Table 12: Energy and Macronutrient contribution to energy by ethnicity over time

	Baseline (n=100)				Follow-up (n=81)			
	South Asian (n= 34)	**African/Caribbean (n= 60)**	**Others (n= 6)**	**P-value**	**South Asian (n= 22)**	**African/Caribbean (n= 53)**	**Others (n= 6)**	**P-value**
Energy kcal/day	1900.5	1615.8	1873.3	0.003	1969.8	1470.0	1641.5	0.003
%TE Carbs	48.6	49.0	43.9	0.625	48.3	55.4	53.0	0.141
%TE Sugars	12.1	15.1	17.4	0.119	14.9	17.4	20.5	0.056
%TE Protein	16.4	17.7	13.8	0.013	15.3	16.4	13.8	0.444
%TE Fats	37.6	32.4	42.8	0.019	36.6	30.1	31.3	0.048
%TE Saturated fats	10.0	10.8	13.0	0.687	12.0	10.7	12.1	0.329
%TE Monounsaturated	11.1	11.3	13.4	0.385	10.8	10.4	11.3	0.768
%TE Polyunsaturated	7.2	4.9	7.0	<0.001	8.1	4.3	5.6	<0.001
Fibre intake g/day	16.0	15.0	20.6	0.256	17.2	15.9	20.3	0.285

4.4.2 Micronutrients intake over time compared with RNIs

In total, 39% (56% Female) and 35% (54% females) of the participants reported taking micronutrient supplements during baseline and follow-up assessments, respectively. The most common supplements reported included multivitamins, vitamin C, vitamin D, iron and calcium. A sensitivity analysis was conducted to ascertain differences in nutrient intakes with or without supplement intakes at both time points. At baseline for females, there were significant differences in intakes with and without supplementation in relation to vitamin D, vitamin A, vitamin E, thiamine, riboflavin, niacin, vitamin B6, vitamin B12, folate and vitamin C intakes (Supplementary file B2). For males, there were significant differences in the intakes of vitamin A, vitamin D, vitamin E, vitamin C and folate between intakes with supplementation and intakes without supplementation (Supplementary file B2). Similar to baseline, micronutrient intakes with and without supplementation for females differed in vitamin A, vitamin D, vitamin B1, vitamin E vitamin B6, vitamin B12, vitamin C and manganese intakes at follow-up (Supplementary file B3). However, there were no significant differences in intakes with and without supplementation for males at follow-up (Supplementary file B3).

The intakes with and without supplementation at both time points were compared with the UK Recommended Nutrient Intakes (RNI), and represented in figures 16 and 17 as the percentage of RNI intakes. Figure 16 shows baseline micronutrient intakes expressed as a percentage of RNI; except for intakes of vitamin B12, phosphorus and manganese for both sexes, all other micronutrient intakes were below the RNI. Females additionally met the RNI for vitamin A, vitamin E, vitamin C, thiamine and niacin. At follow-up, the pattern was similar for both males and females; except for phosphorus, manganese, vitamin C and vitamin B12, all other micronutrients were below the RNI.

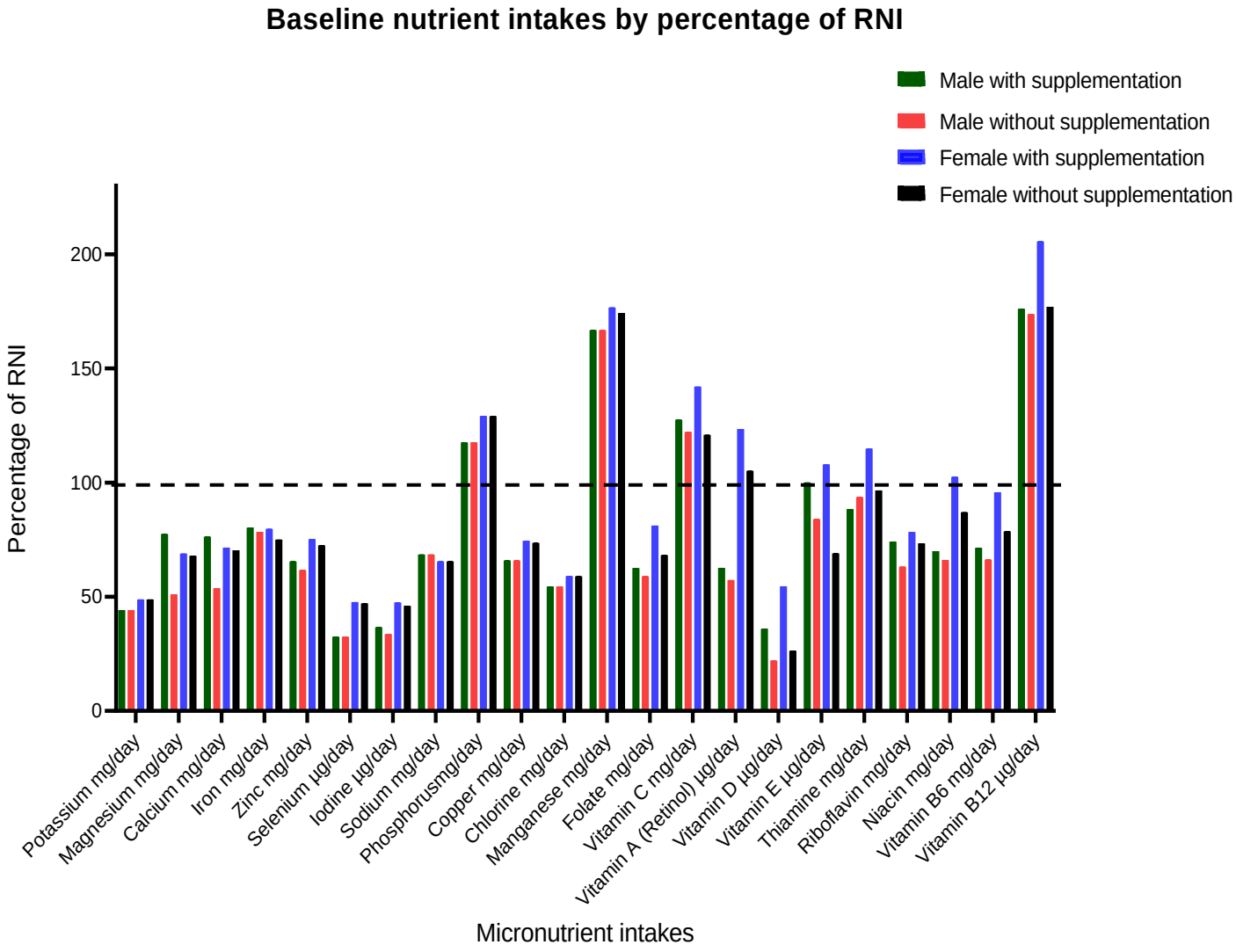


Figure 16: Percentage nutrient intakes by UK RNI with and without supplements at baseline

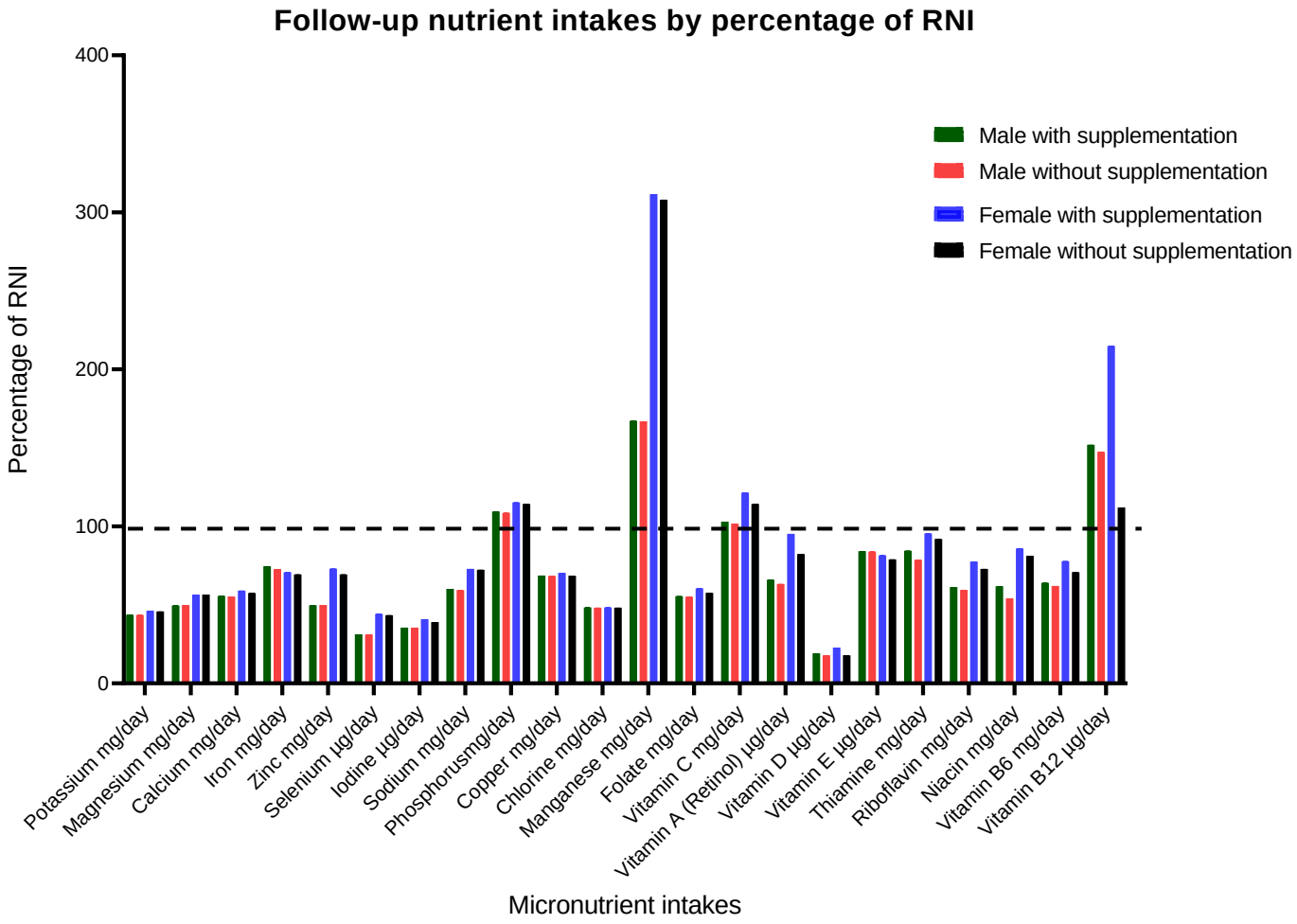


Figure 17: Percentage nutrient intakes by UK RNI with and without supplements at follow-up

4.4.3 Cross-sectional associations between nutrient intake, nutritional status and physical function at baseline

The baseline pairwise correlation found that SPPB was significantly associated with WC (r=-0.466), MNA-SF (r=0.391), BMI (r= -0.224), HGS (r =0.610), fibre (r=0.265), vitamin B6 (r= 0.303) and vitamin D (r=0.223). Nutritional status measured by MNA-SF was significantly associated with vitamin D (r=0.237) and HGS (r=0.198) (Supplementary material B4).

Using the results from the pairwise correlation, hierarchical multiple regression was conducted to determine the contribution of each independent variable to physical function performance (SPPB and HGS scores) and nutritional status. Table 13 shows the fully adjusted model for sociodemographic variables, nutritional status, WC, BMI and nutrient intakes as predictors of the SPPB and HGS. As only fibre, vitamin D and vitamin B6 were found to be correlated with SPPB and HGS, they were the only nutrients included in the multiple regression analyses. Higher SPPB scores were associated with being younger, married, a lower WC, and higher fibre and vitamin D intakes [R^2= 0.534, F (12, 87) =8.319, p<0.01]. Sociodemographic variables explained 21.6% of the variance in SPPB scores. Nutritional status explained 9.1%, WC and BMI explained 15.2%, while fibre, vitamin D and vitamin B6 explained 7.5% of the variance in SPPB scores. For HGS, increasing age was significantly associated with lower HGS scores. In addition, those living in the least deprived areas (determined by the IMD scores) and reporting higher fibre intakes had significantly higher HGS scores [R^2 = .0423, F= (12, 87) =5.317, p<0.01]. Sociodemographic variables explained 34.2% of the variance in HGS scores, while nutritional status measured by the MNA-SF explained 0.9% of the variance in HGS scores. Additionally, WC and BMI explained 1%, and fibre, vitamin D and vitamin B6 explained 6.1% of the variance in SPPB scores.

Table 13: Hierarchical multiple regression predicting Short Physical Performance Battery (SPPB) and handgrip strength scores

	SPPB				Handgrip (kg)			
Predictors	**B (95% CI)**	**SE**	**p-value**	*R^2 change*	**B (95% CI)**	**SE**	**p-value**	*R^2 change*
(Constant)	24.52 (16.40, 32.64)	4.09	<0.001		69.48 (42.33, 96.63)	13.66	<0.001	
Sociodemographic variables								
Male vs female	-0.05 (-1.11, 1.01)	0.53	0.930	0.216	-3.02 (-6.56, 0.52)	1.78	0.093	0.342
Age	-0.09 (-0.15, -0.03)	0.03	<0.001		-0.45 (-0.65, -0.25)	0.1	<0.001	
Married vs not married	-1.34 (-2.45, -0.24)	0.55	0.020		-0.53 (-1.30, 0.24)	0.39	0.177	
IMD	0.14 (-0.09, 0.37)	0.12	0.240		-1.41 (-2.66, -0.15)	0.63	0.028	
No education vs Education	-1.23 (-2.64, 0.18)	0.71	0.090		1.17 (-3.54, 5.88)	2.37	0.623	
Number of diseases	-0.26 (-0.64, 0.11)	0.19	0.170		-2.87 (-6.56, 0.82)	1.85	0.125	
Nutritional status (by MNA-SF)	0.39 (0.10, 0.67)	0.14	0.010	0.091	0.16 (-0.78, 1.10)	0.47	0.732	0.009
WC	-0.15 (-0.22, -0.09)	0.03	<0.001	0.152	-0.05 (-0.52, 0.42)	0.24	0.834	0.010
BMI	0.12 (-0.02, 0.26)	0.07	0.090		-0.06 (-0.28, 0.16)	0.11	0.579	
Nutrient intakes								
Fibre	0.08 (0.02, 0.15)	0.03	0.010	0.075	0.28 (0.07, 0.50)	0.11	0.011	0.061
Vitamin D	-0.04 (-0.12, 0.04)	0.04	0.340		-0.19 (-0.45, 0.08)	0.13	0.164	
Vitamin B6	1.33 (0.35, 2.32)	0.49	0.010		1.33 (-1.95, 4.62)	1.65	0.421	
Total R^2				0.534				0.423

Note N=100; WC= Waist Circumference; IMD= Index of Multiple Deprivation; BMI= Body Mass Index; MNA-SF= Mini-Nutritional Assessment-Short Form.

A hierarchical multiple regression was conducted to test the association of nutritional (MNA-SF) and physical function while controlling for all confounders (see Table 14). This was to determine the impact of nutrient intake and physical function (SPPB and HGS) as predictors of nutritional status. SPPB was the only predictor of nutritional status, with no other variables being significantly associated with nutritional status [R^2 = .0278, F=(14, 85)=2.334, p=0.009]. After controlling for all confounders, higher SPPB scores were associated with better nutritional status. Physical function explained 9.6% of the variance in nutritional status.

Table 14: Results from hierarchical linear regression analyses with socio-demographic, WC, BMI and physical function as predictors of nutritional status (N= 100).

Predictors	**B (95%CI)**	**SE**	**P-value**	*R^2 change*
(Constant)	8.50 (1.57, 15.44)	3.47	0.017	
Sociodemographic variables				
Male vs female	0.17 (-0.61, 0.96)	0.39	0.664	0.107
Age	0.02 (-0.03, 0.07)	0.02	0.379	
Married vs not married	-0.34 (-1.16, 0.49)	0.41	0.420	
IMD	-0.14 (-0.31, 0.03)	0.09	0.112	
No education vs Education	0.27 (-0.78, 1.33)	0.53	0.607	
Number of diseases	-0.24 (-0.52, 0.03)	0.14	0.085	
WC	-0.02 (-0.04, 0.07)	0.03	0.535	0.017
BMI	0.01 (-0.11, 0.10)	0.05	0.953	
Physical function				
SPPB	0.25 (0.08, 0.42)	0.09	0.004	0.096
HGS	-0.03 (-0.08, 0.03)	0.03	0.253	
Nutrient intakes				
Fibre	0.02 (-0.03, 0.06)	0.02	0.530	0.036
Vitamin D	-0.05 (-0.11, 0.01)	0.03	0.092	
Vitamin B6	-0.15 (-0.90, 0.59)	0.37	0.687	
Total R^2				0.256

WC= Waist Circumference; IMD= Index of Multiple Deprivation; BMI= Body Mass Index; HGS= Handgrip strength; SPPB= Short Performance Physical Battery

4.4.4 Longitudinal associations: Changes in nutritional status and physical function over time

There were significant changes in nutritional status measured using MNA-SF, and physical function using SPPB scores over time, (Z=-2.37,p=0.018) and (Z=-4.01, p<0.001) respectively (Table 10). Per the MNA-SF cut-offs, 24% were malnourished/at-risk of malnutrition, and the remaining (76%) were normal at baseline. At follow-up, 37% were malnourished/at-risk of malnutrition, and remaining (63%) were normal. In summary, the proportion of people reporting normal status reduced, while those reporting malnourished/at-risk of malnutrition increased by 13% at follow-up. The changes in nutritional status were: 1) those who remained malnourished/at-risk of malnutrition at follow-up (12.3%); 2) those who changed to malnourished/at-risk of malnutrition at follow-up (24.7%); 3) those who changed to normal at follow-up (n=8.6%); and 4) those who remained normal at follow-up (54.3%). Using the remained normal at follow up as the reference category in a multinomial regression (Table 15), the results indicate no significant predictors were determining the likelihood of remaining malnourished/at-risk of malnutrition as compared to the reference group. However, participants with a higher SPPB score (OR= 0.61) were less likely to change to being malnourished/at-risk of malnutrition. Conversely, participants with a higher BMI (OR=1.29) or WC (OR= 1.10) were more likely to change to being malnourished/at-risk of malnutrition compared to the reference group.

Table 15: Multinomial regression of factors predicting nutritional status membership at follow-up (n=81)

	Remained at Risk/Malnourished			**Changed to at-Risk/Malnourished**			**Changed to Normal**		
	B	SE	OR (95% CI)	B	SE	OR (95% CI)	B	SE	OR (95% CI)
Intercept	-0.14	11.2		1.39	7.29		-25.66	15.25	
BMI	0.19	0.2	1.21 (0.81-1.80)	0.26	0.12	1.29 (1.01-1.65)*	0.29	0.31	1.34 (0.72-2.48)
HGS	-0.08	0.1	0.92 (0.75-1.13)	-0.16	0.07	0.85 (0.74-0.98)	-0.16	0.13	0.85 (0.66-1.11)*
WC	-0.12	0.1	0.89 (0.73-1.08)	0.09	0.06	1.10 (0.97-1.24)*	0.39	0.18	1.48 (1.04-2.10)
Age	0.06	0.09	1.07 (0.90-1.27)	0.12	0.06	1.13 (1.00-1.28)	0.36	0.14	1.43 (1.09-1.87)
IMD	0.21	0.46	1.23 (0.50-3.05)	0.40	0.19	1.49 (1.03-2.16)*	1	0.38	2.71 (1.30-5.68)*
SPPB	-0.26	0.32	0.77 (0.41-1.45)	-0.49	0.22	0.61 (0.40-0.94)*	-0.85	0.45	0.43 (0.18-1.03)
Fibre	-0.28	0.15	0.75 (0.56-1.02)	-0.1	0.06	0.91 (0.81-1.02)	-0.07	0.11	0.93 (0.75-1.15)
Vitamin D	0.16	0.13	1.18 (0.92-1.51)	-0.05	0.1	0.95 (0.78-1.16)	0.12	0.18	1.13 (0.79-1.60)
Vitamin B6	1.17	1.53	3.23 (0.16-64.96)	0.05	0.78	1.05 (0.23-4.79)	0.11	1.44	1.12 (0.07-18.7)
Male	3.07	1.9	21.56 (0.52-892.87)	0.5	0.8	1.64 (0.34-7.90)	-1.53	1.86	0.22 (0.01-8.31)
Female	1			1			1		
Married	0.2	1.41	1.22 (0.08-19.22)	0.93	0.93	2.54 (0.41-15.67)	1.76	2.08	0.25 (0.10-3.43)
No married	1			1			1		
Educated	2.55	1.9	12.85 (0.31-527.7)	1.20	1.07	3.32 (0.41-26.83)	-16.41	0	0.743 (0.07-0.09)
No education	1			1			1		
Number diseases ≤2	-0.54	1.81	0.59 (0.02-20.21)	-1.28	0.93	0.28 (0.05-1.71)	-2.18	1.9	0.25 (0.03-4.69)
Number diseases >2	1			1			1		

Note Reference category: Remained Normal; OR= Odds Ratio, SE= Standard Error, 95% CI = Confidence Interval; SPPB=Short Physical Performance Battery; IMD= Index of Multiple Deprivation; BMI= Body Mass Index; R^2= 0.63 (Nagelkerke) **P value <0.01 *P value <0.05

Regarding SPPB at follow-up, 35.8% remained stable, 47% had a lower score, and 17.2% improved their score. Computed into two groups, improved/stable and decline served as outcome variables in a logistic regression performed to determine the significant predictors of changes in SPPB at follow-up. Baseline MNA-SF scores, WC, sex, age, IMD, educational status, marital status and nutrient intakes were entered as predictors. The results indicate that with an increase in age (OR= 1.105, p= 0.005) or increase in the number of diseases reported (OR= 1.63, P=0.033), participants were more likely to experience a decline in physical function than to improve or remain stable. All other variables showed no significant association with the changes in physical function (See details in supplementary file B5).

4.5 Discussion

This study provides unique and potentially useful evidence regarding the profile of nutrient intakes, nutritional status, and physical function, and their relationships over time, in a sample of ethnically diverse community-dwelling older adults. These findings are particularly relevant as they add to existing literature to broaden our understanding of the relationship between diet and components of healthy ageing within this population. Also, the findings are both timely and pertinent given the growing ethnic diversity in the UK and some parts of Europe, highlighting the need for culturally adapted interventions specifically around diet and physical function to support this group to age more healthfully [4, 41].

The intakes of energy and most nutrients remained unchanged, except decreases in the daily intakes of magnesium, folate, vitamin B1, vitamin B6 and iron. This finding concurs with a 10-year longitudinal study of 25 South Asian women (mean age of 54.2 years) in Glasgow [42]. This study used a 7-day weighed food dairy and found no significant difference in energy intake. However, the findings contrast sharply with the Melbourne Chinese Cohort Study, composed of 262 Chinese adults with a mean age >50 years [43]. The authors found that intakes

of energy, fats, fibre and protein increased significantly over eight years among women, but not men. Among men, the only significant change was a decrease in carbohydrate intake. This study utilised FFQ, which has been found to overestimate nutrient intakes in older adults [27]. This, coupled with the failure of the authors to account for an increase in nutrient supplement intakes at follow-up, could partially account for the differences between these studies. Additionally, the relatively shorter duration of follow-up in the present study as compared to the Melbourne study could also contribute. Furthermore, as previously reported in this sample, eating patterns were linked to cultural and religious purposes rather than health reasons, which could account for the stability of energy and macronutrient intakes over time [44].

In the context of the broader literature, the energy intakes observed over time in this study were comparable with those of the energy intakes of predominately white older adults in the UK aged 65+ years as reported in the National Diet and Nutrition Survey (NDNS) [45]. Also, the energy intakes of males in the present study (1853.8 kcal/day baseline and 1822 kcal/day follow-up) were comparable to energy intakes of males in the Newcastle 85+ cohort (1848 kcal/day), but those of females (1358.5 kcal/day baseline and 1243.5 kcal/day follow-up) were less than the female energy intake values reported in the Newcastle 85+ cohort (1471 kcal/day) [46]. Additionally, the %TE from carbohydrates, protein, MUFA, and PUFA in the present study were higher, while the %TE from saturated fat was lower than the Newcastle 85+ cohort [46]. It has been observed that the traditional foods of ethnic minorities, with the exception of South Asian diets, are relatively higher in %TE from carbohydrate and lower in %TE from fats (including saturated fats), as compared to western diets [47, 48]. Hence, this difference in food composition between these ethnic groups and the disparity in age between the present sample and the Newcastle 85+ cohort might be accounting for the differences in energy and macronutrient intakes observed. The relatively high total energy and %TE from fats within the

South Asian diets were also confirmed in this study, with participants identifying as South Asian having significantly higher intakes of total energy and %TE from fats as compared to those identifying as being African-Caribbean.

Another key finding from the present study is the inadequate amounts of micronutrients consumed. The intakes of these nutrients below the RNI were consistent at follow-up, suggesting a potential micronutrient deficiency in this sample. Given the importance of micronutrients for maintenance of good health, physical function and better quality of life, the low intakes are of concern, particularly when one considers the relatively high prevalence of non-communicable disease within this population [10]. The inadequate intake of various nutrients among older ethnic minorities in the present study is consistent with previous studies in the UK and elsewhere [11, 49]. However, in contrast to the present findings, the results from Years 7 and 8 (combined) of the UK NDNS Rolling Programme (a sample comprised of predominately white older adults), found that intakes of most micronutrients were at the RNI or above the RNI [45]. Variations in the level of deprivation between these two samples could be one factor accounting for these differences. It has been reported elsewhere that poverty and other forms of deprivation lead to poorer diets, and subsequently, a higher prevalence of malnutrition, in both community and hospital settings [50, 51]. Recently, the English Longitudinal Study of Ageing reported that being non-white (OR: 3.8; 95% CI 2.39–6.05) and obese (OR: 1.32; 96% CI 1.09–1.58) were associated with a higher vitamin D deficiency [52]. These findings further highlight the inequalities in nutrient intakes and the need for increasingly culturally tailored community-focussed interventions to promote adequate nutritional intake and the general health of this population.

Given the critical role of supplementation and the increased tendency of poorer nutrition in later life, nutrient supplementation is beneficial to healthy ageing [53, 54]. For instance, a meta-

analysis of randomised controlled trials concluded that supplementation of 17.5–25 µg of vitamin D daily reduces the risk of falls by 19% in older adults [54]. The vital role of nutrient supplementation observed in this study adds to the literature; supplementation significantly contributed to meeting the RNI for nutrients such as vitamin A, vitamin D, vitamin B6 and vitamin B12, thiamine, niacin and vitamin E. However, the consumption of supplementation was relatively low over time, and lower for males as compared to females. Further studies explicitly examining prolonged supplementation within this population is needed to confirm our findings. However, given the benefits of supplementation observed, this population might benefit considerably from micronutrient supplementation.

Nutritional status and physical function declined significantly over the study period. The findings showed an increase of 13% in the number of people classified as malnourished or at-risk of malnutrition over the study period. Likewise, over time, almost half (47%) experienced at least one unit decrease in SPPB scores. These declines over a relatively short period are disturbing, which highlights the need for timely community nutritional and physical function assessment and appropriate strategies to address declines. The prevalence of malnutrition or at risk of malnutrition at both time points within this present study was more than double the estimated prevalence of malnutrition in the UK. It is estimated that more than 3 million older adults suffer from malnutrition, which accounts for more than 10% of the population aged 65 years and older [55, 56]. However, as seasonality is known to impact on eating behaviours and physical function, the season in which data were collected could have affected participants' nutrient intake and subsequent nutritional status, leading to the high proportion of malnourished/at risk of malnutrition observed among this sample [44]. Despite this, the prevalence of malnutrition or at risk of malnutrition in studies outside the UK reported considerably higher percentages than the current study [57, 58]. For example, a study of 360

older adults aged 60 years and over in India found that 70% of the sample were malnourished or at risk of malnutrition [57].

The relationship between physical function and nutritional status in the present study confirms the findings of previous studies [59, 60]. A study of 457 randomly selected older Bangladeshis living in rural communities found that poorer nutritional status, increased age and co-morbidities, and being female were associated with functional limitations [58]. One possible explanation for this relationship could be the difficulty in shopping and preparing food, especially their traditional meals, due to physical limitations, which could eventually lead to inadequate dietary intake and malnutrition, which further exacerbates their physical function limitations [44, 60].

There was no significant relationship between sex and nutritional status in this present study. The role of women in society and their relative financial dependency partly accounts for the differences in nutritional status as reported by previous studies [57, 61]. However, within this study, there was no difference in education and deprivation (IMD scores) between sexes, suggesting that females may have been more comparable to males with regards to resources and access to healthier foods, and hence could afford to cook and eat diets similar to their male counterparts. Also, it could be assumed that by virtue of western economic culture and the availability of supermarkets in the Birmingham area, females had fairly equal access to food as compared to traditional customs of some cultures where men eat first, and older women tend to give their share of their food to other family members, especially their grandchildren [60].

The strengths of this study include the use of the multiple-pass 24-hour recall approach on four-non-consecutive days (including a weekend day) compared to the use of a single 24-hour recall by previous studies which fails to account for day-to-day variation, or the FFQ which has been

found to overestimate energy and nutrient intakes in older adults [11, 27, 62]. However, it is important to acknowledge the high possibility of under-reporting and recall bias in this study. Under-reporting contributes to a significant amount of error in dietary reporting and is even higher in overweight and obese populations, such as those participating in the present study [63]. Additionally, the number of days used in assessing diet in this present study was insufficient to capture some nutrients. Studies have reported a range of 3 to 9 days of 24-hour recalls to capture a true representation of energy and macronutrients, and a much wider range of 4 to 160 days of 24-hour recalls to capture a true representation of micronutrient intakes [64].

Furthermore, given the influence of seasonality and increasing age on dietary intake and nutritional status, the eight months' follow-up period within this present study may have been relatively short to assess the changes in these variables accurately. Hence, one must exercise caution in drawing any firm conclusions from these findings, as they can only provide an insight into the potential changes in dietary trends and nutritional status over time within this population. Future studies with more extended follow-up periods, which control for seasonality, are required to investigate the dietary trends and nutritional status within this population. Lastly, even though the maximum variation technique was used during sampling to ensure a more diverse sample, it was challenging to recruit South Asian females, especially females self-identifying as Bangladeshi. Thus, the findings are not generalizable to all ethnic minorities living in the UK.

4.6 Implications for policy and practice

Given the declines in nutritional status and physical function observed within a relatively short period, strategies for implementing a community-led programme around early nutritional and physical function assessments at community and faith/religious centres could help to identify

and treat malnutrition and physical function limitations before further deterioration. The co-creation of such programmes with health care professionals and community/faith leaders may be effective in increasing accessibility and acceptability of these assessments, and also ensure that consistent health messages are delivered across communities. Interventions that are co-created and run at faith centres have been shown to increase access and improve health outcomes [65, 66]. These benefits can serve as a strong incentive for community-dwelling older adults to visit these meeting places to improve their social networks, which is equally essential for a healthier ageing trajectory.

As previously reported in this same sample, fear of gaining weight and engagement in unhealthy practices to lose weight were observed [44]. The practice of fasting, skipping meals, or drastically reducing portion sizes without proper adherence to diet quality are common practices, which may have contributed to the observed low nutrient intakes in this study. While future studies are recommended to explore this in detail, health professionals could change their advice and avoid generic messages such as "you are overweight/obese, so you need to lose weight," and instead deliver more individually tailored messages to achieve weight loss using healthier practices that do not negatively impact nutritional quality of one's diet.

Lastly, given the importance of supplementation and the low supplement intakes observed in this study, this population would benefit from a free supplementation programme [67, 68]. To increase compliance, such a programme could be integrated into already existing community or faith group activities. Additionally, health professionals, specifically nutritionists and dieticians attending to older ethnic minorities, could include a mandatory dietary assessment and based on the results, prescribe free supplements if needed, in line with safer intake thresholds, to enhance acceptability and intake to improve nutrient status among this

population. This practice could be complemented with appropriately tailored dietary education to ensure that these supplements do not replace a well-balanced diet.

4.8 Conclusion

The present findings indicate that community-dwelling, ethnically diverse older adults consume most micronutrients below the UK RNI over time. In a relatively short period of follow-up, there were significant declines in nutrient intakes (folate, vitamin B1, vitamin B6, magnesium and iron), nutritional status and physical function among this population. These declines, and the observed associations between nutritional status and physical function over time highlight the need for enhanced community programmes targeting early screening of nutritional status and physical function to ensure the majority of older adults are assessed and treated accordingly. Additionally, the inclusion of dietary assessments, provision of free dietary supplements and culturally tailored dietary education by health professionals could improve nutritional intake among this population. Future studies with a longer follow-up period and larger sample size are recommended to confirm the findings of this study.

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CHAPTER 5

PERCEPTIONS AND FACTORS INFLUENCING EATING BEHAVIOURS AND PHYSICAL FUNCTION IN COMMUNITY-DWELLING ETHNICALLY DIVERSE OLDER ADULTS: A LONGITUDINAL QUALITATIVE STUDY

This paper forms part of the third study of this PhD research and is published in the journal *Nutrients* as **Asamane, E.A**.; Greig, C.A.; Aunger, J.A.; Thompson, J.L. Perceptions and Factors Influencing Eating Behaviours and Physical Function in Community-Dwelling Ethnically Diverse Older Adults: A Longitudinal Qualitative Study. *Nutrients* 2019, 11, 1224. https://doi.org/10.3390/nu11061224. This chapter is taken verbatim from the above publication in which I am the principal author.

The following were the research questions answered.

1. What are the perceptions of healthy eating and physical function among community-dwelling ethnically diverse older adults?
2. What are the factors influencing dietary behaviours and physical function within this population, and how are they related?
3. What factors do community-dwelling ethnically diverse older adults perceive to be causing changes in their eating behaviours and physical function over an 8-month period?

5.1 Abstract

Ethnic minorities have a high prevalence of non-communicable diseases relating to unhealthy lifestyle practices. Several factors have been identified as influencing unhealthy lifestyle practices among this population; however, there is little evidence about how these factors differ among a heterogeneous sample living in a super-diverse city. This study aimed to: (1) identify and compare factors influencing eating behaviours and physical function among ethnic older minorities living in Birmingham, United Kingdom; and (2) understand how these factors and their association with healthy eating and physical function changed over 8-months. An in-depth interviewing approach was used at baseline (n = 92) and after 8-months (n = 81). Interviews were transcribed verbatim and analysed using directed content analysis. Healthy eating was viewed as more important than, and unrelated to, physical function. Personal, social and cultural/environmental factors were identified as the main factors influencing eating behaviours and physical function, which differed by ethnicity, age, and sex. At 8-month interviews, more men than women reported adverse changes. The study provides unique and useful insights regarding perceived eating behaviours and physical function in a relatively large and diverse sample of older adults that can be used to design new, and adapt existing, culturally-tailored community interventions to support healthy ageing.

5.2 Introduction

The population in the United Kingdom (UK) is ageing and becoming more ethnically diverse [1]. In England and Wales, the number of ethnic minority older adults aged 50 years and over has increased from 1.3 million in 2001 to 2.4 million in 2016, and is projected to reach 7.4 million by 2051 [2]. It is also estimated that ethnic minorities will comprise one-third of the total UK population by 2050 [1,3]. However, many ethnic minority groups live in areas of higher deprivation and experience disproportionate health inequalities, predisposing them to a lower quality of life and poorer health than the white British population [4–6].

The limited published evidence examining dietary intake in this population suggests that the diets of ethnic minorities who immigrated to the UK are less healthy than when living in their country of origin, due to acculturation [7,8]. The inclusion of diets high in saturated fat and sugar such as pizza, pasties, cakes, sweets, French fries and potato chips as reported elsewhere [9] contributes to these unhealthy eating practices among ethnic minorities. Also, there is reported high prevalence of objectively measured sedentary behaviour and low levels of physical activity among community-dwelling older ethnic minorities in the UK [10–12]. For example, a recent study found that, in a sample of 76 community-dwelling older ethnic minority women with a mean age of 70.8 years, only 15% met weekly physical activity recommendations, while more than half were sedentary during waking hours [11]. Furthermore, the prevalence of low physical activity in the UK, defined as the participation in less than one 30-minute moderate/vigorous activity session a week on the average was observed to be high among ethnic minorities [6]. For instance, as compared with 32% in men and 37% women in the general population, low activity levels were found in 51% in both Bangladeshi and Pakistani men, and 68% in Bangladeshi and 52% in Pakistani women [6]. Together with the low physical activity levels, ethnic minorities have an increased prevalence of obesity as compared to the

general population; 25% of Caribbean men are obese as compared to 23% in the general population, and the risk ratio for obesity in African women, Caribbean women, and Pakistani women stands at 2.0, 1.43 and 1.48 respectively, as compared to the general population [6]. Unhealthy dietary behaviours coupled with the low physical activity levels within this population are contributors to their increased prevalence of obesity, type 2 diabetes and other non-communicable diseases as compared to the general population [7,13,14].

This has significant social and economic implications for the nation, including increases in health and social care costs, and the costs to individuals, families and communities [15]. As such, it is necessary to understand and develop specific policies and interventions that will support community-dwelling ethnic minority older adults to adopt lifestyle behaviours that support them to age more healthily. However, because there are limited published data about the factors influencing healthy lifestyle choices among community-dwelling ethnic minority older adults, it is difficult to develop and deliver effective culturally-sensitive community interventions. Evidence suggests that healthy lifestyle interventions that are culturally/ethnically tailored and that incorporate strategies to optimise healthy eating and physical activity have been shown to achieve significant improvements in lifestyle behaviours, thus contributing to a reduction of the prevalence of non-communicable diseases [16–18].

To develop culturally tailored and appropriate interventions, it is imperative to have an in-depth understanding of how the factors influencing dietary behaviours and physical function may differ and interact in this population. There is some published evidence contributing to our understanding of these factors among ethnic minority communities. For example, a study exploring eating behaviours among 36 overweight and obese South Asian men (18–64 years) found cultural factors, lack of time and motivation, and family and other social networks as

influencing eating behaviours [19]. Similarly, a study of Ghanaian immigrants aged 25 years and older in the UK found that beliefs, perceptions, accessibility and affordability of food, social networks, acculturation and cultural factors influenced eating behaviours [20]. In addition, an investigation of eating behaviours among young Turkish and Moroccan immigrants in the Netherlands found that religion, identity, hospitality and lifestyle changes were key influences [21]. These studies had samples that were, on average, young to middle-aged, and were in some cases studied as single ethnic groups, which makes it difficult to comprehensively compare and understand how these factors differ among a heterogeneous older ethnic minority population living in a super-diverse community. Furthermore, the cross-sectional nature of these studies does not provide evidence as to if and how these influences may change over time. As such, the present study is intended to fill these gaps in the literature.

The present study uses a longitudinal qualitative design to: (1) identify and compare factors influencing eating behaviours and physical function among ethnic older minorities living in Birmingham, United Kingdom; and (2) understand how these factors and their association with healthy eating and physical function changed over 8 months. In addition to building on the existing literature, the findings provide insights and novel information to aid stakeholders, policy makers and health professionals in understanding, designing and implementing effective culturally tailored interventions to support healthy ageing in community-dwelling ethnically diverse older adults.

5.3 Materials and Methods

5.3.1. Study Design and Setting

A longitudinal qualitative approach was used to gather relevant data. This design was effective in generating a rich dataset that supported an in-depth examination of lifestyle changes that

occurred in the target study sample over eight months, the factors that may account for these changes, and the perceived impact of these changes on eating behaviours and physical function [22]. The guidelines from the consolidated criteria for reporting qualitative studies were used to guide this study [23].

The research was conducted in the wider Birmingham area, West Midlands, UK. In this geographic area, ethnic minorities (non-white) comprise 46.9% of the population, with the largest being South Asians (22.6%). The population of ethnic minorities increased in this region by 12.4% from 2001 to 2011, and with the current projected population growth of 7.2% by 2026, the non-white population is expected to make up more than half of the entire population by 2021 [24,25].

5.3.2. Participants and Recruitment

One hundred participants were recruited using purposive sampling coupled with chain referrals and word of mouth. Inclusion criteria were an older adult aged 60 years or older living within the Birmingham area who self-identified as African, Indian, Pakistani, Bangladeshi or Caribbean. Participants were recruited through older age societies, community centres, faith centres and various social events for ethnically diverse older adults across the Birmingham area. Recruitment excluded older adults with a diagnosis of dementia or any cognitive disabilities that might affect their participation in the study. Individuals residing outside of the Birmingham area, institutionalised or hospitalised were also excluded. Maximum variation sampling was employed during the recruitment process to ensure wide representation across older age groups, ethnicities, sexes, religions/faiths and socio-economic groups [26–28].

Several techniques were employed to increase recruitment, obtain quality data and to increase retention in the study. The first author (EAA) established initial contact with community leaders

and potential participants before the start of the study. EAA attended church services and other faith centres' public events to establish rapport with leaders and potential participants. This enhanced trust between EAA and participants. Community leaders who met the inclusion criteria were also encouraged to take part in the study. Acting as role models, this built trust and enhanced credibility of the study [29]. This strategy was used to optimise participants' commitment and retention, which in turn enhanced data quality.

The study received full ethical approval from the University of Birmingham Science, Technology, Engineering, and Mathematics (STEM) Research Ethics Committee (ERN_17_1364). All participants provided written informed consent before data were collected.

5.3.3. Theoretical Framework

A constructivist paradigm, with a phenomenological philosophical underpinning, guided this research. As such, the researchers shared an understanding that knowledge is not comprehensively generated without the researcher and the participant [30,31]. This approach enabled the team to set aside perceived assumptions, personal experiences and other biases, to allow for a comprehensive understanding of the factors influencing eating behaviours and physical function from each participant's perspective. Furthermore, this approach enabled an in-depth exploration of the narrative of factors influencing eating behaviours and physical function, and how these factors changed over time.

Given the aim of this study, an ecological model was used to explore and conceptualise the different levels in which factors influencing eating behaviours and physical function operate [32]. This model best fits this study as it examines multiple factors at different levels influencing eating behaviours and physical function; from the personal level, the social level, the level of

the immediate environment and lastly the level of the macro environmental impacts of factors such as of policies and interventions [32]. In addition to these stages, the Bronfenbrenner's concept of chronosystem was added as the last level of the ecological model to conceptualise the changes, and interactions, of the different levels of influence over time [33] [Adapted model of the ecological model is attached as supplementary file C2].

5.3.4. Interviews

The conceptual framework coupled with the use of relevant literature was used to design the semi-structured guide for the interviews [10,12,34]. The semi-structured interview guide was divided into two main areas:

1. Eating behaviours and factors influencing eating behaviours.
2. Physical function and factors influencing physical function.

   This interview guide was iteratively revised at follow-up to include:
3. Changes in factors influencing eating behaviours and physical function over the previous eight months.

Using this interview guide, two in-depth qualitative interviews (baseline and 8-month follow-up) were conducted. The use of this approach was most appropriate as it allowed us to guide the interviews towards important areas that would yield relevant responses [35]. Additionally, to enhance adequate participation and trust of participants during the interviewing process, the responsive interviewing technique was adopted [36]. This technique is flexible and builds a relationship of trust, leading to a give and take style of conversation. Trained translators were employed in instances where the participant had limited ability to communicate in English (n = 19). Interviews were conducted from March 2017 to February 2019 at locations of preference

for participants including their home, community centres, or at the University. All interviews were digitally recorded and lasted from 25–110 minutes.

5.3.5. Data Analysis

Interviews were transcribed verbatim during the data collection process. This allowed for the reorganisation of some parts of the interview guide to explore in-depth areas of interest [37]. After transcription, the transcripts were uploaded to QSR NVivo 12 Plus software [38] for reorganising and coding. Data analysis was conducted using directed content analysis [39,40] due to its flexibility of use and its ability to explore a detailed analysis of factors influencing eating behaviours and physical function within this population. Moreover, the use of this approach is well-suited for studies in which there is pre-existing research on the phenomenon being tested [40].

The directed content analysis approach involved preparation, organization and reporting phases. The preparation phase involved full immersion into the data, where transcripts and field notes were read and reviewed to understand the pattern of the data. During the organisation phase, two categorisation matrices were developed: one regarding factors influencing eating behaviours and the other regarding factors influencing physical function. A complete matrix developed on eating behaviours is shown in Figure 18. The complete matrix on physical function is shown in Supplementary file C1. These coding matrices were initially developed deductively using insights from a conceptual framework [32] and existing relevant literature [10–12,20,41]. Using an iterative process, these matrices (mainly the generic category and sub-category) were further restructured inductively based on the emerging findings (data-driven) [39].

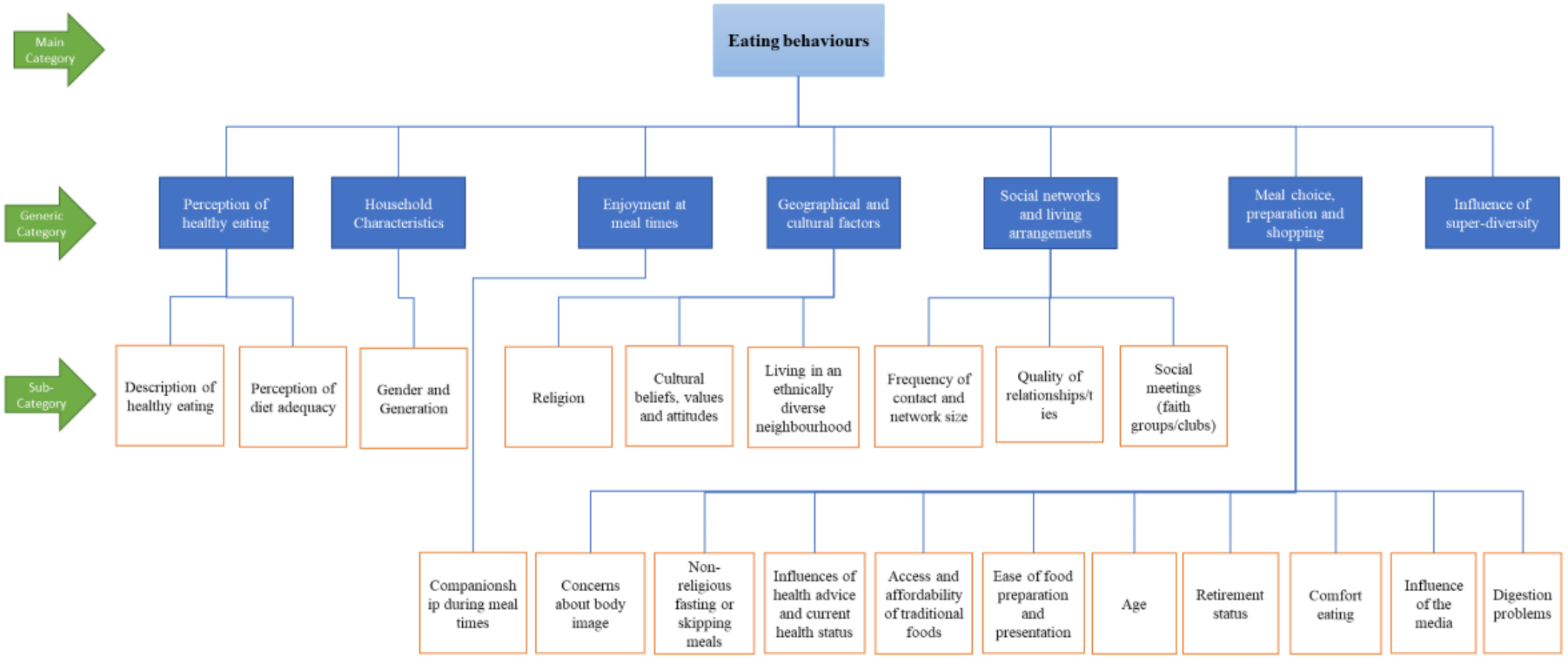


Figure 18: Complete coding matrix on eating behaviours.

To ensure rigour, trustworthiness and the ease of use of the matrices, two researchers (JAA and JLT) independently pre-tested the matrices using preliminary data [39]. Afterwards, all discussions around the difficulty of use of the matrices, interpretations of the categories and the data coded were resolved by consensus, and the matrices further restructured. Following this step, the remaining transcripts were coded by EAA using the updated categorisation matrices. During the final step, or the reporting phase of the analysis process, all findings were systematically presented, showing the association between the various categories and sub-categories of the matrices. Field notes taken during data collection were used to support the interpretation of the data. The data were subjected to additional analysis. The use of universalising and differentiating comparative analysis approaches made it possible to understand the similarities and differences between responses by socio-demographic characteristics and any variable of interest in each category [42]. This enabled us to build a logical conclusion of data and to interpret the data more clearly.

5.4. Results

Table 16 presents the demographic profile of the respondents. Out of the 100 participants recruited, 92 participants were interviewed at baseline and 81 at follow-up. Participant loss to follow-up was due to sickness (n =4); loss of interest (n = 2); and unable to trace participant to schedule the follow-up interview (n = 5). At baseline, the mean age (SD) of participants was 70.1 (8.1) with 24% living alone. The majority of the sample comprised of Caribbean and Africans (60%), followed by South Asians (34%) and the smallest proportion were participants identifying as ‘others’: a mixture of the two major ethnic minority groups (6%). Over half of the sample had completed at least secondary school education (58%), while participants with no formal education made up 15.2% of the sample.

The findings that emerged from the data are presented in detail under the categories below:

1. The differing perceptions of healthy eating and physical function.
2. The personal, social and cultural/environmental factors influencing eating behaviours and physical function and how these factors differ among the sample.
3. Perceived changes to eating behaviours and physical function over the 8-month follow-up period.

Table 16: Socio-demographic characteristics of participants completing interviews at baseline and 8-month follow-up

Variable		**Baseline**			**Follow-Up**		
Sex		Male	Female	Total	Male	Female	Total
N (%)		57 (57.0)	35 (35.0)	92 (100)	50 (62.0)	32 (38.0)	81 (100)
Age mean (SD)		71(7.0)	70 (9.0)	70.6 (8.1)	70 (8.0)	71 (9.0)	70.7 (8.2)
Ethnicity N (%)	Caribbean	14 (24.6)	25 (71.4)	39 (42.4)	13 (26.0)	25 (80.6)	38 (46.9)
	Pakistani	17 (29.8)	3 (8.6)	20 (22)	14 (28.0)	1 (3.2)	15 (18.5)
	African	11 (19.3)	6 (17.1)	17 (18.5)	11 (22.0)	4 (12.9)	15 (18.5)
	Bangladeshi	4 (7.0)	0 (0.0)	4 (4.3)	2 (4.0)	0 (0.0)	2 (2.5)
	Indian	5 (8.8)	1 (2.9)	6 (6.5)	4 (8.0)	1 (3.2)	5 (6.2)
	Others[#]	6 (10.5)	0 (0.0)	6 (6.5)	6 (12.0)	0 (0.0)	6 (7.4)
Marital status N (%)	Married	46 (80.7)	16 (45.7)	62 (67.4)	40 (80.0)	15 (48.4)	55 (67.9)
	Widowed	6 (10.5)	8 (22.9)	14 (15.2)	4 (8.0)	7 (22.6)	11 (13.6)
	Divorced	4 (7.0)	8 (22.9)	12 (13.0)	5 (10.0)	7 (22.6)	12 (14.8)
	Single	1 (1.8)	3 (8.6)	4 (4.3)	1 (2.0)	2 (6.5)	3 (3.7)
Faith/Religion N (%)	Christian	23 (40.4)	30 (85.7)	53 (57.6)	22 (44.0)	28 (90.3)	50 (61.7)
	Muslim	29 (50.9)	1 (2.9)	30 (32.6)	24 (48.0)	0 (0.0)	24 (29.6)
	Sikh	3 (5.3)	3 (8.6)	6 (6.5)	2 (4.0)	2 (6.5)	4 (4.9)
	Hindu	2 (3.5)	0 (0.0)	2 (2.2)	2 (4.0)	0 (0.0)	2 (2.5)
	No religion	0 (0.0)	1 (2.9)	1 (1.1)	0 (0.0)	1 (3.2)	1 (1.2)
Education N (%)	College/University	28 (49.1)	17 (48.6)	45 (48.9)	26 (52.0)	15 (48.4)	41 (50.6)
	Secondary School	10 (17.5)	8 (22.9)	18 (19.6)	8 (16.0)	7 (22.6)	15 (18.5)
	Primary School	9 (15.8)	6 (17.1)	15 (16.3)	9 (18.0)	5 (16.1)	14 (17.3)
	No education	10 (17.5)	4 (11.4)	14 (15.2)	7 (14.0)	4 (12.9)	11 (13.6)
BMI categories N (%)	Normal	4 (7.0)	2 (5.7)	6 (6.5)	6 (12.0)	3 (9.7)	9 (11.1)
	Overweight	22 (38.6)	7 (20.0)	29 (34.5)	13 (26.0)	8 (25.8)	21 (25.9)

	Obese	31 (54.4)	26 (74.3)	57 (62.0)	31 (62.0)	20 (64.5)	51 (63.0)
IMD Quartile * N (%)	1 (Most deprived)	20 (35.1)	12 (34.3)	32 (34.8)	18 (36.0)	11 (35.5)	29 (35.8)
	2	13 (22.8)	6 (17.1)	19 (20.7)	13 (26.0)	6 (19.4)	19 (23.5)
	3	11 (19.3)	6 (17.1)	17 (18.5)	6 (12.0)	5 (16.1)	11 (13.6)
	4 (least deprived)	13 (22.8)	11 (31.4)	24 (26.1)	13 (26.0)	9 (29.0)	22 (27.2)
Self-rated health N (%)	Excellent	9 (15.8)	9 (25.7)	18 (19.6)	8 (16.0)	8 (25.8)	16 (19.8)
	Good	35 (61.4)	17 (48.6)	52 (56.5)	31 (62.0)	14 (45.2)	45 (55.6)
	Fair	7 (12.3)	6 (17.1)	13 (14.1)	5 (10.0)	6 (19.4)	11 (13.6)
	Poor	6 (10.5)	3 (8.6)	9 (9.8)	6 (12.6)	3 (9.7)	9 (11.1)
Length of stay in the UK mean (SD) (years)		41.9 (16.2)	43.8 (14.9)	42.71 (15.9)	41.5 (16.7)	45.9 (15.5)	43.2 (16.4)

BMI = Body Mass Index; IMD = Index of Multiple Deprivation; SD = Standard Deviation

[#]Other ethnicity referring to East African Asians or Mixed ethnic minority group such as a Caribbean Asian

* WHO guidance on BMI thresholds for Asian populations (World Health Organization 2004) was used for categorizing BMI of South Asian participants and standard BMI categories were used for Caribbean and African participants.

5.4.1. The Differing Perceptions of Healthy Eating and Physical Function

5.4.1.1. Healthy Eating

Perceptions of healthy eating differed by sex, ethnicity, the presence of disease condition(s), religion or age. Among women, less than half (43%) perceived healthy eating as cutting down fat, limiting portion sizes, and healthy cooking methods such as reducing the amount of salt and oil during cooking or opting for steaming and baking as opposed to frying. Similarly, a third of men (34%) shared all these views except perceptions around cooking methods. Across both sexes, home cooked meals were commonly considered to be healthier compared with eating out.

"I think for me, less fat in your diet and I'm thinking about my health as well. Less fat, things that are not fried and smothered in fat when cooking, and a little bit more homemade because then you know exactly what's going into them is better" (P51, 62 years, Caribbean, Female).

Among participants with diabetes, one-fifth (20%) reported healthy eating as cutting down on amounts of food eaten, skipping snacks and avoiding sugary or fatty fats to manage their health condition. Some (12%) also reported fruits as foods representing healthy eating, as they were told by their health professionals to have enough fruits daily to manage their blood sugar.

"... I don't eat…between meals, which is good. So, when I get it, at the right time, I eat and eat everything at a go to help me with my sugar level, to control my sugar" (P30, 60 years, African, Male).

Religious teachings, mainly among Muslim participants, were reported as guiding their perceptions of healthy eating. This was reported by more than half (51%) of the Muslim participants.

"Healthy eating means if you have hunger that much [demonstrating using his hand], you eat only that much [demonstrating using his hand 3/4] and leave that much hunger there [demonstrating using his hand 1/4]. And this is what Islam teaches. They say have a glass of water with [your] meal…No, I don't want it, because Islam says you don't eat with water, is not healthy eating" (P48, 69 years, Pakistani, Male).

Across both sexes, traditional foods were mostly considered as healthy foods and tasty as compared to other foods. However, their views appear to differ by ethnicities. For instance, Indian/Pakistani/Bangladeshi male participants with a University/College degree described their traditional foods as being 'fatty', 'greasy' and "tasty with too much sugar". In contrast, Caribbean and African participants, across all levels of educational status, perceived their traditional foods as healthier and lower in fat:

"…I don't think it's very healthy, the traditional Indian diet has got too much sugar in it, too much oil, they fry a lot, it all makes it not healthy" (P50, 80 years, Indian, Male).

"That is the pivotal point in the West Indies food. I see it as healthy. It keeps you healthy and even though you might not [be] feeling well like you have the flu or you have the pain and everything, with our food, you are never sick too big to go to the hospital" (P19, 81 years, Caribbean, Female).

Additionally, the satiation properties of food emerged among Pakistani/Indian women as an important factor in considering food as healthy. As one participant described, not feeling hungry even after hours of not eating was considered as being healthy for her. Hence, she considers the traditional foods that could satiate her for longer hours as healthy foods.

"That [traditional foods] is healthy eating…. It's more filling. So, [I] think it's healthy to eat that, as opposed to feeling hungrier" (P88, 73 years, Pakistani, Female).

5.4.1.2. Physical Function

Physical function was largely perceived as participation in exercise and general fitness level. It was also labelled as 'strength,' which participants viewed as the ability to carry out activities of daily living without difficulty.

"Physical function means how active you are. How active, how you can be independent. How you can do things on your own. In terms of flexibility, how you can [be] flexible with your body movement, and all of that" (P37, 63 years, African, Male).

The study also explored the description of older adults' physical function levels compared with their colleagues. Of the majority (53%) that commented on this, two-thirds rated themselves as having a high physical function (at least eight on a 10-point scale). The remaining participants reported low self-rated physical function and attributed it to increasing age, ill-health and pains as illustrated in the quote below.

"I'm maybe below average, I'm not good, but I'm not very poor too, I think with the few aches and pains now I will say I am about three out of 10" (P39, 70 years, Indian, Male).

Like healthy eating, the concept of improving physical function to manage health conditions also emerged.

"If you want to keep mobile you have to keep your fitness [physical function], I tell you everything is about my blood sugar, it [fitness] does affect your blood sugar and stuff like that" (P63, 67 years, Caribbean, Female).

5.4.1.3. Priority and Association between Healthy Eating and Physical Function

Across educational status, most men (67%) considered healthy eating to be more important than maintaining physical function. This was attributed mainly to the fact that due to age-related

decline in physical function, they believed nothing could be done about improving their physical function levels, hence there was no need to prioritise it above healthy eating.

"To eat well is more important, with my age there is no running round about. I don't bother with the fitness [physical function] now because with my age, but when my daughter cooks me good food, I can still eat well" (P52, 92 years, Caribbean, Male).

In contrast, a few (12%) women thought otherwise and explained that with changes in physical activity level, they prioritised their physical function over healthy eating, as they believed this would help them to maintain their activity level and a healthy weight.

"I think exercise is more important these days because you're not doing any physical work, because one time you used to eat and do physical work and that used to drain you out" (P45, 70 years, Caribbean, Female).

The perceived association between healthy eating and physical function was mixed, in that some participants (34%) believed that they were independent of each other and had no relationship, while a small number of participants (6%) described a relationship between these two factors, stating that healthy eating supports them to maintain a good level of physical function and vice-versa. More women self-identifying as Caribbean or African expressed the latter view as compared to men or women from other ethnic minority groups, as illustrated by the quotes below:

"I think eating well helps your physical function, but sometimes eating well, you still have to do something with the physical function. No point in eating well and just sitting around, you have to do both. They both complement each other" (P75, 62 years, Caribbean, Female).

"Between the physical function and eating? There's no connection between them, just when you're tired you eat, I don't see any link" (P61, 76 years, Bangladeshi, Male).

5.4.2. Factors Influencing Eating Behaviours and Physical Function

Personal, social, and cultural/environmental influences on eating behaviours and physical function were reported. Participants' responses suggested that these influences differed across ethnicity, sex and socio-economic status. Figure 19 illustrates the main categories and the sub-categories of those identified.

5.4.2.1. Personal Influences

Participants highlighted several personal factors influencing their eating behaviours and physical function. As shown in Figure 19, these included current health conditions, pain, body image, age, and retirement status.

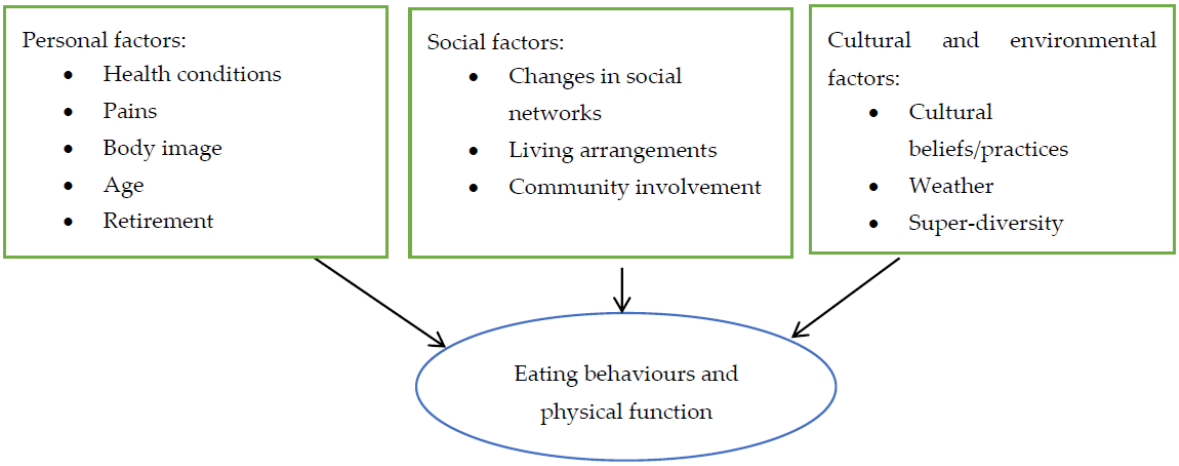


Figure 19: Influences on eating behaviours and physical function among community-dwelling ethnically diverse older adults.

5.4.2.1.1. Health Conditions

Some participants (24%) reported making changes to their eating behaviours such as changing diet, eating patterns or cooking methods to manage their current health conditions. Others (6%) also reported improving their physical function through walking and gardening to manage their current health conditions. These responses differed by sex and disease severity. For instance,

13% of men reported the influence of health on their diet, stating they avoided sugary snacks and reduced portion sizes. In contrast, women (11% of the total sample) reported changing their cooking methods, substituting their regular (or staple) foods with healthier options, and reducing portion sizes.

"… since I was diagnosed [with] this type 2 diabetes, I watch what I eat in between meals. So, I don't take anything sugary…I don't eat between meals. So, when I get it [food], at the right time, I eat and eat everything at a go to help me" (P37, 63 years, African, Male).

"…. No, I don't cook with salt, and I don't fry again, my cooking has changed, and I don't eat our [traditional] food sometimes…Well, your blood pressure, isn't it? I'm on blood pressure tablets, so I need to change. I am also diabetic too, I have to change [my diet] now" (P72, 68 years, Caribbean, Female).

The fear of losing independence and other consequences accompanying complications from diabetes and other diet-related non-communicable diseases emerged as motivating factors for some (12% of the sample) to eat healthily and maintain their physical function. As one participant explained:

"Because I have type 2 diabetes and I've seen, [people] actually suffering. I don't suffer with it, but because I have seen what it can do and has done to members of my family, and I'm not prepared to go there, that's my impetus, that's my motivation, that's my drive. To eat healthily, take a lot of regular physical activity to keep the complications at bay" (P67, 63 years, Caribbean, Male).

5.4.2.1.2. Pain

Pain resulting from health conditions was mostly described by participants to be inhibiting them from doing activities to maintain their physical function.

"Also, like I've got a bit of a dodgy left knee mainly from my arthritis. Sometimes that hinders me from doing a lot of walking… because of my knee pain, so I just stay put" (P65, 70 years, Caribbean, Female).

Pain was also reported to be affecting cooking and shopping, as most could not either stand to cook or go about their regular shopping. A man living alone describes how pain from his knee injury is inhibiting him from preparing traditional meals as they require much attention during cooking, so he has resorted to consuming simple, ready-to-eat meals.

"I am not able to have that food [traditional food] as I will like [to]. Now I just have these easy ones (ready-to-eat meals) as you can see.... buying it myself, it takes time to cook, it takes time to prepare curry goat [traditional Caribbean soup], and with my bad knees, I would not be able to stand for it" (P58, 65 years, Caribbean, Male).

5.4.2.1.3. Body Image

Body image also emerged as a factor influencing eating behaviours and physical function. More women (23%) reported this as compared to males (8%), describing a healthy and 'desirable' weight as a means to good health and a way to manage their health conditions. These were reported to influence their portion sizes, types of foods eaten and enjoyment at mealtimes.

"I don't eat as much cheese as I used to, I used to love cheese, I used to love crackers, and I very rarely eat that. I mean, you see, another thing, it's not just eating to sustain me, I'm trying to keep my weight down as well, so there's that sort of consideration as well" (P65, 70 years, Caribbean, Female).

Maintaining a healthy body weight was also described by some (10%) women participants as a motivator to keep up their physical activities, thus helping them to maintain physical function.

"If you walk, your joints are fine; you keep the weight, so you keep your body and your muscles healthy, your physical function will not fall" (P74, 85 years, Caribbean, Female).

Interestingly, of the majority (93%) that reported having a diet-related non-communicable disease(s), very few (8%) reported making efforts to improve their physical function or commented on the importance of maintaining a healthy weight. However, the few that stated making efforts to lose weight shared similar difficulties in achieving their weight loss goals.

5.4.2.1.4. Age

A third of the participants reported the influence of age on eating behaviours and physical function. Those that recognized a decrease in appetite and decline in physical function attributed it to age.. This participant explains how he is becoming more health conscious with age, hence the need to make certain adjustments for better health.

"I think we are getting more health conscious, put it this way. As we get older, nowadays me and my wife, both think before we eat. In other words, restrict, eat smaller portions" (P14, 60 years, African, Male).

More men living alone than women commonly expressed age-related declines in senses such as taste to be affecting their food intake. As narrated by a man living alone, loss of taste makes eating difficult and less enjoyable.

"I realise after spending a full day to cook food [to feed me] for three days, I eat the first day, and there's no taste left…so it become[s] difficult to eat" (P14, 60 years, African, Male).

5.4.2.1.5. Retirement

Retirement was commonly identified as contributing to changes in lifestyle, in that participants had more time for cooking, shopping or doing physical activities. Some (28%) participants

stated this had substantially changed their eating behaviours as compared to when they were working:

"I didn't have much time to watch what I was eating [while working], and I used just to grab things and go because I was all [the] time working, I probably wouldn't have bothered with green stuff like spinach, I only used to have spinach occasionally. I have it more often now" (P28, 82 years, Caribbean, Female).

In contrast, a few (5%) of recently retired participants thought otherwise. They described the increased 'free' time to be causing them to eat more and resulted in them gaining weight as compared to when they were working:

"Probably my style has changed because I've retired. When I used to work, I was going to work with a cup of tea and one toast, and I would run away to work. Now I'm a bit relaxed, so I have a good breakfast, a good lunch and a good dinner and that has put on my weight. I've got all the time to eat" (P14, 60 years, African, Male).

Regarding physical function, only a few (15%) retired participants, predominantly women, reported that with the increased amount of time available as compared to their working days, they have time to spend doing activities that could improve their physical function.

"Yeah, I was sitting from the car to the office, sit down [through] meetings…I think I've lost a bit of weight and fitter since I left work. I bought a bike and now [with] my friend who is retired as well, we'd be out, probably get out in the park" (P68, 62 years, Caribbean, Female).

"Yeah, you know, when you go to work, especially Monday to Friday, and then you sit in the car, it limits your physical function a bit because you aren't able to exercise your body, but

now that I am home that is not an excuse. I have more time and I walk around" (P30, 61 years, African, Male).

Contrary to this, four women and a man complained of lack of time after retirement, as they have to either care for their grandchildren or have an abundance of social commitments relating to their faith/religion and other social groups. Among participants still in active work, a few (22%) across both sexes reported their work schedules as a hindrance to undertaking activities that might improve their physical function.

"It [is] either to do with working too late….and then after I've worked, I'm so tired, and after I've eaten, then it's too late to get on the cross trainer or do walking…all I can do is just eat and watch TV" (P75, 62 years, Caribbean, Female).

5.4.2.2. Social Network Influences

Social network influences included those of family, friends, and the community. Almost all participants described how mealtimes were more enjoyable when the family size was large. Participants indicated that reduced network size as they have aged, made it challenging to cook often or to cook a variety of foods, due to greater likelihood of food waste.

"I don't cook a lot ever since I am on my own, it has changed ever since my youngest daughter left home to go to the university. Sometimes, I will prepare food and when I am supposed to eat, and I don't want it anymore… Because being on your own I am not looking forward, I am not thinking about food…on my own, I will say 'why will I bother?'. So, I will go for a fruit or anything and end up freezing the food…" (P3, 61 years, African, Female).

"I wouldn't say my eating habits have improved, since the children all left I don't cook that again, when the children were at home, we used to have a lot of eating times, now it has

reduced.....because the excuse is, there's more to eat when I cook and I don't wanna waste it" (P24, 61 years, Caribbean, Female).

However, Sunday dinners were described as a special day of the week where children and other family members would visit. Some (30%) said they enjoyed eating and might eat more on these days, as there is a variety of foods available. In contrast, others (6%, all women) reported that the presence or lack of social interactions at meals had no effect on their eating behaviours.

"I tend to put in more effort in what I do and what I cook while if I am on own, I don't do that much. Yeah, I might just cook something simple but when they come [children] I make it more special...I have more to eat when we are all seated" (P19, 81 years, Caribbean, Female).

"I don't really mind. It's nice to eat with people, but I'm quite content to eat on my own as well. It's not an issue whether people are there or not, I eat [the] same" (P75, 62 years, Caribbean, Female).

It also emerged that a few (17%) men preferred the act of commensality, and attributed its importance to the fact that their spouses and children supported them to eat healthily, especially when eating together during the meal:

"Yeah, eating with them (family) impacts on my eating, it does, because you can see my wife, she's not a very big eater, and she's very conscious of what kind of foods she puts in her body whereas sometimes I'm not conscious. Eating with her I tend to eat healthier, I do, yeah" (P60, 61 years, Caribbean, Male).

Some participants living alone reported that they had regular support with shopping and cooking from their children or friends. They further explained that with a decline in physical function, this was necessary as they could not shop or prepare their meals.

"She [daughter] does the cooking and [brings] it over to me...I do breakfast myself. But the cooking I can't stand that long to do it…my daughter does the shopping once a month for me" (P29, 80 years, Caribbean, Female).

Regarding physical function, a few (11%) participants expressed the support and encouragement received from family and friends as having a positive impact on their physical function. Instrumental support, such as taking them to the gym, paying for personal trainers, buying gym equipment, or providing them with information on how to improve their physical function was highlighted as beneficial. Also, participants that attended community/age-well society meetings considered this engagement as beneficial to maintaining their physical function. At these meetings, some of the activities included leisure activities, board games and occasionally exercise and nutrition classes.

"…So, when I joined here, it has help[ed] me [to] socialise, and the group exercise is keeping me active, my [physical] function is improving" (P15, 75 years, Pakistani, Male).

5.4.2.3. Cultural and Environmental Factors

Across all ethnicities and age groups, the influence of various cultural (traditional) food practices such as eating certain types of food and the food preparation were commonly expressed by participants. Participants referred to these as their "identity", "heritage" or "culture" that were important in bringing back memories and providing a sense of comfort and 'proximity' to their home country.

"I will have to eat Caribbean foods, [it] makes you feel good, and makes you feel as if you are home, [and] that's part of you. Potatoes are not part of me, chapattis are not part of me. So, I've got this [Caribbean foods] as part of me…. Sometimes when you eat it, it brings back

memories of certain things, so that's why I do enjoy it when I cook it. I'll cook it to remember a lot of things" (P83, 71 years, Caribbean, Female).

It emerged that some participants did not like the format and content of some health education messages relating to their traditional foods. While messages around reducing portion sizes were regarded as feasible, messages involving the removal of their traditional food were heavily criticised. For instance, eight participants (six males and two females) described dietary advice that meant they should stop eating their traditional food completely as not realistic or feasible:

"A dietician once told a black woman from the Caribbean to cut out her Caribbean food altogether. You never tell a white person to cut out their potatoes. To deny someone their culture and heritage will not work for me…food is what makes a person what they are…." (P67, 63 years, Caribbean, Male).

The influence of the multi-cultural and super-diverse environment of Birmingham on access and affordability of food was also raised by participants. In general, participants highlighted the diversity in Birmingham as having an important role in ensuring accessibility to, and affordability of, some of their traditional foods which was not the case in cities/areas with less diversity. Besides accessibility and affordability, diversity was also reported as helping them to feel comfortable when buying their traditional foods, as one participant recounted:

"It [diversity] has made myself very comfortable, I feel comfortable because I know they are other people also having the same sort of food. At the market, I see people buying food like me. It makes me feel happy and [at] one with the place" (P6, 62 years, African, Male).

"In Birmingham, you can get anything you want as far as African food is concerned. You can get anything you want here. I think it has made us eat well as we can get yam, gari [flour grains from cassava] or anything at any time" (P97, 72 years, African, Male).

As revealed above, participants considered themselves to be eating 'healthily' because they can access the foods they prefer and value. Also, it was revealed that the diversity in the Birmingham area had encouraged the major grocery chains to sell some traditional foods, thus making it more accessible. Probing further, it emerged that most women, living in the most deprived neighbourhoods per the UK Index of Multiple Deprivation (IMD) scale, described the prices of traditional foods in these supermarkets as slightly more expensive compared with those sold in their local corner shops or the budget market located in the city centre.

"Because of the diversity, you can now shop for traditional foods at the Asian shops, at Tesco, at Lidl, at Asda, but it's a bit dear as compared to the market at Bullring [budget market in the city centre]" (P63, 67 years, Caribbean, Female).

Predominately, more African and Caribbean participants describe their traditional foods as expensive as compared to South Asian participants. These responses were common among both sexes and across the IMD quartiles. However, the influence of traditional food prices on food choices was mixed among this sub-population. While a few (11%) reported that it had no effect, more participants (32%) thought otherwise. As shown in the contrasting quotes below:

"Well, another thing again… provided it's good for you; I never think it's too expensive. I never question that. It doesn't matter…. If I've seen it, want it, I'll buy it" (P96, 76 years, African, Male).

"I don't eat much of the Caribbean [food], we eat more rice and the other stuff because the Caribbean food is very expensive. Rice is cheaper as compared to green bananas, yams, and sweet potatoes…. Yes, I do enjoy these more, but we just have to manage with that rice, because of the prices" (P20, 86 years, Male, Caribbean).

Exploring the importance of diversity further, a few (6%) of the African and Caribbean women reported that the multicultural nature of Birmingham provides them with a platform to share healthy practices across ethnicities. For instance, they reported sharing best practices with friends and church members on healthy ingredients and other efficient ways to manage and control chronic diseases with food.

"Very multicultural…. because especially with the Sikh community, because they tell me about what things are good. My friend, she'll tell you how to use these powders. So, I think the multicultural [environment], you pick up and share different ideas" (P68, 60 years, Caribbean, Female).

Finally, some (32%) participants highlighted the effect of bad weather, notably increased snow and rain, as making it unsafe and demotivating to participate in usual outdoor activities such as walking or gardening. In general, the cold weather was reported as the main cause of an increase in joint pain, making it more difficult to engage in physical activities.

"The only thing that would prevent me from going out is the weather. If the day is a normal day, I'll visit a friend. Doing something to the car or something like that, keeping fit…but if it's raining or snowing, my knees start to hurt, I just stay in bed" (P66, 73 years, Caribbean, Male).

Besides the influence of the weather on maintaining physical function, it also emerged that with the cold weather, eating patterns are disrupted as narrated by one participant, as she prefers vegetables in the summer as compared to the winter:

"Like with my vegetables, in winter I really don't like to eat vegetables, I don't know why. In the summer I will eat any amount of vegetables, but when it comes to winter, my mind just blocks vegetables out. I don't know why" (P72, 68 years, Caribbean, Female).

5.4.3. Perceived Changes at Follow-Up

At the 8-month follow-up, one-third of the participants reported significant changes in their eating behaviours and physical function. The rest of the participants reported little or no changes. Those reporting significant changes described recent sickness and hospitalisation, falls/accidents, fasting, and changes in the level of support as factors influencing their eating behaviours and physical function. The impact of these changes was mixed, while some (42%) described the changes as positive, that is supporting them to either eat well or improve their physical function, the majority (58%) considered these changes as negative, thus affecting their physical function or eating behaviours. Predominantly, more men reported adverse changes compared with women.

"Well, it [eating behaviours] has changed quite a lot, to be honest. Because as I said, I used to have a wife…my wife used to cook, but now I have to do all that myself and it is not easy. I don't think I am eating that well" (P58, 65 years, Caribbean, Male).

Most men who reported these negative changes were living in the most deprived neighbourhoods as per the UK IMD scores. However, this was not the same trend with most women reporting positive changes, who lived in areas of lower deprivation. There were also differences in responses by age among the men reporting changes. Men who were older than

70 years expressed more negative changes as compared to those aged less than 70 years. However, this trend of responses again did not apply to women, as their responses to experiencing changes were evenly distributed across the age range. Participants who engaged in health education opportunities during the study described these as accounting for their experiencing positive changes over the 8 months. A woman reporting a positive change, explained how her recent visit to a clinic-based health education session during the study period led her to make healthy dietary changes.

"To be fair, I have cut out sugar. That's one of the things I've done since I saw you, I did go down from one [teaspoon of sugar] to half. Now, I can drink things. Well, I went to the hospital and the nurse said a group of us who are pre-diabetic, that it will help…." (P68, 60 years, Caribbean, Female).

The introduction of fasting (both religious and non-religious) was also an important change discussed by participants, especially those reporting sicknesses during the follow-up period. As described by one participant, introducing fasting was perceived as an effective way to lose weight and regain fitness:

"I'm putting on the weight, because of the drugs or because I was in the hospital or whatever the reason might be. So, now I decided to start fasting. If I'm fasting, I feel lighter with my weight and more energy" (P80, 84 years, Indian, Male).

Consistent with the baseline responses, changes in weather were repeated as influencing physical function. Participants interviewed during the summer months at follow-up expressed this as an enabling factor to maintaining their physical function and to getting out of the house, engaging in activities, visiting community clubs and religious groups. In contrast, participants

interviewed during the winter perceived it as a barrier to maintaining their physical function as they opted to stay in bed at most times.

"The weather, I will say yes. You see, like, when the weather [is] hot and nice [like] now, it makes you want to come out of the house, and find different things to do but when you [researcher] came in the winter, I was always in bed, you don't want to go out, no, there is no motivation to do anything" (P72, 68 years, Caribbean, Female).

5.5. Discussion

This study found diverse perceptions of healthy eating and physical function among ethnic minority older adults that were in some cases shaped by socio-demographic characteristics. The findings revealed that eating behaviours and physical function were influenced by a wide range of factors, from personal, social to environmental factors. At follow-up, more men reported negative changes to eating behaviours and physical function. The key findings are summarized and discussed as follows.

5.5.1. Perceptions of Healthy Eating and Physical Function

Perceptions of healthy eating differed by sex, ethnicity, age and educational attainment. Common perceptions of healthy eating were a reduction in portion sizes, cutting out fat and not skipping meals. In addition to these, women perceived healthy eating to be related to cooking methods. Some of these findings are consistent with previous studies conducted among ethnic minorities and the white English population [43–45]. However, the comparison of perceptions by socio-demographic characteristics within a large sample of ethnic minority groups makes the findings of this study unique.

One of the significant findings is that South Asian women considered healthy eating to be eating more satiating foods. In previous research, South Asian participants preferred traditional foods

for their satiating properties, however, they added that these were not healthy [8]. The study also found that participants with a medical condition and having recently attended a relevant health education session were likely to report making changes to their diets or improving their physical function. Similar to the Hertfordshire study, older white British participants commented on diets during their upbringing and the effort made to change later in life due to health reasons, citing the influence of the media [46]. The reliance on the media was different in the current study. Participants in this study relied mainly on health care providers for information. This could be attributed to the relatively lower literacy rates among ethnic minorities [47], or alternatively, to the fact that most media sources might not have culturally-tailored messages targeting these populations.

Differing perceptions about traditional foods were present between ethnicities. Those self-identifying as Indian or Pakistani perceived their foods to be generally unhealthy, whereas African and Caribbean older adults viewed it otherwise. These findings are in contrast to a comparative study of African and Caribbean women in the USA, in which African women were more likely to consider their diets as unhealthy and hence made changes to foods and cooking methods [48]. Consistent with this study, Caribbean women valued their traditional foods and cooking practices and believed it kept them healthy [48]. The perception of Indian and Pakistani older adults of the healthiness of their traditional foods within this study also resonates with the findings of a study looking at perceptions of British-Pakistani older adults living in Bradford, which found that they considered their traditional foods, among other things, to be heavy and unhealthy [8]. Furthermore, African and Caribbean older adults in the present study also considered their traditional foods expensive compared with their South Asian counterparts, and therefore had to make uncomfortable dietary adjustments in some instances. This might have

implications for the enjoyment of meals and diet quality and should be investigated further in future studies.

Most participants rated their physical function highly and perceived that physical function was related to health/fitness, exercise, and the ability to carry out activities of daily living. The present study found that participants' self-rated health was in most cases opposite to self-rated physical function. Previous research reported that the social and economic disadvantages experienced over the life course partly accounts for low-self reported health [49], and that low self-rated health was associated with limitations in activities of daily living [50]. In the present study, participants commonly expressed a fear of losing independence, which could have influenced the discrepancy between self-rated physical function and self-rated health. Some recounted stories of family or friends losing their independence and having a poor quality of life; this fear of loss of independence may have been a reason for the high self-rated physical function, and a possible motivator to maintain physical function as explained in the extended Health Belief Model (HBM) [51].

5.5.2. Factors Influencing Eating Behaviours and Physical Function

The present study found that at the personal level, health conditions, pain, age and retirement were factors influencing eating behaviours and physical function. At the social level, changes in social support, living arrangement and community involvement were identified as key factors. At the cultural or environmental level, superdiversity, the cultural identity of food, and the weather were identified. These factors also differed by socio-demographic characteristics of participants and were in some instances consistent with previous studies [19–21,34,46,52,53]. However, there were some unique differences compared with the existing literature. For example, at the physical environment level, the influence of super-diversity was

quite novel. Super-diversity refers to the unprecedented collection of different nationalities, faiths, languages, cultures and ethnicities in a society [54]. This study found that participants living in super-diverse communities not only appreciated the accessibility and affordability of traditional foods, but also, they described it as providing them with a comfortable environment to eat and shop. This is in contrast to previous studies, where white British older adults expressed shopping difficulties, such as access to supermarkets and being able to purchase single portion foods [46,55]. Possibly, the influx of ethnic minority corner shops and supermarkets due to the diversity of the geographic area might account for the differences found between the present study and previously published research. Our findings also contrast with those reported in a study from the Netherlands, in which young immigrants had difficulty in reconciling lifestyle from their country of origin and the host country [21]. The increased length of time that the older participants had lived in the UK may account for these differences.

Furthermore, the diverse environment was reported as enabling minority ethnic older adults to share cultural practices. The multicultural nature of these communities was serving as a basket of knowledge for them to share culinary skills and recipes for combating diseases. Thus, it highlights more evidence of heterogeneity among ethnic minority communities. The differences shared among and within these groups could be used in tailoring community-based interventions to give the desired results as proven effective in previous interventions [16,18].

At the personal level, most of the findings were consistent with previous literature [41,56,57]. However, the comparative analysis of these factors revealed new insights. For example, not all participants in this study saw retirement as impacting eating habits positively, as data from white British older adults has previously found [46]. Some participants saw retirement as negatively affecting their eating behaviours and physical function, as they either had more time

to ‘overeat’ or not get out of the house more to improve on their physical activities. In some cases, increased religious and family commitments after retirement also affected eating behaviours and physical function.

At the social level, the act of commensality was described as supporting older adults not only to eat better but to enjoy meals more, and this is comparable with previous literature including white British older adults [55,58]. Our data suggest that eating together might also be enhancing the variety of meals, as participants reported eating more varied diets when with company. This concurs with a study of factors influencing varied diets in community-dwelling older adults in Europe [56]. Furthermore, the dietary advice and support received from family and friends during meal times were also considered vital. This could contribute to diet quality as observed in previous studies [46,56], but more investigation is needed in this population to confirm this supposition. In addition to the family’s support in eating better, our data suggest that family support also played a role in keeping some participants active through encouragement, buying exercise equipment and buying gym memberships. This was different from other studies in which family members were overprotective and in some cases prevented older adults from engaging in physical activities due to fears for their safety and health [57]. One possible explanation for this difference could be attributed to the fact that family and friends within this study were reported to be physically active and interested in healthy eating, which may not have been the case in previous studies.

The regular meetings of ethnic minority older adults at faith centres, clubs and community centres were also reported as significant influences on eating behaviours and physical function. These meeting places were expressed as an avenue to worship, exchange ideas, offer support for colleagues during difficult times and engage in leisure activities with friends. Also, a few

of these gatherings offered meals, exercise classes or nutrition talks; these could form part of the 'active ingredients' of how social networks influence health outcomes in later life. These findings concur with previous research which found that increased social networks and greater involvement in leisure activities did not only improve diet quality in older adults but also enhanced resilience to cope with lifestyle changes [58,59].

Given that not all older adults experience the same level of changes in eating behaviours and physical function as they age, this study provided novel findings with regards to perceived changes with time and how these differed within this sample of ethnically diverse older adults. Our results indicated that a third of the participants experienced changes within a rapidly short period. Some of the changes during follow-up were the introduction of fasting (with the primary goal of weight loss), changes in the level of support, sickness, accidents/falls and changes in the weather. Men living in higher areas of deprivation were more likely to experience negative changes perceived to be affecting their diet and physical function as compared to women. Previous literature supports these findings as they suggest that men, especially those with poor cooking skills, are likely to have negative changes to diet after losing their spouse, as most meals were previously prepared by their spouse [60,61].

Considering that most participants in this study had one or more diet-related non-communicable disease, it was surprising to note that at follow-up only a few participants reported making a positive change to improve their health condition(s). This is contrary to previous findings, where a majority attributed changing their diet due to their health conditions [52,62]. One possible explanation for these differences could be the maintenance of eating behaviours for reasons beyond health concerns among this population. The cultural identity of food appeared

to be more of a primary reason for eating habits than health, as participants purported a variety of benefits of eating their traditional foods.

Perceived negative changes that affected both men and women were the change of weather. Staying at home during these months may not only affect their physical function, but also makes it difficult for participants to engage in other community activities, thus the likelihood of experiencing declines in social ties. This is a commonly-reported issue affecting the ability of adults to engage in regular physical activity across the lifespan [12,63].

5.5.3. Perceived Priority and Association of Healthy Eating and Physical Function

Our study revealed that community-dwelling ethnically diverse older adults are more likely to consider healthy eating and physical function to be separate entities with no relationship. Furthermore, participants commonly prioritised healthy eating over physical function for general health. While more men prioritised healthy eating over physical function, some women prioritised physical function, mostly for weight management reasons. However, more women than men, especially from African/Caribbean backgrounds, viewed healthy eating and physical function as related. This has implications for how they are likely to understand and adopt healthy lifestyle practices based on the already existing generic health education messages. Considering that this population is more sedentary, with some possibly having poorer dietary habits due to acculturation [7,10,11], this justifies the need to build awareness of the interrelation of healthy eating behaviours and physical function. This could serve as a primary factor in increasing knowledge and informing strategies to assist these older adults in making the adoption of healthy lifestyle practices more feasible.

5.6. Implications for Policy and Practice

Given the importance of the cultural significance of eating patterns, culturally tailored educational messages about healthy eating using traditional foods as practical examples could be designed by health care providers to ensure proper adherence to dietary advice. Additionally, considering the differing perceptions and influences on eating behaviours and physical function, community health interventions and health messages, when delivered, should consider these heterogeneities between and within ethnicities to avoid broad generalizations and stereotyping, and to celebrate and harness this diversity to develop and deliver programs that can achieve the desired results.

Some participants were conscious of their health as they aged and ready to choose healthy lifestyle options. Hence, resources highlighting the nutrient content of traditional foods, such as the Ismaili nutritional data on traditional foods [64], could be made readily available. This tool could also be used to equip health care providers to deliver quality dietary advice per the UK recommendations, and could inform the development and dissemination of an ethnic minority version of the Eat-Well plate [65]. Additionally, healthy traditional cooking classes could be more evidence-informed in their design and content, and delivered at social, religious and community centres to support older adults in adopting healthier cooking methods. The addition of these activities to these accessible and ethnicity-specific meeting places would encourage attendance with the potential of improving social networks and reducing the impact of loneliness on eating behaviours and physical function found in this study.

Following health education, participants who reported they had been identified as having pre-diabetes made significant efforts at follow-up to change their diet; thus, increased early screening and dietary advice would be beneficial in this population. Also, given that some of

the meeting places for ethnic older minorities are willing to support these activities, health authorities could better deliver assessments and health education at these centres to ensure increased access and acceptability.

5.7. Strengths and Limitations

The inclusion of an under-represented population is a major strength of this study [66]. Moreover, the sample size of the present study was relatively large for a qualitative study, which benefited the comparative analysis of ethnicities, sex and other socio-economic characteristics. The study also benefited from a rigorous data analysis process that enhanced the reliability and trustworthiness of the findings. Two experienced researchers independently coded a sub-sample of interview transcripts using the developed categorisation matrices. This could have reduced bias and misinterpretation of data [67]. The longitudinal qualitative design also adds strength to the study.

Additionally, the diverse experiences of the research team were an advantage. JLT and CAG are both senior female researchers with vast experience of working with older adults and ethnically diverse communities. EAA is a doctoral researcher with expertise in qualitative research in diverse populations. As a male researcher, he was able to recruit more men than previous studies. However, we must recognise the potential limitations in how we interpret the data due to the younger age, gender, and different ethnic backgrounds of the research team.

Likewise, the use of interpreters for 19 interviews could have introduced translation bias. We felt it was essential to utilise trained interpreters to allow for the inclusion of participants with low English literacy to ensure the sample was more representative of the current level of literacy in Birmingham [24]. Recognising the potential of compromising validity and reliability of the study due to the use interpreters, we adopted the following strategies to improve the quality of

the data [68,69]: (1) interpreters were carefully interviewed and selected, and were trained to ensure they fully understood the interview process and their defined roles; and (2) a second interpreter who understood the respective language of the participant reviewed and evaluated the recording of the first interview conducted with the trained interpreter before any further interviews were conducted. This enabled us to revise the interview guide and work with the interpreter to improve the quality of the translation. These strategies should have contributed to enhancing the reliability and validity of the data. Additionally, eight months of follow-up maybe considered a relatively short period of time to observe particularly environmental changes, hence the authors recommend future studies incorporating a longer follow-up period. Lastly, despite efforts to recruit similar numbers of older adults across the major ethnic minority groups living in the Birmingham area, the sample underrepresents older adults of Bangladeshi origin and South Asian women. Hence, the findings should be interpreted with caution.

5.8. Conclusions

This longitudinal qualitative study found diverse perceptions of healthy eating and physical function among ethnically diverse older adults. Traditional foods were highly regarded as healthy foods by African and Caribbean older adults. The presence of super-diversity was reported as positively influencing accessibility and affordability of traditional foods. Also, diversity supported them to feel comfortable and encouraged to shop, eat and engage with other cultures. More men than women perceived healthy eating and physical function to be unrelated, and prioritised healthy eating over physical function. At follow-up visits, more men than women reported adverse changes such as changes in the level of support (decline in social networks), sickness and accidents/falls. These changes were perceived to negatively affect eating behaviours and physical function.

5.9 References

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CHAPTER 6

GENERAL DISCUSSION

The purpose of this PhD research was to explore profiles of SN, nutrition, and physical function, and changes in these variables among community-dwelling ethnically diverse older adults at baseline and after 8-months. The research also explored the key factors influencing eating behaviours and physical function and the extent to which these change over an 8-month period in this population. As such, a longitudinal mixed-method approach was used, with data collection structured into two visits each at baseline and follow-up. The findings are novel and particularly useful given the unique study design and the inclusion of both genders of ethnic minority older adults from the major ethnic minority groups living in an ethnically diverse city, Birmingham, UK. This final chapter discusses the unique and important contribution of this research to the literature. It also explores the strengths and limitations of this PhD research and concludes by discussing the implications and recommendations for research, policy and practice.

6.1 Summary of Key Findings (Chapters 3-5)

As the first longitudinal mixed-methods study to explore the profile of, and changes in, SN, nutrition and physical function in ethnic minority older adults, the findings present new insights into the profile and dynamics of SN, nutrition and physical function within eight months. Most participants experiencing changes transitioned from an integrated SN to non-integrated SN (63%), and more importantly, these changes occurred over a relatively short period. Participants were cognizant of the influence of these changes, and those who remained in, or transitioned to, non-integrated SN had relatively higher declines in physical function and poorer nutrient intakes. Specifically, intakes of most micronutrients across the sample over time were lower

than the UK RNI, suggesting a prolonged nutrient deficiency in this population. Similarly, there were significant declines in nutritional status and physical function, identifying those with higher physical function at baseline having a reduced rate of decline in nutritional status at follow-up. Furthermore, this PhD research found that most participants considered healthy eating and physical function as separate entities with no relationship, and considered super-diversity as vital in aiding the accessibility and affordability, and the feeling of comfort when eating and shopping for their traditional foods.

6.2 Reflection of main findings and their contribution to the literature

The following sections provide a deeper reflection on the main findings of this PhD and their significant contribution to literature.

6.2.1 Ethnic and Sex Differences in a Super-Diverse City

In the context of the heterogeneity shared between and within ethnic minority groups, there is evidence that good knowledge of gender and ethnic differences in factors influencing health among ethnic minorities and the subsequent integration of these differences into health interventions is vital in ensuring the success of public health interventions (Liu et al., 2015). Despite this, the existing studies in ethnic minorities have often focussed on one specific ethnic group (mostly South Asian or Caribbean populations) or simply just on a specific sex group (Castaneda-Gameros et al., 2018a; Earland et al., 2010; Emadian, England, & Thompson, 2017; Garcia & Da, 2011). For example, Earland and colleagues (2017) explored the nutrient status and health outcomes of a single ethnic group, African-Caribbean aged 19-65 years in the UK. Additionally, a recent study exploring dietary acculturation and factors affecting eating patterns was conducted in a single ethnic group, Ghanaian immigrants aged 25 years and older (Osei-Kwasi *et al.*, 2017). It is also found that even though some studies included multi-ethnic samples, the findings were not powered sufficiently to highlight the differences or similarities

shared by ethnicities (Castaneda-Gameros et al., 2018a; Terragni *et al.*, 2014). For instance, a study exploring the early phase of migration on food acculturation of 21 African and Middle Eastern women aged 30-69 found collectively that the early phase of migration was characterised by the fear of eating certain unknown foods, thus restricting to familiar or safe foods. These previous studies have limited our understanding of how the factors influencing eating behaviours and physical function contrast between and within ethnic minority groups, especially when living together in a super-diverse city. In addressing this literature gap, this PhD research recruited a much larger multi-ethnic sample (n=100), allowing the findings to be contrasted clearly between ethnicities. The findings of ethnic differences in nutrient intake in chapter 4 (study 2), were supported by the distinct perceptions of healthy eating, and factors influencing eating behaviours such as the perceived price of traditional foods between South Asians, Africans and Caribbean in Chapter 5 (study 3). This new information is vital, supporting the heterogeneity shared within ethnic minorities and could be used to tailor interventions accordingly.

Similarly, the fairly equal representation of gender (59% males and 41% females) in this PhD research provided a deeper understanding of the potential differences in SN and nutrient profiles by gender, and also how the factors influencing these, are shaped by gender, which was lacking from previous research in single gender samples (Castaneda-Gameros et al., 2018a; Emadian et al., 2017; Terragni et al., 2014) or in most studies that had poorer representation of males (Earland et al., 2010). In this PhD research, chapter 3 (study 1) found that males had significantly less integrated SN as compared to females. These findings explained the poorer nutrient intakes and perceived negative changes of factors influencing eating behaviours and physical function expressed by males in chapter 4 (study 2) and chapter 5 (study 3), respectively. These findings contrast with previous studies that observed that females were

more likely to experience poorer SN and poorer health outcomes (Burholt et al., 2018; Kim, Park, & Antonucci, 2016). For example, a SN study in Birmingham among 590 ethnic older minorities aged 55 years and older found that females had a lower odds of belonging to a Multigenerational Household: Younger Family (an integrated SN) as compared to remaining in a restricted Non-kin SN, and additionally being female was associated with a higher risk of loneliness (Burholt et al., 2018). However, in the context of the broader literature in non-ethnic minority populations, the findings of lower SN of men and their resultant impact observed throughout this PhD research are consistent with other studies (Conklin et al., 2014; Schwartz & Litwin, 2018).

Overall, ethnic and gender differences in factors influencing eating behaviours and physical function, and their consequential impact on nutrient intake over time observed has bridged an important literature gap, and serves as an essential resource to design effective interventions for better health outcomes in this population.

6.2.2 The observed changes in SN, nutrient intake, nutritional status and physical function

The cross-sectional findings are consistent with the majority of SN literature in older adults that highlight the importance of integrated SN for better health outcomes and quality of life (Burholt et al., 2018; Santini et al., 2015; Seeman, 1996; Stephens et al., 2011). Also, regarding nutrient intakes, the cross-sectional findings are consistent with other studies, highlighting the inadequate nutrient intakes among ethnic minorities, which accounts partly for the higher prevalence of diet-related non-communicable diseases among ethnic minorities as compared to the general population (Bruins, Van Dael, & Eggersdorfer, 2019; Castaneda-Gameros et al., 2018a; Garcia & Da, 2011; Johnson & Garcia, 2003; Sproston & Mindell, 2006; Vyas *et al.*,

2003; Zhang, Hsu-Hage, & Wahlqvist, 2002). Beyond these similarities in the findings shared by the present PhD thesis and previous literature, the provision of detailed information on the scope of changes in SN, nutrition, physical function, and how perceived factors influencing these variables change over time, have contributed to the literature, which otherwise included 'snapshot' knowledge provided by the majority of cross-sectional studies in this population. It has also contributed in dispelling a common belief, which indicates that all ethnic minorities have stable integrated SN due to the presence of multigenerational households. This new knowledge has important implications for the provision of formal and informal services to support older adults embedded in non-integrated SN to improve their SN, eat well and maintain a healthier ageing trajectory.

Regarding the direction of change, these PhD findings contrast with some longitudinal studies exploring changes in SN, nutrient intake and physical function in either ethnic minority groups or the general population of predominately white Europeans (Buttery *et al.*, 2016; Schwartz & Litwin, 2018; Zhang et al., 2002). In this PhD thesis, the majority of participants (63%) experiencing changes declined from an integrated SN to a non-integrated SN over just 8-months; in contrast, a study of older Europeans aged 65 years and older found a general trend of network expansion over time, with participants having an increased proportion of family ties and addition of new members over a period of 3 years (Schwartz & Litwin, 2018). Also, as compared to the significant declines in some observed micronutrient intakes in the present PhD research, an 8-year longitudinal study of 262 Chinese older adults in Melbourne (mean age at follow-up 55+ years) reported a substantial increase in all nutrients over time (Zhang et al., 2002). The study of Zhang and colleagues utilised the FFQ, which has been found to overestimate nutrient, and the failure of the authors to account for increase supplements at follow-up could be accounting for the differences (Adamson et al., 2009). In addition, the

differences in the follow-up time between the PhD research and previous literature could largely be accounting for the differences in the direction of change. In general, the eight months follow-up of this PhD research was greater than other studies (Newsom *et al.*, 2003; Vinokur & Van Ryn, 1993). For instance, a longitudinal study exploring changes in SN in relation to the positive and negative exchanges of SN in 277 older adults used a brief follow-up period of 13 weeks and found no changes in SN (Newsom et al., 2003). However, the majority of longitudinal literature exploring SN, nutrient intake and physical function, incorporated a longer follow-up period (minimum of two years), which makes this PhD follow-up time relatively short (Kim et al., 2016; Schwartz & Litwin, 2018; Zhang et al., 2002). Despite the main differences in follow-up, the negative changes observed in just eight months makes this PhD research particularly note-worthy, suggesting the rapid instability of SN, which explained the decrease in nutrient intakes, nutritional status and physical function. What will be interesting and could be an important area of focus for future studies, is to examine over a longer follow-up whether these changes are transient or potentially part of negative changes that persist over time in this relatively under-researched population.

6.2.3 The Observed Association of SN, Nutrient intake and Physical function over time

Given the dearth of literature regarding how these variables are related among ethnic minority older adults, the findings of integrated SN at baseline associated with higher physical function at follow-up provided important insights to the literature. Additionally, the association of a higher physical function with higher nutritional status at follow-up and most notably how participants perceived these associations over time are very important in bridging the literature gap. What is particularly crucial in this PhD research was the provision of knowledge that explains why these changes occur over time. For instance, in chapter 3 (study 1), the qualitative findings revealed that with declines in SN, participants were more reluctant to shop, cook and

eat healthy meals; hence the poorer nutrient intakes and the subsequent declines in nutritional status and physical function observed in chapter 4 (study 2). Also in chapter 5 (study 3), some perceived factors influencing eating behaviours demonstrate that ethnic minority choices of meals are not primarily guided by health reasons but by a host of cultural, religious and environmental reasons. This might partly explain the consistently lower nutrient intakes as compared to the UK RNI or even in studies in predominately white population samples, in chapter 4 (Study 2). Additionally, the perceived impact of social support on eating behaviours and physical function in chapter 5 (study 3), enlightened the direct path of the mechanism of impact of SN as described in the 'social control' model (Umberson, 1992).

Overall, the findings of this PhD research have contributed significantly in advancing the literature on SN, nutrient intake, nutritional status and physical function of older ethnic minority older adults. It has provided a more comprehensive knowledge of what, how and why these changes occur in community-dwelling, ethnically diverse older adults over time.

6.3 Strengths and Limitations

Regardless of the unique findings observed in each study of this PhD thesis (Chapter 3-5), it is essential to highlight the strengths and limitations of this PhD research to guide the interpretation and use of the findings.

As what appears to be the first longitudinal mixed-method study to explore SN, nutrition and physical function in community-dwelling, ethnically diverse older adults (based on existing published literature), the findings are new and provide a deeper understanding of changes in SN, nutrition and physical function that are lacking with the snapshot evidence provided by previous cross-sectional studies in this population (Burholt et al., 2018; Burholt et al., 2000; Earland et al., 2010; Emadian et al., 2017; Garduno-Diaz & Khokhar, 2014). Additionally, the

study design provided detailed information on the perceptions of factors influencing eating behaviours and physical function, in particular how these factors change over time, which was missing in the existing literature within this population.

Given the scarce literature about SN, nutrition and physical function in ethnic minorities, especially among the older population, the inclusion of this relatively under-researched population serves as a major strength of this PhD thesis. The sample size, although relatively small from a quantitative perspective (chapter 4), was ample for the qualitative and mixed-methods studies (chapter 3 and 5). As such, this PhD research was able to use a comparative analysis to compare and contrast perceptions of, and key influences on, eating behaviours and physical function by sociodemographic characteristics such as ethnicity and sex, which have not been explored in most previous studies (Garcia & Da, 2011; Osei-Kwasi et al., 2017; Terragni et al., 2014).

Furthermore, most previous studies in ethnic minority older adults have often included a subjective measure of physical function (Garcia & Reyes, 2017; Ran *et al.*, 2017); which when compared to performance-based measures (SPPB and HGS) have an increased tendency to misrepresent older adults' physical function, thus giving inaccurate associations of physical function with other health indicators such as mortality or the need for long term care (Cooper, Kuh, & Hardy, 2010; Guralnik *et al.*, 1989). As such, this PhD research included performance-based measurements of physical function that provided a more accurate representation of physical function over time and their relationship with social networks and nutrition.

The ethnic minority status (Ghanaian) and religious affiliation (Christian) of the student researcher was vital in building rapport among community-dwelling ethnically diverse older adults, especially African/Caribbean and Christians. This improved participant recruitment and

retention in the study significantly, and enhanced the trust and credibility of the researcher, which has been shown to improve the quality of interviews with ethnic minorities (Garduño-Diaz et al., 2014). Participants often saw the student researcher as an 'insider,' thus their overwhelming interest in the success of the study as evidenced in the qualitative interviews (Mullings, 1999). Additionally, the male status of the ethnic minority researcher may have aided in recruiting a high proportion of males as compared to previous ethnic minority studies that encountered difficulty in recruiting them (Earland et al., 2010; Nicolaou *et al.*, 2009). For instance, a study of dietary intake and health status among African-Caribbean aged 19-65 years in the UK managed to recruit only 15% of males (Earland et al., 2010). The balanced representation of gender in the present findings provided new insights lacking in previous ethnic minority studies that were over-represented by females (Earland et al., 2010; Nicolaou et al., 2009).

Despite the advantage of the ethnic minority status of the student researcher as an "insider", there is a possibility that the student researcher's previous knowledge and experiences of dietary acculturation as a migrant could have influenced the interpretation of the qualitative findings (study 1 and 3) (Kanuha, 2000). Also, given the nationality of the student researcher as a Ghanaian, younger age and academic background, some participants might have viewed the student researcher in such instances as an 'outsider' which could have influenced their participation in the study and the depth of the data generated (Kanuha, 2000; Mullings, 1999). To address these potential limitations, the student researcher attended regular community and faith group meetings with potential participants prior to the start of the study. The remarkably warm reception received by the student researcher, and the willingness of the community/faith leaders and potential participants to support and take part in the study, could be strongly argued as having reclassified the researcher as an 'insider' or a 'highly acceptable outsider', hence

improving data collection and the retention of participants in the study (Mullings, 1999). Additionally, the student researcher had regular discussions and informal communications regarding the interpretation of the data from community/faith leaders and also from an ethnically diverse research team, comprised of a white British male and female, an Irish male, a Ghanaian female and a white American female (with extensive experience in working with diverse populations within and outside of the UK).

Limitations of this PhD research included the use of convenience sampling, the difficulty in recruiting specifically Bangladeshi women, and the inability to include some ethnic minority groups such as the Chinese or Arabs. This made the sample less reflective of the diversity of all ethnic minority groups in Birmingham (Birmingham City Council, 2011b). Hence, these findings may not be generalizable to all ethnic minority older adults living in super-diverse communities in Birmingham and the UK. Also, the smaller representation of some of the SN groups, specifically the privately restricted SN group and the local self-contained SN (study 3) might have influenced the outcome of some of the analysis, hence the results should be interpreted with caution.

A further limitation was the use of self-reported assessment of diet, which has the potential of leading to under-reporting of nutrient intakes. Under-reporting contributes to a significant error in dietary reporting, and is even higher in overweight and obese populations (Rennie, Coward, & Jebb, 2007; Vyas et al., 2003). However, as compared to previous studies using a single 24-hour recall which fails to account for day-to-day variation, or the FFQ which has been found to overestimate energy and nutrient intakes in older adults, this study used an adapted interview approach multiple-pass 24-hour recall approach on two-non-consecutive days (including a weekend day) (Adamson et al., 2009; Castaneda-Gameros et al., 2018a; Earland et al., 2010; Garcia & Da, 2011; Vyas et al., 2003). A well-conducted 24-hour recall on multiple days can

provide a closer habitual representation of energy and nutrient intakes than the FFQ (Adamson et al., 2009; Hoffmann et al., 2002). As such, the four non-consecutive days of multiple-pass 24-hour recall in this PhD research might have minimised the errors of self-reporting of diets in this study. Despite this, it is possible that the number of days used assessing diet in this present study were insufficient to accurately capture some nutrients, especially many micronutrients. The wide day-to-day variation of intake of some micronutrients requires many days of assessment to capture a closer true representation. A study in Japan found that to capture true estimates of energy and macronutrients, 3 to 9 days of 24-hour recalls are required, while a much wider range of 4 to 160 days of 24-hour recalls are required for micronutrients (Tokudome *et al.*, 2002).

The relatively short follow-up time as compared to previous studies was another limitation and might have influenced the outcome of the findings as earlier discussed (Buttery et al., 2016; Kim et al., 2016; Schwartz & Litwin, 2018; Zhang et al., 2002). One must exercise caution when interpreting these findings, as the changes observed may have been transient, and may not be reflective of longer-term changes. In addition, seasonality has been found to account largely for differences in nutrient intake and other activities (Suga *et al.*, 2014; Tokudome et al., 2002; Tucker & Gilliland, 2007). The design of this PhD data collection did not account for the impact of seasonality, hence the potential influence of seasonality on the changes in SN, nutrition or physical function cannot be ruled out.

The use of interpreters was an additional limitation, having the potential to compromise validity and reliability of the qualitative data, mainly due to translation bias (studies 1 and 3). However, the use of interpreters was also a strength, as utilising trained interpreters allowed for the inclusion of participants with low English literacy to ensure the sample was more representative

of the mixed level of English literacy in Birmingham (Birmingham City Council, 2011b). Measures were kept in place to improve the validity and reliability of the translated data. First, the interpreters were carefully selected with help from the community or religious leaders to ensure that they were capable of serving as interpreters. Second, they were trained by the student researcher to ensure they fully understood the interview process and their defined roles. Finally, before further interviews were conducted, a second interpreter who understood the respective language of the participant reviewed and evaluated the interview recording done by the first trained interpreter to ensure it reflected what was discussed.

6.4 Implications and Recommendations of this PhD research

The findings of this PhD study have significant practical implications for researchers working in ethnic minority communities, and for health and social care professionals and policymakers.

6.4.1 Future research

The majority of SN research including this present thesis has often focussed on the activities around the respondent (the ego), with little or no attention on the network members related to the ego (the alters). Given the bidirectional nature of SN, this has often provided less information on the extent of support (perceived or actual) that is given or received by the egos and alters in the entire network (Ellwardt *et al.*, 2019; Seale, 2004). To advance towards a deeper understanding of SN in ethnic minority older population, it is recommended that future studies should incorporate measures to explore the profile and changes of SN of the entire network (ego and alters). Moreover, as some research has shown the 'contagious nature' of behaviour, particularly depression, loneliness or changes in physical health in networks, measuring SN from the perspective of the ego and their alters is essential to exploring the spread of behaviours within the entire network, and to inform the design of appropriate interventions

to support behaviour change (Cacioppo, Fowler, & Christakis, 2009; Rosenquist, Fowler, & Christakis, 2011).

As highlighted earlier, the potential influence of seasonality on the outcome of the findings cannot be ruled out (Rossato *et al.*, 2010; Tucker & Gilliland, 2007). Hence, if this study is to be replicated, researchers could overcome this limitation by designing data collection in a manner capable of accounting for the influence of seasonality and other important ethnic minority festivals that could have the potential of influencing SN, nutrient intake or physical function. This could be done by designing multiple waves of data collection across the year (fall, spring, summer, winter data collection) to capture seasonal variation. Also, given the instability of SN along with nutritional status and physical function found in this PhD thesis within a relatively short period of follow-up, future prospective studies exploring these variables could include a longer follow-up period to confirm if these changes persist for longer-term or were just transient changes among this population.

As ethnic diversity continues to increase in the UK and parts of Europe, so will the increase in the heterogeneity among ethnic minority groups and that of the general population. Hence, it will be vital for future research in the UK to include more ethnic minority groups, such as East Asians or Arabs to explore the differences in SN, nutrition and physical function shared among ethnic minorities and that of the wider population. This resource will support them to age healthily in an ethnically diverse country.

The design of the present thesis made it impossible to establish cause and effect between the variables of interest. Future research in ethnic minority older adults should be interventional to explore the impact of SN on improving healthy eating and physical function in this population. Given the available evidence of the impact of SN interventions to changing behaviours, a

successful SN intervention in this population could be a key to improving the adoption of healthier behaviours to support successful ageing of ethnic minority older adults (Latkin & Knowlton, 2015; Shaya *et al.*, 2014).

6.4.2 Policy

Despite the benefits of social support reported by participants attending age-well or other ethnic specific community centres in this PhD research (studies 1 and 3), the sustainability of these centres were threatened due to budget cuts, forcing some to shut down or reduce their opening days. Long-term financial support provided by interested organisations and public funding sources could improve the sustainability of these ethnicity-specific age-well societies and faith centres.

Also, given the impact of the sudden changes in living arrangements and other significant life events on social networks observed (studies 1 and 3), local councils and other charity organisations could support ethnic minority communities to implement community navigators or/and befriending schemes. These schemes will support less socially integrated older adults by introducing them to older adults that are more socially integrated to develop long term relationships, where they can support them to improve their social networks and general wellbeing. As a predominately voluntary activity (with initial start-up funding by the local councils or other non-governmental organisations), this will serve as an effective and sustainable scheme to support those living in non-integrated social networks with no access to social groups to improve and maintain stronger social networks.

In addition seeking support from local councils or other funding bodies, it is essential for religious/faith and other community groups to actively implement strategies to monitor the social aspect of their members regularly to ensure that those facing significant life event

changes such as retirement, changes in living arrangements, bereavement and illness are identified timely and supported. This could be done by increasing visits to the homes of these individuals, involving them in social activities when possible and sign posting them to formal support services. This will help to fill the void created through the sudden changes in life events. This would serve as a way to support them to maintain their social networks and prevent the sudden transition to non-integrated networks as observed in studies 1 and 3 of this PhD research.

Additionally, given the importance of supplementation and the low supplement intakes observed in this PhD research, this population could benefit considerably from a free supplementation programme (Barnes *et al.*, 2006; Blumberg *et al.*, 2017; Talwar *et al.*, 2007). Based on the findings from this PhD research, this policy would particularly benefit those living in more deprived neighbourhoods. To ensure effective implementation, compliance and sustainability, such a programme could be integrated into existing community or faith group activities and run by health professionals as an outreach activity at these centres. Additionally, health professionals, specifically nutritionists and dieticians attending to older ethnic minorities, could include a mandatory dietary assessment and based on the results, prescribe free supplements if needed, in line with safer intake thresholds, to enhance acceptability and intake to improve nutrient status among this population (Food Standards Agency, 2003). This practice could be complemented with appropriately tailored dietary education to ensure that these supplements do not replace a well-balanced diet.

6.4.3 P**ractice**

The provision of informational (the dietary advice), emotional (providing a sense of empathy), or instrumental support (exercise classes or free medical assessment) at a few existing ethnic and religious centres were found to be important and promoted the maintenance of integrated social networks (Chapter 5). Given these benefits, advertising the services offered at some of

these centres more widely to community-dwelling, ethnically diverse older adults could improve access to these centres, which would subsequently provide them with the opportunity to transition to more integrated social networks and thereby reduce their risk for social isolation. As strategies, it is recommended that health and social care professionals could collaborate with these centres to explore the services they render and signpost their clients to these centres.

To improve the services offered at these centres, which could also support their sustainability, health professionals could provide free nutritional and physical function assessments at these centres as part of outreach programmes. Given the observed significant declines in nutritional status and physical function, these assessments would allow for the identification and subsequent treatment of malnutrition and physical function limitations to help prevent further deterioration. In addition, conducting regular assessments at these centres may serve as an incentive for community-dwelling older adults to visit these meeting places, which could enhance their social networks. Also, as these PhD findings suggest that these meeting places are willing to support these activities, the co-creation of such programmes with health care professionals and community/faith leaders would be effective in increasing accessibility and acceptability of these assessments, and further enhance the health and wellbeing of older adults. Interventions that are co-created and run at these faith centres have been shown elsewhere to increase access and improve health outcomes (Dehaven *et al.,* 2004; Sattin *et al.*, 2016).

Participants in this PhD research reported low nutrient intakes as compared to the RNI and in comparison, to studies conducted with predominately white participants. Given the heterogeneity in what is perceived as healthy and the cultural significance of dietary patterns observed, it is evident that the traditional ‘one size fits all’ dietary education is not effective in supporting this population to eat adequately to support healthy ageing. Personalised dietary

education and culturally tailored health education using traditional foods as practical examples should be co-created between academic researchers, community leaders and health care professionals. This could ensure better adherence to dietary advice, and that delivery of the same messages are given at health care, and community, and faith centres. Also, to respect and honour diversity, and achieve the desired impact of health interventions when delivering community health interventions and health messages, the heterogeneities between and within ethnicities should be considered to avoid broad generalisations and stereotyping.

As discussed previously, the influence of social networks can have a positive impact on healthy eating, such as increasing food intake, increasing the provision of varied and quality meals, and prompts from others to eat more healthily during meals. However, in very few cases (study 3), some women expressed the influence of some network members, mainly husbands, to have a negative influence on their eating behaviours. One example of a negative influence expressed was encouragement to over-eat or pushing against switching to healthier options. Given this, it is important for health professionals aiming to support healthy eating in older adults to explore extensively the impact of network members when it comes to behaviour change. In doing this, they will have a comprehensive understanding to enable them to create more holistic interventions. Weaving in family and friends that play a significant role in the individual's life, to ensure behaviour change is successful and sustained.

At the family level, interventions targeting social network improvements such as the introduction of community navigators and befriending schemes mentioned earlier, should also increase awareness among family and friends about the importance of maintaining consistent and healthy relationships. For example, the increased awareness would help children living away from their parents to intensify and maintain regular contacts with their parents to reduce

the impact of the void created by their absence. As observed in this PhD, such regular contacts, either face-to-face or via telephone, were found to be beneficial in promoting healthy eating practices and good physical function.

Lastly, a fear of gaining weight, and engagement in unhealthy practices to lose weight was observed in some participants in this PhD research. The practice of fasting, skipping meals, or drastically cutting down portion sizes without proper adherence to diet quality were common practices, which contributed to the observed low nutrient intakes. While future studies are recommended to explore this in detail, health professionals could change their advice and avoid generic messages such as "you are overweight/obese, so you need to lose weight" and instead deliver more specific messages to achieve weight loss using healthier practices, without it negatively affecting the nutritional quality of their diets.

6.5 Conclusion

This PhD thesis has contributed significantly to the literature with regards to SN, nutrition and physical function of community-dwelling, ethnically diverse older adults living in super-diverse communities in Birmingham, UK. It has demonstrated that many ethnic minority older adults do not have integrated networks as often assumed and might be experiencing rapid declines in SN, which could lead to poorer nutritional status and reduced physical function. It is recommended that culturally tailored interventions are better designed to support the maintenance of integrated social networks and address the increasing health inequalities in this population. Furthermore, the low micronutrient intakes, and the declines in nutritional status and physical function over a relatively short time reported in this thesis suggest an urgent need to implement early community nutrition and physical function screening to identify and treat malnutrition and physical function limitations. Finally, this PhD thesis demonstrates that it is possible to conduct mixed methods longitudinal research in this population, hence, it is

anticipated that these findings will encourage more research into community-dwelling ethnically diverse older adults, a relatively under-researched group.

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APPENDICES

Appendix A: Chapter 3 Supplementary files

Supplementary file A1: The differences in nutrient intake among the transitioned groups of social networks at follow-up

(showing only nutrients with statistically significant differences)

	SN changes				P-value
	Maintained non-integrated	Changed to non-integrated	Changed to integrated	Maintained integrated	
	Mean	Mean	Mean	Mean	
Energy at follow-up	1914.4 (833.3)	1777.3 (533.5)	1609.4 (850.6)	1543.8 (468.0)	0.241
%TE saturated fat	11.2 (4.3)	14.0 (4.7)	11.2 (3.8)	9.8 (3.3)	0.019
Potassium $mg.d^{-1}$ follow-up	1501.2 (406.9)	1412.1 (288.3)	1959.5 (501.2)	1709.2 (548.3)	0.015
Sodium $mg.d^{-1}$ follow-up	1095.8 (656)	895.3 (298.7)	1536.3 (635.6)	1006.1 (384.6)	0.03
Folate µg. d^{-1} follow-up	115.3 (44.9)	94.8 (33.6)	140.3 (58.4)	133.3 (45.2)	0.032

Supplementary file A2: Association of social networks with MNA-SF, WC, HGS and selected nutrients. Model 2 fully adjusted for sex, age, IMD, self-reported health, educational status and number of diseases.

MNA-SF								
	Model 1 (Unadjusted model)				Model 2 (Fully adjusted model)			
	B	SE	β	p value	B	SE	β	p value
(Constant)	12.20	0.76		0.00	16.79	2.35		0.00
Locally integrated	0.38	0.81	0.12	0.64	-0.48	0.84	-0.15	0.57
Wider community	0.40	1.07	0.06	0.71	0.62	1.10	0.09	0.58
Family-dependent	0.47	0.84	0.12	0.58	-0.21	0.86	-0.06	0.81

Local self-contained	0.23	0.88	0.05	0.80	-0.31	0.89	-0.07	0.72
Handgrip kg								
	Model 1 (Unadjusted model)				Model 2 (Fully adjusted model)			
	B	SE	β	p value	B	SE	β	p value
(Constant)	25.24	4.22		0.00	82.68	10.92		0.00
Locally integrated	3.63	4.51	0.19	0.42	-4.06	3.91	-0.21	0.30
Wider community	-2.26	5.97	-0.06	0.71	-0.06	5.12	0.00	0.99
Family-dependent	5.27	4.70	0.24	0.27	-3.07	4.00	-0.14	0.45
Local self-contained	-1.27	4.92	-0.05	0.80	-5.29	4.12	-0.21	0.20
Waist circumference cm								
	Model 1 (Unadjusted model)				Model 2 (Fully adjusted model)			
	B	SE	β	p value	B	SE	β	p value
(Constant)	108.15	4.72		0.00	109.90	15.09		0.00
Locally integrated	-8.26	5.04	-0.39	0.11	-5.19	5.40	-0.25	0.34
Wider community	-7.05	6.68	-0.16	0.29	-6.83	7.07	-0.16	0.34
Family-dependent	-9.78	5.25	-0.41	0.07	-8.48	5.53	-0.36	0.13
Local self-contained	-7.56	5.50	-0.27	0.17	-6.11	5.70	-0.22	0.29
Energy kcal								
	Model 1 (Unadjusted model)				Model 2 (Fully adjusted model)			
	B	SE	β	p value	B	SE	β	p value
(Constant)	1902.60	233.72		0.00	2913.00	713.97		0.00
Locally integrated	-173.09	249.43	-0.17	0.49	-213.18	255.67	-0.21	0.41
Wider community	-240.30	330.53	-0.11	0.47	-231.26	334.58	-0.11	0.49
Family-dependent	-74.70	260.06	-0.06	0.78	-221.52	261.80	-0.19	0.40
Local self-contained	-280.81	272.28	-0.21	0.31	-262.92	269.56	-0.19	0.33

Carbohydrates g								
	Model 1 (Unadjusted model)				Model 2 (Fully adjusted model)			
	B	SE	β	p value	B	SE	β	p value
(Constant)	229.65	28.64		0.00	319.08	88.19		0.00
Locally integrated	-7.24	30.56	-0.06	0.81	-22.67	31.58	-0.18	0.48
Wider community	-24.11	40.50	-0.09	0.55	-28.28	41.33	-0.11	0.50
Family-dependent	-7.20	31.86	-0.05	0.82	-30.82	32.34	-0.21	0.34
Local self-contained	-36.03	33.36	-0.22	0.28	-44.34	33.30	-0.27	0.19
Fibre g								
	Model 1 (Unadjusted model)				Model 2 (Fully adjusted model)			
	B	SE	β	p value	B	SE	β	p value
(Constant)	20.91	3.40		0.00	20.23	9.36		0.03
Locally integrated	-3.39	3.62	-0.23	0.35	-6.49	3.35	-0.43	0.06
Wider community	0.77	4.80	0.03	0.87	-1.87	4.39	-0.06	0.67
Family-dependent	-3.55	3.78	-0.21	0.35	-7.18	3.43	-0.42	0.04
Local self-contained	-4.04	3.96	-0.20	0.31	-7.10	3.53	-0.36	0.05
Protein g								
	Model 1 (Unadjusted model)				Model 2 (Fully adjusted model)			
	B	SE	β	p value	B	SE	β	p value
(Constant)	87.17	11.18		0.00	128.22	34.80		0.00
Locally integrated	-16.33	11.93	-0.33	0.18	-15.91	12.46	-0.32	0.21
Wider community	-12.40	15.81	-0.12	0.44	-12.41	16.31	-0.12	0.45
Family-dependent	-6.93	12.44	-0.12	0.58	-9.74	12.76	-0.17	0.45
Local self-contained	-14.49	13.02	-0.22	0.27	-11.65	13.14	-0.18	0.38

Fats g								
	Model 1 (Unadjusted model)				Model 2 (Fully adjusted model)			
	B	SE	β	p value	B	SE	β	p value
(Constant)	72.82	16.31		0.00	118.70	51.29		0.02
Locally integrated	-8.38	17.41	-0.12	0.63	-3.62	18.37	-0.05	0.84
Wider community	-8.74	23.07	-0.06	0.71	-5.59	24.04	-0.04	0.82
Family-dependent	1.50	18.15	0.02	0.93	-1.48	18.81	-0.02	0.94
Local self-contained	-11.98	19.00	-0.13	0.53	-6.15	19.36	-0.07	0.75

Supplementary file A3: Predictors of changes in nutritional status of community-dwelling, ethnically diverse older adults (N=81)

	Remained Malnourished/at-risk-of malnutrition						Changed to Malnourished/at-risk-of malnutrition						Changed to Normal					
	B	SE	Sig.	Exp(B)	95% Confidence Interval for Exp(B)		B	SE	Sig.	Exp(B)	95% Confidence Interval for Exp(B)		B	SE	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
					Lower Bound	Upper Bound					Lower Bound	Upper Bound					Lower Bound	Upper Bound
Intercept	-5.49	4.71	0.24				-7.59	3.14	0.02				-19.84	8.85	0.03			
IMD	0.19	0.29	0.51	1.21	0.69	2.14	0.38	0.17	0.03	1.47	1.05	2.05	0.49	0.28	0.09	1.63	0.94	2.83
Age	0.06	0.07	0.37	1.06	0.93	1.21	0.08	0.04	0.05	1.09	1.00	1.18	0.26	0.12	0.03	1.30	1.03	1.64
Integrated	0.89	1.25	0.48	2.44	0.21	28.37	-0.51	0.65	0.43	0.60	0.17	2.13	1.12	1.61	0.49	3.05	0.13	71.76
Non-integrated	0[b]						0[b]						0[b]					
Male	0.69	1.02	0.50	2.00	0.27	14.64	0.55	0.64	0.39	1.73	0.49	6.12	0.79	1.40	0.57	2.20	0.14	34.04
Female	0[b]						0[b]						0[b]					
No education	1.02	1.31	0.44	2.77	0.21	36.06	1.15	0.90	0.20	3.17	0.54	18.44	-19.82	0.00		0.00	0.00	0.00
Primary	0.88	1.24	0.48	2.41	0.21	27.45	0.58	0.88	0.51	1.79	0.32	10.00	-1.18	1.79	0.51	0.31	0.01	10.31
Secondary	0.50	1.37	0.72	1.64	0.11	24.25	1.10	0.80	0.17	3.00	0.62	14.43	0.81	1.46	0.58	2.24	0.13	39.36
University/College	0[b]						0[b]						0[b]					
Excellent	-3.12	1.79	0.08	0.04	0.00	1.47	-1.36	1.29	0.29	0.26	0.02	3.25	-22.92	8895.23	1.00	0.00	0.00	.[c]
Good	-3.64	1.65	0.03	0.03	0.00	0.66	-1.07	1.15	0.36	0.34	0.04	3.30	-5.14	2.42	0.03	0.01	0.00	0.68
Fair	-1.95	1.75	0.27	0.14	0.01	4.43	0.06	1.32	0.97	1.06	0.08	13.91	-1.67	2.01	0.41	0.19	0.00	9.70
Poor	0[b]						0[b]						0[b]					

a. The reference category is: Remained normal.

b. This parameter is set to zero because it is redundant.

c. Floating point overflow occurred while computing this statistic. Its value is therefore set to system missing.

Appendix B: Chapter 4 Supplementary files

Supplementary file B1: Differences between participants that remained in the study (n=81) and participants that dropped out (n=19)

Variables		Completed study (n= 81)	Lost to follow-up (n= 19)	P-value
Age (median)		70	71	0.878
Sex (N)	Males	50	9	0.252
	Females	31	10	
Marital status (N)	Married	55	11	0.41
	Not married	26	8	
Education (N)	Educated	70	14	0.175
	Not educated	11	5	
IMD (median)		2.7	3.1	0.121
Number of diseases (median)		2.0	2.1	0.141
BMI (mean)		29.5	29.7	0.882
WC (median)		99.2	106.1	0.036
MNA-SF (median)		13.1	13	0.404
SPPB (Median)		11.1	8	0.007
HGS (kg) (mean)		27.9	22.5	0.027
Energy kcal (median)		1733	1878	0.186

Supplementary file B2: Differences in micronutrient intakes with and without supplementation at baseline

	Male (% of RNI)			Female (% of RNI)		
Micronutrients	**Supplements**	**Without supplements**	**p-value****	**Supplements**	**Without supplements**	**p-value****
Potassium mg/day	43.92	43.92	1.000	48.67	48.65	0.323 [a]
Magnesium mg/day	77.24	50.91	0.109	68.65	67.71	0.180
Calcium mg/day	76.07	53.48	0.109	71.37	70.12	0.144
Iron mg/day	80.09	78.24	0.119	79.48	74.82	0.068
Zinc mg/day	65.33	61.48	0.059	75.05	72.26	0.655
Selenium µg/day	32.26	32.26	1.000	47.43	46.85	0.317
Iodine µg/day	36.44	33.44	0.980	47.27	45.78	0.317
Sodium mg/day	68.31	68.31	1.000 [a]	65.31	65.31	1.00
Phosphorus mg/day	117.36	117.34	0.321 [a]	128.93	128.83	0.323 [a]
Copper mg/day	65.68	65.68	1.000	74.39	73.37	0.317
Chlorine mg/day	54.24	54.24	0.625 [a]	58.82	58.8	0.317
Manganese mg/day	166.59	166.59	0.998	176.48	174.04	0.317
Folate mg/day	62.38	58.77	0.043	81.01	68.05	0.012
Vitamin C mg/day	127.36	122	0.043	141.83	120.65	0.012
Vitamin A (Retinol) µg/day	62.49	57.14	0.043	123.2	104.92	0.008
Vitamin D µg/day	35.81	21.86	0.008	54.34	26.1	0.001
Vitamin E µg/day	99.83	83.83	0.018	107.71	68.83	0.003
Thiamine mg/day	88.14	93.43	0.066	114.63	96.34	0.011
Riboflavin mg/day	74	63	0.066	78.12	73.19	0.012
Niacin mg/day	69.74	65.9	0.068	102.3	86.77	0.012
Vitamin B6 mg/day	71.19	66.1	0.068	95.53	78.46	0.011
Vitamin B12 µg/day	175.93	173.56	0.066	205.37	176.75	0.011

**p-values were calculated using absolute values controlled for energy intake and not computed percentages

[a] Normally distributed dated, p-values were calculated using paired t-test analysis.

Supplementary file B3: Differences in micronutrient intakes with and without supplementation at follow-up

	Male (% of RNI)			Female (% of RNI)		
Micronutrients	**Supplements**	**Without supplements**	**p-value****	**Supplements**	**Without supplements**	**p-value****
Potassium mg/day	43.47	43.32	0.123 [a]	45.89	45.58	0.132 [a]
Magnesium mg/day	49.37	49.68	0.229 [a]	56.18	56.21	0.723 [a]
Calcium mg/day	55.38	55.01	0.237 [a]	58.73	57.2	0.322 [a]
Iron mg/day	74.3	72.45	0.455	70.46	69.13	0.212
Zinc mg/day	49.53	49.56	0.577	72.8	69.15	0.434
Selenium µg/day	30.98	30.86	0.987	43.98	43.17	0.280
Iodine µg/day	35.23	35.26	0.090	40.6	38.76	0.242
Sodium mg/day	59.95	61.05	0.462	72.65	72.08	0.932
Phosphorus mg/day	109.12	108.29	0.228 [a]	115.02	113.94	0.128 [a]
Copper mg/day	68.37	68.11	0.352	70.1	68.18	0.490
Chlorine mg/day	48.09	47.89	0.588	48.09	47.89	0.571
Manganese mg/day	166.91	166.56	0.521	311.34	307.71	0.017 [a]
Folate mg/day	55.32	54.79	0.541 [a]	60.19	57.36	0.122 [a]
Vitamin C mg/day	102.71	101.39	0.061	121.23	114.03	0.021
Vitamin A (Retinol) µg/day	65.75	63.05	0.256	94.92	82.05	0.027
Vitamin D µg/day	18.86	17.56	0.641	22.48	17.6	0.012
Vitamin E µg/day	83.96	83.63	0.795	81.18	78.68	0.025 [a]
Thiamine mg/day	84.13	78.46	0.914	95.19	91.63	0.005
Riboflavin mg/day	61.07	59.28	0.169	77.27	72.66	0.089
Niacin mg/day	61.59	53.79	0.102	85.63	80.95	0.174 [a]
Vitamin B6 mg/day	63.7	61.71	0.122	77.6	70.56	0.016 [a]
Vitamin B12 µg/day	151.7	147.13	0.195	214.67	111.74	0.031

**p-values were calculated using absolute values controlled for energy intake and not computed percentages

[a] Normally distributed dated, p-values were calculated using paired t-test analysis.

Supplementary file B4: Pairwise correlations

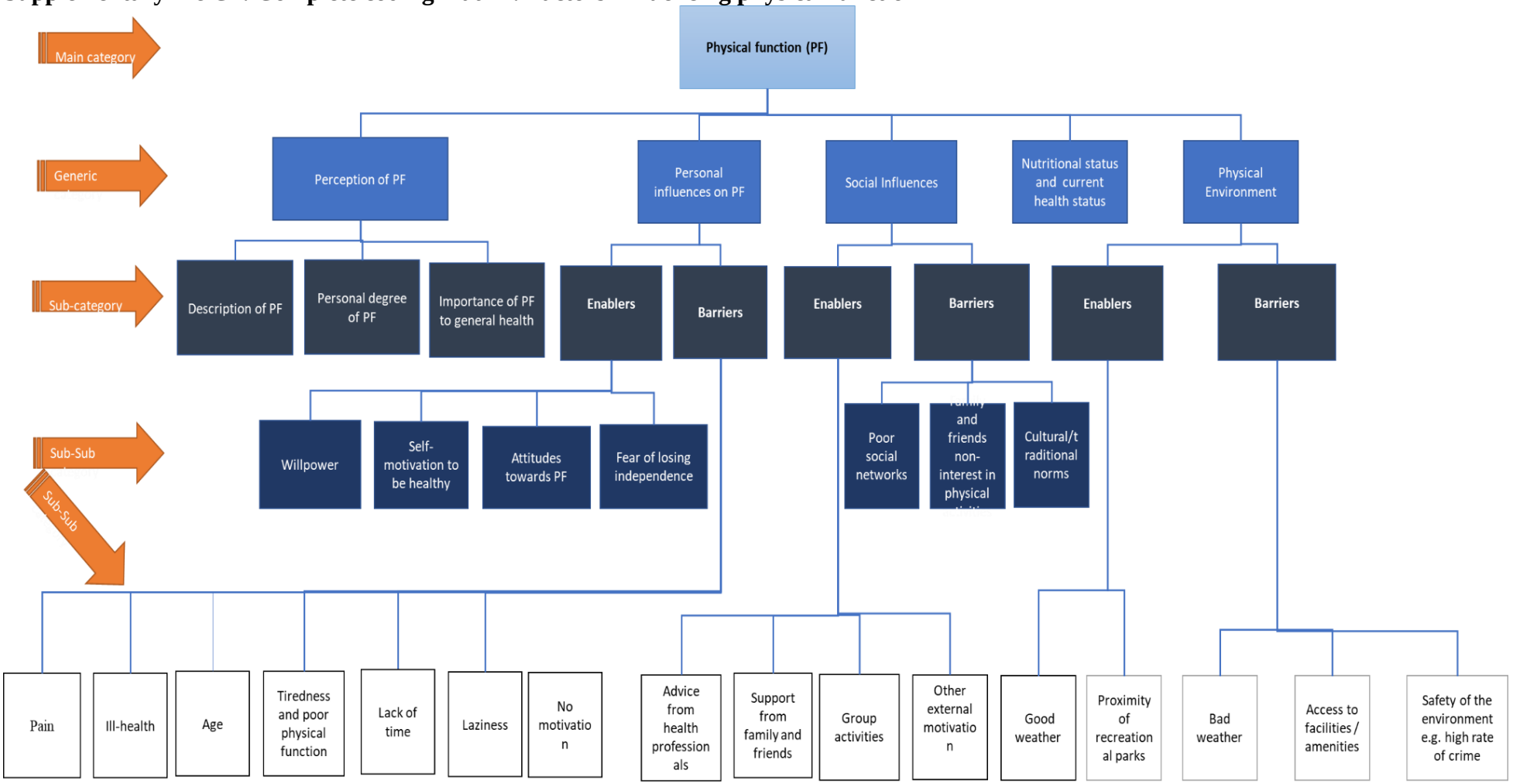
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	BM1	1																					
2	HGS	-.13	1																				
3	SPPB	-.22*	.61**	1																			
4	WC	.67**	-0.17	-.46**	1																		
5	MNA-SF	-.07	.19*	.39**	-.18	1																	
6	Energy	.06	.09	.08	.06	.03	1																
7	Protein	.01	-.03	.08	.01	-.10	.72**	1															
8	Fibre	-.07	.28**	.26**	-.06	.19	.23*	.06	1														
9	Potassium	-.16	.10	.18	-.13	-.01	-.39**	-.16	.39**	1													
10	Calcium	.08	-.01	-.01	.09	-.18	-.12	-.03	.61	.51**	1												
11	Magnesium	-.15	.11	.14	-.07	.10	-.36**	-.25*	.45**	.75**	.47**	1											
12	Iron	-.15	-.08	-.00	.05	-.14	-.16	-.08	.32**	.48**	.32**	.61**	1										
13	Zinc	.00	-.18	-.12	.09	-.15	-.10	.25*	-.08	.24*	.20*	.33**	.45**	1									
14	Vit A	.08	-.04	.05	-.01	.06	.01	.11	.04	.01	.054	.12	.09	.11	1								
15	Vit D	-.03	.12	.22*	-.08	.24*	-.09	.07	.06	.02	.07	.00	-.21*	-.14	.06	1							
16	Riboflavin	.07	.02	.11	.10	-.05	-.13	.08	-.01	.44**	.61**	.35**	.22*	.26**	.28**	.20*	1						
17	Niacin	-.07	.07	.18	-.07	.02	-.13	.28**	-.07	.27**	-.03	.08	.01	.12	-.06	.24*	.41**	1					
18	Vit B6	-.11	.16	.30**	-.07	.17	-.284**	-.04	.154	.62**	.23*	.49**	.27**	.17	-.05	.212*	.58**	.69**	1				
19	Vit B12	-.08	-.08	.09	-.09	-.04	-.05	.31**	-.14	.171	.16	-.111	-.05	.16	.25*	.423**	.34**	.22*	.08	1			
20	Sodium	.19	.01	-.16	.04	-.19	-.04	-.05	.02	.18	.23*	.14	.13	-.02	.04	-.09	.11	.07	.04	-.03	1		
21	Vit C	-.15	.18	.15	-.13	.05	-.25*	-.24*	.38**	.51**	.19	.38**	.33**	.00	.02	.01	.27**	.18	.49**	.03	.19	1	
22	Folate	-.12	.15	.18	-.03	.03	-.23*	-.16	.417**	.49**	.34**	.61**	.52**	.11	.12	.08	.47**	.21*	.60**	.03	.02	.49**	1

Supplementary file B5: Predictors of changes in physical function (SPPB) over time

	OR	95% CI	SE (B)	P-value
Constant	0		5.26	0.007
Male vs Female	1.54	0.46-5.17	0.62	0.486
Age	1.1	1.03-1.18	0.04	0.005
Married vs Not married	0.91	0.25-3.34	0.66	0.885
IMD	1.02	0.78-1.33	0.14	0.908
Educated vs Not educated	1.98	0.35 -1.27	0.89	0.443
Number of diseases	1.63	1.04-2.55	0.23	0.033
WC	1.08	0.99-1.17	0.04	0.072
BMI	0.84	0.70-1.02	0.1	0.081
MNA-SF	1.21	0.84-1.74	0.19	0.302
Fibre	1.03	0.96-1.11	0.04	0.412
Vitamin D	1.05	0.95-1.15	0.05	0.373
Vitamin B6	0.99	0.35-2.86	0.54	0.994

Appendix C: Chapter 5 Supplementary files

Supplementary file C1: Complete coding matrix: Factors influencing physical function



Supplementary file C2: Adapted Ecological model depicting the influences of eating behaviours and among community-dwelling ethnically diverse older adults

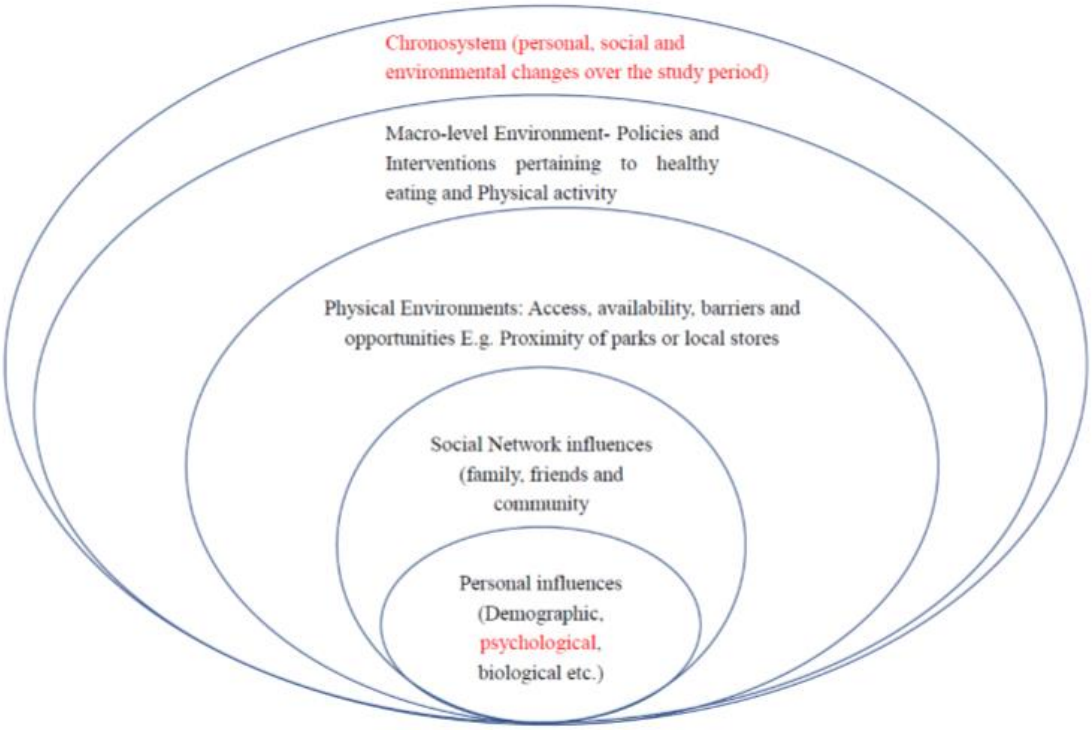


Figure S1. Adapted Ecological model depicting the influences of eating behaviours in community-dwelling ethnically diverse older adults.

Appendix D: Participant information sheet and consent form, and data collection tools

Appendix D1. Participant Information sheet



UNIVERSITY OF BIRMINGHAM

(Information sheet)

Dietary intake, eating behaviours and physical function in community-dwelling ethnically diverse older adults: cultural tailoring of assessment methods and identification of key social influences.

You have been invited to take part in a research study. Before you decide whether or not to participate, it is important that you understand what the research is about, why it is being done, what it will involve and what role you will play in it. Please take time to read the following information carefully.

WHAT IS THE PURPOSE OF THE STUDY? The study seeks to increase our understanding of what and how older people eat and how this is related to their level of physical function (which includes tests of balance, standing from a chair, and a short 4 metre walk). In addition, we want to understand how your social networks i.e. friend, family, community relationships might influence what and how you eat, and your physical function. We feel your experiences will help us to understand how a person's diet and social networks influences their ability to age in a healthy way while living within varying cultural and religious groups in communities in the UK

WHO IS ORGANIZING THE STUDY?

Evans A. Asamane, a doctoral researcher with the University of Birmingham, will carry out the study with supervision from Professor Janice L. Thompson and Dr. Carolyn Greig.

INCLUSION CRITERIA:

- Self-identification as being: Black Caribbean, Black African, Indian, Pakistani, or Bangladeshi
- At least 60 years of age
- Living in the Birmingham area
- No diagnosis of dementia or any cognitive or physical disabilities that might affect participation

WHY ARE WE ASKING YOU TO PARTICIPATE?

We are asking you to participate as you have identified yourself as being at least 60 years of age, and being Black Caribbean, Black African, Indian, Pakistani, or Bangladeshi. You have also expressed an interest in the study. If you choose to participate, the experiences you share during this study will help us better understand the key personal and social factors that can affect what and how older adults eat, and their physical function while living in a super-diverse community.

WHAT WILL WE ASK YOU TO DO?

If you agree to take part in this study, you will be asked to attend four (4) data collection visits. These visits will be held at a time and place that you prefer. Each visit is described below:

1. On the first visit, you will be asked to recall and describe all foods and drinks consumed in the previous 24 hours. You will be shown photographs of foods and drinks to help you describe the amounts you have consumed.

   You will also be asked questions about your age, marital status, education, migration history, faith beliefs, work status, health, medication use, and whether you smoke.

   We will also ask you some questions about factors that may be affecting how you eat, if you have recently lost weight, how well you can physically move around, and daily activities you can do.

   We will also take physical measurements, including height, weight, waist circumference, and hand grip strength. We will also measure physical function using the Short Physical Performance Battery test. This is a test of your ability to balance while standing, how well you can sit and stand up from a chair, and the time taken to walk for 4 metres (which is about 13 feet).

   This visit is expected to take approximately **90 minutes.**

2. The second visit will be scheduled about 14 days after the first visit, again at your selected time and place of convenience. Similar to visit 1, you will be asked to recall and describe all foods and drinks consumed in the previous 24 hours. In addition, you

will participate in an interview to understand the things that affect what and how you eat, and how your social networks (friend, family, community relationships) might affect your food intake and physical function.

This visit is expected to take approximately **60-90 minutes.**

3. The third visit will be done about 8 months after Visit 2. You will be contacted by the researcher to arrange this visit to suit your convenience. Similar to visits 1 and 2, all the food and drinks consumed over the previous 24 hours will be recorded, and the researcher will further have a discussion with you about why you eat the way you do and how your social networks (friend, family, community relationships) might affect your food intake and physical function.

   This visit is expected to take **60-90 minutes**.

4. The fourth visit will be arranged with you again to suit your time and place of convenience, about 14 days after visit 3. At this visit, you will be asked to

   recall and describe all foods and drinks consumed in the previous 24 hours. We will also ask you the same questions as in visit 1 about factors that may be affecting how you eat, if you have recently lost weight, how well you can physically move around, and daily activities you can do.

   Also, similar to visit 1, we will take physical measurements, including height, weight, waist circumference, and hand grip strength, and will measure physical function using the Short Physical Performance Battery test (ability to balance while standing, how well you can sit and stand up from a chair, and the time to walk for 4 metres). On this last occasion, you will be asked to answer some questions and to perform some tasks to test your memory. As I am not a trained health professional conducting this test, the results of the test do not represent a medical diagnosis of any cognitive impairment. You will be provided with a copy of the results of the test at the end of the study. You will also be advised to discuss the results further with your GP depending on the outcome of the test.

   This visit is expected to take **50-70 minutes.**

During any visit, you can decline to answer any questions you do not want to answer or feel uncomfortable about. There is no right or wrong answer. We will ask you to express yourself freely at these visits. All interviews will be digitally recorded with your permission to allow us to better understand your responses after the interview.

HOW WILL WE MAINTAIN YOUR PRIVACY AND CONFIDENTIALITY?

All information collected in this study will be kept private. The information obtained from you will be anonymised and you will not be identified in any report. This means that we will assign you with a number ID to protect your identity, so that you are not recognised in any reports or publications. All records from this study will be kept in a locked cabinet in a locked room at the University of Birmingham in the School of Sport, Exercise, and Rehabilitation Sciences. As this study is part of an EU funded project called PANINI, your data will be processed and shared confidentially with only researchers and partners on this project within Europe.

DO I HAVE TO TAKE PART?

Your participation in this study is entirely voluntary. It is solely based on your own decision. If you do decide to take part, you will be required to sign a consent form at the beginning of visit 1.

You can withdraw from the study at any point in time for any reason. Your withdrawal will not influence how you are treated as a participant, and will not affect any medical care you receive. If you decide not to take part, you may withdraw from the study at any time without giving a reason and also with no penalty or consequences of any kind.

If you choose to withdraw from the study at any point, we will retain all of the information collected up to that point in time. This is because we would like to include this information in analyses and reports. If you withdraw from the study and do not want any of your information included in analyses and reports, you can inform us of this and we will delete all of your information and it will not be used in any analyses or reports.

WHAT ARE THE RISKS AND BENEFITS OF MY PARTICIPATION?

We anticipate no risks to you participating in this study other than those encountered in everyday life. It is up to you to decide what you want to share in these one to one interviews. If you feel upset or uncomfortable about anything that is discussed, you can skip specific questions or if necessary, the interview can be stopped straight away.

At the end of the study, information about the health level of your diet and your level of physical function information will be available upon request. You may choose to share this information with your health practitioner and/or family members.

The information you share with us during this study may help health professionals, researchers, and policy makers develop culturally appropriate programmes to promote healthy ageing in our communities.

CONTACT INFORMATION:

If you have any questions or concerns regarding the study, please contact Evans A. Asamane at [redacted] or on [redacted] **or** [redacted]**.** You may also contact the supervisors on the project: Professor Janice L Thompson at [redacted] or on [redacted] or Dr. Carolyn A. Greig at [redacted] or on [redacted]**.**

Thank you so much for considering to take part in this study

If you have any formal complaints about this research, you can contact Professor Brett Smith (Head of Research) by email at [redacted] or Tel: [redacted]

Appendix D2. Participant consent form

UNIVERSITY OF BIRMINGHAM

School of Sport and Exercise Sciences
The University of Birmingham
Edgbaston
Birmingham
B15 2TT
Tel: [redacted]

Dietary intake, eating behaviours and physical function in community-dwelling ethnically diverse older adults: cultural tailoring of assessment methods and identification of key social influences.

Please write your initials in each box:

I confirm that I have read the participant information sheet (Or have had it read to me) and have had the opportunity to discuss the study with the researcher for clarification	
I understand that my participation in this study is entirely voluntary and that I am free to withdraw at any time without penalty and without giving any reason	
I agree to the audio-taping of the face-to-face interviews between myself and a researcher	
I understand that I will be asked to provide information relating to my health, eating behaviors, social networks, cognition, and physical function. This information will be gathered using questionnaires, interviews and testing procedures	
I understand that I will be assigned a unique numeric code/ID, which will be used to confidentiality in publications and reports. I understand that sections of my interviews will be transcribed and quoted, and used to write a doctoral thesis and will be used in academic journals. I also understand that confidentiality will be maintained and it will not be possible to identify me from this quoted material in reports and publications	
I understand that the information collected about me will be stored on a password-protected computer and locked in filing cabinets in a locked room in the School of Sport, Exercise and Rehabilitation Sciences at the University of Birmingham.	
I understand that at the last visit, I will be asked some questions to test my memory	
I agree to take part in the above-titled research study.	

_____ _____ _____

Name of participant Date Signature

_____ _____ _____

Name of researcher Date Signature

If you have further questions about the study, please feel free to contact Evans Asamane at [redacted] or at [redacted] or [redacted] or my lead supervisor Professor Janice L. Thompson at [redacted] or at [redacted]

Appendix D3. Socio-demographic questionnaire

Form 1

Participant ID: _____ Date: _____

Interviewer: Please explain to the participant that the following questions are to gather general information about her age, origin, education, household, and health. Please tick only one box for each question.

1. GENERAL INFORMATION

Age: _____DOB:_____

Country of birth: _____

Ethnicity

Mixed/ Multiple ethnic backgrounds

White and Black Caribbean ☐

White and Black African ☐

White and Black Asian

Other _____ ☐

Asian ☐

Indian ☐

Pakistani ☐

Bangladeshi

Other _____ ☐

Black/ African/ Caribbean

African ☐

Caribbean ☐

Other_____ ☐

Any other _____ ☐

Marital status

Single ☐

Married ☐

Separated ☐

Divorced ☐

Widowed ☐

Number of children _____

How long have you been living in the UK? _____

Education ☐

No qualifications ☐

Primary school ☐

Secondary school ☐

College ☐

University/Higher education

Faith/Religion

Buddhist

Christian

Hindu

Jew

Muslim

Sikh

No religion

Other (please state) _____

2. HOUSEHOLD

Postcode _____

How long have you been living at this address?

How many people are currently living in your household, including yourself? _____

Do you work for pay outside the home? …… Yes ☐ No ☐

If yes, check the box that best corresponds to you

Working full time …… ☐

Working part time …….. ☐

Have you ever worked in the UK? Yes ☐ No ☐

If yes, are you retired? Yes ☐ No ☐

3. HEALTH

How would you describe your health compared to other persons of your age?

Excellent ……. ☐

Good …… ☐

Fair ……... ☐

Poor…….. ☐

Have you been diagnosed with any of these diseases in the past?

….. Yes ☐ No ☐

Hypertension ……... ☐

Diabetes …… ☐

Heart disease and stroke.…….. ☐

Hyperlipidaemia …… ☐

Renal disease ……. ☐

Osteoporosis …… ☐

Arthritis ……. ☐

Cancer …….. ☐

Other: _____ ☐

Do you take any medication? Yes ☐ No ☐

Description: _____

Yes ☐ No ☐

Do you currently smoke?

Frequency_____cigarretes/week Yes ☐ No ☐

Did you use to smoke? For how long (years)? _____

Do you consume drinks containing alcohol? Yes ☐ No ☐

Frequency _____ /week Type_____

Appendix D4. Physical measurement recording form

Form 2

Participant ID: _____ Date of assessment: _____

Physical Measurements

1. Weight (Kg) 1st_____ 2nd_____ 3rd_____ Average of closest 2 values _____

2. Height (cm) 1st_____ 2nd_____ 3rd_____ Average of closest 2 values _____

3. Waist circumference (cm) 1st_____ 2nd_____ 3rd_____ Average of closest 2 values _____

5. Hand Grip 1st _____ 2nd_____ 3rd_____ Average to 2 highest values _____

6. SPPB: Physical function tests recording sheet

4m walking speed

ATTEMPT	≤4.81s	4.82-6.20s	6.21-8.70s	8.71-59.99s	>60s/Unable	Aid used? (circle)	Code non-attempt/fail	Time (circle best)	SCORE
#1	❒ [4]	❒ [3]	❒ [2]	❒ [1]	❒ [0]	No / Stick / Oth			

#2	❒ [4]	❒ [3]	❒ [2]	❒ [1]	❒ [0]	No / Stick / Oth			

Standing balance

	Side-by-side		**Semi-tandem**		**Full tandem stand**		**BALANCE SCORE (SUM)**
	< 10 s	❒ [0] END	< 10 s	❒ [0] END	< 3 s	❒ [0]	
	≥ 10 s	❒ [1]	≥ 10 s	❒ [1]	3-9.99 s	❒ [1]	
					≥ 10 s	❒ [2]	
Time (record *only if* <10s)							
Code non-attempt /fail [0]							

Chair rise(s)

Completed single chair stand? (circle)	**≤11.19s**	**11.20–13.69s**	**13.70-16.69s**	**16.70-59.99s**	**>60s/Unable to complete 5 stands/used hands**	**Code non-attempt/fail**	**Time**	**SCORE**
Yes / No / Used hands [0]	❒ [4]	❒ [3]	❒ [2]	❒ [1]	❒ [0]			

CODES for non-attempt or failure
1 Tried but unable
2 Participant could not hold position/stand/walk unassisted
3 Not attempted, researcher felt unsafe
4 Not attempted, participant felt unsafe
5 Participant unable to understand instructions
6 Other (specify in tables above)
7 Participant refused

PARTICIPANT'S FINAL SPPB SCORE	

Appendix D5. Mini-nutritional Assessment-Short Form (MNA-SF)

Form 3

Participant ID: _____ Date of assessment: _____

SCREENING

A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?

0 = severe decrease in food intake

1 = moderate decrease in food intake

2 = no decrease in food intake

B Weight loss during the last 3 months

0 = weight loss greater than 3 kg (6.6 lbs)

1 = does not know

2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs)

3 = no weight loss

C Mobility

0 = bed or chair bound

1 = able to get out of bed / chair but does not go out

2 = goes out

D Has suffered psychological stress or acute disease in the past 3 months?

0 = yes 2 = no

E Neuropsychological problems

0 = severe dementia or depression

1 = mild dementia

2 = no psychological problems

F1 Body Mass Index (BMI) (weight in kg) / (height in m)^2

0 = BMI less than 19

1 = BMI 19 to less than 21

2 = BMI 21 to less than 23

3 = BMI 23 or greater

Screening score

(max. 14 points)

12-14 points: Normal nutritional status

8-11 points: At risk of malnutrition

0-7 points: Malnourished

Appendix D6. Katz Index of Independence in Activities of Daily Living

Form 4

Participant ID: _____ Date of assessment: _____

ACTIVITIES POINTS (1 OR 0)	**INDEPENDENCE:** (1 POINT) **NO** supervision, direction or personal assistance	**DEPENDENCE:** (0 POINTS) **WITH** supervision, direction, personal assistance or total care
BATHING POINTS: _____	**(1 POINT)** Bathes self completely or needs help in bathing only a single part of the body such as the back, genital area or disabled extremity.	**(0 POINTS)** Needs help with bathing more than one part of the body, getting in or out of the tub or shower. Requires total bathing.
DRESSING POINTS: _____	**(1 POINT)** Gets clothes from closets and drawers and puts on clothes and outer garments complete with fasteners. May have help tying shoes.	**(0 POINTS)** Needs help with dressing self or needs to be completely dressed.
TOILETING POINTS: _____	**(1 POINT)** Goes to toilet, gets on and off, arranges clothes, cleans genital area without help.	**(0 POINTS)** Needs help transferring to the toilet, cleaning self or uses bedpan or commode.
TRANSFERRING POINTS: _____	**(1 POINT)** Moves in and out of bed or chair unassisted. Mechanical transferring aides are acceptable.	**(0 POINTS)** Needs help in moving from bed to chair or requires a complete transfer.
CONTINENCE POINTS: _____	**(1 POINT)** Exercises complete self-control over urination and defecation.	**(0 POINTS)** Is partially or totally incontinent of bowel or bladder.
FEEDING POINTS: _____	**(1 POINT)** Gets food from plate into mouth without help. Preparation of food may be done by another person.	**(0 POINTS)** Needs partial or total help with feeding or requires parenteral feeding.

TOTAL POINTS = _____ 6 = High (*patient independent)* 0 = Low (*patient very dependent)*

Appendix D7. Wenger PANT Scoring Instrument for measuring social networks

Form 5

Participant ID: _____ Date of assessment: _____

Question	Response Codes	Family dependant	Locally integrated	Local self-contained	Wider community	Private Restricted
How far away in distance does your nearest relative live? Excluding spouse	1. Same house/1km 2. 1-5km 3. 6-15km 4. 16-50km 5. 50+ km 9. No relatives	1	2 3	3 4	4 5	4 5
If you have any children, where does your nearest child live?	1. Same house/1 km 2. 1-5km 3. 6-15km 4. 16-50km 5. 50+ km 9. No children	1 2	1 2 3	3 4 9	5	5 9
If you have any living sisters or brothers, where does your nearest sister of brother live?	1. Same house/1km 2. 1-5km 3. 6-15km 4. 16-50km 5. 50+ km 9. No siblings	1 2	1 2 3	2 3 4	5 9	5 9
How often do you see any of your children or other relatives to speak to?	1.Daily 2. 2-3 times a week 3. At least weekly 4. At least monthly 5. Less often 6. Never/no relatives	1 2	1 2	3 4	4 5	5 6
If you have friends in this community/ neighbourhood, how often do you have a chat or do something with one of your friends?	1.Daily 2. 2-3 times a week 3. At least weekly 4. At least monthly 5. Less often 6. Never/no friends	4 5	1 2 3	4 5	1 2 3	5 6
How often do you see any of your neighbours to have	1. Daily 2. 2-3 times a week 3. At least weekly 4. At least monthly 5. Less often	4 5 6	1 2 3	3 4	3 4	5 6

a chat with or do something with?	6. No contact with neighbours					
Do you attend any religious meetings?	1. Yes regularly 2. Yes occasionally 3. No	2 3	1	2 3	1	3
Network type Highest circles						

Burholt network generator questions

a) Who lives in this household with you? (household membership)

(b) How often do you have a chat or do something with one of your friends? After this question the interviewer elicited information on up to five named friends.

(c) If you were ill and could not leave the house, is there someone who would look after you?

(d) Does anyone go to buy food for you?

(e) Does anyone cook for you?

(f) Does anyone help you with any other [than laundry or cooking] household chores?

(g) If you needed advice about money, is there someone you would ask?

(h) If you were feeling unhappy and just wanted someone to talk to, is there someone you would go to?

(i) If you were worried about a personal problem, is there someone you would talk to?

Appendix D8. 24-hour recall recording form

Form 6

Participant ID…… Date of assessment…….....

Date and day food was consumed …….

Time and Place *AM/PM*	*Description of food and Drinks (fresh, frozen, low-fat, etc*	*Amount (weight, volume)*	*Method of preparation and cooking (baked, boiled, grilled, friend, etc.)*	*Where did you eat it*

Would you consider your intake of foods and beverages today to be typical of most days or was it considerably more or less yes no?

Explain why if not typical?

Please do you take any supplements? If Yes

Supplements:

Type/ Brand	*Reason for taking*	*Amount taken*	*Frequency*

Appendix D9. Semi-structured questionnaire for interviews

Form 7

Qualitative in-depth interviews

The topic guide is divided into 4 sections; introduction, eating behaviours, Physical function behaviours, social networks, and other key personal and social influences on dietary intake, eating and physical activity behaviours.

Prior to starting the interview, the researcher will confirm that the participant agrees to an audio-recording of the interview. Once agree, the researcher will begin recording the interview.

1. **Introduction to the interview *(aim = to explain the topics that will be covered during interview and to reassure the person being interviewed)***

The interviewer will confirm that:

- The purpose of the study is to explore their eating behaviours and social network ties, and how these influence healthy life choices.
- I (interviewer) am/is a Doctoral researcher at the University of Birmingham
- You are free to say as much or as little as you wish in response to any line of questioning.
- All information gathered in the interviews will be anonymous and confidential.
- A brief summary of the results of the study will be available after finalising your participation in the study.
-

2. **Eating behaviours**

The main rationale of this section of the interview is to find out more about eating behaviors (all behaviors that relate to food intake namely, grocery shopping, meal planning and preparation, and eating) of ethnically diverse older adults living in a super-diverse city. Some of the major areas this section seeks to explore include:

- Eating behaviors and changes over the course of the year
- Perceptions of healthy eating
- Factors that facilitate and impede the perceived healthy eating behavior practices

Interviewer: Think about the questions I just asked you concerning your food and eating habits during the 24-hour dietary recall interview. Please reflecting back on those responses, I will like to ask you to tell me more about your eating behaviours.

- Please could you describe your eating profile in a typical day? Is this how you would regularly eat? Or was this day unusual?

  Probe: For snacks, fasting, alcohol, fruits and vegetables, eating with others?

- Do you enjoy eating? Why or why not?
- Do you commonly eat with others or are you more likely to eat alone? Do you prefer either of these more than the other?

- To what extent have your eating behaviors changed over the course of your life?
- Can you identify any major changes in your dietary behaviours since you moved to this country? Please can you describe these changes?
- How do you think these changes have influenced your eating and food choices?

  Probe: in food selection, shopping and cooking.
- What does 'healthy eating' mean to you?

  Probe: What do you consider healthy foods to be?
- Do you think that your diet is healthy?

  Probe: healthy or adequate for your needs
- How often do you change or modify your meals to make them healthier?
  Probe
- Do you think living in a super-diverse city has influenced your eating habits and food choices? If yes, in what ways?
- How would you describe the ease or difficulty of eating healthfully in this city?
- Are you responsible for your own cooking? If no, who is responsible for your cooking? Has this changed over time?
- Are you responsible for your own shopping? If no, do you have any input into what is bought for you to eat and drink?
- In what way, do you think the foods you eat affects your physical function

  Probe: By physical function, I mean your strength and energy, ease to get out and about
- Could you describe the importance that cultural traditions and norms have on your eating habits and food choices? If these are important, how do you manage to keep those dietary traditions living in Birmingham? If not important, why?
- If you do still consume traditional foods, do you find it difficult to locate and purchase your traditional foods in Birmingham?

3. Physical Function

The main rationale of this part of the interview is to explore the perceptions of participants' physical function and how their social networks may influence it.

Now, if you think about physical function (your ability to balance, stand from a chair, and walk about easily) This is the test that we did at our first meeting.

- What does 'physical function' mean to you?
- Would you consider yourself as having a good degree of physical function? Why?
  Probe: Explain physical function to the participant.
- Could you please tell me how physical activities fits (or do not fit) into your life?
- What are the most important factors that influence whether you are active or inactive?
- Do you feel that what you eat and how physically active you are affects your physical functioning? If yes, could you describe how? If not, why not?
  Probe: by functioning I mean your walking speed, strength and energy, ease to get out and about.

4. Social network, personal and social influences to healthy dietary intake and physical activity

The purpose of this section is to explore how participants perceive the influences of social networks to making decisions with regards to healthy eating and physical function in a super-diverse community. The section will conclude by finding out how these influences might change with any potential changes in social network structures over the 8-month period of follow-up.

- How would you describe your network ties with family, friends and the community? How have these ties influenced (positively or negatively) your eating behaviors?
- I would like you to think about what it would take to help you eat healthier and to improve on your physical function.
  Probe: Do you think family/friends and community social network ties will support you in making these decisions?
- Has any of these ties changed over time, if yes how has it changed and how does this now impact on the way you eat?
  Probe: Movement/absence/addition of family members and friends (i.e. including those that have died)
- Do you think your living arrangements has positively or negatively influenced your eating patterns over the past 8 or so months? Please explain how your living arrangements may have changed, and if/how this has influence your dietary intake.
- To what extent are you willing to adopt new strategies in order to eat healthier and be more physically active? Do you feel that one is more important than the other?
  Note: Explore if they value diet more than physical activity, or vice versa, and do they feel one is easier to achieve than the other?

Additional questions to be asked at Visit 3 only to explore potential changes in eating behaviours with possible changes in social networks:

- Have your ties with family, friends and the community changed for the past 8 months? If yes:
    - Have these changes affected your eating behaviors over this period of time? What do you think contributed to these changes?
    - What helps you to manage these changes?
    - How do you feel about these changes?

5. Concluding questions

- *Please do you have anything to add?*
- *Please do you have any question to ask me?*

Thank you very much for participating in this interview