IS SOCIAL CAPITAL A DETERMINANT OF ORAL HEALTH AMONG OLDER ADULTS?

AN ANALYSIS OF THE ENGLISH LONGITUDINAL STUDY OF AGEING (ELSA)

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Declaration of authorship

I, Patrick Rouxel, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in this thesis.

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Abstract

Background: A growing body of evidence shows that social capital may affect the health and well-being of older adults. A number of studies also suggest that social capital is a determinant of oral health. However, the evidence for these claims is weak in terms of causal inference criteria such as temporality because previous studies are mostly based on cross-sectional analysis. With the proportion of older adults in the population increasing, there is an urgent need to explore the role of wider social determinants of health that could improve health in later life.

Aims: The aims of this thesis were to examine whether social capital is a determinant of oral health among older adults, and whether this association is explained by socio-demographic, socio-economic, health and behavioural factors.

Methods: Secondary data from waves 3 (2006-07) and 5 (2010-11) of the English Longitudinal Study of Ageing (ELSA) were analysed with 6,977 adults aged 50 and over in the cross-sectional analysis, and 5,385 and 5,114 older adults in the longitudinal and modelling of change analyses respectively. Four measures of social capital were derived from the ELSA study, reflecting structural (membership in organisations and volunteering) and functional (number of close ties and social support) dimensions of the concept. Oral health outcomes were assessed using measures of self-rated oral health, oral health-related quality of life and edentulousness. Binary and multinomial logistic regression models were used to estimate the odds of poor oral health for different levels of social capital, sequentially adjusted for socio-demographic, socio-economic, health and behavioural factors.

Results: There was some evidence that lower levels of social capital were associated with poorer oral health among older adults in the cross-sectional and longitudinal analyses. The size of the statistically significant associations ranged from odds ratios of 1.21 (95%CI:1.01-1.46) to 2.14 (95%CI:1.62-2.84) independent of other dimensions of social capital and several measures of oral health. Poor oral health at baseline (2006-07) also predicted lower levels of social capital 4 years later. There was weaker evidence that positive/negative changes in social capital were associated with improving/worsening oral health. The only consistent finding was the association between low social support and poor self-rated oral health, with odds ratios of 1.36 (95%CI:1.11-1.66) in the cross-sectional analysis, 1.27 (95%CI:1.01-1.60) in the longitudinal analysis, and 1.46 (95%CI:1.13-1.90) in the modelling of change analysis.

Conclusions: Overall, the results of the thesis found weak evidence that low social capital is a determinant of poor oral health among older adults. There was some evidence of longitudinal associations between functional dimensions of social capital and subjective oral health, but little evidence for other measures of social capital and oral health. There was also some evidence that poor oral health predicted low social capital, although this association may not be causal. The changes in functional social capital correspond to plausible changes in an older person's life course, which could result in deterioration in subjective oral health status. One key area of further research is the mechanisms and interventions by which older adults are able to generate and maintain social support and close ties in later life.

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List of abbreviations

CAPI	Computer Assisted Personal Interviewing
CI	Confidence Interval
df	Degree of freedom
DMFT-index	Decay-Missing-Filled-Teeth-index
ELSA	English Longitudinal Study of Ageing
OECD	Organisation for Economic Co-operation and Development
OHIP-14	Oral Health Impact Profile-14
OHRQoL	Oral Health-Related Quality of Life
OIDP	Oral Impacts on Daily Performances
ONS	Office for National Statistics
OR	Odds Ratio
RRR	Relative Risk Ratio
sd	Standard deviation
SROH	Self-Rated Oral Health
WHO	World Health Organisation

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Rapid demographic changes in global ageing populations have led to the concept of 'Active Ageing' and 'Healthy Ageing', which emphasises the participation of older people in social, economic, cultural, spiritual and civic affairs in order to enhance their quality of life (WHO, 2002; WHO, 2012). For the individual, healthy ageing means having a sense of well-being, the capacity for independent activity, meaningful involvement, supportive environments and positive attitudes (Bartlett and Peel, 2005). The role of social engagement in maintaining optimal life satisfaction is an important topic of inquiry within the field of social gerontology (Adams et al., 2011). Research suggests that older people see healthy ageing as an active achievement created through personal effort and supportive social ties in the face of the many challenges that accompany old age (Sixsmith et al., 2014).

Population ageing is a global phenomenon that affects all individuals in society and has consequences and implication for all facets of life such as economic, health, social, cultural and political. The health and welfare expenditure required to care for the post-war baby boom generations now their reaching retirement is expected to increase, and there are debates over how resourcing this additional expenditure may impact negatively on economic growth and disadvantage later-born generations (Kuh et al., 2014). However the implications of population ageing could be viewed more positively if there was evidence that the social determinants of health could result in healthier older adults through active ageing processes. Social capital is one of the key components of the social determinants of health framework (Solar and Irwin, 2010). However, evidence in relation to oral health is more limited. This thesis investigates the role of social capital in relation to oral health among older adults.

1.2 Demographic and oral health transitions

The ageing population of the UK reflects that of many other European countries. It is partly a consequence of the age structure of the population alive today, in particular the ageing of a large number of adults born during the post world war II baby boom period (Kuh et al., 2014), alongside remarkable improvements in life expectancy and lower fertility rates in younger generations (Christensen et al., 2009). In the UK, the proportion of the population aged under 16 has dropped from 25.0% in 1971 to 19.0% in 2010 (ONS, 2011). Meanwhile, the proportion of individuals aged 65 and over has risen from 13.0% in 1971, to 17.0% in 2010. This trend in population ageing is projected to continue. By

2035, nearly a quarter (23.0%) of the population is expected to be 65 years and older. The fastest population increase is occurring among those aged 85 and over, often known as the 'oldest old' (ONS, 2011).

Alongside the increased longevity among older adults, the oral health of older individuals is also changing. More adults now retain some natural teeth (Fiske, 2000; Marcenes et al., 2013), and in later life, fewer rely on complete dentures for oral health functioning. Kiyak (2000) suggested this illustrates the compression of morbidity phenomenon (Fries et al., 2011) as newer generations of older adults have fewer oral health problems. From an oral health perspective, the demographic transition has been complemented by an oral health transition (Tsakos, 2011a). One of the key indicators of oral health is the extent to which any natural teeth are retained throughout a person’s entire lifetime. In 1968, 37.0% of the population of England and Wales were edentate (had no natural teeth at all), and many individuals had lost all of their natural teeth by a relatively young age (Steele et al., 2012). The young edentate adults of 1968 now form part of an older generation of adults, although they are increasingly being replaced by a dentate generation. The proportion of adults in England who were edentate fell by 22 percentage points in the last 30 years, from 28.0% in 1978 to 6.0% in 2009 (Steele et al., 2012). This is a pattern that is also observed in other high and middle income countries (Douglass et al., 2002; Petersen et al., 2010).

However, despite the improvement in some indicators of oral health status, only 17.0% of dentate adults in England were free of any periodontal disease (White et al., 2012). High prevalence rates of coronal dental caries and root surface caries are found among old-age populations in several countries worldwide (Schou, 1995). The available data worldwide shows that dental caries is a major public health problem in older people and closely linked to social and behavioural factors (Schou, 1995; Petersen, 2003; Petersen et al., 2010). A review of dental longitudinal studies of older adults found that older individuals are highly susceptible to caries. The review suggested that older adults experience new dental disease at a rate at least as great as that of adolescents (Thomson, 2004).

Another key demographic feature of oral health are marked socio-economic variations in the population. In the UK, oral health surveys have revealed social class gradients with respect to indicators of oral health such as edentulousness, decay experience, and periodontal disease (Fuller et al., 2011). For instance, the 2009 Adult Dental Health

Survey for England showed that 2.0% of adults of all ages from managerial and professional occupation households were edentate compared to 10.0% of adults from the lowest socio-economic occupational group (Fuller et al., 2011). Among adults in England aged 50 and over, the socio-economic difference in the prevalence of edentulousness is significant - 10.8% of older adults from managerial and professional occupation households were edentate compared to 27.7% of older adults from semi-routine and routine occupational households (Tsakos et al., 2011b).

1.3 Dental public health challenge of older adults

With older adults becoming a larger proportion of the population, society faces the challenge of spiraling health care needs among this demographic group and the need to maintain, enhance and promote individual and population health (Petersen and Yamamoto, 2005). Alongside these shifts in health needs, individuals' expectations about their oral and general health are also changing. For example, there is increasing concern about dental functionality and appearance (MacEntee et al., 1997; Brondani et al., 2007). As older adults include a wide range of individuals with different needs, expectations and aspirations, the dental public health challenge posed by this demographic transition does not have easy or simple solutions.

Oral health has been identified as an integral component of general health. Oral health remains particularly important for the health of older people, as compromised oral health reduces overall general health and quality of life (Gift and Atchison, 1995). Poor oral health, poor general health, and quality of life are interrelated (Kandelman et al., 2008) because of common risk factors (Sheiham and Watt, 2000; Petersen, 2003; Watt and Sheiham, 2012). Indeed, evidence is growing to support links between oral health and general health (Kandelman et al., 2008; Tsakos and Quiñonez, 2013). For instance, epidemiological studies have shown that periodontal disease is associated with diabetes mellitus (Mealey, 2006), atherosclerosis and heart disease (Joshipura et al., 1996; Janket et al., 2003; Lockhart et al., 2012) and chronic respiratory disease (Azarpazhooh and Leake, 2006), while number of teeth and tooth loss (Hämäläinen et al., 2003; Holm-Pedersen et al., 2008; Österberg et al., 2008; Padilha et al., 2008; Holmlund et al., 2010; Hayasaka et al., 2013) and even oral health care such as tooth brushing, dental attendance, and use of dentures (de Oliveira et al., 2010; Hayasaka et al., 2013), have been shown to be risk factors for disability, cardiovascular disease and mortality. Tooth loss has also been linked with increased risk of ischemic stroke (Joshipura et al., 1996; Janket et al.,

2003) and poor mental health (Schou, 1995).

Oral health status in older adults is also an important determinant of nutritional status (Walls and Steele, 2004; Moynihan, 2007; Mesas et al., 2010). Oral health impairment such as tooth loss (Ritchie et al., 2000), lack of or inadequate prosthetic rehabilitation (Weyant et al., 2004; Yoshida et al., 2005) and the presence of pain or discomfort related to caries (Allen, 2005) may restrict the selection, and mastication of foods by older adults. The retention of 21 or more natural teeth is widely used to define the minimum number of teeth consistent with a functional dentition (Steele et al., 2012). This goal for oral health is necessary for the maintenance of a good masticatory performance, enabling most dentate individuals to eat what they want in comfort, and to support a healthy diet, a satisfactory nutritional status, and an acceptable body mass index (Sheiham et al., 2002; Marcenes et al., 2003). Impaired dentition imposes dietary restriction and affects food taste, food selection and food eating patterns (Sheiham et al., 2001; Nowjack-Raymer and Sheiham, 2007; de Marchi et al., 2011). This process of oral health ageing can compromise nutritional status over time and place older people at greater health risk (Chauncey et al., 1984).

Research has demonstrated that oral health also impacts on the quality of life of older individuals (Slade and Spencer, 1994; Mojon et al., 2004; Gerritsen et al., 2010). Good oral health is important for social interaction (Petersen and Nortov, 1989; Donnelly and MacEntee, 2012; Tsakos et al., 2013) and general well-being (Petersen and Yamamoto, 2005; Gerritsen et al., 2010; Thorstensson and Johansson, 2010). Older adults are often vulnerable, and may require help in maintaining their independence and preserving their confidence in oral health functioning activities such as eating, talking and smiling (Chalmers, 2003). These are key social behaviours that affect communication and interaction with other people; any impairment in such oral health functioning could lead to lower self-esteem and well-being (Locker et al., 2000; Locker et al., 2002; Naito et al., 2006; Jensen et al., 2008; Kandelman et al., 2008). Moreover, psychological factors such as stress and depression are risk factors for poor oral health (Locker, 2009).

1.4 Social determinants of oral health

'If we really want to make a difference to inequalities in dental health, we must address the causes of the social distribution of the causes of dental illness' (Marmot and Bell, 2011).

The social determinants of health have been described as 'the causes of the causes' (Rose, 1992). They are the social, economic and environmental conditions that influence the health of individuals and populations (Venkatapuram et al., 2010). They include the conditions of daily life and the structural influences upon them (Dahgren and Whitehead, 1992), shaped by the distribution of money, power and resources at global, national and local levels (WHO, 2012), and themselves influenced by policy choices (Campbell, 2010). For many years, population health studies have concentrated on clinical risk factors. Currently population studies have evolved and incorporated non-medical indicators, particularly those related to the social field. However, research into the social determinants of oral health has been limited by the absence of a theoretical framework, which reflects the complexity of real life social processes and the network of causal pathways between social structure and oral health and disease (Newton and Bower, 2005).

In most studies of oral health, social determinants are treated as isolated risk factors for individuals. There is little attempt to investigate how such social determinants relate to other oral health determinants across the life course. There is a paucity of studies on the characteristics of social life that impact on individuals' oral health that go beyond simplistic individual level risk factors (Newton and Bower, 2005). Further, it has been argued that the social determinants of health framework also applies to oral health (Watt, 2012). Watt (2012) claimed that there was too much emphasis placed upon the proximal behavioural causes of oral inequalities and little focus on tackling the more distal upstream causes of the social gradients in oral diseases. Furthermore, aetiological models based on biological processes of oral diseases have been demonstrated to only partially explain oral health inequalities among population (Watt, 2002; Sisson, 2007; Watt, 2007). In contrast to the bio-medical model of disease, the social determinants of health approach has been suggested as a more complete framework for explaining oral health inequalities. In this context, social capital has been recognised as a key social determinant of health, or as recently defined by WHO, a crosscutting determinant of health (Solar and Irwin, 2010).

1.5 Social capital and oral health

The concept of social capital occupies a key but contested place in the conceptual framework on the social determinants of health (Solar and Irwin, 2010). Social capital cuts across different levels of social life with features related to upstream structural social processes such as political context and socio-economic position, as well as more downstream intermediary determinants of health including material and psychological circumstances; behavioural and biological factors. In the last two decades, the interest in social capital has increased exponentially in the public health field with social capital and related concepts being increasingly used to explain health outcomes and health inequalities. However, social capital is a contested concept with debates on its definition, measurement, and application (Portes, 1998; Muntaner, 2004; Navarro, 2004). Furthermore, social capital has been translated into the dental public health field with relatively little attention paid to the key questions posed by these broader debates. In recent years, its popularity in dental public health stems partly from a potential promise that social capital as an oral health determinant could lead to better oral health in the population (Zarzar et al., 2012).

A growing body of research has revealed that social capital might have an influence on oral health. However, there has been little attempt to critically evaluate the limitations of existing studies on this topic. There have been claims made that social capital was a determinant of oral health (Zarzar et al., 2012), although the evidence base for these claims was weak. Hence the overall aim of the thesis is to examine whether social capital is a determinant of oral health among older adults.

Ageing is a story of change in individuals, as they grow older. Many aspects of their lives tend to change including the array of people with whom they are connected, their social context, their families and their health (de Nooy, 2011; Broese van Groenou et al., 2013). Ageing is also a story of losses: losses of physical and mental function, loss of job, loss of family, friends and loss of spouse. These losses take place at different rates for different individuals and groups. Individuals often adapt to losses with change in their behaviour, environment, making ageing a complex and dynamic process (Waite and Das, 2010).

This study focuses on older people, social capital and oral health, motivated by three main reasons. Firstly, strengthening good health and preventing ill-health are important strategies for ‘active and healthy ageing’ (WHO, 2002; WHO, 2012). Oral health as part of general health is essential to the well-being of the population. Secondly, a growing body of evidence in the gerontological literature advocates that some aspects of social capital may have a significant positive effect on older people. Social interaction and social support may be one of the cornerstones for ageing well. Thirdly, there are no studies that have examined whether social capital is a determinant of oral health in older adults using longitudinal data from a large national population sample. The English Longitudinal Study of Ageing (ELSA) provides a unique opportunity to explore the association between social capital and oral health, since it is a rich interdisciplinary data resource on health, economic position, psychosocial factors and quality of life as people age.

1.6 Summary of the remaining chapters

Chapter 2 presents a review of the concepts of social capital and their application to general health and oral health. This includes a review of studies on social capital and general health; social capital and mental health; social capital and health in older populations; social capital and oral health; and the potential pathways linking social capital and health. The gaps in the literature are highlighted. This is followed by the conceptual framework, the aims, objectives and hypotheses of the thesis.

Chapter 3 describes an overview of the secondary data used in this thesis, the ELSA study, and outlines in detail the data and the analytical strategy. The description of the data includes the study population, a brief account of the sampling procedures, data collection process, and variables. The analytical strategy is also discussed which includes the rationale for sampling restrictions and statistical analysis.

Chapter 4 investigates the cross-sectional association between structural and functional aspects of social capital and oral health in wave 3 of ELSA (2006-07). This chapter also investigates the role of covariates in explaining the cross-sectional association between social capital and health.

Chapter 5 The longitudinal association between social capital and oral health is examined with the assumption that lower social capital at wave 3 is associated with poorer oral health status at wave 5 (2010-11). Furthermore, in order to examine whether lower levels of social capital is a consequence of poor oral health, these associations are analysed in reverse temporal order, i.e. poorer oral health at wave 3 predicting lower social capital at wave 5.

Chapter 6 examines the dynamic of change in social capital and change in oral health-related outcomes between wave 3 and wave 5. This chapter addresses the nature, size and direction of change in the three oral health outcomes and how they are associated with change in social capital.

Chapter 7 summarises the main findings in relation to the objectives and hypotheses of this thesis and discusses them in the light of previous studies, methodological considerations and future research and policy implications.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Social capital has become a popular concept in public health research in recent years, however its precise meaning has been contested since its inception. It has been linked to diverse social outcomes, including: families and youth behavioural problems; schooling and education; community life; work and organisations; democracy and governance; economic development; criminology; and public health (Kawachi and Berkman, 2000). The potential for social capital to make a positive contribution to outcomes in these diverse areas captured the interest of policy makers, social analysts and researchers. Furthermore, it has also been conceptualised as a social determinant of population health, which can potentially explain social inequalities in health (Uphoff et al., 2013).

Despite the enthusiasm for the use of social capital in public health, the concept has also been highly criticised, being identified as both a 'falsely inflated' concept and as a 'new term for an old product' (Labonte, 1999), or 'old wine in new bottles' (Kawachi et al., 2004). Critics of social capital claim that it does not contribute any new sociological ideas and that public health researchers have a tendency to combine different social phenomena under the umbrella term of 'social capital' (Portes, 1998; Szreter and Woolcock, 2004; Kawachi et al., 2008b). Furthermore, the evidence that links social capital with population health derives from a large variety of disciplinary backgrounds and methodological traditions. Results from different studies on social capital are difficult to compare because of the lack of consistency and the multiple ways of conceptualising, operationalising and measuring social capital (Oksanen, 2009).

The purpose of this chapter is to present a critical review of the different conceptualisations of social capital and their application to general, mental and oral health. The review is divided into the following sections. First, a number of concepts, definitions and measurement issues of social capital are discussed and criticised (sections 2.2 to 2.5). This is followed by an overview of the literature on social capital and general health; social capital and mental health; social capital and health in older populations and social capital and oral health (sections 2.6 to 2.8). In section 2.9, the potential pathways linking social capital and health are then discussed. The gaps in the literature with regard to social capital and oral health are highlighted in section 2.10. This is followed by the conceptual framework of the thesis, and the aims, objectives and hypotheses of the study (sections 2.11 and 2.12).

2.2 Approaches and definitions of social capital

The idea of social capital can be originally traced to the work of Alexis de Tocqueville (1805-1859), Emile Durkheim (1858-1917), Karl Marx (1818-1883), and Georg Simmel (1858-1918) (Portes, 1998). The first known reference to "social capital" in its contemporary sense was used in the context of its importance for education and local communities, by a social reformer, Hanifan (1916), who was a state supervisor of rural schools in West Virginia, USA. He defined social capital as: *'those tangible assets...namely good will, fellowship, sympathy, and social intercourse among the individuals and families who make up a social unit...If an individual comes into contact with his neighbour, and they with other neighbours, there will be an accumulation of social capital, which may immediately satisfy his social needs and which may bear a social potentiality sufficient to the substantial improvement of living conditions in the whole community'*.

Since then, it took several decades before the concept was further developed by the principal theorists: Pierre Bourdieu (1980; 1986), James S. Coleman (1988; 1990), and Robert D. Putnam (1993; 2000).

2.2.1 Bourdieu: Symbolic capital

The French sociologist Pierre Bourdieu (1980) is acknowledged to be the first to dedicate an entire work to the concept of social capital, while further refinements came from Coleman (1990), Putnam (1993), and Portes (1998) among others.

Social capital as defined by Bourdieu (1986) is: *'the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalised relationships of mutual acquaintance and recognition'*. In Bourdieu's definition, social capital has two components: first, it is a resource that is connected with group membership and social networks: *'The volume of social capital possessed by a given agent...depends on the size of the network of connections that he can effectively mobilise'* (Bourdieu, 1986). It is a quality produced by the totality of the relationships between individuals, rather than merely a common quality of the group (Bourdieu, 1980).

The second characteristic of social capital is that it is based on mutual cognition and recognition (Bourdieu, 1980; Bourdieu, 1986). That is how it acquires a symbolic character, transforming into symbolic capital (Bourdieu, 1986): *'Symbolic capital...is* *nothing other than capital, in whatever form, when perceived by an agent endowed with categories of perception arising from the internalization (embodiment) of the structure of its distribution, i.e. when it is known and recognised as self-evident'* (Bourdieu, 1985).

Bourdieu's analysis of the concept is instrumental, going as far as noting that people intentionally build their relations for the benefits that they would bring later (Bourdieu, 1985). The unequal distribution of power and prestige is at the centre of his theory of social capital. Bourdieu's concept is connected with his theoretical ideas on social class. In "The Forms of Capital", Bourdieu (1986) differentiated three dimensions of capital each with its own relationship to class: economic, cultural, and social capital; and illustrated how they are distinguished from one another according to how easily they are transmitted. Bourdieu contended that this conversion process is used by individuals and social groups to ensure the reproduction of capital. Differences in the control of social capital may explain why the same amount of economic and cultural capital can yield different degrees of profit, and different powers of influence to different individuals. This conceptualisation suggests an interaction effect between social capital and other forms of capital on individual well-being and profit. Group membership creating social capital has a multiplicative effect on other forms of capital (Bourdieu, 1986). Voluntary associations as social capital can be understood as resources produced by the association as a collective and shared by its members. Thus social capital for Bourdieu is a collective phenomenon, even though it is viewed from the perspective of individuals who are exploiting its possibilities to gain economic and social power (Bourdieu, 1980; Bourdieu, 1986).

The Bourdieu approach is an important reminder that social capital can be exclusionary and contribute to the reproduction of inequalities. However, few empirical studies have incorporated his concept of social capital (Portes, 1998; Carpiano, 2008). Many sociologists refer to American sociologist James S. Coleman's concepts, whose definition of social capital overshadows the conflict-oriented definition of Bourdieu.

2.2.2 Coleman: Civic society and education

Coleman introduced social capital as a conceptual tool for understanding a theoretical orientation to social action that combines components of both sociological and economic perspectives. In his book on the foundations of social theory, Coleman (1990) associated social capital with social relationships that are formed between individuals: *'Social* *capital would therefore be constituted by relationships of authority, relationships of trust and norm...Like other forms of capital, social capital is productive, making possible the achievement of certain ends that would not be possible in its absence...Contrary to other forms of capital, social capital inheres the structure of relationships between persons and among persons. It is lodged neither in individuals nor in physical implements of production'* (Coleman, 1990).

Coleman made a distinction between social, physical and human capital based on the way by which the capital is created. He stated that physical capital is created by change in the materials that facilitate production and human capital by change in the personal skills and knowledge that help people to act in new ways. Coleman (1990) defined social capital as a property of social structures that have an influence on individuals. He further argued that if the social environment lacks social capital networks, social exchange would tend to be inefficient in the same ways that barter economies cause inefficient allocation of goods. Thus, social capital refers to the resources gained through social ties, membership of networks and sharing of norms. This definition includes not only the largely informal and local relationship, but also the more formalised institutions such as government, political regimes, and rule of law, courts system, and civil and political liberties.

Both Bourdieu and Coleman were concerned with the links between individuals and small groups, in particular families, and wider social organisations and institutions. While Coleman was concerned by social consensus and control, Bourdieu was more concerned with class-based power conflicts. Coleman's definition could be viewed as naively optimistic, as social capital is viewed almost entirely benign in its functions with little attention paid to structural inequalities and power relations. In contrast, the conflict-oriented nature of Bourdieu's approach describes a 'dark-side' for the oppressed, and a 'bright-side' for the privileged (Field, 2003). The basic idea behind this scenario depicts a situation where the category of people who are privileged in terms of economic and cultural capital acquire, accumulate and use social capital whereas a lack of economic and cultural capital might prevent individuals from accessing social capital.

While important differences exist between the works of Bourdieu and Coleman, both approached the study of social capital in terms of resources found or accessed through a person's social relationships (Portes, 1998).

2.2.3 Putnam: Civic participation

The real expansion in the use of the concept of social capital was stimulated by the work of political scientist Robert Putnam. He defined social capital as: *'the characteristics of the social organization such as networks, norms and social trust that facilitate coordination and cooperation for mutual profit'* Putnam et al. (1993). Putnam's concept of social capital has three components: moral obligations and norms, social value, especially trust, and social networks represented mainly by voluntary associations. Putnam described social capital as a sociological concept used in business, economics, organisational behaviour, political science, public health and the social science in general, to refer to connections within and among social networks. Similar to physical and human capital, social contacts can increase the productivity of individuals and groups (OECD, 2001).

Putnam et al. (1993) focused on explaining the institutional performance and socio-economic development of certain regions in Italy. The findings led to a classification of the regions according to their level of civic vitality and, subsequently, to the establishment of a link with their socio-economic development. In a community, the presence of citizen's networks, such as neighbourhood associations, choirs, cooperatives, sports clubs and political parties, reflects an intense horizontal interaction (Putnam et al., 1993). For Putnam et al. (1993), interactions among people in groups and organisations create horizontal networks of civic engagement that help participants to act collectively in a way that has an impact on community productivity and well-being (OECD, 2001), and to a large extent, determine the future economic and political development of the region.

Putnam's arguments have been criticised as being circular and tautological – *'as a property of communities and nations rather than individuals. It could be argued that in his theory, social capital is simultaneously a cause and an effect. It leads to positive outcomes, such as economic development and less crime, and its existence is inferred from the same outcomes'* (Portes, 1998). His theory of social capital also presumes that the more an individual connects with other people, the more is their mutual trust (Putnam, 1995). This guides the assumption that more social capital is always better and as a result, poverty alleviation and health interventions should aim primarily at increasing social capital. This assumption can be dangerous because it ignores social capital's repressive dimensions (Portes, 1998; Aguilar and Sen, 2009) and the influence of power and politics (Navarro, 2002).

2.2.4 Fukuyama: Civil society and development

In a perspective that converges with that of Putnam, the American political and economic scientist Francis Fukuyama (1995a) emphasised the cultural dimension of economic life. Specifically, culture was considered as the source of the differences in economic performance among countries. Comparing Western countries with those of South East Asia, Fukuyama distinguished two types of societies, those centered on the family (China, France, Italy and South Korea), and those centered on trust (Japan and Germany). The latter have large business corporations that are not family-based. Work relations in these companies are more efficient and satisfying and the work can be organised along more innovative lines. Furthermore, Fukuyama considered social trust as the principal component of social capital: *'Social capital is a capability that arises from the prevalence of trust in a society or in certain parts of it. It can be embodied in the smallest and most basic social group, the family, as well as the largest of all groups, the nation, and in all other groups in between'* (Fukuyama, 1995b).

Fukuyama is best known for working within an economic framework rather than a sociological one like Coleman or a political science perspective like Putnam (Harper, 2001). Indeed, strong support for including macro-level aspects of society comes from economic institutions, such as the Organisation for Economic Co-operation and Development (OECD) and the World Bank.

2.2.5 Organisation for Economic Co-operation and Development (OECD): Collective action and cooperation

The OECD defined social capital as: *'Networks together with shared norms, values and understandings that facilitate co-operation with or among groups'* (OECD, 2001). Their concept of social capital is relational in nature rather than being the exclusive property of any one individual. Social capital can be considered as a public asset in that it is shared by a group, and is produced by societal investments of time and effort. The cultural context in which shared attitudes, values and knowledge are transmitted from generation to generation are important in understanding the choices of individuals and groups in relations to co-operation. Shared norms and values enable people to communicate and make sense of common experiences, as well as divergences in some norms and values (OECD, 2001).

Various UK government departments have adopted the OECD definition of social capital (Harper and Kelly, 2003; Babb, 2005; Foxton and Jones, 2011). This is partly because it was produced by the OECD, a well-recognised and respected international organisation. The definition was also drawn from an extensive international literature review covering both the conceptual issues and frameworks for measurement (OECD, 2001). Finally, the definition suggests social capital is an attribute of the group rather than the individual, making the concept more attractive in terms of policy interventions. With the group approach, everyone living in an area of high social capital benefits even if individuals within the group have low social capital (Harper, 2002).

2.2.6 World Bank: Pro-social development and institutions

The World Bank included institutions in their definition of social capital. According to the World Bank social capital refers to: *'the institutions, relationships and norms that shape the quality and quantity of a society's social interactions'* (Grootaert and van Bastelaer, 2002*). 'Social capital is not just the sum of institutions, which underpin a society, but the glue that holds them together' and 'without which there can be no economic growth or human being. Without social capital, society at large will collapse'* (Krishna and Uphoff, 1999).

The notion of social capital is closely related to the notions of social cohesion and human capital (World Bank, 1998). It is generally agreed that social capital is both a consequence and a cause of social cohesion (Schuller, 2001). 'Social cohesion is the ongoing process of developing a community of shared values, shared challenges and equal opportunity, based on a sense of trust, hope and reciprocity among individuals' (van Kemenade, 2003). Social capital is an asset of civil society that strengthens social cohesion. Work at the World Bank on the role of social capital in reducing poverty and promoting sustainable development has emphasised the role of institutions, social arrangements, trust and networks. Papers in the Social Capital Initiative Working Papers Series (World Bank, 2014) indicate that the size and density of social networks and institutions, and the nature of interpersonal interactions, affect the efficiency and sustainability of development programs. The World Bank has played a major role in promoting the concept regarding it as an important development tool or the 'missing link' (Grootaert, 1998), which is essential for alleviating poverty and achieving societal development, along natural capital, physical capital, and human capital (Grootaert and van Bastelaer, 2001).

2.2.7 Social capital and public health

The concept of social capital has provoked debates and provided exciting opportunities for public health research to understand the social processes behind health and health inequalities (Solar and Irwin, 2010). Social capital has entered the field of public health and epidemiology through the work of Wilkinson (1996) who introduced Putnam's notion of social capital to the public health field (Szreter and Woolcock, 2004). Wilkinson (1996) examined the relationship between health, as measured by mortality statistics, and social inequalities. He showed that in the developed world, it is not the richest countries that have the best health, but those with the smallest income inequalities. He suggested that the concept of social capital might be an explanation for his findings, because egalitarian societies are more socially cohesive.

Giving force to Wilkinson's arguments, the concept of social capital was used to explain inequalities in health, particularly the relationship between income inequality and mortality. Based on the works of Putnam, Kawachi et al. (1997b) demonstrated that social trust and group memberships were associated with all-cause mortality. In addition, social capital was thought to operate as a mediating variable between income inequality and mortality. Since then a growing body of evidence has suggested that social capital is a determinant of population health (see section 2.5).

In public health there are two distinct theories of social capital, a theory of social cohesion or communitarian, and a theory of social networks (Kawachi, 2006). The communitarian approach emphasises social capital as a group attribute and analyzes it as a contextual influence on individual health. In contrast, the network theory defines the concept in terms of resources that are embedded within an individual's social networks. However, as pointed out by Kawachi (2006), these two approaches are not mutually exclusive.

2.2.7.1 The communitarian approach

The communitarian approach in public health research looks at the number and density of local organisations such as clubs, associations and civic groups in a given community. This approach assumes that social capital is inherently good, and its presence always has a positive effect on a community's welfare (Putnam et al., 1993; Fukuyama, 1995a; Fukuyama, 1995b; Putnam, 1995; Kawachi et al., 1997a).

The terms social capital, social cohesion and sense of community although closely related, often were used indiscriminately (Putnam et al., 1993; Wilkinson, 1996; Kawachi et al., 1997a; Kawachi et al., 1997b; Kawachi and Berkman, 2000). Social capital includes several dimensions while social cohesion and a sense of community might be regarded as outcomes, as well as sources (Ferlander, 2007).

2.2.7.2 The network approach

In contrast to the communitarian approach, the network approach considers social capital in term of resources that are embedded within an individual's social network (Lin, 1999; van der Gaag and Webber, 2008), and focuses on how individuals gain returns through access to social networks. This approach takes into account both the positive and negative effects of social capital (van der Gaag and Webber, 2008). This is the most common approach in sociology (Bourdieu, 1985; Coleman, 1990; Portes, 1998; Lin, 2001). A network-based approach to social capital implies that decisions taken by groups or individuals are influenced by social contexts (Carpiano, 2006; Moore et al., 2006; Carpiano, 2007).

In the field of public health, Kawachi and Berkman (2000) had in previous work distinguished between social capital/social cohesion, social networks, and social support. They defined social capital as an ecologic characteristic of the human sociality, external to the individual, inherent in the structure of relationships, and a public good. They used social cohesion as a surrogate term for social capital, referring to the degree of connectedness and solidarity among groups in society. The authors further differentiated social capital from social network and social support. Social capital was considered a community-based concept, while social networks and social support were defined as characteristics measured at the individual level, as it 'makes no sense to measure social capital at individual's level' (Kawachi and Berkman, 2000). Nonetheless, a number of studies on social capital and health have examined individual level social capital, including one co-authored by Kawachi (Kim and Kawachi, 2006). This is an approach that has dominated public health research (Navarro, 2002). Even though, both Putnam and Coleman included networks in their definition of social capital, the term was absent from Kawachi's version. The networks approach to social capital has been largely ignored in public health research (Moore et al., 2005; Moore et al., 2006). However in more recent work, Kawachi et al. (2008a) have reconsidered their approach on the concept of social capital. Firstly, they recognised that social capital is both an attribute of individual and group. Secondly, that social capital should be conceptualised as social cohesion and as resources embedded in networks. In addition, Kawachi (2006) recognised that social capital could produce both socially positive and negative outcomes. Going further, they highlighted that in some future date, an international consensus of scholars *'...might agree to reserve the use of the term social capital only to refer to network-based resources, and to expel social cohesion from the umbrella of the label'* (Kawachi et al., 2008b).

2.2.8 Social capital: Commonalities and criticisms

The various definitions and applications of social capital identified in the literature seem to have some commonalities that they focus on social relations that have productive benefits. Since social capital has multiple origins developed across different disciplines, there is no consensus in definitions. This poses the greatest challenge to the social capital debate. The definitions vary depending on whether they focus on the substance, the sources, or the effects of social capital (Grootaert and van Bastelaer, 2002).

There has been an attempt to dichotomise the theories mentioned above (Ferlander, 2007). Kawachi et al. (2008a) distinguished between the network approach and the social cohesion approach. The network approach reflects Bourdieu's conceptualisation of social capital as an individual attribute where resources are accessible through one's social networks. The social cohesion or communitarian approach aligns with Coleman, Fukuyama and Putnam's concept of social capital as a collective attribute comprised of social trust, reciprocity and effective norms. The diversity of interpretations has led to a lack of consensus about what precisely constitutes social capital. Critics of the concept recognised its value in focusing on sociability and the way that informal networks can help individuals to generate and access information and resources (Portes, 1998). Much of the controversy surrounding social capital has to do with its application to different types of problems and its use in theories involving different units of analysis. The most frequent criticism of the literature on social capital is that the concept has been stretched, modified, and extrapolated to cover so many types of relationships, at so many levels of individuals, groups, institutional, and state analysis that the term has lost all heuristic value (Portes, 1998; Woolcock, 1998; Macinko and Starfield, 2001). This lack of consistency regarding the use of social capital is reflected in the lack of clarity on how to measure the concept and in the variety of constructs and labels that are used to refer to social capital such as social network, social support, social resources, social cohesion, informal social control.

For Coleman, community ties are important for the benefits they yield to individuals (Coleman, 1990). A subtle transition took place as the concept was exported into other disciplines where social capital became an attribute of the community itself. This conceptual stretch initiated by the political scientist Putnam, described the ‘stock’ of social capital possessed by communities and even nations and the consequent structural effects of their development (Putnam et al., 1993). Individual and collective benefits derived from primordial ties are not incompatible. But social capital as a property of cities or nations is qualitatively distinct from its individual version (Portes, 2000).

Criticisms of Putnam’s work (1993; 1995) focus on the lack of theoretical specificity in the link between associational life, high social trust and better government. In empirical studies, Putnam’s civil society is reduced to the examination of the function of voluntary associations, which consist mainly of sports clubs and cultural association (Putnam et al., 1993). This dimension, that is, horizontal interaction and reciprocity, forms the basis for what Putnam defined as civic engagement or people’s participation, on a broader scale than that of politics, in the life of their communities (Putnam et al., 1993). In his thesis of the decline of social capital in the US, Putnam (2000) used the example of declining participation over the years in traditional parent-teachers associations, without taking account of alternative parent-teacher organisations that could represent bridging social capital (van Rooy, 2001).

Concepts of network social capital have also been criticised. It is closely related to social support, and several authors have questioned the validity of network social capital (McKenzie et al., 2002; Kawachi et al., 2004). They stated that network social capital theory is simply re-labelling terminology (Kawachi et al., 2004) and that the contribution of the concept of social capital has to be found at the collective level.

Another criticism of the concept of social capital is that it has been exported wholesale from the US to other countries, ignoring the cultural context. Putnam did not discuss conflicts between interests, such as conflicts between different parts of civil society that do not share the same political, or cultural values. Putnam also did not mention conflicts between the civil society and the political society, focusing on the integrative functions of voluntary associations (Mouritsen, 2001).

A crucial limitation of many theories of social capital is that they assumed social capital to be a societal good, while ignoring its negative effects. For instance, Halpern (1999) suggested that organised crime or gangs involve a social network, which entails shared norms but they do not constitute a societal good. Portes (1998) listed the negative consequences of social capital as the exclusion of outsiders, restriction on individual freedom and a downward leveling of behavioural norms with potentially adverse outcomes. For instance, strong ties that are needed for people to act together can lead members of a community to exclude others, such as the poor or minority groups. Moreover, a community with strong social capital can exercise tight control over its members, which may increase the level of conformity and reduce the degree of privacy or autonomy. Thus, social capital and the resulting levels of social norms and social control might be demanding and place large claims on community members. Social capital can also foster downward leveling norms that undermine individuals within the group who want to improve their situation (Portes, 1998).

Like other forms of capital, there is considerable evidence to suggest that there is an uneven distribution of social capital in society, organised along such dimensions as social class, gender, sexuality, age, ethnicity and locality (Ferlander, 2007). Field (2003) explained the negative consequences of social capital in two respects. First it may reinforce inequality, that is, attributed to power asymmetry. Second it may play a part in supporting antisocial behaviour, related to the idea of a downward leveling of social norms (Portes, 1998).

Muntaner et al. (2000) also warned against a benign view of social capital. They argued that one of the implications of the social capital hypothesis in public health is that transferring the responsibility of health care from the state to the civic society might understate the structural sources of health inequalities.

There has also been a concern that focus on social capital might detract attention from socio-economic inequalities, and that policy makers may be tempted to hand over responsibility to local communities and neighbourhood associations, thus reducing the need for upstream structural interventions by the state. Muntaner and Lynch (1999) warned that *'an emphasis on social cohesion can be used to render communities responsible for their mortality and morbidity rates: a community-level version of blaming the victim.'* Kawachi et al. (2004) has accepted that *'unbridled enthusiasm for the adoption of social capital in public health has generated a backlash and some of the criticisms, for example, the perception that social capital is a cheap solution for solving public health problems, or the tendency to view social capital as a panacea whilst ignoring its negative aspects, are justified'.*

By analysing several concepts of social capital, Pawar (2006) highlighted that many definitions missed an important element, selflessness or altruism, and argued that often individuals offer help and provide support without expecting anything in return. While Putnam et al. (1993) defined social capital as 'trust, norms and networks' that facilitate cooperation for mutual profit, Pawar (2006) claimed that *'Trusting relationships and social interactions need not and do not always have mutual expectations and benefits'*. However in a free-market based society, it would be naive to assume that the interest of individuals, governing institutions, and businesses in social capital is completely altruistic.

2.3 Dimensions and forms of social capital

As a result of the different concepts and theories of social capital, it is important to distinguish between the different forms and dimensions of social capital because their associations with health may vary (Putnam, 2000; Putnam, 2001; Harpham et al., 2002; Stone and Hughes, 2002; Kawachi et al., 2004; Szreter and Woolcock, 2004; Islam et al., 2006; Kim et al., 2006; Ferlander, 2007; Kawachi et al., 2008a). A multi-dimensional approach may help to understand the range of outcomes observed in the literature (Woolcock, 2001).

Islam's et al. (2006) conceptualisation of social capital, based on other works (Putnam et al., 1993; Krishna and Uphoff, 1999; Harpham et al., 2002; McKenzie et al., 2002; Szreter and Woolcock, 2004) categorised social capital into two aspects, cognitive and structural social capital, and into two dimensions horizontal and vertical social capital (Figure. 2.1).

Figure 2.1: Dimensions and forms of social capital with operationalisation of the notion in empirical studies

Sources: Adapted from Islam et al. (2006)

2.3.1 Functional or cognitive social capital

Functional social capital includes norms, values, attitudes and beliefs. That refers to 'what people feel' (social cohesion, trust, social support), which can be subjectively measured (Harpham et al., 2002). The functional component assesses individuals' perceptions of the level of interpersonal trust, sharing and reciprocity and is thought to relate to the quality of social relations.

2.3.2 Structural social capital

Structural components of social capital refer to externally observable aspects of social organisation such as the density of social networks, or patterns of civic engagement. That refers to 'what people do' (associational links, networks) and objectively measured (Harpham et al., 2002). The structural component examines the extent and intensity of associational links and activity in society such as measures of informal sociability, density of civic associations, and indicators of civic engagement. Furthermore, two distinct dimensions of social capital are recognised: Horizontal and vertical (also refers to linking) social capital.

2.3.3 Horizontal social capital

Horizontal social capital, that reflect ties that exist among individuals or groups of equals or near equals, has been divided into two types 'bonding' and 'bridging'.

Bonding and bridging social capital

Bonding social capital describes ties and networks among homogeneous groups, those based on family, ethnicity, and/or religion. Typically, but not always, such ties are dense and predicted on high levels of inter-personal trust and may be useful for 'getting by' in life (Putnam, 2000; Woolcock and Narayan, 2000). In other words, bonding social capital often fulfills a protective role and may facilitate immediate integration for the most vulnerable. In contrast, bridging capital is heterogeneous and refers to weak social ties across diverse groups (ethnic, regional, socio-economic) including formal or informal social interactions (Granovetter, 1973). Bridging may be more useful in connecting people to external assets that help them for 'getting ahead' (Putnam, 2000; Woolcock and Narayan, 2000). Bridging is important to the success of civil society and also recognised as an important source of benefits for individuals, communities, and societies (Granovetter, 1973).

Some types of bonding social capital can have a negative impact in the sense that close ties and in-group trust can exclude outsiders (Portes and Landolt, 1996; Portes, 1998; OECD, 2001). This reinforces intolerance within social or political groups, and creates a context for the growth of reactionary ideology such as sectarianism (Harper, 2001), religious bigotry or racism. Such particular forms of bonding social capital have the potential to impede social cohesion. As Powell and Smith-Doer (1994) observed: *'The ties that bind may also turn into lies that blind'*. It can be expected that negative external effects are more common with this form of social capital (van Oorschot et al., 2006). More generally, it is well understood that strong bonding networks with limited access to external influences and information are likely to promote unhealthy norms of behaviour (Ferlander, 2007).

Bridging social capital can also have a negative impact. It can nurture insider networks and thus reproduce inequality, and may also serve perverse goals. Exclusive forms of social bridging may include forms of extreme or totalitarian ideologies that may have socially destructive consequences (OECD, 2001).

2.3.4 Vertical or linking social capital

Woolcock (2001) introduced a third dimension of social capital, linking or vertical social capital, which represents norms of respect and networks of trusting relationships between individuals who are interacting across explicit, formal, or institutionalised power or authorities gradients in societies (Szreter, 2002; Szreter and Woolcock, 2004). In other words, this dimension of social capital refers to relationships between parties that know themselves not only to be alike, but furthermore to be unequal in their power and their access to resources (Szreter and Woolcock, 2004). These ties between community members and representatives of formal institutions are important for leveraging resources, ideas, and information (Woolcock, 2001). Building vertical social capital across power differentials is essential to promote civic engagement and empowerment of citizens in government decision-making processes. Encouraging the participation in politics and policy decisions provides opportunities for interaction and exchange that may lead to shape the welfare and well-being of communities. Nevertheless, as many have pointed out (Putnam et al., 1993; Szreter, 2002; Szreter and Woolcock, 2004), linking social capital can also be used for negative purposes, such as nepotism, corruption and suppression.

Bonding, bridging and linking capital are equally important, clearly co-exist in many situations and can be mutually reinforcing. However the challenge is to find the appropriate balance and ensure that bonding activities do not lead to isolation or exclusion. As suggested by Szreter and Woolcock (2004): *'Without such...a balanced development of all three forms of social capital, however, social capital, in any of its three forms, may easily be used as a resource for exclusionary and sectional interests, which may have an ambivalent or even negative consequence for the overall population health of society'.*

2.4 Measurement of social capital

Social capital researchers aimed to identify methods and tools, which can quantify and qualify social capital to inform policy makers and stakeholders to enable them to benefit people and nations. This is especially challenging because social capital is comprised of concepts such as 'trust', 'norms of reciprocity', and 'networks' which are difficult to quantify. The challenge is increased when one considers that the quest is to measure not just the quantity but also the quality of social capital. How one measures social capital depends on how one defines it. The most comprehensive definitions of social capital are multidimensional, incorporating different levels and units of analysis (Woolcock and

Narayan, 2000). Depending on the definition of social capital and the context, some indicators may be more appropriate than others (World Bank, 2014).

The Well-Being of Nations report (2001) argued for measures of social capital which are *'...as comprehensive as possible in their coverage of keys dimensions-networks, values and norms, balanced between attitudinal or subjective elements on the one hand (e.g. reported level of trust) and behavioural aspects on the other (e.g. membership of associations and extent of social ties)'* (OECD, 2001).

Although the measurement of social capital is dependent on the cultural context (Blaxter et al., 2001; Webber and Huxley, 2007), specific components of social capital, both cognitive and structural, have now been measured in a consistent way across different studies (Kawachi et al., 2008a). The measurement of social capital depends on how it is defined (structural or cognitive), the types of social ties (bonding, bridging, or linking), the level of analysis (micro or macro), and whether it is conceptualised as an individual or a collective attribute (Harpham, 2008). Some argued that social capital should be measured at both the individual and collective levels (Szreter and Woolcock, 2004; Kawachi, 2006; Kawachi et al., 2008a) because social capital resources at each level may have differential associations with health (Lochner et al., 1999; Harpham, 2008).

Some of the previous measurement attempts have been flawed by problems with separating forms, sources and consequences of social capital, and have diverged in that some studies have assessed the construct as a property of individuals, while others have considered it to be a property of groups. The different concepts underpinning social capital render the measurement and the design of suitable indicators difficult, which forces one to rely on various proxy indicators (Dubois and Mahieu, 2002). Despite being practical and convenient, this practice has the risk of 'logical circularity' or 'tautology'. This is because these proxies could be considered as either predictors or outcomes of social capital (Harpham, 2008).

At the individual level, social capital has been quantified using individual-level proxies, such as interpersonal trust, trust in institutions, voluntary group and community participation, voting and perceived reciprocity (Kawachi et al., 1997b; Baum and Ziersch, 2003; Harpham et al., 2004; Sundquist and Yang, 2007; Fujiwara and Kawachi, 2008; Islam et al., 2008). However, the measurement of social capital at an individual level has been criticised, as a particular type of individual social capital is not equally important to everyone, and is dependent on individual needs and opportunities (Phongsavan et al., 2006).

One school of thought is to aggregate individual level indicators to a contextual level such as neighbourhood or community, in order to capture contextual effect (Kawachi et al., 2004). Such aggregations may not actually capture group characteristics because the context is potentially different than the sum of the individuals living in a community. Contextual levels are often chosen solely by availability of data such as post-code sectors, constituencies or states, and may hold little relevance to individuals' day-to-day social interactions. Furthermore, any contextual level effects may be the result of confounding if individual effects are not also taken into account (Poortinga, 2006). This approach has also been criticised because it assumes that social capital can be defined by locality when the characteristics may be geographically dispersed (Subramanian et al., 2002; van der Gaag and Webber, 2008). One difficulty widely recognised, attached to this movement from one level to another is that objective and subjective definitions of the boundaries of an area or a community differ (Blaxter et al., 2001).

For the development of systematic, comparable social capital measurement instruments, the perspective of individual level social capital offers the most simple and clearly defined unit of measurement, that avoids the common interpretation problems in analyses that stem from the use of aggregated data, in which the problem of 'modifiable area unit' may be encountered.

Many UK surveys have included questions related to social capital and a variety of approaches have been used to measure the different dimensions. Some explicitly measure social capital, while others measure related dimensions. Adopting the OECD definition of social capital, and drawing essentially on work carried out by Blaxter et al. (2001) and the UK's General Household Survey and Citizenship survey, the Office National for Statistics (ONS) identified five key dimensions that underpin social capital, namely: civic participation, social network and support, social participation, reciprocity and trust, and views about the area (Harper and Kelly, 2003; Babb, 2005; Foxton and Jones, 2011).
The first two dimensions can be considered to be measuring individual level characteristics while the last three are more closely related to community level attributes (Harper, 2002). This provides a framework for the development of a harmonised set of

questions to describe the patterns of social capital within the UK. Questions that formed the harmonised set were selected from the Social Capital Question Bank, a collection of questions measuring social capital used in UK government surveys (Ruston and Akinrodoye, 2002).

After this review of the different concepts and measurements of social capital, the next section investigates the evidence on the association between social capital and health.

2.5 Social capital and health: Evidence from systematic reviews

There are a number of reviews on studies on social capital and health, including a few systematic reviews. The results from these reviews are summarised and discussed below.

2.5.1 Social capital and general health

One of the earliest systematic reviews on social capital and health was conducted by Kawachi et al. (2004). They reviewed evidence on the association between community level measures of social capital (such as collective efficacy, social and electoral participation, civic engagement, reciprocity and social trust) and health from 31 ecological studies, and 15 multilevel studies. They excluded all studies conducted exclusively at individual level, such as studies of social networks and social support. With a few exceptions, the ecological and multilevel studies showed a consistent positive association between social capital and population health outcomes, including self-rated health, mortality, sexually transmitted diseases and health-related behaviour. Social trust and collective efficacy (reciprocity, social cohesion, informal social control) were positively associated with self-rated health. Social trust, association membership, civic engagement, and reciprocity were inversely associated with all-cause mortality rates. Community organisational life, civic engagement, and social trust were inversely associated with sexual risk behaviour and disease rates. However, all the studies but one were cross-sectional.

Studies using ecological data are susceptible to the ecological fallacy and so greater emphasis should be placed on the results from the multilevel studies. However, the review did not detail what individual level covariates (such as socio-economic factors) were controlled for in the multilevel studies. Hence, the positive association found in this systematic review between community level social capital measures and population health needs to be set within the context of the lack of detail on multilevel studies, making it hard to infer whether community social capital affects population health. Furthermore, none of the studies reviewed attempted to distinguish between the different dimensions of social capital such as bonding/bridging/linking social capital.

Islam et al. (2006) reviewed a number of social capital studies published between1995 and 2005. The studies reviewed used a variety of indicators of social capital such as trust, reciprocity, and group membership and health outcomes (cause-specific mortality and self-rated physical and psychological health). The authors identified 42 studies (17 individual level, 13 ecological studies and 12 multilevel studies), 27 of which studies were not included in the review by Kawachi et al. (2004). They divided the studies by level of analysis: individual-level (with individual measures of social capital) or multilevel (with both individual and community level measures of social capital). Nearly all the 30 single-level studies (individual and ecological data) reviewed found significant positive associations between social capital and better health, although some of the associations were weak. For example, among studies conducted in the US, there was a strong association between higher levels of social capital and better health, while in Canada and other OECD countries, findings were weaker and inconsistent. The findings from the 12 multilevel studies were however inconsistent. This review suggested that population health may be more significantly affected by individual level social capital rather than by community level social capital, especially in more egalitarian countries than the US.

A more recent systematic review of social capital and physical health identified 15 studies on social capital and life expectancy or mortality; 32 on self-rated health; 7 on cardiovascular disease; 4 on cancer; 4 on obesity or diabetes; and 3 on infectious diseases (Kim et al., 2008). They found fairly consistent positive associations between social capital (as indicated by trust) and better health, but the evidence was stronger for self-rated health than for other health outcomes. This review found non-significant or negative associations between some concepts of social capital such as trust, social network, social support, and cause-specific mortality, including from infectious diseases, neoplastic, cardiovascular diseases, as well as all cause mortality, obesity and diabetes prevalence rates. Furthermore, the associations at the individual level were stronger compared to associations between health and the same indicator measured at the community level (Kim et al., 2008). Of all the studies included in this review only 6 were prospective, which was considered by the authors to constitute a major gap in the evidence. The authors also highlighted the common reliance of data measuring social capital on secondary sources and the paucity of studies distinguishing between the effects of different dimensions of social capital on health. Studies were also inconsistent in controlling for potential confounding factors at both the individual and area levels.

A meta-analysis of the association between structural and functional aspects of social relationships measured at the individual level (social network, social participation, social support) and mortality follow-up was conducted across 148 studies with 308,849 participants (Holt-Lundstad et al., 2010). The authors concluded that the protective influence of social relationships on mortality risk was comparable with well-established behavioural risk factors for mortality. Individuals with adequate social relationships had a 50% greater likelihood of survival compared to those with poor or insufficient social relationships after controlling for baseline health status, age and gender. The size of this effect was comparable with stopping smoking and exceeded many well-known risk factors for mortality such as obesity and physical inactivity. The life-protective benefits of relationships were strongest for complex measures of social integration such as a combined measure of marital status, network size and network participation; and lowest for simple measures of relationships such as cohabiting status.

One of the limitations of this study was the lack of information on relationship quality. Hence the 50% increased odds of survival may underestimate the benefit of healthy relationships as the effects of negative relationships were grouped in with the positive ones. Another limitation was that structural and functional aspects of social relationships were combined, even though they may have different associations with mortality.

The most recent systematic review of social capital and health addressed a key limitation of previous reviews by reviewing longitudinal studies (Murayama et al., 2012). The review identified 13 longitudinal studies conducted in community and workplace settings, using multilevel analysis. The studies used different indicators of social capital ranging from proxy measures of social cohesion such as volunteering and voting, to validated multi-item instruments that captured both the cognitive and structural dimensions of social capital. The authors concluded that *'both area/workplace social capital and individual social capital generally appear to have a positive effect on health outcomes'*, but '*due to the limited number of studies, the robustness of the evidence is questionable'* (Murayama et al., 2012). The link between individual level perceptions of social trust with different health outcomes appeared to be robust. However the association between community-level social capital and health was weak. Moreover, of the 13 studies identified in the systematic review, 8 of them did not simultaneously adjust for individual-level measures of social capital when examining the association of community level social capital with health. Thus the associations reported between contextual measures of social capital and health may reflect residual compositional confounding by individual characteristics. Once again, the studies were mainly conducted in Western countries as no prospective studies on social capital and health have been conducted in other parts of the world. Four of the studies reviewed were based on the same cohort - the Finnish Public Sector cohort, making it difficult to infer to other populations around the world.

The reviews discussed in this section have tended to find stronger associations between individual level social capital and general health, in comparison to community level social capital. The next section investigates the reviews on social capital and mental health. Mental health is a particularly important dimension of health to investigate as apart from being an important outcome in itself, it could also potentially lie on the pathway linking social capital and general health.

2.5.2 Social capital and mental health

There have been a few reviews of social capital and mental health (Almedom, 2005; de Silva et al., 2005; Whitley and McKenzie, 2005; Almedom and Glandon, 2008). De Silva et al. (2005) included quantitative studies published up to March 2003 and a similar review conducted by Almedom (2005) reviewed studies published up to December 2003. Although the reviews used similar search strategies in the main electronic databases, de Silva et al. (2005) identified 21 social capital studies, of which only 4 were included in the review by Almedom (2005). The most recent review on social capital and mental health was conducted by Almedom and Glandon (2008) who added another four studies published in 2004 - 2005.

De Silva et al. (2005) divided the studies according to the level of measurement of social capital. Out of the 21 studies reviewed, there were 14 studies with a positive association between individual level social capital and the mental health of adults and children. However, there were a few studies where social capital was not associated with mental health and a few studies where a high level of social capital was linked to poorer mental health. Cognitive social capital rather than structural social capital was more consistently associated with better mental health. The authors were not able to conclude anything in relation to the 7 studies with community level measures of social capital due to the diversity in methodology, populations and mental health outcomes. This review also stressed the importance of distinguishing the structural components of social capital from its cognitive components. These two aspects may affect mental health outcomes differently. None of the studies included in the review had measured any aspect of bridging or linking social capital.

Almedom (2005) described the results of 12 studies on social capital and mental health. The review mainly comprised of a thematic discussion about issues related to social capital and mental health, rather than a summary of findings on social capital and mental health. A similar thematic discussion was also conducted by Almedom and Glandon (2008). Both these reviews considered the cross-sectional design of the studies reviewed to be an important limitation. It is thus problematic to conclude whether social capital affects mental health as the direction of the association between mental illness and social capital was unclear. De Silva et al. (2005) put forward the weakness of the research conducted to date: *'A particularly serious limitation is the predominance of cross-sectional studies, which makes the direction of association between social capital and mental illness impossible to determine. It is highly plausible that mental illness could result in low social capital'* (de Silva et al., 2005).

Whitley and McKenzie (2005) reviewed the evidence from 7 studies published in 2000 - 2005, on social capital and mental health, namely depression, anxiety and psychosis. They concluded that the studies reviewed did not provide evidence for a strong association between social capital and mental health. The key limitations in the studies reviewed were the lack of validated instruments measuring social capital and prospective study designs. Evidence on the association between social capital and mental health was further limited by the fact that there had been little empirical research that used a multilevel framework to assess whether social capital at the community level was associated with individual mental health.

It is difficult to make decisive conclusions about the association between social capital and health (both general and mental health) from these systematic reviews due to the different types of indicators used to assess social capital, the variability in the quality of the social capital measures, and the analytic methods used in each study. The strongest and most consistent associations between social capital and health have been found for individual level measures that measure cognitive aspects of social capital like trust and social support. Furthermore, although a number of current research studies analyse social capital at the individual and community levels by adopting multilevel study design, one of the core issues of social capital, that is, the endogeneity issue, is still not fully resolved (Kawachi, 2006; Kim et al., 2008; Sirven and Debrand, 2008b; Sirven and Debrand, 2008a; d'Hombres et al., 2010). According to Kawachi (2006): *'Existing studies, even those with a panel design have not adequately dealt with the problem that social capital is endogenous. At the individual level, it is not completely established whether good health is the result of social capital or whether social capital is the result of good health and/or other unmeasured personal characteristics that determine both health status and patterns of social engagement...'*.

The meaning of social capital is possibly different in older age groups compared to younger cohorts (Nyqvist et al., 2013). In the next section, some key empirical studies on social capital and the health of older adults are reviewed with a focus on the association between the gerontological health and the different measures of social capital used in this thesis.

2.6 Social capital of older adults and its effects on health

Access to social capital enables older people to maintain productive independent and fulfilling lives (Cannuscio et al., 2003). Social contacts and activities are important health resources for older adults (Cagney and Wen, 2008; Lee et al., 2008; Ichida et al., 2009; Nummela et al., 2009; Snelgrove et al., 2009; d'Hombres et al., 2010; Muckenhuber et al., 2013). Social capital is relevant to successful ageing as older people are at greater risk for losing critical parts of their social ties as they age, which makes them more dependent on social capital available within their communities (Cannuscio et al., 2003; Cagney and Wen, 2008). It is well known that social relations change with age. Some quantitative aspects of social relations such as network size decrease with age because of death among friends and relatives (van Tilburg, 1998; Avlund et al., 2002). The meaning of these aspects of social capital tends to increase with age along with decreased health status (Fratiglioni et al., 2000).

The socio-emotional selectivity theory is particularly relevant to life course change in social capital. This theory describes how social relationships change over the entire life course due to change in a person's perspectives on how much time they have left to live (Carstensen, 1991; Carstensen, 1992; Carstensen, 1995). Aspects of this theory are echoed in the social convoy model that describes how people maintain a network of social relationships that escorts them over the life course like a convoy, that is, like a group of fellow travellers on the road of life (Kahn and Antonucci, 1980).

2.6.1 Social networks and social support among older adults

There are four major aspects of social networks that have particular relevance for the older population, namely network structure and interaction, social exchange, social engagement, and subjective network perception (Litwin, 2009; Litwin and Shiovitz-Ezra, 2011). Social gerontologists have documented numerous benefits of social connectedness for older adults. Large social networks are beneficial because they provide access to more social resources. However the specific composition and structure of older people's network is also important. Older adults place a greater emphasis on emotional satisfaction in social relationships whereas younger adults tend to prioritise social ties that yield access to instrumental resources (Carstensen, 1992). Thus, individuals appear to regulate the quality, structure, and function of their social ties and thereby enhance their social resources. Therefore, older adults may prefer networks that are comprised of kin and strong ties, that is, a consequence as same generation of friends are lost to illness or death (Carstensen, 1992; Litwin, 2001; Litwin, 2006; Fiori et al., 2007; Litwin, 2009). As older adults tend to value close bonding ties and because they seem to value emotional satisfaction over instrumental and entrepreneurial goals (Carstensen, 1992), it is reasonable to expect bridging ties to decline with age (Cornwell, 2009). In other words, close emotional ties are relatively stable until later in life, whereas peripheral social relationships are preferably discontinued (Lang, 2001). Positive support derived from older adults' relationships with partners and children protects against the development of or persistence of depression, although similar protective effects of positive support from their relationships with friends were not observed (Stafford et al., 2011). Nevertheless, friends may provide different amounts and types of support than family members, perhaps providing access to other resources of bridging social capital (Huxhold et al., 2013).

Network size may be a main determinant of social capital inherent in support networks. Network size has been found to be related to well-being (Steunenberg et al., 2006), but evidence points to the benefits of selective diminution of network ties in late life (Carstensen, 1991). Older adults may actively narrow their social environments in an adaptive process of emotion regulation, limiting their interactions to only the most satisfying ones. This include for example, the choices individuals make in their social worlds with respect to social partners as well with respect to the functions and course of social contacts in everyday life (Lang, 2001). Family ties are seen to dominate the networks of older adults (Cornwell et al., 2009). Contact frequency, a measure of network interaction, is frequently associated with positive outcome (Litwin, 2006; Gray, 2009), but it may also confound with health status. That is, frequency of contact, especially with close family, may rise due to increasing care needs, which in turn, may be associated with lower well-being (Litwin, 2009). Earlier research by Lang and Baltes (1997) explored the associations of daily social contacts, everyday functioning, subjective autonomy, and well-being. Among older people who did not experience difficulties in every day activities, social contacts were associated with stronger well-being. However among older people who experienced difficulties, social contacts were associated with reduced feelings of autonomy. This finding is an illustration of the social convoy model (Kahn and Antonucci, 1980). Under ideal circumstances, social relationships have a beneficial effect, helping in successful ageing. However, under sub-optimal conditions, the convoy could also have negative effects, such as undermining a person's aspirations, and creating, rather than solving, problems (Antonucci et al., 2004).

The more restricted a network is (e.g. in term of potential for support), the more vulnerable is the position of the older adult with respect to well-being (Fiori et al., 2007). In their study, Aida et al. (2011a) found that lower friendship network levels among elderly Japanese adults were associated with all-cause mortality in men and women. In addition, studies on the exchange of goods and services within the networks, particularly across generations, defined as reciprocity, suggested that giving help to network members was associated with positive outcome (Chen and Silverstein, 2000), whereas receiving help from them was associated with lower well-being (Reinhardt et al., 2006).

2.6.2 Social participation among older adults

In a cross-national comparative analysis of older adults in Germany and the US (Pollack and von dem Knesebeck, 2004), lack of social participation was associated with poor self-rated health among older adults in Germany but not in the US. Social participation was also positively associated with good self-rated health in a cross-European study (SHARE) conducted by Sirven and Debrand (2008a). Older adults in Finland with high social participation and high social trust, had better self-rated health than other adults with lower levels of social participation and trust (Nummela et al., 2009).

Data from the Australian Longitudinal Study of Ageing showed that church attendance had a protective effect against the emergence of depressive symptoms among the elderly (Law and Sbarra, 2009). Going to church on a regular basis is a type of shared spiritual activity, which has the potential of communicating a shared meaning system and promoting a sense of purpose in life (Ardelt and Koenig, 2006). Veenstra (2000) has also showed positive effects of attending religious services and participating in clubs on self-rated health among elderly Canadians. One reason could be that older people have more time to take part in social activities due to retirement or fewer family constraints (Sirven and Debrand, 2008b).

2.6.3 Volunteering among older adults

There is a growing body of research indicating that active involvement through volunteering is linked to both mental and physical health. Volunteering provides people especially older adults, with role enhancement and role identity, which in turn promotes positive psychological benefits such as increased self-esteem and happiness contributing to a positive self-evaluation of health. With respect to mental health, research shows that older adults who volunteer report fewer symptoms of depression than those who do not volunteer (Borgonovi, 2008; McMunn et al., 2009). Volunteering was also associated with a lower hypertension risk (Burr et al., 2011).

A review of the evidence on volunteering and health identified 43 papers on the topic of volunteering and health (Casiday et al., 2008). Out of these, only seventeen papers conducted longitudinal analyses. The authors concluded that there was an ‘overwhelmingly’ positive impact of volunteering on health (measured by mortality, self-rated health, activities of daily living, and frequency of hospitalization) in almost every study. Furthermore, the association between volunteering and health appeared to be greater for older people than younger people. Nonetheless, the review was limited by the variable quality of the component studies and the few longitudinal studies on older adults (Nazroo and Matthews, 2012).

Other studies have examined the role of the quality of the voluntary work in relation to health, and the extent to which the volunteer feels adequately appreciated for the work done. Here the evidence suggested that older adults who reported being appreciated and adequately rewarded for their voluntary work had better quality of life and less depression than non-volunteers (Wahrendorf et al., 2006; McMunn et al., 2009). A similar analysis of older adults in England also found that reciprocity in volunteering was associated with higher quality of life and lower odds of being depressed for both men and women (Zaninotto et al., 2013).

2.7 Social capital and oral health

A growing body of research has revealed that social capital might have an influence on oral health. However, there have not been any systematic reviews of the association between social capital and oral health. A systematic review of this literature is problematic because of the different measures of social capital and oral health used in studies. As the central focus of this thesis relates to oral health outcomes, this section comprehensively reviews the entire published literature on social capital and oral health. This narrative review is organised by the level of measurement of social capital - at the individual- and community-levels - as well as whether the findings reported are positive, null or mixed. Some of the studies reviewed are multilevel analyses with individual and community measures of social capital; findings from each level of measurement are discussed in the corresponding sections. Within each level, the studies are not described chronologically, but arranged by type of social capital measure used, although some studies have multiple measures of social capital. The studies are described in detail first and then the limitations of the evidence on social capital and oral health are discussed.

Tables 2.1 and 2.2 display the key characteristics and findings from these studies organised by the type of studies design (individual level; ecological/multilevel) and are listed chronologically by year of publication within each grouping. From each study the following characteristics were abstracted: study authors and year of publication, sample size and population setting, age range, measures of social capital and oral health, factors included as covariates in statistical models, and individual and community-level effect estimates for social capital (odds ratios and 95% confidence intervals; β-coefficient and 95%confidence intervals).

Table 2.1: Individual-level studies on social capital and oral health

Authors years	Population sample size Settings	Age and gender(%)	Social capital measures	Oral health measures	Covariates	Findings
Arcury et al., 2013[1,2]	Individuals from the Rural nutrition and Oral Health Study, in two rural North Carolina counties N=635	60 years + 54.1% women	-Social engagement (senior centres + church + clubs + employment) -Social network size: a) number of children, other relatives, friends the participant interact each month b) number of children, other relatives, friends the participant speak on the phone each week	-Self-rated oral health -Number of teeth:0; 1-16; 17-32 -Oral health problem (sum of self-reported of mouth or tooth pain, ill fitting dentures, sore or bleeding gums, dry mouth, periodontal disease)	Ethnicity, general physical functioning, age, sex, marital status, household size, year of education, health insurance, dental insurance, household income	-Those with 17-32 teeth had greater social engagement (p<0.001). -Self-rated oral health was **not** associated with social engagement. -Oral health problems were **not** associated with social network size
Lida and Rozier, 2013[2]	Children whose mothers participated in the 2007 National Survey of Children Health, USA N=67,388	1 to 17 years	Mothers' perceived social capital of reciprocal health, support and trust in the neighborhood. Responses were summed to create a social capital index score ranging from highest to lowest	-Mothers' perceived condition of child's teeth -Maternal report of child's use of preventive care in the last 12 months -Maternal report of child's unmet dental care needs -Condition of child's teeth aged over 12 months	Child's age in years, gender, race/ethnicity, special health care need, family income, health insurance, presence of a usual source of health advice, primary language spoken in the household, mother's education, mother's mental health status, family composition, mother's perceived neighborhood safety, and maternal Aggravation in Parenting Scale (Parenting Stress Index and Childrearing Scale)	Mothers' perceived social capital was not associated with the reported rating of child' s oral health Lowest social capital index was associated with unmet dental care needs: 1.79 (1.14-2.80) Low and lowest social capital index were associated with no preventive dental visit: 1.40 (1.17-1.68); 1.38 (1.05-1.81) respectively
Takeuchi et al., 2013[2]	Individuals from the Japan Gerontological Evaluation Study (JAGES) living in Iwanuma city N=3,517	65 years + 52.2% women	-Social participation: belonging to political organizations, industrial or professional groups, volunteer groups, senior citizens' clubs, religious groups or associations, sports groups, neighborhood community associations, or hobby clubs. -Frequency of participation -Numbers of social activities	Self-reported number of remaining teeth Having 20 or more teeth	Physical heath status measured by activity of daily living, current medical history, sex, age, marital status, educational attainment measured by number of years of education, annual equivalent income divided into quartiles	Overall social participation was associated with having a greater number of teeth 1.30 (1.10-1.53)

Table 2.1…continued: Individual-level studies on social capital and oral health

Authors years	Population sample size Settings	Age and gender (%)	Social capital measures	Oral health measures	Covariates	Findings
Tsakos et al., 2013[2]	Individuals from National Health and Nutrition Examination Survey (1999-2004) N=4,014	60 years + 49.7% women	-Social relationships referred to social networks (marital status/living with partner, number of close friends) -Social support (emotional support need, provision of financial support = instrumental)	-Edentulism, -Number of decayed teeth, root decay, number of sound or filled teeth -Self-rated oral health	Age, sex, ethnicity/race, income, education (years), smoking, dental attendance, self-rated general health, use of medication	-**No** association with edentulism -Widowed (0.89, 082-0.97) divorced (0.90; 0.83-0.97) associated with sound and filled teeth - **No** association between number of friends and self-rated oral health -Having 4-6 friends related with teeth decay 0.60 (0.43 to 0.84) ≥seven friends associated with root decay 0.62 (0.46-0.83) -Emotional support associated with root decay 1.41 (1.05-1.90) and poorer self-rated oral health 1.18 (1.04-1.35) -Financial support associated with decayed 1.43 (1.09-1.87)
Brennan and Spencer, 2012[3]	Children from the School Dental Service of South Australia 1988-1989 2005-2006 Follow up using the Electoral Roll N=421	30 years	Social support using the Multidimensional Scale of Perceived Social support (from family, friends and others)	Dental caries experience (decayed, missing, filled) Oral health-related quality of life (OHIP-14)	Sex, income, work status, education, dental visit, tooth brushing, optimism assessed by the Life Orientation Test	**No** association between social support and decayed/missing/filled teeth Social support was associated with Oral Health Impact Profile: β -1.25 p<0.001
Lamarca et al., 2012[3]	Women pregnant and post partum from two middle size Brazilian cities, Rio de Janeiro State N=1,403 in two groups 1- work-based social network (in paid work) 2- home-based social network (housewives or unemployed)	25.2±6.3 years Women	Social network: Relatives and friends Participation in meetings, charity work and religious activities Social support: Material, affectionate, emotional, positive social interaction and informational.	Oral Health Impacts Profile (OHIP-14)	Maternal age, ethnicity, number of children, marital status, year of schooling, familial income, housing condition, social class, smoking and alcohol consumption (before pregnancy)	Home-based social network and moderate level of positive interaction was associated with OHIP≥4: 1.64 (1.08-2.48) Home-based social network and low level of positive social interaction was associated with OHIP≥4: 2.15 (1.40-3.30). Effect modifier of positive social interaction

Table 2.1…continued: Individual-level studies on social capital and oral health

Authors years	Population sample size Settings	Age and gender (%)	Social capital measures	Oral health measures	Covariates	Findings
Rodrigues et al., 2012[2]	Individuals from a medium-size city in southeastern Brazil N=163	60 years + 68.7% women	Social participation: Participation in activities of daily living in the community	Edentulism	Age, sex, household income	Low social participation associated with edentulous at the 10% level of significance: PR 2.12 (1.10-4.00)
Zini et al., 2012[2]	Individuals from the Jewish population, Jerusalem, Israel N=248	38.6±3.2 years 50.4% women	Perceived social support using the Multidimensional Scale of Perceived Social Support (family, friends and others)	Dental caries experience (DMFT) dichotomised into above and below the median (10.7)	Age, gender, level of education, employment status, home density, level of plaque, sugar consumption, type of school their children attended, spirituality	High social support from family was associated with low DMFT 0.47 (0.26-0.84)
Furuta et al., 2011[2]	Convenience sample of Okayama University students, Japan N=967	18-19 years	Perceptions of family social capital, neighborhood trust, community informal social control, school trust (vertical), school trust (horizontal), reciprocity at school	Self-rated oral health	Gender, household income, dental fear, tooth brush frequency, dental floss use	Lower level of neighborhood trust was associated with poor self-rated oral health: 2.22 (1.40-3.54) Informal social control was inversely associated with poor self-rated oral health: 0.54 (0.34-0.85) Low vertical school trust was associated with poor self-rated oral health: 1.71 (1.05-2.80) No association between horizontal school trust / reciprocity and self-rated oral health

Table 2.1…continued: Individual-level studies on social capital and oral health

Authors years	Population sample size Settings	Age and gender (%)	Social capital measures	Oral health measures	Covariates	Findings
Sabbah et al., 2011[2]	Individuals from the National Health and Nutrition Examination Survey 2001–2004 N=1,632	60 years + 51.0% women	-Social networks: indicated by number of close friends and marital status -Social support: indicated by the need for emotional support	-Loss of periodontal attachment ≥3mm: expressed as the percentage of affected sites -Moderate periodontitis: defined by the presence of two or more interproximal sites with loss of attachment of 4mm or more or two or more interproximal sites with pocket depth 5mm or more	Smoking, dental visits, age, gender, race/ethnicity, income, level of education	-Widowed and those with lowest number of close friends had higher rates of the extent of loss of periodontal attachment 1.27 (1.03-1.58) and 1.22 (1.03-1.45) -**No** association between marital status / number of close friends and moderate periodontitis -**No** association between need for emotional support and periodontal diseases
Vered et al., 2011[3]	Ethiopians immigrants in Jerusalem At baseline 1999-2000 N=792 At follow up 2004-2005 N=340	18-75 years 57% women	Validated social support scale including instrumental and emotional social support	DMFT index (dental caries experience) Community Periodontal Index (Periodontal health status)	Age, gender, income (employed/unemployed), education (years), dental status at baseline (caries/caries free), psychological distress	-Social support was associated with dental caries status (continuous variable) (ß=-0.063, p=0.03) -Social support was associated with dental caries status (dichotomised by median ≥2): 0.46 (0.28-0.77) **No** association between social support and periodontal disease
Wu et al., 2011[2]	Individuals from the NHANES 1999 to 2004 N=4,859 Dentate n=3,414 (weighted) Edentate n=1,094 (weighted)	60 years + 56.4% women	Social support measured by: Marital status Number of close friends and relatives Perceived financial support	Self-rated oral health	Age, gender, education, dental coverage, income, health status, alcohol consumption, smoking, physical activity, dental care utilisation, edentulous	**None** of the social support indicators was associated with self-rated oral health among dentate individuals Only number of close friends was associated with self-rated oral health among edentate individuals: 1.19 (1.04-1.36)

Table 2.1…continued: Individual-level studies on social capital and oral health

Authors years	Population sample size Settings	Age and gender (%)	Social capital measures	Oral health measures	Covariates	Findings
Finlayson et al., 2007[2]	Individuals from the Detroit Dental Health Project, USA N=719 mother-child dyads 1-3 years n=446 4-5 years n=273	1-5 years	Instrumental social support: Errands; financial, childcare, transportation	Early childhood caries assessed using the International Caries Detection and Assessment System	Social Cognitive Theory variables: self-efficacy, fatalistic belief, knowledge hygiene-needs, bottle use knowledge, mom brushed Psychosocial factors: depressed, Parenting Stress Score Education, income, household size, mother's age, child's age, dental insurance, brushing rate, dental visit	**No** association between instrumental social support and Early Childhood Caries status
Nicolau et al., 2007[2]	Mothers of 13-year-old school adolescents living in urban areas, Cianorte, Brazil N=224	Mean age 40	Social support in childhood: Mothers' and fathers' levels of support (summing score from trust, love, attention and understanding) Social support in adulthood: Emotional support from any source	Proportion of number of teeth present with loss of periodontal attachment. Dichotomised into low≤0.419 and High>0.420 level of severity using mean as cut-off point	Childhood variables: father's education (years); paternal and maternal level of discipline; paternal and maternal level of support Adulthood variables: education (years); income; age; plaque levels; smoking	-No emotional support in adulthood was associated with periodontal disease: 3.74 (1.16-12.0) -**No** association between social support in childhood and periodontal diseases

Table 2.1…continued: Individual-level studies on social capital and oral health

Authors years	Population sample size Settings	Age and gender (%)	Social capital measures	Oral health measures	Covariates	Findings
Sanders 2007[2]	Individuals from the 1999 and 2002 cross-sectional National Dental Telephone Interview Surveys, Australian, excluding edentate N=?	25 years + 50% women	Social support dimension: Instrumental, informational, emotional and appraisal	Tooth loss (retention of less than 20 teeth) Oral Health Impact Profile (OHIP-14) Self-rated oral health	N/A	Bivariate association: -No instrumental support and informational support was associated with tooth loss, relative risk (RR) 1.32 and 1.38 p<0.05 -**No** association between emotional / appraisal support and tooth loss -Any of the dimensions of social support was associated with prevalence of severe OHIP-14, Emotional RR: 1.75; Appraisal RR: 1.56; Instrumental RR: 1.70; Informational RR: 1.73 -Any of the dimensions of social support was associated with poor self-rated oral health, Emotional RR: 1.28; appraisal RR: 1.46; instrumental RR: 1.44; informational RR: 1.29
Sanders and Spencer, 2005[2]	Individuals from the 1999 National Dental Telephone Interview Survey, Australia, excluding edentate N=3,678	18 to 91 years 50% women	Parenting supportive style (positive/negative) Social support: emotional, appraisal, instrumental and informational	Oral Health Impact Profile (OHIP-14)	Age, sex, geographical location, household income, paternal occupation at age 10 years, parental cohabitation at age 10 years, psychological factors (chronic stress, sense of control, life satisfaction, social support)	Social support was associated with OIDP-14 β -0.41 (-0.82.-0.01) Parental style rearing was associated with OHIP-14 but **No** longer when adjusted for psychological factors

Table 2.1…continued: Individual-level studies on social capital and oral health

Authors years	Population sample size Settings	Age and gender (%)	Social capital measures	Oral health measures	Covariates	Findings
Siriphant and Drury, 2004[2]	Dentate individuals from the 1988 to 1994 NHANES, USA N=8,449	16 to 64 years 51.7% women	Social relationship measured by summing five dimensions: frequency to talk on the phone with family, friends and neighbours; frequency to get together with friend or relatives; frequency to visit neighbours; frequency to attend church or religious services	Self-rated oral health	Age, gender, ethnicity, education, income, marital status, labour force, census region, location of residence, time lived at the current address, dental visit, gingival bleeding, periodontal pocket, number of teeth, untreated tooth decay	Low social relationship was associated with poor self-rated oral health 1.43 (99%CI: 1.04-1.95) Effect modification of low social relationship on the association between health practice (HP) and poor self-rated oral health: Very low HP 3.30 (2.01-5.41); Low HP 2.06 (1.15-3.69)
Avlund et al., 2003[3]	Individuals from the Kungsholmen Elders Oral Health Study (KEOHS) - 1987 N=129 Seven years follow-up	80 years + 64.6% women	Social relations measured in terms of marital status, living alone, frequency of contacts, number of confidants, and satisfaction with social contacts and with the frequency of contacts	Coronal caries and root caries.	Age ≥85; 80-85; gender; cognitive function; functional ability; school education; regular use of dental services; medications; number of teeth, number of crown, salivary flow rate	Living alone or becoming alone associated with coronal caries 2.4 (1.0-5.7) Dissatisfaction with frequency of social contacts associated with root caries 2.9 (1.2-7.2)
Merchant et al., 2003[3]	Individual from the Health Professionals Follow-up Study, US-based 57.6% dentists N=42,523 Four years follow-up	40 to 75 years only men	Perceived social support defined by: Marital status/Number of close friends and relatives/Frequency of contact with friends and relatives/Religious group and community organizations.	Self-reported periodontitis for the first time from 1996 to 2000	Age, marital status, smoking, alcohol, diabetes, body mass index	**No** association between marital status, seeing family, relative, friend, having child, relative and periodontitis -Having at least one close friend associated with lower risk of periodontitis 0.70 (0.51-0.96) -Participating in religious meetings associated with lower risk of periodontitis 0.73 (0.640.83)
McGrath and Bedi, 2002[2]	Individuals from Omnibus Surveys, Great Britain N=876	65 years + 60% women	Living alone	Denture status	Age, gender, social class, level of education	Living alone was associated with no full denture 1.52 (1.12-2.07) and last dental visit because of pain 1.67 (1.07-2.58)

Table 2.1…continued: Individual-level studies on social capital and oral health

Authors years	Population sample size Settings	Age and gender (%)	Social capital measures	Oral health measures	Covariates	Findings
Maupome and McEntee, 1998[2]	Individuals from the voters' list in Vancouver, British Columbia, Canada N=5,255	70 years + % women (N/A)	Index of social network (cohabiting status+contact frequency+social participation), Index of social support (material and informational+emotional (received and given help)+marital status)	Prosthodontic profile: -Use of complete denture upper, lower or both (CD) -Use of removable partial denture alone or with complete denture RPD) -1 or more missing anterior teeth replaced (MAT) -1 or more missing anterior teeth not replaced (OAS)	Age, gender	-**No** association between social network/social support and RPD/MAT -Association between low social participation and OAS 3.8 (95%CI unknown)
Hanson et al., 1994[2]	Individuals born in 1914 in Malmö, Sweden defined from the register August 1982 N=500	68 years 100% men	Four dimensions of social network: 1. Social anchorage: what degree the person belongs to formal and informal groups 2. Contact frequency with children, relatives, neighbours, friends and workmates. 3. Social Participation in formal and informal groups in society 4. Adequacy of social participation Four dimensions of social support 1. Availability of material and informational support 2. Availability of emotional 3. Adequacy of emotional support 4. Cohabiting status: defined as cohabiting with a woman (whether married or not)	Clinical examination regarding number of teeth, prevalence of removable dentures, fixed bridges and anterior open tooth spaces	Social class	**Only** low social anchorage (p=0.009) and low social participation (p=0.01) were associated with low number of teeth **Only** low social anchorage 2.0 (1.2-3.2); low social participation 1.7 (1.0-2.7); and low adequacy of social participation 1.9 (1.2-3.2) were associated with anterior open tooth space **None** of the dimensions of social network and social support was associated with fixed bridges

[1]Oral health predicting social capital
[2]Cross-sectional study design
[3]Longitudinal study design

Table 2.2: Ecological-level and multi-level studies on social capital and oral health

Authors years	Population sample size Settings	Age and gender (%)	Social capital measures	Oral health measures	Covariates	Findings OR
Santiago et al., 2013[1]	Multi-level study of individuals from three cities, Paraiba, Brazil N=624	Three age-groups 15-19 (adolescent) 35-44 (adults) 65-74 (elderly) 62.8% women	Contextual social capital covering 5 dimensions: social trust score; social control score; empowerment score; Political efficacy score; neighbourhood safety score. Final score by summing subscale score divided into low, intermediate and high social capital Individual social capital includes -social support – bonding social capital (functional, material, affective, emotional, positive interaction, information) -social network – bridging social capital was assessed by questions on relationship with family and friends??, and participation in social groups	Prevalence of reporting dental pain in the last 6 months (yes/No)	Age, sex, ethnicity, schooling, family income, sanitation conditions, frequency of sugar intake, tooth brushing, use of dental services, self-rated oral health, number of decayed teeth	Neighbourhood-level: High social capital was inversely associated with dental pain 0.48 (0.27-0.85) Individual-level: Bonding/positive social interaction was inversely associated with dental pain 0.88 (0.80-0.91)
Aida et al., 2011[1]	Multi-level study of individuals from the Aichi Gerontological Evaluation Study Project 2003 (AGES) N=3,451 in 79 local districts	65 years + 46% women	Community level social capital created by aggregating individual data: Structural social capital: proportion of respondents reporting non-volunteering Cognitive social capital: proportion of respondents reporting mistrust	Self-reported number of teeth: Having 20 or more teeth/having 19 or less teeth	Sex, age-group, marital status, educational attainment, smoking status, individual- and community-level equivalent income	At the community level: rate of mistrust and rate of non-volunteer were **Not** associated with poor dental status At the individual level: mistrust was associated with poor dental status 1.41 (1.04-1.93) no-volunteering was **Not** associated with poor dental health status

Table 2.2…continued: Ecological-level and multi-level studies on social capital and oral health

Authors years	Population sample size Settings	Age and gender (%)	Social capital measures	Oral health measures	Covariates	Findings OR
Aida et al., 2010[1]	Multi-level study of individuals from the Ohsaki Cohort 2006 Study, Japan N=21,736 in 356 administrative districts	65 years + 58% women	Neighbourhood-level social capital created by aggregating individual data: Structural social capital: proportion of respondents with at least one or more social network (civic networks, sports and hobby networks, volunteer networks, friendship networks) Cognitive social capital: proportion of respondents with high social support	Self-reported number of teeth: Having 20 or more teeth/having 19 or less teeth	sex, age, individual social networks and social support, educational attainment (years), neighbourhood educational level, dental health behaviour (tooth brushing, use of dental floss or interdental brushes, dental check-up, sugar consumption), smoking status, diabetes, self-rated health	- At the neighbourhood-level **Only** highest vs. lowest friendship 1.17 (1.04–1.30) was associated with having 20 or more teeth -At the individual-level **Only** highest sport network (1.12; 1.02-1.22) and medium friendship network (1.14; 1.04-1.25) were associated with number of teeth -**No** association between individual- / neighbourhood-level social support and number of teeth.
Aida et al., 2009[1]	Multi-level study of individuals from the Aichi Gerontological Evaluation Study Project 2003 (AGES) N=5,560 in 25 communities	65 years + 51.6% women	Community-level social capital Average of respondents': -Vertical social capital belonging to political, industrial and professional groups, religious associations, local community associations, clubs, and volunteer fire-fighting groups. -Horizontal social capital participating in volunteer groups, citizens' and consumer action groups, sports groups and clubs, and hobby clubs	Self-reported number of teeth: Having 20 or more teeth/having 19 or less teeth	Sex, age, educational attainment, equivalent income, oral health behaviour (taking care of dental health, visit to dentist, smoking, self-rated health, depression (GDS-15) Community-level annual equivalent income	Low community-level horizontal social capital associated with having 19 or fewer remaining teeth 1.25 (1.03–1.52) Low and intermediate individual-level horizontal social capital associated with having 19 or less teeth 1.45 (1.21-1.73) and 1.23 (1.01-1.48) - **No** association between individual level vertical social capital and number of teeth

Table 2.2…continued: Ecological-level and multi-level studies on social capital and oral health

Authors years	Population sample size Settings	Age and gender (%)	Social capital measures	Oral health measures	Covariates	Findings OR
Aida et al., 2008[1]	Multi-level study of children from 39 Japanese municipalities N=3,086	3 years 48.1% girls	Community level variable: -Social support measured by the number of volunteer care workers per 100 000 residents -Social cohesion measured by the number of community centres per 100 000 residents	dmft (dental caries experience)	Individuals variables: Age, sex, family composition, parent's smoking status, occupation, breastfeeding, tooth brushing, use of fluoride toothpaste, frequency of sugary intake Community variables: Average income, unemployment rate, number of dentists per 10 000 residents, expenditure for public health activities per child, number of grocery stores per residents	**No** association between number of volunteer care workers and dmft Number of community centres was associated with lower dmft β -0.01 $p<0.01$
Pattussi et al., 2006a[1]	Multi-level study of students from 39 public schools of two cities in the Distrito Federal, Brazil N=1,302	14-15 years 47.7% girls	Neighbourhood level variable: Empowerment score aggregated from individuals' responses to 5 subscales: perceived occurrence which people signed petitions, made formal complaints, contacted local authorities, attended meeting, joined groups to talk about issues to improve their neighbourhood	DMFT dichotomised using the median as a cut-off point Low DMFT 0 to 2 High DMFT≥3	Sex, systemic fluoride, tooth brushing, sugar consumption, dental attendance, social class, Neighbourhood poverty	Low neighbourhood empowerment was associated with high DMFT 1.54 (1.09-2.18)

Table 2.2…continued: Ecological-level and multi-level studies on social capital and oral health

Authors years	Population sample size Settings	Age and gender (%)	Social capital measures	Oral health measures	Covariates	Findings OR
Pattussi et al., 2006b[1]	Multi-level study of students from 39 public schools of two cities in the Distrito Federal, Brazil N=1,302	14-15 years 47.7% girls	Neighbourhood social capital index based on answers to the parent's questionnaire and the mean score for each catchment area includes social trust, social control, empowerment, neighbourhood security, political efficacy	Dental injuries to upper and lower incisors	Individual variables: Age, lip coverage, incisal overjet, BMI, social class Neighbourhood variables: Rates of leisure time; religious; establishments, security, educational and health facilities; philanthropic and social organisations per 10 000 residents	For 1 unit increase in social capital index the odds ratio of dental injury decreases by 0.55 (0.32-0.81) in boys **No** association between social capital and dental injury in girls
Moyses et al., 2006[1]	Multi-level study of school children from 52 public school in 29 deprived areas, Curitiba, Brazil N=2,126 living in the schools' catchment areas	12 years	Community-level: Social cohesion: -Community participation in Health and Social Care conferences ratio 1:10,000 inhabitants 1997 -Number of local Health Committees ratio 1:10,000 inhabitants 1997 Social support: -public social policies (integral schools, food policy in schools, availability of area healthy food projects, public daycare centres, domestic sewer system, negative sub-standard dwellings.	Dental injury based on the BASCD criteria	Individual variables: Gender, children's family income, parent's employment, mother's education, children's birthplace, family geographical origin, children's access to and frequency of dental care, access to water fluoridation, fluoridated toothpaste, time living in the area. Area-level: Latency to health process Physical environment	**No** association between social cohesion and dental injury For each increasing unit of supportive public social policies there was a decrease of 2.6% in dental injury β – 2.62 (-4.90, -0.34)

Table 2.2…continued: Ecological-level and multi-level studies on social capital and oral health

Authors years	Population sample size Settings	Age and gender (%)	Social capital measures	Oral health measures	Covariates	Findings OR
Tellez et al., 2006[1]	Multi-level study of African-American children's caregiver living in the poorest 39 census tracts clustered in 27 neighbourhood in Detroit, Michigan, USA N=1,005 excluding edentate	14 to 70 years 95.5% women	Neighbourhood-level variable: Number of churches Individual-level variable: Emotional support	Dental caries measured by the International Caries Detection and Assessment System	Individual variables: Age, income, employment status, availability of dental services, perception of oral health, oral hygiene status, total sugar intake Neighbourhood variables: Median household income, number of dentists, number of grocery stores, percent public facilities, percent unemployed, percent vacant housing units	1 SD increase in number of neighbourhood churches was associated with decrease of 2.7 untreated decayed surface score No emotional support was associated with 2.3 increase in untreated decayed surface score
Pattussi et al., 2001[1]	Ecological-level study of school children from three sources of data: 1997 social survey; 1995 census data; 1997 oral health survey; D F, Brazil N=7,296 in 19 districts	6-12 years	Social cohesion measured by: -per thousand number of participants in meetings of the budget decision -per thousand number of homicide and attempts of homicide by Administrative region	-Percent of children caries free (DMFT = 0) -Mean DMFT scores	% with less than secondary school; % earn less than two Brazilian minimum wage; % did not have a maid; % did not have a bathroom; % did not have a car, GINI coef.	**None** of the indicators of social cohesion was associated with caries experiences
Moyses, 2000[1] (thesis)	Multi-level study of school children from 52 public school in 29 deprived areas, Curitiba, Brazil N=2,126 living in the schools' catchment areas	12 years	Community-level: See Moyses et al., 2006 Social cohesion Social support	Caries-free (DMFT=0) Dental trauma Dental pain (BASCD criteria)	Individual variables: See Moyses et al., 2006	Social cohesion associated with caries-free (β 5.60; 2.26-8.84) and dental pain (β -2.95; -5.35 -0.56) Social support associated with caries-free (β 4.00; 1.87-6.12) and dental trauma (β -2.62; -4.90 -0.34) **No** association between social cohesion and dental trauma **No** association between social support and dental pain

[1]Cross-sectional study design

2.7.1 Individual level measures of social capital: Associations of social participation, social network and social support with oral health

Out of the 27 studies found on individual level social capital and oral health (22 from individual studies; 5 from multilevel studies), 8 reported positive associations, whereas 19 reported mixed or null findings.

Positive findings

Takeushi et al. (2013) analysed data from 3,517 adults aged 65 and over from Iwanuma city who were part of the Japan Gerontological Evaluation Study to investigate the associations between social participation and dental health status. Social participation was assessed by asking whether participants belonged to political organisations or associations, industrial or professional groups, volunteer groups, senior citizens' clubs, religious groups or associations, sports groups, neighbourhood community associations, or hobby clubs. Participants were also asked to indicate the frequency of participation in each group and the number of social activities. The results showed that respondents who participated frequently in social activities had a greater number of teeth (OR=1.30; 95%CI:1.10-1.53). These findings support the results from another cross-sectional study carried out with 163 Brazilian individuals aged 60 year and over residing in a medium-size city in southeastern Brazil (Rodrigues et al., 2012). The study showed that lower level of social participation was associated with edentulism (no natural teeth).

Relationships between women's occupational contexts and oral health related quality of life were analysed in a follow-up study limited to 1,403 pregnant and post-partum women living in two cities in the State of Rio de Janeiro, Brazil (Lamarca et al., 2012). The results suggest that women who had low positive social interaction and whose social network was restricted to the home environment, were more likely to report worse oral health related quality of life compared to women with high levels of positive social interaction and whose social network was extended to work-place (Lamarca et al., 2012).

Siriphant and Drury (2005) investigated the effects of healthy practices and social relationships on self-rated oral health using data from the Third National Health and Nutrition Examination Survey of 8,449 U.S. dentate adults aged 18-64 years. Three categories of low, medium and high social relationships were derived by summing five items that include the frequency with which an individual talks on the telephone with family, friends or neighbours; the frequency with which an individual gets together with friends or relatives; the frequency with which an individual visits neighbours in his or her own or others' homes; the frequency with which an individual attends church or religious services; and the frequency with which an individual attends meetings of clubs or other voluntary organisations. The results showed that respondents who had a low social relationships score were more likely to report fair or poor oral health. Furthermore there was evidence of an effect modification of social relationships on the association between healthy practices (healthy diet, physical activity; non-smoker, non-binge drinker) and self-rated oral health. Among the low social relationship group, those who had very low healthy practices were more than three times more likely to report poorer oral health, compared to those who reported high healthy practices and high social relationships.

Zini et al., (2012) focused on a sample of 248 married Jewish adults (mean age 38.6±3.2) living in Jerusalem, Israel. They found that being religious (measured by the type of schools that their children attended-secular, religious non-orthodox or religious orthodox schools) had a protective effect on caries experiences (OR=0.28; 95%CI:0.12-0.68). Furthermore the study identified that higher social support assessed by the validated Multidimensional Scale of Perceived Social Support, a 12-item self-report questionnaire that measures social support from family, friends and others (Dahlem et al., 1991), was associated with lower DMFT (OR=0.47; 95%CI:0.26-0.84) and mediated the association between religiosity and dental caries experiences. Higher levels of religiosity were related to higher social support, which in turn was related to lower sugar consumption, and lower DMFT.

In a multilevel analysis study, Tellez et al. (2006) assessed the association between individual emotional social support and the severity of dental caries in a low-income African-American population study of 1,005 caregivers, aged 14 to 70 years who resided in Detroit, Michigan. The authors reported that at the individual level, lack of emotional support was associated with a higher score of untreated decayed tooth surface.

Marriage can provide men and women with a specific type of social capital (Coleman, 1988), by providing access to the family and friends of their partners who can help them find jobs (Nock, 1998). These contacts of marital partners can also provide individuals with recommendations, which can thereby improve their chances of job success (Aguilera, 2003; Neckerman and Fernandez, 2003; Aguilera, 2008). Although marital status is not an optimal measure of social capital, it does represent a powerful source of social capital in term of resources available to the partner. However, the qualitative aspect of the marital relationship often was not addressed in these studies and hence marital status measure lacks this key aspect of social capital.

On a sub-sample of 129 dentate community-dwelling individuals over the age of 80 years, from The Kungsholmen Elders Oral Health Study, Avlund et al. (2003) provided evidence that certain aspects of social relations are related to oral health. Individuals who lived or became alone during the 7 years prior to the dental assessment were more likely to have untreated coronal caries compared to those who continually lived with others. Similarly, elders who are married or living with others have better periodontal health and more filled and fewer decayed coronal and root surfaces than those who are unmarried or are living alone (Persson et al., 2004).

In a national UK study involving a random sample of 876 non-institutionalised older people (aged 65 or older), those who lived alone were more likely to have none of their natural teeth and wear full dentures compared to those who did not live alone (McGrath and Bedi, 2002). This result supports findings of the 1998 Adult Dental Health Survey in the UK, that reported that adults who were single, widowed, divorced or separated were more likely to have lost all their natural teeth compared with married/cohabiting adults (Treasure et al., 2001).

Mixed or null findings

Aida et al. (2009) examined the association of horizontal versus vertical social capital in a sample of 5,560 elderly people (72.9±6.0 years) as part of the Aichi Gerontological Evaluation Study project. Vertical social capital was defined as participating in groups, which encouraged hierarchical relations (belonging to political associations, professional groups, religious groups, local community associations, old age clubs, and volunteer fire-fighting groups) and horizontal social capital as participating in homophilous social groups (volunteer groups, citizens’ and consumer action groups, sports groups and clubs, and hobby clubs). While low individual-level horizontal social capital was associated with having 19 or less remaining teeth (OR=1.45; 95%CI:1.21-1.73), individual-level vertical social capital was not significantly associated with dental status. In the multilevel study of 21,736 adults aged 65 and over in the Ohsaki Cohort 2006 study, at the individual-level, only larger friendship networks and sport networks had significant associations with individual dental status (having 20 or more teeth), while other kinds of networks namely, civic network, leisure network, and volunteer network were not. Moreover, individual-level social support was not significantly associated with dentate status (Aida et al., 2010).

In a more recent study, Aida et al. (2011b) analysed data for 3,451 adults aged 65 years and over from the Aichi Gerontological Evaluation Study Project 2003, an ongoing prospective cohort study that included 79 local districts in Aichi prefecture, Japan. They showed that individual-level mistrust was associated with poor dentate status (having 19 or fewer teeth) (OR=1.41; 95%CI:1.04-1.93). However, volunteering was not associated with dentate status.

In a population-based multilevel study involving 624 adolescents and adults randomly selected from 30 census tracts in three cities in the State of Paraíba, Brazil (Santiago et al., 2013), individual level bonding social capital, defined on the basis of positive social interaction and information, was inversely associated with dental pain. However, bridging social capital, defined by the relationships with relatives and friends, and participation in social groups, was not associated with dental pain.

Using self-rated oral health as an outcome, Furuta et al. (2011) investigated the associations of oral health with perceived social capital indicators. The population under study was a convenience sample of 967 Okayama University Japanese students aged 18 to 19 years. Results showed that lower levels of neighbourhood trust, higher levels of neighbourhood informal social control, and lower level of vertical school trust were associated with poor self-rated oral health whereas family social capital, horizontal school trust and reciprocity at school were not significantly associated with poor self-rated oral health. The ‘unexpected’ adverse association between informal social control and self-rated oral health underlies an example of the downside of social capital where strong control on individual increases the level of conformity and subsequently might reduce the degree of privacy and autonomy and leads to detrimental effects.

Using data from 1,632 older adults aged 60 years and over in the NHANES, Sabbah et al. (2011) found that social network assessed by the number of close friends and marital status were associated to the severity of loss of periodontal attachment (expressed as the percentage of affected sites). Widowed respondents and those with the least number of friends had higher rates of the extent of loss of periodontal attachment. On the other hand, marital status and number of friends were not associated with moderate periodontitis as defined by the presence of two or more inter-proximal sites with loss of attachment of 4mm or more or two or more inter-proximal sites with pocket depth 5mm or more. Furthermore there was no association between need for emotional support and the two indicators of periodontal disease.

In a cross-sectional study of 635 adults aged 60 years and over living in two rural North Carolina counties, Arcury et al. (2013) investigated whether oral health was associated with social integration. They reported that respondents with more teeth and fewer oral health problems such as tooth pain, gum bleeding or dry mouth were more socially engaged. However number of teeth and oral health problems were not associated with social network size. Self-rated oral health was associated neither with the level of social engagement nor with the social network size.

Lida and Rozier (2013) examined in their cross-sectional population based survey the association between mother-perceived neighbourhood social capital and oral health status in 65,053 US children aged 1 to 17 years. A social capital index was constructed based on 4 items that capture mothers' perception of reciprocal help, support, and trust in the neighbourhood. After controlling for potential confounders, the mother's perceived social capital was associated with children's unmet dental care but not with the reported rating of children's oral health. Children's oral health status was based on mothers' reports and was not validated by clinical examination.

Finlayson et al. (2007) analysed data from 719 African-American children aged 1 to 5 years living in 39 low-income census tracts in Detroit, Michigan and showed that the mother's perceived instrumental social support was not associated with children's caries status.

Vered et al. (2011) did not find a significant association between social support (validated social support scale including instrumental and financial support) and periodontal disease among a group of 340 immigrants aged 18-75 years from Ethiopia to Israel. However the study found a protective effect of social support on occurrence of dental caries. For each unit increase in social support the odds for higher level of caries reduced. This result confirmed the finding from a US study in which decayed and missing teeth were more prevalent in specific ethnic minority groups experiencing low social support (Wu et al., 2011). In addition, this study found that none of the measures of social support (marital status, number of close friends and financial support) were associated with self-rated oral health among older adults. When the analysis was stratified by dentate status, the number of close friends was associated with self-rated oral health among edentate individuals.

Among a stratified random sample of 255 participants aged 70 years and over drawn from the voters' list in Vancouver, British Columbia, Canada, Maupomé and MacEntee (1998) found evidence of a more frequent presence of anterior spaces where 1 or more missing teeth had not been replaced by a prosthodontic device among respondents who are more isolated and restricted to their home. However, neither removable partial denture nor missing anterior teeth replaced by dentures were associated with social networks (cohabiting status; contact frequency; formal and informal social participation) or social support (material and informational; emotional and marital status). Similarly a Swedish study of 500 men born in 1914 (aged 68 at the time of the survey) found that men with low sense of belonging to informal / formal groups and low social participation had fewer functioning teeth. Compared to men without anterior open tooth spaces, men with anterior open tooth spaces more often had lower sense of belonging to one's group, lower social participation and lower adequacy of social participation. However none of the dimensions of social support (material / information support; emotional support; adequacy of emotional support and cohabiting status) were associated with the number of functioning teeth, fixed bridges and anterior open tooth spaces (Hanson et al., 1994). A restricted measure of cohabiting status (only married with a woman against living alone) was used in the study, and this ignores other supportive cohabiting relationships.

Social support has been shown to enhance better oral health status. Within the four aspects of social support, instrumental and informational social support were positively associated with tooth retention among Australian dentate adults (Sanders, 2007). However emotional and appraisal social support were not related to tooth retention. All four aspects of social support were related to self-rated oral health and oral health impact on quality of life.

In another study of 3,678 dentate adults aged 18 to 91 years in Australia that covered childhood familial circumstances among other topics, Sanders and Spencer (2005) showed that adults who grew up in a positive supportive familial environment had significantly lower Oral Health Impact Profile (OHIP-14) scores, indicating better oral health-related quality of life. Parenting supportive style was also associated with OHIP-14, but not after adjusting for psychological factors such as chronic stress, sense of control, life satisfaction and social support.

Tsakos et al. (2013) employed indicators of social network such as marital status and number of close ties and indicators of social support, namely emotional support need, and provision of financial support, to examine their potential association with edentulism, decayed teeth, root decay and sound or filled teeth, in a sample of 4,014 American adults aged 60 years and over. The authors found that respondents who were married or living with a partner had more sound and filled teeth whereas need for emotional support was associated with root decay, and with poorer self-rated oral health. Furthermore respondents who had fewer close friends had higher rates of decayed teeth and root decay but there was no association between the number of close friends and self-rated oral health. Edentulism was not associated with any of the social capital markers.

Merchant et al. (2003) found evidence that US men with more social support were less likely to develop periodontitis. Men who reported having at least one close friend and those who participated in religious services were at reduced risk of periodontitis. However, marital status and frequency of contact with friends and relatives were not associated with periodontitis. One of the limitations of this study was that it was conducted in a specific occupational group – 58.0% of the sample was dentists - and periodontal disease was assessed using self-reported data.

Furthermore, in a life course approach study investigating the association between psychosocial factors at two periods of life and periodontal diseases in 224 Brazilian adult women, Nicolau et al. (2007) showed that low emotional support in adulthood was a predictor of severe periodontitis. Women who reported no emotional support in adulthood had an increased risk of experiencing high levels of periodontal attachment loss, but there was no association between a lack of social support in childhood and periodontal disease.

Brennan and Spencer (2012) conducted a study of 421 Australian adults aged 30 years to assess the associations of social support measured by the Multidimensional Scale of Perceived Social Support and optimism with oral health (Dahlem et al., 1991). The results of the unadjusted analyses revealed that high social support was associated with less negative impact on quality of life (OHIP-14), but not with dental caries experience (DMFT). The adjusted analyses showed that the joint effect of social support and optimism was negatively associated with OHIP-14 and caries experience. The combination of social support and optimism was associated with better oral health, with the highest levels of DMFT and OHIP-14 observed among those in the low support/low optimism group.

2.7.2 Community level measures of social capital: the contextual influence of social capital on oral health

Out of the 11 studies (10 multilevel and 1 ecological studies) found on community social capital and oral health, only 3 reported positive associations, whereas 8 reported mixed or null findings. The studies reporting positive associations are first described below and the mixed or null findings are then described.

Positive findings

A Brazilian study of secondary school children suggested that low levels of social capital may be an important factor associated with dental caries. Among a population of 1,302 Brazilian, 14/15-year-old students from two cities of the Distrito Federal (DF), Brazil, Pattussi et al. (2006b) showed that lack of empowerment, a community level indicator of social capital, created by summing five items on the perceived occurrence with which people signed petitions, made formal complaints, contacted local authorities, attended meetings, joined groups and talked about issues to improve their neighbourhood, was associated with higher risk of dental caries with an odds ratio (95% confidence interval) of 1.54 (1.09-2.18).

In the previously reported study, Tellez et al. (2006) assessed the association between social cohesion and the severity of dental caries in a low-income US African-American population. The study found that a 1 standard deviation increase in the number of churches in neighbourhoods (5.9 churches) was associated with a lower level of caries (2.7 decrease in the untreated decayed tooth surface score). The presence of churches may have been a proxy for the degree of social support and informal social control (Putnam, 2001) within the neighbourhood clusters, with churches fostering more social ties within the community.

In a multilevel analysis conducted in neighbourhoods within three cities in Brazil, individuals living in neighbourhoods with high social capital assessed by aggregating measures of social trust, social control, empowerment, political efficacy and neighbourhood safety, were less likely to report dental pain compared to those living in neighbourhoods with low social capital (Santiago et al., 2013).

Mixed or null findings

In his thesis, Moysés (2000) found that social cohesion, the contextual dimension of social capital, measured by items such as community participation in health and social care meetings, ratio of community associations and local health committees, was the strongest predictor for dental caries-free in deprived areas of Curitiba, Brazil among a population of 2,126 12-year-old children. For each increasing unit of social cohesion index there was an increase of 5.6% in being caries-free (β=5.60; 95%CI:2.26, 8.84). While social cohesion was also inversely associated with dental pain (β=-2.95; 95%CI:-5.35, -0.56), community social support, measured by policies that support implementation of public day care centers, healthy food projects in schools, and adequate community dwellings, was not associated with dental pain. The publication from this thesis reported that social cohesion was not significantly associated with dental injury among school children (Moysés et al., 2006). However, an association was found between community social support and dental injury. For each increasing unit of supportive public social policies there was a decrease of 2.6% in dental injury (β=-2.62; 95%CI:-4.90, -0.34).

An ecological study of 7,296 school children from 19 Districts of the Distrito Federal of Brazil (Pattussi et al., 2001), did not find a significant association between indicators of social cohesion, measured by per thousand number of participants in meetings of the participative budget and per thousand number of homicides and attempted homicides, and dental caries. However, Pattussi et al. (2001) argued that there was a tendency for areas with high number of homicides to have higher levels of caries experience. In addition, children living in areas with high levels of income inequality, expressed by the Gini coefficient had higher levels of dental caries (Pattussi et al., 2001). Furthermore, a neighbourhood social capital index that covered 5-dimensions such as social trust, social control, empowerment, neighbourhood security, and political efficacy was associated with reduced odds of dental injury to anterior teeth, but only among boys (OR=0.55; 95%CI:0.32-0.81) and not among girls (Pattussi et al., 2006a).

Investigating the association between contextual social capital and caries in 3,086 randomly selected 3-year-old Japanese children from 39 municipalities, the multilevel analysis conducted by Aida et al. (2008) revealed a protective effect of social cohesion, measured by the number of community centers, on the occurrence of dental caries. However, the number of volunteer care workers per 100 000 residents, used as a marker of community social support, was not associated with dental caries.

In the previously reported Aichi Gerontological Evaluation Study (Aida et al., 2009), low community-level horizontal social capital was positively associated with fewer numbers of remaining teeth (OR=1.25; 95%CI:1.03-1.52). However community-level vertical social capital was not significantly associated with dentate status.

In the Ohsaki Cohort 2006 study (also previously reported), Aida et al. (2010) found that only the friendship networks had a significant effect on individual dentate status (having 20 or more teeth), while other kinds of networks namely, civic network, leisure network, and volunteer network did not. Moreover, the study highlighted that neighbourhood social support was not associated with dentate status.

In the more recent study of the Aichi Gerontological Evaluation Study, Aida et al. (2011b) showed that rate of non-volunteering and rate of mistrust were not associated with poor dentate status (having 19 or less teeth).

2.7.3 Limitations of studies on social capital and oral health

This review of studies on concepts related to social capital and oral health has highlighted a number of issues. Although some studies find associations between social capital and oral health, there are many studies that find no association or mixed findings. The reasons for such contradictory findings are discussed below.

2.7.3.1 Studies used different measures and instruments for social capital

The studies discussed above reflect the general trend of theoretical and empirical advances made in the last two decades. As expected, multiple definitions and measurements, scales and assessment tools have been employed to investigate the association between social capital and oral health. Hence, we have to be very cautious in interpreting these often contradictory findings, as many studies have addressed the association between social capital and oral health status by using diverse instruments and approaches.

Various ecological, community-level indicators have been proposed such as neighbourhood safety (Santiago et al., 2013), number of community centers and care workers (Aida et al., 2008), level of empowerment (Pattussi et al., 2006b; Pattussi et al., 2006a), political efficacy and neighbourhood security (Pattussi et al., 2006a), volunteering rates (Aida et al., 2011b), number of churches (Tellez et al., 2006), community participation, number of local Health Committees and ratio of community entities (Moysés, 2000; Moysés et al., 2006) as an indicator of social capital. Most of these are very culturally specific and thus limits comparability.

There has been a particular focus on secondary analysis of individual level survey datasets not collected specifically to measure social capital, aggregated to community or neighbourhood. The ad hoc measures from such surveys often do not reflect common definitions of social capital, as the original survey questions were not originally designed to measure social capital. Typically, such survey questions do not measure both aspects of social capital (structural and functional) and often combine different dimensions of social capital into a single score.

2.7.3.2 Studies used proxy measures to operationalise the construct of social capital

There was a tendency to measure lot of things that are not social capital and to aggregate them under the heading of social capital. According to Harpham (2008) some measures used to capture social capital are usually considered as intermediate variables between social capital and health. These include neighbourhood security and number of homicides (Pattussi et al., 2001; Pattussi et al., 2006b; Santiago et al., 2013). Furthermore, this grouping of different concepts into a single social capital variable can mean that investigators do not really know which indicators could be essential to explain their studied outcomes. For example, will an hypothesised effect of social capital stem from the presence of specific individuals, types of relationships, social resources, the structure or size of the social network, all of these, or some of these aggregated into some useful combination? (Harpham, 2008).

One example of how proxy measures of social capital are used without adequate conceptualisation in a number of studies is the variable marital status. Marital status was sometimes used to indicate social network (Avlund et al., 2003; Sabbah et al., 2011; Tsakos et al., 2013), while in other studies, it was used to indicate social support (Hanson et al., 1994; Maupome and MacEntee, 1998; McGrath and Bedi, 2002; Merchant et al., 2003; Wu et al., 2011). Although not all the cited studies directly refer to social capital, many of them use the variable as a proxy for social support. However, marital status is only a very poor proxy of social support, as it does not capture the quality of the relationship and the availability of support.

Another example of the inadequate conceptualisation of social capital is in the study by Santiago et al. (2013). The study used measures of social support to refer to bonding capital, and measures of social networks (such as relationships with friends and family) to refer to bridging social capital. However, bonding social capital refers to ties and networks among homogenous groups (Putnam, 2000), and does not explicitly mention social support. Bridging social capital refers to social ties across diverse groups (Putnam, 2000) and is not measured using social networks with friends and family.

2.7.3.3 Different levels of aggregation

Based on such secondary data analysis, studies have been conducted at different levels of spatial aggregation, dependent on the catchment area of the survey, so there may be different mechanisms of action involved at each level (Aida et al., 2011b; Santiago et al., 2013). There are only a few studies that assessed social capital at both the individual and community levels (Pattussi et al., 2001; Pattussi et al., 2006b; Pattussi et al., 2006a; Tellez et al., 2006; Aida et al., 2008; Aida et al., 2009; Aida et al., 2010; Aida et al., 2011b; Santiago et al., 2013).

A number of the studies reviewed measured two or more types and components of social capital, namely the structural and/or the cognitive components of bonding and bridging social capital measured in geographically delineated areas. However notions of the community, neighbourhood are not consistent across these studies. One of the most difficult problems in social capital research is defining ‘community’ in a standardised, meaningful way to respondents. For example neighbourhood can mean small or large census areas, or school catchment area, which have little relation to a person’s notion of neighbourhood or shared social environment. The boundaries of a neighbourhood, such as the limits of the catchment areas, may not coincide with perceived boundaries (Pattussi et al., 2006b; Pattussi et al., 2006a). Moreover, many of the studies did not justify their choice of community level unit of analysis, although a few acknowledge the limitation that their findings on social capital may not be generalizable to communities (Pattussi et al., 2001; Tellez et al., 2006; Finlayson et al., 2007; Santiago et al., 2013).

2.7.3.4 Lack of validity on measures of social capital

Another limitation in the literature is a lack of examination of validity of measurement of concepts related to social capital in many studies. For example, the measurements of social capital used are often based on a self-administered questionnaire, and as such they are subject to response bias by social desirability or social approval (Aida et al., 2011b). The assessment of social networks is also often subject to limitations, as the variables used measure the size of the networks but did not provide information on the intensity and quality of social contacts (Sabbah et al., 2011; Tsakos et al., 2013). Although this may be a valid measure of the size of social networks, which the cited studies aimed to investigate, they are limited measures of social capital. Some studies used principal components analysis to measure social capital, although the categorizing may not necessarily be correct (Aida et al., 2009). Other studies explicitly mentioned that their measurement of social relations was not validated (Avlund et al., 2003).

2.7.3.5 Different measures of oral health

Another issue limiting the comparability of studies on social capital and oral health is the use of different measures of oral health outcomes. The studies considered different objective and subjective measures of oral health and the objective measures include both clinical and self-reported indicators of oral health status.

Clinical measures include the validated DMFT index (WHO, 1997), that is expressed as the number of decayed (D), missing (M) and filled (F) teeth (T) in an individual, although some studies have measured different components of oral health separately such as dental caries, dental injuries, number of remaining teeth. The DMFT index has been used as a continous outcome (Pattussi et al., 2001; Aida et al., 2008) and has also been dichotomised (Pattussi et al., 2006b) or used in both continuous and dichotomised format (Vered et al., 2011). Some studies did not use the WHO criteria and dental caries were measured by the criteria developed by the International Caries Detection and Assessment System (Tellez et al., 2006; Finlayson et al., 2007). Other clinical measures include dental injury adopting the British Association for the Study of Community Dentistry (BASCD) criteria (Moysés et al., 2006) or the criteria used in the UK Children's Dental

Health Survey (Pattussi et al., 2006a), the number of decayed teeth and the presence of root decay (Tsakos et al., 2013); edentulism (Rodrigues et al., 2012). In one study, the measure of coronal caries and root caries were included in the dichotomous outcome (presence or absence of caries); and also as a continuous caries outcome (Avlund et al., 2003), but the study did not mention the criteria of caries assessment. In Hanson et al.'s study (1994) and Maupome and MacEntee (1998) dental status was clinically assessed by number of teeth / missing teeth, and the presence / absence of removable dentures or/and fixed bridges. Periodontal disease has also been measured in different ways in Nicolau et al. (2007), Vered et al. (2011), and Sabbah et al. (2011).

Objective and self-reported measures of oral health include number of remaining teeth (McGrath and Bedi, 2002; Aida et al., 2009; Aida et al., 2010; Aida et al., 2011b; Arcury et al., 2013; Takeuchi et al., 2013) and self-reported edentulism (Tsakos et al., 2013). Self-reported periodontal disease (Merchant et al., 2003) has also been used, although most people may not know their periodontal health status.

Subjective measures of oral health include self-rated oral health (Siriphant and Drury, 2005; Sanders, 2007; Furuta et al., 2011; Wu et al., 2011; Arcury et al., 2013; Tsakos et al., 2013), presence of dental pain (Santiago et al., 2013) and Oral Health Impact Profile – OHIP-14 (Sanders and Spencer, 2005; Brennan and Spencer, 2012; Lamarca et al., 2012). Children's oral health status and dental needs in one study were based on maternal reports (Iida and Rozier, 2013). Studies that use only subjective measures of oral health and social capital may be affected by common method bias: there may be unobserved factors such as psychological states or traits that cause the association between low reports of social capital and participation and poorer self-assessments of oral health.

One of the more striking patterns that emerges from the literature review is the robust association between structural dimensions of social capital and objective measures of oral health (Hanson et al., 1994; Maupome and MacEntee, 1998; Moysés, 2000; McGrath and Bedi, 2002; Avlund et al., 2003; Merchant et al., 2003; Moysés et al., 2006; Pattussi et al., 2006b; Pattussi et al., 2006a; Tellez et al., 2006; Aida et al., 2008; Aida et al., 2009; Aida et al., 2010; Aida et al., 2011b; Sabbah et al., 2011; Rodrigues et al., 2012; Arcury et al., 2013; Takeuchi et al., 2013; Tsakos et al., 2013). In contrast, a number of null associations between functional social capital and objective measures of oral health have been reported (Hanson et al., 1994; Maupome and MacEntee, 1998; Finlayson et al., 2007; Aida et al., 2010; Sabbah et al., 2011; Vered et al., 2011; Brennan and Spencer, 2012), while other studies have reported associations between functional social capital and subjective oral health (Sanders and Spencer, 2005; Sanders, 2007; Furuta et al., 2011; Brennan and Spencer, 2012; Iida and Rozier, 2013; Santiago et al., 2013; Tsakos et al., 2013). This suggests a pattern of association between structural social capital and objective oral health measures and an association between functional social capital and subjective oral health. Studies examining the association between social capital and oral health need to use both subjective and objective oral health measures to reflect different aspects of oral health.

2.7.3.6 Lack of longitudinal and life course analysis

Few studies adopted a life course approach to understanding the association between social capital and health. According to the life course approach, the influence of social capital on oral health may accumulate over time (Krieger, 2001; Watt, 2002; Sanders, 2007; Sisson, 2007). For instance, the oral health status of older people reflects their oral health over the life course and may not necessarily correspond to their social capital at the time of measurement. Furthermore, there is a lack of longitudinal studies to establish the temporal order between social capital and oral health. Most of the studies reviewed are cross-sectional which limits the ability to make causal inferences. Three studies used retrospective methods, which have a potential for recall bias and misclassification of exposure (Sanders and Spencer, 2005; Nicolau et al., 2007; Sanders, 2007). Recall bias in such retrospective studies can produce a high rate of false negatives and substantial measurement error (Hardt and Rutter, 2004). Five longitudinal studies on oral health and social capital-related measures include a short follow-up period of 9 months (Lamarca et al., 2012); a 4-year follow-up (Merchant et al., 2003); a 5-year follow-up (Vered et al., 2011); a 7-year follow-up (Avlund et al., 2003); and a 17-year follow-up (Brennan and Spencer, 2012).

2.7.3.7 Inadequate control for confounding factors

One of the key issues in studies on social capital and oral health is confounding bias. As oral health reflects accumulated life course influences, confounders of the association between social capital and oral health need to be accounted for across the life course. Socio-economic position is one of the key confounders of the association between social capital and health and most of the studies reviewed control for a measure of social position as a covariate. However, many studies do not take into account social position over the life course and fail to control for social position in early and later life. There is also the potential for neighbourhood selection bias when measuring social capital at the community level. Individuals may chose where to live on the basis of neighbourhood characteristics, and so the association of community level social capital and oral health may be a result of individuals selecting themselves into particular types of neighbourhoods and other individual level characteristics.

2.7.3.8 Population heterogeneity

Another key feature of the literature review is the heterogeneity in populations investigated. These include culturally different populations with different norms about social capital, populations of different age groups and characteristics including pregnant women (Lamarca et al., 2012); preschool children (Finlayson et al., 2007); school children (Pattussi et al., 2001); adolescents (Moysés, 2000; Moysés et al., 2006; Pattussi et al., 2006b; Pattussi et al., 2006a); students (Furuta et al., 2011); adults (Nicolau et al., 2007; Zini et al., 2012); older adults (Aida et al., 2009; Aida et al., 2010; Aida et al., 2011b; Sabbah et al., 2011; Arcury et al., 2013; Takeuchi et al., 2013; Tsakos et al., 2013); the oldest-old group (Avlund et al., 2003) and combined population subgroups of adolescents, adults and elderly (Santiago et al., 2013). Social capital meanings vary according to age (Cagney and Wen, 2008; Nyqvist et al., 2013) and so the measures of social capital need to be appropriate for each age group. Furthermore, some studies aggregated individual social capital data from adolescents, adults and elderly to build the neighbourhood social capital measure, although there may be generational differences in the meaning of social capital.

2.7.3.9 Small sample sizes

Another limitation of some of the studies is the lack of representative population samples (Furuta et al., 2011; Takeuchi et al., 2013) and small sample sizes (Maupome and MacEntee, 1998; Avlund et al., 2003; Nicolau et al., 2007; Brennan and Spencer, 2012; Rodrigues et al., 2012; Zini et al., 2012; Arcury et al., 2013; Santiago et al., 2013).

This thesis aims to address many of the aforementioned limitations on the evidence relating social capital and oral health.

2.8 Potential link between social capital and health: The different pathways

Social capital has been recognised to be associated with mental health, physical health (de Silva et al., 2005; Almedom and Glandon, 2008; Kim et al., 2008), and oral health (Aida et al., 2009; Aida et al., 2010; Aida et al., 2011b; Furuta et al., 2011; Sabbah et al., 2011; Tsakos et al., 2013), but how social capital affects health outcomes is still considered a contentious issue (Pearce and Davey-Smith, 2003; Muntaner, 2004; Kawachi et al., 2013b).

Epidemiologists have suggested that the mechanisms by which social capital influence health include access to psychosocial support, as well as the diffusion of health information (Kawachi and Berkman, 2000). Economists have proposed that social capital may directly enter the utility function (Folland, 2008; Islam et al., 2008). In particular, in Folland's formulation (2008) the presence of social capital modifies the risk/reward tradeoff of engaging in risky behaviour such that individuals with higher level of social capital will be less prone to engage in risky behaviour. Nonetheless, some steps have already been taken identifying the psychological, behavioural, and physiological pathways linking social relationships to health (Kawachi and Kennedy, 1999; Berkman et al., 2000; Cohen et al., 2000; Uchino, 2006).

Kawachi et al. (1999), as well as Kawachi and Berkman (2000) addressed plausible pathways where social capital might affect individual and community health, including promotion of a more rapid diffusion of health information which fosters healthy norms of behaviour, increased likelihood that healthy norms of behaviours are adopted, social control over unexpected health-related behaviour, increased access to local services and amenities, and psychosocial processes such as affective support, self esteem and mutual respect. Generally positive outcomes are thought to operate through social control or norm observance, family support, and benefits mediated through extra familial networks (Portes, 1998). However, one has to keep in mind that social networks and social ties reflected in the concept of social capital can also have adverse consequences on health and well being of individuals or communities (Portes, 1998).

The next section reviews some of the specific pathways linking social capital to general and oral health. Although the analysis of these pathways go beyond the scope of this thesis due to a lack of data on all these pathways, it is important to consider the evidence basis of these different pathways.

2.8.1 Biological pathways

The influence of social relationships on health cannot be completely explained by the behavioural and/or psychological processes, as social relationships exert an independent effect (Holt-Lundstad et al., 2010). Reviews of such findings (Holt-Lundstad et al., 2010) suggested that there are multiple biologic pathways involved (physiologic regulatory mechanisms, themselves intertwined) that in turn influence a number of disease endpoints (Uchino, 2006). A number of studies indicated that social network and social support are linked to better immune functioning (Cohen et al., 1997; Lutgendorf et al., 2005), lower allostatic load (McEwen, 2001; Nicolau et al., 2007), and to immune mediated inflammatory processes (Kiecolt-Glaser et al., 2005). The latter study showed how hostile or abrasive marital relationships affect physiological functioning and health. In contrast, other studies have shown that social support does not directly influence the immune response, but instead, functions by decreasing distress, which has subsequent effects on the immune response (Baron et al., 1990).

2.8.2 Psychological pathways

In their conceptual model, Berkman et al. (2000) described a cascading causal process in which macro social framing forces affect social networks, which in turn activate selected psychosocial mechanisms. These mechanisms subsequently influence health via psychological processes.

There may be two psychological pathways by which social capital could influence health (Cohen and Wills, 1985). According to the ‘main effects’ model, positive and negative aspects of social relations may have an independent effect on health. For example, low social networks and a lack of social support could act as stressors and result in poor general health, while large social networks and satisfactory social support could improve well-being (Melchior et al., 2003). It has been postulated that individuals perceiving high levels of trust and reciprocity in their communities have better health due to reduced exposure to chronic stressors (Wilkinson, 1996; Giordano and Lindstrom, 2010; Giordano and Lindstrom, 2011). Furthermore, active social participation has a positive effect on psychological well being through increasing social ties and community integration (Kawachi and Berkman, 2001). Social networks and social ties tend to provide social support, affecting an individual’s health through mechanisms such as promotion of self efficacy, self esteem, and reduction of stress that might influence health outcomes (Berkman, 2000; Veenstra, 2000). Strong ties can also be a strong emotional burden for the support provider. That might explain why women generally report more health problems than men. Studies show that women with large networks are often highly involved in dealing with the stress of others, and thus experience more stress themselves than women with smaller networks or than men (Kunitz, 2004).

Another psychological pathway is that social networks and social support might 'buffer' the health effects of other stressors in a person's life. According to this hypothesis, there is an interaction between social relations and life stressors (related to financial, marital, employment and other living conditions) such that these stressors only have a detrimental effect on well being in the absence of satisfactory social relationships (Stansfeld et al., 1998a; Stansfeld et al., 1998b; Liang et al., 1999). Social contacts can attenuate stressful experiences by helping to solve problems, or by giving a new interpretation of adverse events (Cohen, 2004), thereby buffering the harmful effect of stress (Uchino, 2006). The protective effect of positive social support on depression was greater among older adults aged 50-69 years old compared to those aged 70+ years (Stafford et al., 2011) suggesting a buffering effect of social support in early old age. Social support might also play a role as a coping strategy with psychological distress, which has been found to be related to caries and periodontal status (Honkala et al., 1992; Merchant et al., 2003; Dolic et al., 2005; Tang et al., 2005; Ng and Leung, 2006; Vered et al., 2011).

2.8.3 Behavioural pathways

Kawachi et al. (1999) postulated that communities with high levels of social capital (social cohesion) were more likely to deter unhealthy activities such as alcoholism, tobacco smoking, and crime, maintain access to local resources and even promote healthier behaviours, such as regular exercise. The quantity and quality of peer social networks may have strong influences on health-related behaviours. Interpersonal relationships, particularly among adolescents may be indicators of oral hygiene behaviours such as toothbrushing (Hodge et al., 1980; Rajala et al., 1980; Dorri et al., 2010). Tsakos et al. (2013) provided some evidence for the role of behaviours such as smoking and dental attendance in the pathway between social relationships and oral health among older adults in the US.

Lindstrom et al. (2001) showed that low social participation was the strongest predictor of low physical activity. Daily smoking has been showed to be negatively associated with both low social participation and low trust (Lindstrom et al., 2003; Lindstrom, 2010).

Furthermore, smoking habits may heavily depend on the groups' characteristics that may influence smoking behaviour. Social networks with little access to external information and high levels of social influence can promote unhealthy norms of behaviour, such as tobacco and alcohol consumption, illicit drug use, unhealthy dietary pattern, physical inactivity and damaging sexual practices (Berkman et al., 2000).

There is a human tendency to follow one's peers. Whether this is beneficial or harmful to one's health depends on the particular norms that prevail in the network and on the extent of external information added to it (Ferlander, 2007). Furthermore health related behaviours are determined not only by conscious rational choice, on the basis of appropriate information, but also by the extent to which broader contextual factors support the performances of such behaviours.

An important aspect has to be highlighted at this point, that is, the behavioural and psychological processes are intertwined as each has been shown to exert an influence over the other. For instance, feelings of stress can adversely impact the practice of health behaviours (Ng and Jeffery, 2003) such as inadequate dietary intake (Hwang et al., 2010), neglect of oral hygiene, and increase in smoking (Sanders, 2007), while health behaviours such as exercise can have beneficial effect on feelings of stress. A study of Swedish children showed that those who had low levels of self-esteem had significantly poorer oral health behaviours than those with high levels of self-esteem (Källestål et al., 2000).

2.8.4 Access to services and amenities

The association between social capital and health outcomes may also be explained in part by the access to goods and services that tend to be higher among people living in communities with high levels of social capital (Policy Research Initiative, 2005). High level of bridging and linking social capital may have the power to influence political decisions then more likely to provide access to local services (Kawachi, 1999) which may include access to health service, schools, housing, transports among others.

In his literature review, Derose (2009) shows that bonding social capital is related to overall improved health care access, that is, better access to medical services, receipt of preventive care and utilisation conditional on needs. However the empirical evidence of these findings have to be cautiously interpreted, as the studies tend to mix different aspects of social capital into overall indicators (Derose, 2008).

Focusing on dental health care access and utilization among a specific group, there is evidence that older adults with strong interpersonal ties maintain their oral health better than their peers who are isolated. The research suggested that social networks play a role in promoting the utilization of dental care (Nahoouraii et al., 2008). Social support has been associated with greater use of dental care among elderly Swedish men (Hanson et al., 1994) and older English and Danish adults (Petersen and Nortov, 1989; McGrath et al., 1999; McGrath and Bedi, 2002), and church attendance is an important correlate of dental care among African Americans (Aaron et al., 2003). In addition, studies have found that persons who live alone or are unmarried use dental services less often than others (Rickardsson and Hanson, 1989).

Research has shown that older people make extensive use of medical facilities but they seem to underuse dental facilities (Kiyak, 1987). Mobility problems, lack of information, and misconceptions about the values of dental visit have been mentioned as contributing to this apparent disinterest in dental care (Kiyak, 1987; MacEntee et al., 1997). A minority of persons within an elderly population may not see a need to make use of clinical dental services, regardless of how accessible these services are to them. Social network and social support issues may be important determinants in this perceived need to use clinical services (Maupome and MacEntee, 1998).

To summarise, the potential link between social capital and health suggests important pathways by which health may be improved or not. The mechanisms described often interact with each other to produce a synergistic effect on health (Scheffler et al., 2008). However, as Folland (2008) points out, most of the studies fall short of measuring a true causal effect of social capital on health outcomes. Statistical associations do not allow us to make any conclusion about causality. Thus, Petrou and Kupek (2008) recognised that it is unclear whether the observed associations are causal or due to reverse causality. Furthermore, the causal association goes both ways. Individuals who are healthier are better able to cope and to participate in community and economics activities. On the other hand poor health of individuals also contributes to their withdrawal from social participation subsequently reducing their social network. In other words, the direction of causality is difficult to determine, in that social capital and enhanced health may be mutually reinforcing (Sirven and Debrant, 2012). Social capital, in a broader context of social determinants, may therefore be a potential vector of health inequalities (Sirven and Debrant, 2012; Uphoff et al., 2013).

2.9 Gaps in the literature

The concept of social capital has taken a broad range of definitions across a diverse set of disciplines. There is little congruence in how social capital is defined, measured, and interpreted. Applied to population health research, the concept is potentially useful in understanding how certain aspects of social capital may affect health. However, this review has pointed out several gaps in the literature that need to be addressed through further research.

1. Studies need to distinguish between structural and functional dimensions of social capital. Most studies grouped together these different dimensions with little attempt to validate the concept.

2. Relatively few studies have examined the association between individual social capital and oral health. To date, the mainstream of social capital research has mainly focused on the association between social capital and general health, that is, physical and mental health. Few studies used individual measures of social capital as predictors of oral health.

3. Few studies analysed the dynamic nature of social capital. The temporal order is an important but seldom discussed topic and must be addressed using more robust study designs. Longitudinal studies, therefore, are needed to determine the association between life course exposure of social capital and various health outcomes. Most studies on social capital and oral health relied on cross-sectional designs, which do not rule out the possibility of reverse causation.

4. Few studies used large datasets and representative population samples. A number of studies in oral health used non-random and small opportunity samples, which make it hard to generalise their findings to the wider population.

5. Few studies adequately took account of key potential confounding factors. For example, most studies adjusted for a single measure of socioeconomic position like

education, but this may not be a relevant measure of socioeconomic position for older populations.

6. Few studies examined interactions between social capital and other oral health risk factors. Effect modification is seldom examined although theoretically, there are suggestions that social capital may interact with other factors that influence oral health, such as socio-economic position.

The purpose of this research is not to attempt to reconcile the diverse conceptualisations of social capital. Instead, the goal is to contribute to the flourishing literature by investigating whether social capital measured at the individual level can explain oral health and oral health inequality among older adults.

2.10 Proposed conceptual framework

While there are many legitimate differences in opinions on how to conceptualise social capital, in this thesis the definition of social capital based on the Bourdieu's theory (1986) was applied. Conceptualising social capital based on Bourdieu's theory necessitates consideration of potential and actual network-based resources that people use to achieve individual or collective benefits. In contrast to the communitarian approach, the network approach provides an analysis of actual structure of relationships among people without setting a priori geographical boundaries (Berkman et al., 2000).

Putnam's communitarian approach primarily addresses social cohesion and focuses on social processes (such as network formation, norms of reciprocity, and mutual trust) prior to the resources embedded within social networks that are central to Bourdieu's approach (Carpiano, 2006). Bourdieu's theory acknowledges the existence of community social networks, but emphasises the individual's ability to draw upon the resources within the social network in order to pursue their own individual goals, which may be different from the goals of the community. This approach also emphasises the interaction between an individual's economic and social capital resources in enabling their goals and helps in understanding how social capital operates in reproducing social inequalities.

Furthermore, the thesis adopts the division of individual social capital into the structural and functional dimensions (also referred in the literature as cognitive) (Harpham et al., 2002; Almedom, 2005; de Silva et al., 2005). The structural dimension emphasises the behavioural dimension of the concept and is operationalised by measures of social participation and volunteering. The functional dimension emphasises the relational content and quality of social interaction within the structure of social relationships and is measured by close ties and emotional social support.

The model depicted in Figure 2.2 is based on the diverse theoretical perspectives (Berkman et al., 2000; OECD, 2001; Edwards, 2004; Carpiano, 2006; Islam et al., 2006; Uchino, 2006; Solar and Irwin, 2010) linking social capital to health. It serves as a template for the conceptual analysis model displayed in Figure 2.3.

The framework (Figure. 2.2) conceptualises social capital as a resource, drawing on and feeding back into other types of resources. These other resources are grouped as natural, physical, and human capital. These resources interact in a context of cultural, political, institutional and legal conditions. There is potentially a strong complementarity between human, social capital and political, institutional and legal arrangements. The potential impact of social capital on various outcomes will vary depending on individual characteristics and experiences and on the way in which its effects are enhanced or diminished by the wider social, political, economic, and cultural environment.

Social capital resources are presented as attributes of networks, organised into structural and functional dimensions. The characteristics of the networks' *structure* include the size, density, diversities, and frequency of interactions. The characteristics of the networks' *function* include resources or support (emotional, instrumental, informational, and appraisal) that emerge from the interactions between individuals or group members.

An important aspect of the model concerns the proposed links to and from health outcomes. This makes salient two aspects of this broad model: Firstly, the link with health outcomes highlights the potential role of social capital in the development of certain diseases. Secondly, the feedback loop between health outcomes and social capital highlights the challenge faced by individuals with ill disease than can impact their social network. Furthermore, the association between social capital and health is hypothesised to be mediated through relevant pathways namely, behavioural processes, psychological processes, access to services and amenities, and relevant physiological processes.

Figure 2.2: Conceptual framework: Human and social capital and health

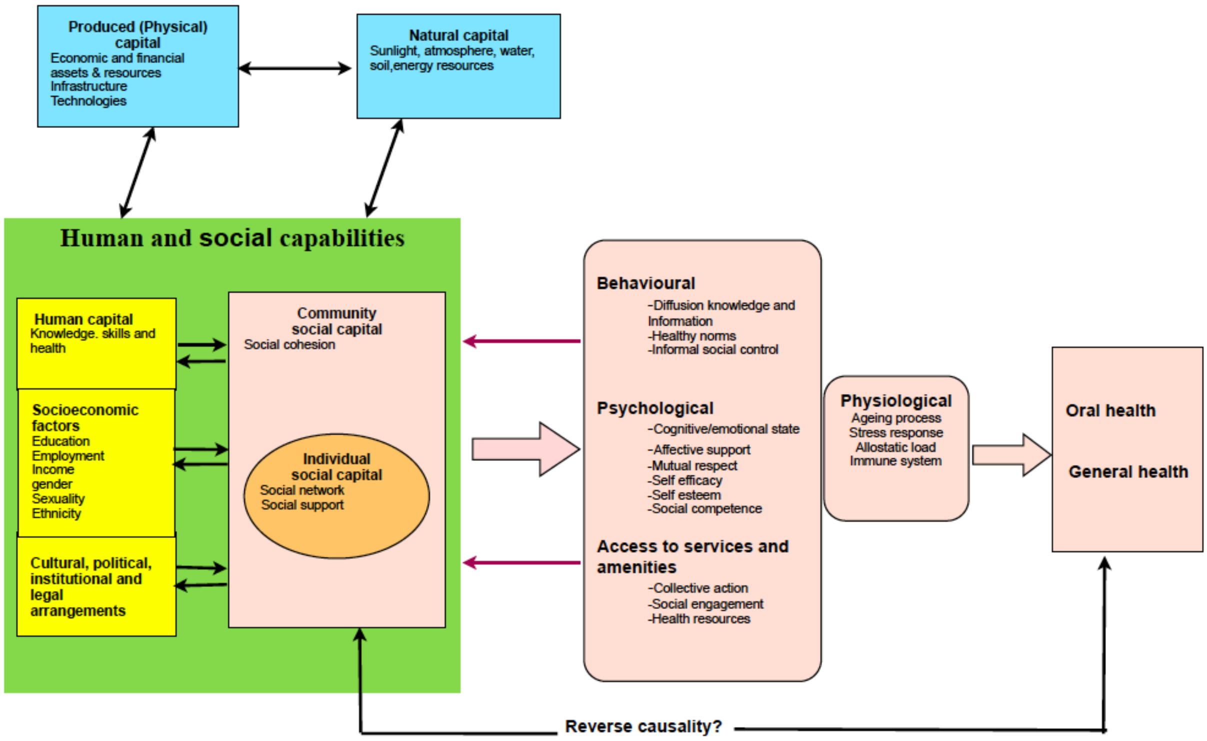
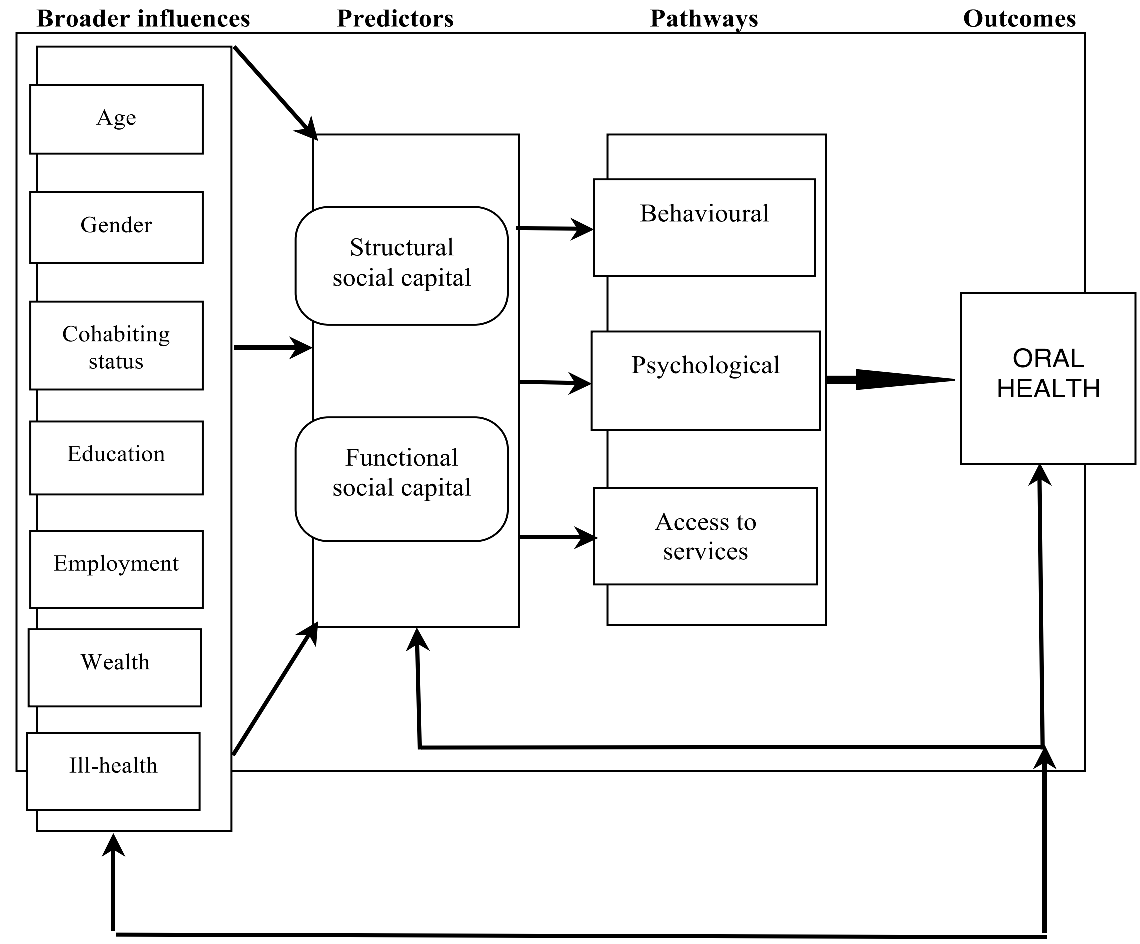


Figure 2.3 presents the specific model used in the thesis for the analysis of the association between social capital and oral health, and is derived from the overall conceptual model in Figure 2.2. Social capital (the structural and functional dimensions) may influence oral health through behavioural, psychological and dental health service access pathways (see section 2.8). In addition, there are a broad range of socio-demographic and socio-economic factors that can influence both social capital and oral health (discussed in the methodology chapter, section 3.3). Thus, according to this conceptual model, behavioural, psychological and health service factors are potential mediators between social capital and oral health. Socio-demographic and socio-economic factors are potential confounders of the association between social capital and oral health. If the association between social capital and oral health remains after taking into account these potential confounding and mediating variables, then this is stronger evidence that social capital may affect oral health. However, there may also be a feedback loop - oral health may influence the structural and functional aspects of social capital. This is a key issue with any analysis of social determinants of health, as low social capital may result from poor oral health.

Figure 2.3: Conceptual analysis model of social capital, demographic, socio-economic, health-related factors, and oral health



2.11 Aims, objectives and hypotheses

Aims of the study

1. To investigate the cross-sectional association between social capital and oral health in a national sample of older adults in England.
2. To investigate the longitudinal association between social capital and oral health among older adults in England.
3. To identify potential mediating factors that may link social capital to oral health among older adults in England.

Specific objectives

Aim 1: To investigate the cross-sectional association between social capital and oral health in a national sample of older adults in England.

Objectives:

1.1 To describe characteristics of the analytical sample.

1.2 To identify potential confounders or mediators in the association between social capital and oral health.

1.3 To assess the unadjusted and adjusted association between social capital and oral health.

1.4 To investigate effect modification in the association between social capital and oral health (stressor effect vs. buffer effect).

Hypotheses:

1.1 Lower levels of social capital are associated with poorer oral health.

1.2 Structural aspects of social capital are associated with objective oral health measures while functional aspects of social capital are associated with subjective oral health measures.

1.3 The association between social capital and oral health remains significant even after adjusting for socio-demographic, socio-economic and health risk factors.

1.4 Social capital buffers the association between oral health risk factors and poor oral health.

Aim 2: To investigate the longitudinal association between social capital and oral health among older adults in England.

Objectives:

2.1 To examine the unadjusted and adjusted longitudinal association between social capital at baseline and oral health at follow-up.

2.2 To examine the unadjusted and adjusted longitudinal association between oral health at baseline and social capital at follow-up.

2.3 To examine the association between change in social capital and change in oral health.

Hypotheses:

2.1 There is a bi-directional association between social capital and oral health.

2.2 After adjusting for covariates, structural social capital at baseline is associated with change in objective measures of oral health. Similarly, functional social capital at baseline is associated with change in subjective oral health.

2.3 Positive change in social capital is associated with improvement in oral health. Similarly, negative change in social capital is associated with worsening oral health.

Aim 3: To identify potential mediating factors that may link social capital to oral health among older adults in England.

Objectives:

3.1 To examine whether psychological and behavioural factors explain the association between social capital and oral health.

Hypotheses:

3.1 Depression will explain some of the association between social capital and oral health.

3.2 Smoking will explain some of the association between social capital and oral health.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The purpose of this chapter is to describe the study and to then outline in detail the data and the analytical strategy carried out to address the objectives of this thesis. The description of the data includes the study population, a brief account of the sampling procedures, data collection process, and variables. As this is a secondary analysis of data collected by the ELSA team, a clear distinction between the data and variables already contained in the ELSA study and the derived social capital variables used for this thesis is presented. The analytical strategy is also discussed which includes the rationale for sampling restrictions and statistical analysis.

3.2 Data

3.2.1 Overview of the English Longitudinal Study of Ageing (ELSA)

The English Longitudinal Study of Ageing - ELSA - is a panel study of men and women aged 50 and over and their partners, designed to be a nationally representative sample of the population living in a private residential address in England. The sample has been drawn from households that have previously participated in the Health Survey for England (HSE) between 1998 and 2006. ELSA aims to collect high quality longitudinal data that can be used to investigate changes in economic circumstances, social status, physical and mental health, social relationships, cognitive function and biology, as people prepare for and move into retirement and old age (Steptoe et al., 2012). ELSA has a particular focus on the associations between different aspects of the ageing process and on data that are relevant to this thesis. The same group of individuals is contacted every two years to measure different aspects of the ageing process.

3.2.2 Funding and ethical approval

ELSA is funded by the US National Institute on Ageing and by a consortium of UK government departments led by the Office for National Statistics - ONS - (Department of Health, Department of Work and Pensions, Department of Environment, Transport and the Regions, Department for Education and Skills, Department of Culture, Media and Sport and HM Treasury). Ethical approval was granted by the Multi-centre Research and Ethics Committee (MREC).

3.2.3 Sample source: Health Survey for England

The HSE is an annual cross-sectional household survey that collects a wide range of health data and biometric measures and is designed to be representative of the English population living in private residential addresses. Three HSE years, 1998, 1999, 2001 were selected as the sampling frame for ELSA wave one, with the 'core' samples from each HSE year being nationally representative.

3.2.4 Baseline sampling and recruitment - Wave one - 2002-03, ELSA Cohort 1

The first ELSA survey was carried out in 2002-03, and is referred to as wave 1. The term 'Cohort' is used to reflect the wave in which new sample was added. All those who were recruited for the first wave or have since the HSE 1998, 1999 and 2001 interviews become partners of core members are known as cohort 1. Core members are defined as age-eligible sample members who participated the first time they were approached to join the ELSA study. They represent the core element of the longitudinal ELSA sample.

At the first wave, 12,099 interviews were conducted. Ninety four per cent (n=11,391) of the participants were Cohort 1 core members. Six percent (n=708) of the interviewed were with young and new partners (Figure 3.1). Young partners were under the age of 50 at the time of interview. New partners were living with the core member at the time of the first ELSA interview, and had joined the household since the HSE interview. Interviews with Cohort 1 core member and their eligible partners were attempted every two years following wave 1 (Taylor et al., 2007).

3.2.5 Follow-up phases

3.2.5.1 Wave two - 2004-05

There is no 'Cohort 2' in ELSA because no new sample was issued at wave 2. Throughout the fieldwork period (June 2004 - July 2005) an overall of 9,432 main interviews were conducted. The majority of the interviews, 93.0% (n=8,780), were conducted with Cohort 1 core members, and 7.0% (n=652) with cohort 1 partners (Scholes et al., 2008).

3.2.5.2 Wave three - 2006-07: Refreshment sample, ELSA Cohort 3

As the study progresses, the youngest people (between 50-54 years old) are no longer represented. In order to maintain a full range of age-groups in the sample, new individuals from HSE 2001 to 2004 who were entering their 50s were sampled for wave 3. These individuals form the Cohort 3. At the third wave, 9,771 interviews were conducted. Seventy seven per cent (n=7,535) and 13.0% (n=1,275) of the interviews were conducted with Cohort 1 and 3 core members respectively (Scholes et al., 2009).

3.2.5.3 Wave four - 2008-09: Refreshment sample, ELSA Cohort 4

At wave 4, a new refreshment sample was added to the ELSA panel, Cohort 4, covering age groups between 50 and 74 year old. The sample members were taken from HSE 2006. The Cohort 4 sample had two main purposes: firstly to supplement the sample with individuals aged 50-51; and secondly, to help with previous attrition and 'top-up' the proportion of 52-74 years old in the ELSA study. The fieldwork for wave 4 included 11,050 interviews. Sixty per cent (N=6,623) of these interviews were conducted with Cohort 1 core members; nine per cent (n=972) with Cohort 3 core members; and twenty one per cent (n=2,291) with Cohort 4 core members. The remaining 1,164 (10.5%) were with partners (Cheshire et al., 2012a).

3.2.5.4 Wave five – 2010-2011

At wave 5, three cohorts (Cohorts 1, 3 and 4) of individuals made up the sample. Throughout all three cohorts, a total of 10,274 main interviews were completed. Sixty one per cent (n=6,242) of interviews were with Cohort 1 core members from the original wave 1 sample; nine per cent (n=936) were with core members from Cohort 3 and nineteen per cent (n=1,912) were with core members from Cohort 4. The remaining interviews were with partners of core members (Cheshire et al., 2012b). An overview of the ELSA sample design is provided in Figure 3.1

Figure 3.1: Overview of ELSA study wave 1 (2002-03) to wave 5 (2010-11)

[1]Sample sizes are for the complete study
[2]C1CM Cohort 1 core members; C3CM Cohort 3 core members; C4CM Cohort 4 core members
Adapted from Steptoe et al. (2012)

3.2.6 Data collection methods

At each wave, the core ELSA questionnaire was administered by computer aided personal interviewing (CAPI). At the end of the CAPI interview, a paper self-completion questionnaire was also given to respondents. Every four years, a nurse visit is carried out for the assessment of biomarkers. Additional modules have been included at different stage of ELSA study to address other topics such as life history and risk module amongst other. Most of the variables analysed in this thesis are covered in the CAPI interview. However, three of the four social capital indicators are from the self-completion questionnaire, which has lower response rates compared to the main CAPI interview.

3.2.7 Waves of ELSA used in this analysis

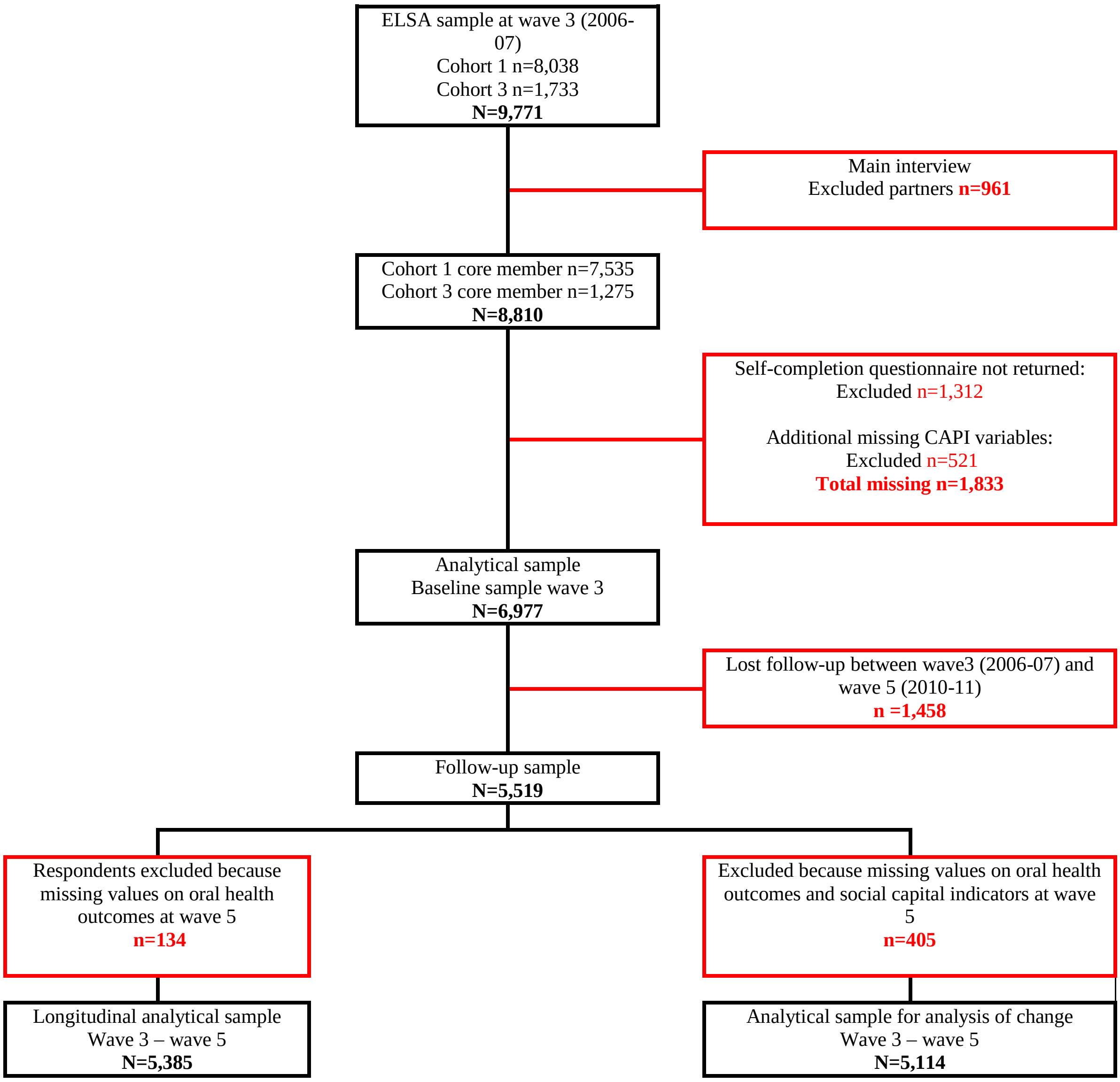
The thesis used data from the ELSA study wave 3 (2006-07) and wave 5 (2010-11). Wave 3 (2006-07) was the baseline for the thesis as the oral health outcome measures (self-rated oral health; edentulousness (having no teeth); and Oral Impacts on Daily Performances - OIDP) were included for the first time at this stage of ELSA. The oral health module was not included at wave 4 but was repeated at wave 5. Hence, only data from waves 3 and 5 were used in this analysis. The social capital exposure variables described in section 3.3 (membership status; volunteering status; number of close ties; and social support) were also derived from waves 3 and 5. The main confounding and mediating variables were obtained from wave 3 and are referred to as the baseline covariates in the text. A detailed description of the measurement of variables is given in a subsequent sub-section of the current chapter.

3.2.8 Thesis samples and population

The target population under study was all eligible individuals aged 50 years and over defined as ELSA core members at wave 3. The sample included cohort 1 core members and cohort 3 core members. From the ELSA sample at wave 3 of 8,810 core members, 1,833 participants were excluded from the analysis because they did not return the self-completion questionnaire or/and did not provide relevant information on the main interview (CAPI). The eligible sample of 6,997 respondents constitutes the analytical sample for the cross-sectional analysis (Chapter 4). This is also referred to as the 'baseline sample wave 3' in the context of the later longitudinal analysis.

As in all longitudinal studies, ELSA is subject to attrition. A total of 1,458 respondents who were present at baseline were missing at wave 5 (2010-11). From the follow-up sample of 5,519 respondents, two subsets of dataset were derived. Firstly, for the longitudinal analysis that assessed the association between baseline social capital and oral health at wave 5, respondents who had missing information on any of the oral health outcomes were excluded (n=134). Thus a total of 5,385 formed the analytical sample for the longitudinal analysis presented in Chapter 5. Secondly, for the analysis of change of social capital between waves 3 and 5 and its association with change in oral health, in addition to the respondents who did not answer the questions on oral health, those who did not provide data on social capital measures at wave 5 were omitted from the analysis of change. This resulted in 5,114 respondents for the analytical sample for analysis of change. Figure 3.2 displays the specific samples for the cross-sectional and longitudinal analyses after exclusions and loss to follow-up. A full description of the analytical samples and missing respondents is presented at the beginning of each results chapter.

Figure 3.2: ELSA study sample and samples selected for analysis after exclusion criteria and loss to follow-up



3.3 Variables

The oral health outcomes and covariates were already contained in the ELSA dataset. However, for the purpose of this thesis, the social capital variables were derived on the basis of theory and existing studies of social capital. A description of this derivation is now presented in the following section, along with a description of the oral health outcomes and covariates.

3.3.1 Oral health outcomes

3.3.1.1 Self-rated oral health

Self-rated oral health provides more information about how a certain disease affects an individual's life, rather than the objective measurements of this disease, and constitutes a valid, reliable and cost effective tool to assess oral health (Locker and Miller, 1994; Gilbert et al., 1998). This incorporates a broader multidimensional subjective assessment of oral health, rather than just clinical morbidity (Benyamini et al., 2004; Locker et al., 2005).

Among older adults, poor self-rated oral health has been associated with poor self-rated general health, low socio-economic position, missing teeth, dental pain, untreated dental caries, reduced functional ability, lower self-esteem and life satisfaction (Matthias et al., 1995; Benyamini et al., 2004; Pattussi et al., 2007; Pattussi et al., 2010; Tsakos et al., 2011). For the question "Would you say dental health (mouth, teeth and/or dentures) is...": excellent; very good; good; fair or poor; following the convention established by previous studies, self-rated oral health was dichotomised into 'good' (excellent/very good/good) and 'poor' (fair/poor) (Pattussi et al., 2010; Tsakos et al., 2011).

3.3.1.2 Edentulousness

Edentulousness was measured through self-assessment of the presence of natural teeth. Edentulousness is a crude and aggregate oral health indicator that reflects the accumulation of oral disease and experience of dental treatment throughout the life course. It is a robust measure of total tooth mortality (Tsakos et al., 2013).

In the CAPI questionnaire, respondents were asked: "In relation to dental health, which of the following applies to you? The answer question is divided in four categories: no natural teeth and wear denture; both natural teeth and denture(s); only natural teeth; neither natural teeth nor dentures. A dichotomised variable was derived as follows: dentate versus edentate. Dentate refers to respondents who have either natural teeth and dentures or only natural teeth. Edentate refers to respondents who have no natural teeth and wear dentures or those without any natural teeth or dentures. However, there is a large variation in the dentate group as respondents can be classified as dentate with only one tooth and the group may also include individuals with a complete and functional set of natural teeth.

3.3.1.3 Oral Impacts on Daily Performances (OIDP)

Oral health-related quality of life (OHRQoL) was measured using a simplified version of the Oral Impacts on Daily Performances (OIDP) questionnaire for elderly populations (Tsakos et al., 2001). Studies have shown that older populations experience difficulties in daily activities because of conditions affecting their mouth and dentition (Locker, 1992; Slade and Spencer, 1994; Adulyanon et al., 1996; Leao and Sheiham, 1996). The OIDP instrument was developed to assess the oral impacts on the individual's ability to perform daily activities, which consists of physical, psychological and social performances. The theoretical background is based on the WHO conceptual framework for classification of impairment, disability and handicap and was adapted by Locker (1988) for measuring oral health in an attempt to capture the functional and psycho-social outcomes of oral disorders.

A modified version of OIDP has been developed by Tsakos et al. (2001) and has been shown to be a valid and reliable measure of oral health-related quality of life in elderly population in the UK. The OIDP version for elderly people included the following performances:

- eating food;
- speaking clearly;
- cleaning teeth and dentures;
- doing light physical activities such as household activities;
- going out, for example to shop or visit someone;
- sleeping, relaxing, smiling, laughing and showing teeth without embarrassment; becoming more emotional or more easily upset than usual;
- enjoying contact with other people, e.g. relatives, friends or neighbours.

For each reported oral impact on any of these performances, then its frequency and severity are assessed on 5-point ordinal scales. Both these are incorporated in the overall OIDP score calculation. In addition, the prevalence of oral impacts is reported according to the proportion that has reported at least one OIDP performance affected due to oral conditions.

A simplified version that consists of five OIDP items was available in the ELSA CAPI questionnaire. The frequency of oral impacts and the severity of their effect on the daily life of the respondents were not assessed. Instead, respondents were only asked if they had had any difficulties in any of the following five performances, due to problems with teeth, mouth or dentures in the past six months:

- difficulty eating food;
- difficulty speaking clearly;
- problems with smiling, laughing and showing teeth without embarrassment;
- problems with emotional stability, for example, becoming more easily upset than usual;
- problems enjoying the company of other people such as family, friends, or neighbours; or none of these.

A dichotomised variable was derived distinguishing between participants reporting at least one oral impact against those reporting none (Tsakos et al., 2011).

3.3.2 Main exposure variables for the study: Social capital

Items to describe individual-level social capital were selected from the ELSA questionnaires. In accordance with previous social capital research (Harpham et al., 2002; Islam et al., 2006; Kawachi et al., 2008a), a distinction between structural and functional social capital measures was made as they appear to influence health differently (Nyqvist and Nygård, 2013).

The literature review has revealed that a variety of approaches were used to measure specific and/or different aspects of social capital in previous studies. This has led to a lack of cohesion and disparities in concepts and definitions. In line with the UK harmonised question set from the Office for National Statistics (ONS), the ELSA study covers the five key dimensions as identified by the UK ONS: civic participation; social networks and support; social participation; reciprocity and trust; and views about area (Harper and Kelly, 2003). For this thesis, social participation; social network and social support were chosen because these indicators measure the social capital at the individual level while civic participation; reciprocity and trust; and views about area are more closely related to community level attributes (Harper, 2002) (see literature review, section 2.4).

3.3.2.1 Structural social capital: membership in organisations and volunteering

The structure of social relations is a core part of any measure of social capital (Stone, 2001; Harpham, 2008). More contact with members potentially means greater access to resources and social support (Lin et al., 1985). Participation in social networks has been almost exclusively measured by the number of social contacts (Grootaert and van Bastelaer, 2002; Lindstrom et al., 2002). A summary of the questions used to assess structural social capital is provided in Table 3.1

3.3.2.1.1 Membership in organisations

Formal social participation refers to the number of interactions resulting from involvement in established organisations in society (Broese van Groenou and Deeg, 2010). Membership in organisations was measured from the self-completion part of the ELSA study by asking participants to indicate whether they were a member of specific organisations, clubs or societies. The organisations, clubs and societies included:

- political party, trade union or environment groups;
- tenant's groups, resident's groups or neighbourhood watch;
- church or other religious groups;
- charitable associations; education, arts or music groups or evening classes;
- social clubs; sports clubs, gyms, exercise classes;
- any other organisations, clubs or societies.

One of the limitations of this measure of formal social participation was that one can be a member of most of these organisations without having any contact with other members or participating in any activities. Hence it is also important to measure intensity of participation in these organisations. Intensity of participation was measured by the question: 'Thinking about all the organisations, clubs or societies that you are a member of, how many committee meeting, if any, do you attend in a year?' As this question was asked about all the organisations, the overall measure of social participation in organisations was not broken down by specific organisational types.

From these two variables (organisational membership and number of meetings attended), a variable on membership status with three categories was derived: 'not a member'; 'passive member' (member of any organisation but did not attend any committee meeting in a year or did not answer the question on intensity of participation); 'active member' (attending at least one meeting in a year). In addition, a fourth category of 'not answered' respondents was created for the respondents who did not answer the questions on organisational membership. It was important to create this 'not answered' category because there was a substantial number of respondents in this category and they would otherwise have been eliminated from the analysis.

Around 15.3% (n=1,073) of members of organisations at wave 3 did not answer the question on intensity of participation but they answered the question on membership. These observations were not considered as missing values but set as passive members, assuming that the participants who did not answer the question did not respond because they did not go to any meeting (Scherger et al., 2011). Similarly, for the analysis of change using data from wave 5, 5.0% (n=273) of members of organisations were considered as passive members. This assumption was checked by creating two groups of passive members - those who answered the intensity question but did not attend any meetings and those who did not answer the intensity question but were otherwise members of organisations. The associations with the oral health outcomes were similar in that the risk of poor oral health for both groups of passive members always fell in between the active member group and the not a member group. Thus in order to simplify the number of categories for the membership variable, the two types of passive member groups were analysed together and not as separate groups.

3.3.2.1.2 Volunteering

Volunteering represents a discretionary, but committed use of time within a formal organisational structure for which no material remuneration is expected (Burr et al., 2011). Cornwell et al. (2008) argued that older persons seek out activities such as volunteering to replace social network ties that have been lost due to retirement and/or a reduction in family responsibilities. Thus, volunteering provides opportunities to increase one's social network size and social capital, and might provide a social role that gives a sense of purpose in life.

At wave 3, volunteering was assessed by two questions in the CAPI questionnaire. However no precise definition of volunteering was provided. First, respondents were asked to report each of the activities they were involved in during the previous month, one of which was voluntary work, but also included other activities such as paid work, self-employment, and caring responsibilities. The second question asked the respondent to report the frequency they engaged in voluntary work, choosing from 'twice a month or more' to 'never'. Almost all of those who reported volunteering in response to the first question also reported volunteering in response to the second question. Consequently, responses to the second question were used to define volunteers (Nazroo and Matthews, 2012). Those who reported volunteering once a year or more were classified as volunteers.

Table 3.1: ELSA questionnaire on social participation and volunteering

Organisational memberships	Categories	
1. Are you member of any of these organisations, clubs or societies?		
a) Political party, trade union, environmental groups	yes	no
b) Tenants groups, residents groups, neighbourhood watch	yes	no
c) Church or other religious groups	yes	no
d) Charitable associations	yes	no
e) Education, arts or music groups or evening classes	yes	no
f) Social clubs	yes	no
g) Sports clubs, gyms, exercise classes	yes	no
h) Any other organisations, clubs or societies	yes	no
2. Thinking about all the organisations, clubs or societies that you are a member of, how many committee meetings, if any, do you attend in a year?		
Volunteering status		
1. Did you do any of the following activities in the last month? Voluntary work	yes	no
2. How often do you do voluntary work?	twice a month or more about once a month every few months about once or twice a year less than once a year never	

3.3.2.2 Functional social capital: number of close ties and social support

3.3.2.2.1 Number of close ties

The degree to which respondents were socially integrated with their spouses, partners, children, relatives, and friends was assessed in the self-completion questionnaire. ELSA measures emotional closeness between the respondent and their partner using the following question: ‘how close is your relationship with your spouse or partner?’ Possible responses include ‘very close’; ‘quite close’; ‘not very close’; ‘not at all close’. Emotional closeness to spouse or partner is a subjective emotional quality of relationship (Cornwell et al., 2009). Respondents who characterised their relationship with their spouse/partner as ‘very close’ or ‘quite close’ were included in the measure of number of close ties. In addition, a count of the number of children, relatives and friends the respondent felt close to, was added to this measure. The number of close ties was assessed by type of relationship: ‘how many of your (children/relatives/friends) would you say you have a close relationship with?’

The derived variable ‘number of close ties’ was grouped into tertiles because the distribution of the number of close ties was skewed to the right. Similar to the 'not answered category' in membership, an additional category of 'not answered' was created so that respondents who did not answer the self-completion questions on close ties but who otherwise responded to other self-completion questions were not excluded from the analysis.

3.3.2.2.2 Emotional social support

Social support is a concept that implies "a relationship with others that may result in feelings of attachment, security, being loved, being part of a group, reassurance of self-worth, availability of informational, emotional, and material help, and reliable alliance with others" (Weiss, 1974). Emotional social support is associated with sharing life experiences. It involves the provision of empathy, love, trust and caring (House, 1981). Perceived emotional support was measured in ELSA self-completion questionnaire by asking participants about support perceived from spouse, children, other relatives, and friends based on the following questions:

'How much do they really understand the way you feel about things?'

'How much can you rely on them if you have a serious problem?'; and

'How much can you open up to them if you need to talk about your worries?'

Possible responses were on a 4-point scale: not at all; a little; some; a lot (Table 3.2). For the purpose of the analysis, possible responses were summed to create a social support scale for all types of relationship combined with possible range from 0 (absolute lack of social support from all sources) to 36 (highest possible score) (Stafford et al., 2011). The derived social support scale was grouped into tertiles because the distribution of social support was skewed to the left. Also an additional category of 'not answered' was created so that respondents who did not answer the self-completion questions on social support but who otherwise responded to other self-completion questions were kept in the analysis.

Table 3.2: ELSA questionnaire on close ties and social support

	Category
Number of close ties	
Spouse or partner	
1. Do you have spouse or partner with whom you live?	yes no
2. How close is your relationship with spouse or partner	very close quite close not very close not at all close
Children	
1. Do you have any children	yes no
2. How many of your children you have a close relationship with	
Relatives	
3. Do you have any relatives	yes no
4. How many of relatives you have a close relationship with	
Friends	
1. Do you have any friends	yes no
2. How many of friends you have a close relationship with	
Social support	
From spouse or partner	a lot
a) How much do they really understand the way you feel	some
b) How much can you rely on them if you have a problem	a little
c) How much can you open up to them to talk about your worries	not at all
From children	
a) How much do they really understand the way you feel	a lot
b) How much can you rely on them if you have a problem	some
c) How much can you open up to them to talk about your worries	a little not at all
From relatives	
a) How much do they really understand the way you feel	a lot
b) How much can you rely on them if you have a problem	some
c) How much can you open up to them to talk about your worries	a little not at all
From friends	
a) How much do they really understand the way you feel	a lot
b) How much can you rely on them if you have a problem	some
c) How much can you open up to them to talk about your worries	a little not at all

3.3.3 Covariates

Potentially important covariates were identified on the basis of previous studies linking social capital and health, and the WHO social determinants of health framework (Solar and Irwin, 2010). Existing literature confirms that socio-demographic, socio-economic and behavioural factors are important predictors of oral health (Sanders and Spencer, 2005; Sabbah et al., 2007; Finlayson et al., 2010; Marmot and Bell, 2011; Sheiham et al., 2011; Tsakos et al., 2011; Burr and Lee, 2012). Furthermore, socio-economic factors are related not only to oral health, but also to social resources, such as social networks and social support (Lin, 2001). The literature review in Chapter 2 has presented evidence on the associations between social capital, health and health behaviours. Consideration of confounding factors such as socio-demographic and socio-economic factors has been recommended as one of the key issues in studying the association between social capital and health (Harpham et al., 2002). Thus the potential confounders of the association between social capital and oral health include socio-demographic, socio-economic, health and behavioural factors. However, some of these confounders could also be on the causal pathway between social capital and oral health. So at times in this thesis, they are referred to generically as ‘covariates’ or ‘oral health risk factors’. Information on all the covariates was obtained from the main ELSA questionnaire (CAPI).

3.3.3.1 Socio-demographic factors

Age

In line with other studies of older people, age was coded into the following three groups to reflect different stages of life: 50-64 years (when most respondents are still working); 65-74 years (when most respondents have retired but are still fairly active); and 75 years and older (when most respondents have health problems and need for support) (Breeze and Stafford, 2010). In order to test if there was an additional linear effect of age, age as a continuous variable was entered into the regression models. However there was no linear trend in most of the analyses. Where a linear trend was identified in addition to the age categorical variable, there was little difference in the odds ratios. Hence age was used as a categorical variable.

Gender

The social construct of gender rather than the biological sex was used in this thesis. Gender refers to socially constructed roles, behaviours, activities, and attributes that a given society considers appropriates for men and women (WHO, 2014).

Cohabiting status

This indicator was derived from two variables. First the respondent was asked about their current marital status. The response options were: single; married; legally recognised civil partnership; legally separated; divorced; widowed. Then a derived variable from the household grid that identified whether the respondent was living with their partner was used to create the cohabiting status variable. For the analysis, a binary variable ‘living with partner' / 'not living with partner' was used (Zaninotto et al., 2013).

3.3.3.2 Socio-economic factors

Educational status

The participants' education was measured on a 7 point scale as follows: 1) NVQ4/NVQ5/university degree or equivalent; 2) higher education below university degree; 3) NVQ3/GCE A level equivalent; 4) NVQ2/GCE O level equivalent; 5) NVQ1/CSE other grade equivalent; 6) foreign/other; and 7) no qualifications. Around one third of the ELSA respondents did not have any qualifications, which is common among older generations. Hence, a binary variable was derived to distinguish respondents with some level of education against those who did not have any educational qualifications.

Self-reported labour market status

The participants' labour market status was assessed as follows: in paid employment; not currently in paid employment; retired; permanently unable to work; permanently sick or disabled or looking after home and family. Three analytical categories were derived as follows: in paid employment; retired; and other (not currently in paid employment /permanently unable to work/sick/disabled/looking after home/family). It is important to distinguish between these categories of labour market status as their social networks and extent of social capital could differ.

Household wealth – wealth quintiles

ELSA data depositors have derived household wealth variables. Total non-pension wealth was defined as the sum of financial worth, physical worth (such as business wealth, land or jewellery) and housing wealth after deducting debts (Banks et al., 2006). Wealth was used rather than income because it represents a better measure of the long-term economic status of older people (Banks et al., 2003; Banks et al., 2006; Demakakos et al., 2010a; Stafford et al., 2011). Wealth reflects command over material resources much better than any other measure of socio-economic status (Oliver and Shapiro, 1997), and is appropriate to use in older people as this indicator mostly informs the current socio-economic status better than other socio-economic measures and was found to be the best socio-economic predictors of health in ELSA (Demakakos et al., 2008). For the analysis, the quintiles of net total non-pension wealth were used.

3.3.3.3 General health-related factors

Self-rated general health

This measure is a robust predictor of mortality (Idler and Benyamini, 1997) and a valuable tool for evaluating health (Jylhä, 2009). Self-rated general health was measured by asking participants to rate their health on a five point scale: very good; good; fair; bad; and very bad, and was dichotomised as good (very good, good) and poor (fair, bad, very bad) (Breeze and Lang, 2008).

Presence of limiting long-standing illness

Participants were also asked if they suffered from one or more long-standing illness, and if the illness limited their daily activities. The two questions were combined to form a derived dichotomous variable, classifying participants as suffering from a limiting long-standing illness or not (McMunn et al., 2003).

Depression

Depression was measured using the 8-item version of Centre for Epidemiological Studies Depression Scale (CES-D) in the interview. This instrument is widely used to identify person at risk of depression (Radloff, 1977). Participants were asked about the feeling they have experienced in the past week such as:

...you felt depressed?;

...you felt that everything you did was an effort?;

...your sleep was restless?;

...you were happy?;

...you felt lonely?;

...you enjoyed life?; .

..you felt sad?; .

..you could not get going?

A CES-D score was derived by summing responses to all eight dichotomous questions. Participants reporting 4 or more depressive symptoms were classified as being depressed (Steffick, 2000), which is equivalent to the conventional cut point of 16 or higher on the full 20-items CES-D (Demakakos et al., 2010b).

3.3.3.4 Behavioural factors

There was very limited information on oral health related behaviour collected in ELSA.

Smoking status

Participants were asked if they had ever smoked and whether they were currently smoking. Participants who replied in the affirmative were asked if they smoked currently. Based on this, smoking status variable was recoded into three categories: never smoked; ex-smoker and current smoker.

3.4 Analytical strategy adopted in this thesis

The main aims of the thesis were to investigate the cross-sectional and longitudinal association between social capital and oral health in the ELSA sample. To achieve these aims, as well the related specific objectives, this section describes the analytical strategy of the thesis.

Weighting

Cross-sectional and longitudinal weights were derived by the ELSA data depositors. The purpose of the cross-sectional weights was to correct for non-response and keep the ELSA sample representative of the population of people aged 50+ in England taking into account the complex survey design. Hence, in order to generalise to the population aged 50+ in England, the cross-sectional weights were used in the cross-sectional analysis (Chapter 4). However, longitudinal non-response weighting was not applied for the longitudinal analysis (Chapters 5 and 6) because the longitudinal weights were calculated only for the core members who had participated at all waves of ELSA. Consequently it would have resulted in a much smaller analytical sample, as applying the longitudinal weights would have eliminated the wave 3 core members, as well as any core members who participated in waves 3 and 5 but did not participate at wave 4.

Significance

Results in the analyses are statistically significant if the p-value is below the 0.05 level. The null hypothesis was rejected if $p<0.05$.

Software

Descriptive analyses and logistic regression models were performed using Stata/SE 12.1

3.4.1 Cross-sectional analysis (Chapter 4)

Aim 1: to examine the cross-sectional association between social capital and oral health in the ELSA baseline analytical sample

To address the specific objectives, the cross-sectional analysis was carried out using the following steps:

Objective 1.1: to describe characteristic of the analytical sample

A description of the cross-sectional analytical sample was presented using a flow chart starting from the overall ELSA wave 3 sample. Exclusion criteria were described. A description of missingness in the cross-sectional sample was analysed using logistic regression models to estimate the odds of missingness in the eligible ELSA sample by oral health, social capital and covariates. The frequency distribution of the oral health outcomes, social capital explanatory variables, and covariates were examined and descriptive statistics presented.

Objective 1.2: to identify potential confounders or mediators in the association between social capital and oral health

Potential confounders or mediators have to be associated with both the social capital indicators and oral health outcomes. Bivariate associations between oral health and the selected covariates were examined using logistic regression models. Similarly, bivariate associations between social capital indicators and covariates were examined using binary and multinomial logistic regression models. For consistency in the estimates of Odds Ratios (ORs) and Relative Risk Ratios (RRRs) in all the regression models, the reference category (1) for all the independent variables was the group with the lowest risk of poor oral health.

Objective 1.3: to assess the unadjusted and adjusted association between social capital and oral health

Multivariable associations between social capital indicators and the oral health measures were analysed using a series of logistic regression models to estimate the odds of poor oral health by categories of the social capital indicators, sequentially adjusted for socio-demographic, socio-economic, general health and smoking status. The adjusted models follow the WHO's conceptual framework for the social determinants of health (Solar and Irwin, 2010). The most distal factors that affect oral health were adjusted for first (socio-demographic and socio-economic markers) and the more proximal factors (general health and behavioural factors) were adjusted in later models.

The process of adjusting for covariates was as follows:

Model 1: the unadjusted model examined the strength of the association between social capital and oral health; Model 2: is Model 1 additionally adjusted for age; Model 3: is Model 2 additionally adjusted for other socio-demographic factors - gender and cohabiting status; Model 4: is Model 3 additionally adjusted for socio-economic markers - education, employment status and wealth quintile; Model 5: is Model 4 additionally adjusted for general health measures - self-rated general health, limiting long-standing illness and depression; Model 6: is Model 5 additionally adjusted for the behavioural measure of smoking status.

Adjusting for socio-demographic (Models 2 and 3) and socio-economic factors (Model 4) takes account of potential confounders of the association between social capital and oral health. Adjusting for general health (Model 5) and smoking status (Model 6) takes account of potential confounders and mediators of the association between social capital and oral health.

Objective 1.4: to investigate effect modification in the association between social capital and oral health

Interaction between two exposure variables is said to exist when the association between an exposure variable and an outcome variable is modified by another variable. The existence of an interaction indicates that the effect of an exposure variable on an outcome variable is different for each category of a third variable (Rabe-Hesketh and Skrondal, 2008). For this reason, statistical interaction is also called effect modification. The F-adjusted test was used as a statistical test for interaction by comparing a model with an interaction tem between two variables and comparing this with the same model without the interaction term. The null hypothesis in this statistical test was that the interaction terms do not improve the fit of the model. A p-value <0.05 for the improvement in fit in the model following the addition of the interaction term thus provides evidence for the existence of an overall interaction between two variables in their association with the outcome of interest. In addition, p-values for interaction terms can be estimated for specific categories and the null hypothesis is that the coefficient of the interaction term is zero.

Effect modification of the association between social capital and oral health was examined by using the interaction between social capital indicators and oral health risk factors. The interaction term was entered into the regression models after fitting the fully adjusted logistic regression models (Model 6). If the association of social capital with oral health does not differ by risk factors, this is labelled a main effect (Cohen and Wills, 1985) of social capital on oral health. If the odds of poor oral health are higher among respondents with risk factors and greater social capital, compared to those with the same risk factors and lower social capital, this is labelled a stressor effect of social capital. On the other hand, if the odds for respondents with risk factors decrease with higher social capital, this is labelled a buffering or resiliency effect (Cohen and Wills, 1985) of social capital.

3.4.2 Longitudinal analysis (Chapter 5)

Aim 2: to examine the longitudinal association between social capital and oral health

Objective 2.1: to examine the unadjusted and adjusted longitudinal association between social capital at baseline and oral health at follow-up

Before examining the longitudinal associations, a description of the characteristics of attrition to the baseline sample was presented. Logistic regression was used to estimate the odds of non-participation at wave 5 among the baseline sample wave 3, by oral health, social capital and covariates.

To assess the longitudinal associations between social capital at baseline and subsequent oral health, time lagged models were fitted as follows: the social capital predictor variables at wave 3 (2006-07) were related to the oral health outcome variables at wave 5 (2010-11), adjusted for covariates at wave 3 (2006-07) (models 1 to model 6). This followed the same pattern of adjusting for covariates as in the cross-sectional analyses. Time lagged models take into account the temporal sequence of a possible cause and effect. Furthermore, autoregressive models were fitted by adjusting for the baseline dependent variable (Model 7). Autoregressive models help to “remove” the cross-sectional part of the relationships, in order to estimate the real influence of the predictor variables on the outcome variables (Twisk, 2003). The autoregressive models thus examined the association of the social capital indicators at baseline with change in oral health between waves 3 and 5. In other words, in an autoregressive model the value of the oral health outcome variable at wave 5 was related to the value of the social capital predictor variable at baseline and also to the value of the oral health outcome at baseline.

Effect modification of the association between baseline social capital indicators and oral health at follow-up was examined using interaction terms between social capital and covariates in the fully adjusted autoregressive logistic regression models.

Objective 2.2: to examine the unadjusted and adjusted longitudinal association between oral health at wave 3 (baseline) and social capital at wave 5 (follow-up)

The reverse temporal association between oral health at baseline predicting social capital at follow-up was examined. Binary and multinomial logistic regression models were used to estimate the odds of categories of lower social capital at wave 5 by oral health at baseline (Model 1), adjusted for covariates at baseline (time-lagged models; Model 6), and including social capital at baseline (autoregressive models; Model 7).

3.4.3 Analysis of change (Chapter 6)

Aim 2: to examine the longitudinal association between social capital and oral health

Objective 2.3: to examine the association between change in social capital on change in oral health

These analysis of change regression models were different from the longitudinal models used in Chapter 5 because they modelled the association between change in social capital and change in oral health. The autoregressive models in Chapter 5 only modelled the association between baseline social capital and change in oral health and although they adjusted for a number of covariates, there may be other confounders that were not measured or not included in the analyses. One of the methods of reducing such unobserved confounding was the analysis of change in social capital and change in oral health (or modelling of change). By examining the association between the change in social capital and the change in oral health, the analysis of change examined within person change and thus all time invariant confounders such as gender, ethnicity and birth year were eliminated from the analyses.

The variables measuring change in social capital and change in oral health are described below.

3.4.3.1 Measuring change in oral health

Self-rated oral health and oral impacts on daily performances

For dichotomous variables, the change between two subsequent measurements (waves 3 and 5) resulted in four categories. First there were individuals who stayed in the category of good oral health, then there were individuals who stayed in the category of poor oral health, and finally there were individuals who moved from one category to another. The resulting change variable was reduced to three categories for the analysis: individuals who did not change their oral health, individuals who improved their oral health and individuals whose oral health worsened.

Edentulousness

For edentulousness, the only possible change between waves was to remain dentate/edentate or to become edentate. Thus, a dichotomous variable of change in edentulousness was created as follows: no change in dental status and becoming edentate.

3.4.3.2 Measuring change in social capital

Membership status, tertiles of number of close ties and tertiles of social support were categorical variables with 4 categories (all these variables included a 'not answered' category). The change between waves 3 and 5 for each social capital indicator resulted in a categorical variable with 16 categories. To simplify the analysis, these social capital variables were reduced to four categories in the following way.

***Membership status*:**

- No change: individuals who did not change their membership status (i.e. they remained active members, passive members, or not members).
- Positive change: individuals who moved from not members to passive/active members, or from passive to active members.
- Negative change: individuals who moved from active to passive/not members, or from passive to not members.
- Not answered: this category referred to those individuals who did not answer the membership status question at either wave 3 or wave 5.

Tertiles of number of close ties:

Similarly the change in tertiles of number of close ties was reduced to a four-category variable:

- No change in tertiles of number of close ties.

- Positive change in tertiles of number of close ties: individuals who increased from a lower to higher tertiles of number of close ties.
- Negative change in tertiles of number of close ties: individuals who had decreased from a higher to lower tertiles of number of close ties.
- Not answered: this category describes the individuals who did not answer the question on number of close ties either at wave 3 or wave 5.

Tertiles of social support:
- No change in social support referred to those individuals who stayed in the same category of tertiles of social support.
- Positive change in social support referred to those individuals who moved from the lower tertiles of social support to the higher tertiles of social support.
- Negative change in social support was a decrease from the higher tertiles of social support to the lower tertiles of social support.
- Not answered category referred to those individuals who did not answer the question on social support at either wave 3 or wave 5.

***Volunteering* status** was a dichotomous variable. For the analysis of change three categories were created:
- No change in volunteering status between the waves 3 and 5.
- Positive change: Individuals who did not volunteer at wave 3 but volunteered at wave 5.
- Negative change: individuals who volunteered at wave 3 but did not volunteer at wave5.

Before carrying out the analysis of change models, a description of the analytical sample for analysis of change and an analysis of missingness in the analytical sample were examined. Furthermore, correlates of change in social capital and correlates of change in oral health were examined using the percentage distributions of the change variables by covariates. The Pearson chi-square statistic was used to examine significant differences between the categories of change (in oral health and social capital measures) and the covariates.

To explore whether there was any association between each of the social capital 'change over time' variables and each of the oral health 'change over time' variables, multinomial and binary logistic regression models were performed as follows: unadjusted models showing the association between change in social capital and change in oral health status;

models adjusted for age; and fully adjusted models with socio-demographic (gender, cohabiting status); socio-economic (education, employment, wealth), health-related factors (self-rated general health, limiting long-standing illness, and depression), and smoking status variables at baseline (wave 3, 2006-07). Subjects whose oral health had remained the same over the past 4 years were used as a reference group for the relative risk ratio (RRR), and compared with those whose oral health had improved and those whose oral health has worsened.

3.4.4 Summary

The methodology chapter has described the data that was used to analyse the association between social capital and oral health, the measures of oral health, social capital and covariates used in the analysis and the analytical plans and statistical models used to examine the associations. The results of the analyses are presented in the next three chapters.

CHAPTER 4

CROSS-SECTIONAL ASSOCIATION BETWEEN SOCIAL CAPITAL

AND

ORAL HEALTH

ELSA WAVE 3 (2006-07)

4.1 Introduction

The literature review in Chapter 2 showed that there is convincing evidence that social capital is associated with both physical and mental health. There is also some evidence, though inconsistent, that social capital may have an impact on oral health. In oral epidemiological research many factors have been implicated in the development of oral diseases. These risk factors are usually clustered within individuals, with interactions between socio-economic, psychological, behavioural and biological factors. The association between social capital and oral health may be confounded by these other determinants of oral diseases. The attribution of causation based on observational evidence is not straightforward.

The objective of this chapter is to investigate, at the individual level, the cross-sectional association between structural and functional aspects of social capital and oral health.
The three oral health outcome variables to be investigated are self-rated oral health (good vs. poor); edentulousness (dentate vs. edentate) and Oral Impacts on Daily Performances (OIDP) (no impact vs. at least one impact).

The main exposure, social capital, was broken down into structural and functional components. Membership in organisations and volunteering were used as a measure of two social network variables (structural social capital). Number of close ties and social support were regarded as the functional aspects of social capital.

The key hypotheses to be tested in this chapter are:

1. Lower levels of social capital are associated with poorer oral health.
2. Different measures of social capital have different associations with oral health. Structural aspects of social capital are associated with objective oral health measures while functional aspects of social capital are associated with subjective oral health measures.
3. The association between social capital and oral health remains significant even after adjusting for socio-demographic, socio-economic and health risk factors.
4. Social capital may buffer the association between oral health risk factors and poor oral health.

Logistic regression was used to determine the association between social capital and oral health. Models were sequentially adjusted for: age (Model 2); gender, cohabiting status

(Model 3); educational status, labour market status, wealth (Model 4); self-rated general health, limiting long-standing illness, depression (Model 5). In the fully adjusted model, smoking status was also introduced (Model 6). Detailed description of all the variables used in this chapter and analytical strategy can be found in the methodology chapter (Chapter3, sections 3.3 and 3.4).

As a first step, the characteristics of the overall eligible sample in ELSA and the analytical sample for this chapter were compared in terms of missing respondents (section 4.2). In section 4.3, the distributions of all the variables in the analytical sample used in the cross-sectional analyses were described (section 4.3.1). Also in the same section, the results of the regression models that assessed the association between social capital and oral health were described (section 4.3.2). Section 4.3.3 examined the evidence for effects modifications in the association between social capital and oral health. Interpretations of the results, implication for public policy, potential limitations and further research issues are all discussed in the final discussion chapter.

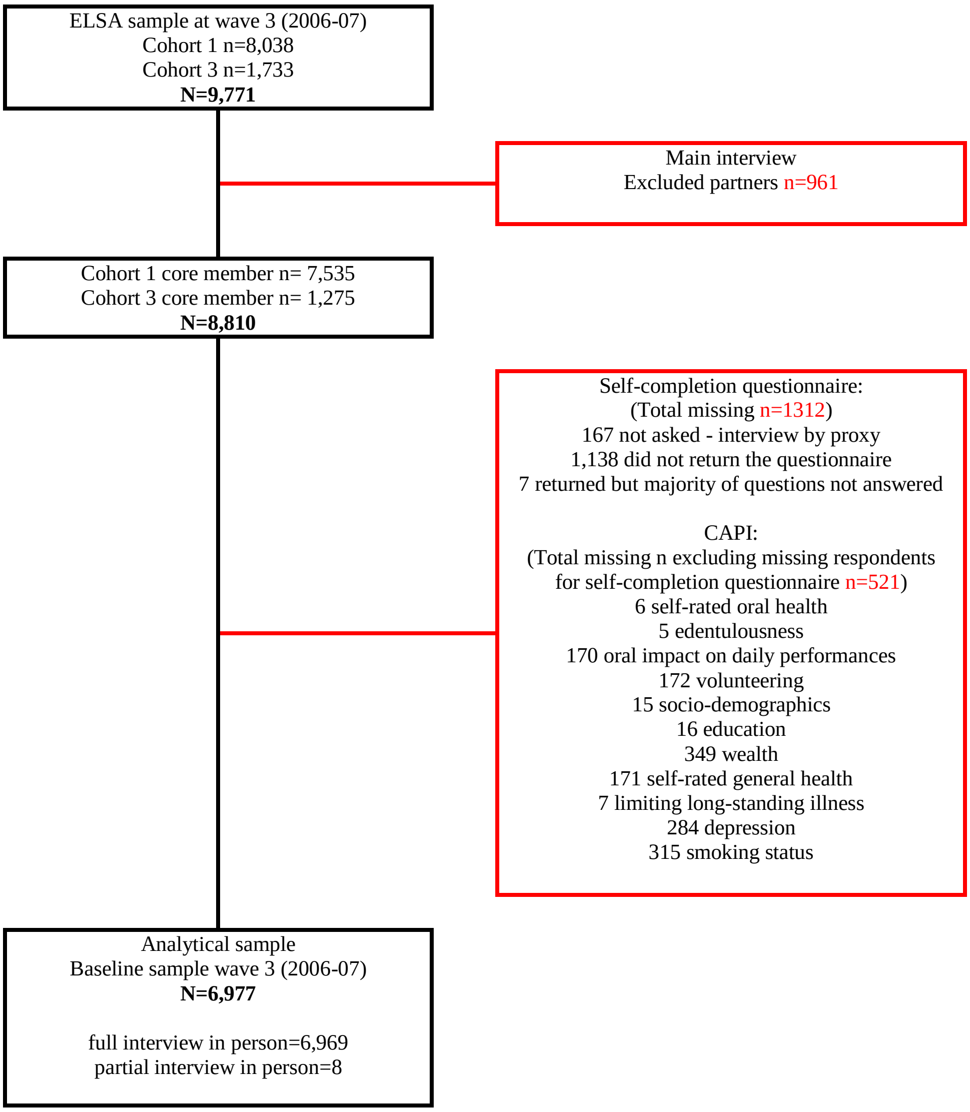
4.2 Eligible ELSA population sample and cross-sectional analytical sample

As discussed in the methodology chapter, the analytical sample for the main analysis, including the current chapter was a subset of the data for ELSA wave 3 (2006-07). A full detail of the ELSA sample design was described in the methodology chapter (Chapter 3, section 3.2). From the full ELSA wave 3 sample of 9,771 participants, 961 partners of the core members (Cohort 1 and Cohort 3) were excluded (Figure 4.1). This left an eligible sample population of 8,810 ELSA respondents who were aged 50 and older. Of these, 7,535 (85.5%) were Cohort 1 core members and 1,275 (14.5%) Cohort 3 core members. Some respondents were excluded from further analysis because they were interviewed by proxy (n=167). Furthermore, there was some missing data because some respondents did not return the self-completion questionnaire (n=1,138), and some did not answer the majority of the questions from the self-completion questionnaire (n=7). A further 521 participants were excluded because of missing values, either with any of the oral health outcomes variables or any of the selected covariates used for the analysis. A total of 1,833 respondents were thus excluded, that is a decrease of 20.8% from the total eligible sample population.

The final number of participants included in the analysis was 6,977 subjects from which 6,098 (87.4%) were Cohort 1 core members and 879 (12.6%) Cohort 3 core members.

This was the analytical sample on which further analyses were conducted, also referred to as baseline sample wave 3. The following section analyses the covariates associated with missing data among the 8,810 eligible sample population.

Figure 4.1: Analytical sample for the cross-sectional analysis



Description of missingness in the eligible ELSA sample

This section analyses the covariates associated with those who were excluded from the baseline sample wave 3 because of missing data (n=1,833) among the 8,810 ELSA eligible sample respondents. As there were also missing data among the covariates, the sample N reduced from 8,810 (and the missing n reduced from 1,833) for all the covariates except gender and labour market status for which there was complete information. For example, 1.9% (n=170) of the eligible sample participants did not answer the question on oral impact on daily performances. Furthermore, 14.8%

(n=1,305) of the eligible sample had missing data on membership in organisations, number of close ties and social support, as these respondents did not return the self-completion questionnaire or were interviewed by proxy (and hence were not eligible for the self-completion questionnaire). Other variables with missing information were wealth 4.0% (n=349), self-rated general health 1.9% (n=171), depression 3.2% (n=284) and smoking 3.6% (n=315).

Table 4.1 examines the logistic regression of those who were excluded from the baseline sample wave 3, by wave 3 covariates including socio-demographic, socio-economic, health, smoking status, oral health and measures of social capital. Only bivariate associations are shown, as the associations adjusted for all the covariates simultaneously would reduce the number of observations to complete cases on all the covariates.

ELSA respondents who were aged 65-74 were less likely to be missing from the baseline sample, whereas those who were aged 75 years and over were more likely to be missing compared to those aged 50-64 years. Also compared to those in paid employment, retired ELSA respondents were less likely to be missing. Furthermore, respondents who were not living with a partner, had no educational qualification, in the poorer wealth quintiles, who reported poor general health, limiting long-standing illness, depression, poor oral health, and who were a current smoker and did not volunteer were more likely to be missing from the baseline sample wave 3. Consequently, the analysis of the baseline sample may be biased because the oldest ELSA respondents who were poor and with poor health were more likely to be missing. The implications of such biases from missing data in relation to the hypotheses are discussed in the discussion chapter (Chapter 7, section 7.5.2).

Table 4.1: Correlates of missingness in the eligible ELSA sample wave 3 (2006-07), % (95%CI) distribution and OR (95%CI)

Covariates W3	missingness %	n missing/N	Odds ratio (95%CI)	Covariates W3	missingness %	n missing/N	Odds ratio (95%CI)
Socio-demographic and socio-economic factors							
Age-groups				**Educational status**			
50-64	21.6%	964/4,465	1	Education	18.6%	1,140/6,141	1
65-74	15.9%	366/2,305	0.68 (0.60-0.78)***	No education	25.5%	677/2,653	1.50 (1.35-1.67)***
≥75	24.5%	499/2,036	1.18 (1.04-1.33)**	Total	20.7%	1,817/8,794	
Total	20.8%	1,829/8,806					
Gender				**Labour market status**			
Men	20.2%	797/3,941	1	In paid employment	23.0%	692/3,002	1
Women	21.3%	1,036/4,869	1.07 (0.96-1.18)	Retired	17.5%	800/4,482	0.47 (0.65-0.81)***
Total	20.8%	1,833/8,810		Others	25.7%	341/1,326	1.16 (0.99-1.34)
				Total	20.8%	1,833/8,810	
Cohabiting status				**Wealth quintile**			
Living with partner	18.4%	1,090/5,936	1	wealthiest quintile	11.8%	213/1,798	1
No living with partner	25.6%	732/2,863	1.53 (1.37-1.70)***	4th	13.4%	230/1,716	1.15 (0.94-1.41)
Total	20.7%	1,822/8,799		3rd	17.2%	294/1,707	1.55 (1.28-1.87)***
				2nd	18.8%	312/1,661	1.72 (1.42-2.08)***
				Poorest quintile	27.6%	435/1,579	2.83 (2.36-3.39)***
				Total	17.5%	1,484/8,461	
Health and behavioural factors							
Self-rated general health				**Depression**			
Good	17.0%	992/5,842	1	No	16.4%	1,110/6,768	1
Poor	23.9%	670/2,797	1.54 (1.38-1.72)***	Yes	25.0%	439/1,758	1.70 (1.50-1.92)***
Total	19.2%	1,662/8,639		Total	18.2%	1,549/8,526	
Long-standing illness				**Smoking status**			
No	18.6%	1,066/5,721	1	Never smoked	15.9%	504/3,172	1
Yes	24.7%	760/3,082	1.43 (1.29-1.59)***	Ex-smoker	17.6%	706/4,015	1.13 (0.99-1.28)
Total	20.7%	1,826/8,803		Current smoker	23.6%	308/1,308	1.63 (1.39-1.91)***
				Total	17.9%	1,518/8,495	
Oral health status							
Self-rated oral health				**OIDP**[1]			
Good	19.2%	1,375/7,177	1	No impact	18.8%	1,489/7,900	1
Poor	27.8%	452/1,627	1.62 (1.43-1.84)***	At least one impact	23.5%	174/740	1.32 (1.11-1.58)**
Total	20.7%	1,827/8,804		Total	19.2%	1,663/8,640	
Edentulousness							
Dentate	19.7%	1,434/7,287	1				
Edentate	26.0%	394/1,518	1.43 (1.26-1.63)***				
Total	20.8%	1,828/8,805					
Social capital indicators							
Membership status				**Number of close ties**			
Active member	6.8%	162/2,388	1	Highest tertile	7.1%	147/2,066	1
Passive member	6.2%	167/2,701	0.90 (0.72-1.13)	Middle tertile	6.6%	174/2,628	0.93 (0.74-1.16)
Not a member	8.1%	159/1,971	1.21 (0.96-1.51)	Lowest tertile	7.3%	127/1,730	1.03 (0.81-1.32)
Not answered	9.0%	40/445	1.36 (0.94-1.95)	Not answered	7.4%	80/1,081	1.04 (0.79-1.38)
Total	7.0%	528/7,505		Total	7.0%	528/7,505	
Volunteering status				**Social support**			
Volunteering	13.2%	301/2,274	1	Highest tertile	7.6%	200/2,625	1
Not volunteering	21.4%	1,360/6,364	1.78 (1.56-2.04)***	Middle tertile	6.6%	194/2,961	0.85 (0.69-1.04)
Total	19.2%	1,661/8,638		Lowest tertile	6.8%	108/1,580	0.89 (0.70-1.13)
				Not answered	7.7%	26/339	1.00 (0.66-1.54)
				Total	7.0%	528/7,505	

[1]Oral Impacts on Daily Performances

$^{**}p<0.01$; $^{***}p<0.001$

N=8,810

N dropped out because missing values: 1,312 (Self-completion questionnaire) + 521 (CAPI – Covariates) n=1,833

4.3 Results of the cross-sectional analysis

Data from 6,977 ELSA respondents that constituted the baseline sample for this study are analysed in this section. First, the characteristics of the baseline sample and the bivariate associations with oral health are presented (section 4.3.1.). Then, section 4.3.2 examines the association between the social capital variables and oral health adjusted for covariates (multivariable analysis). Finally, section 4.3.3 examines the interaction between social capital and poor socio-economic position in relation to oral health.

4.3.1 Characteristics of the baseline sample

The distributions of all the analytical variables are presented in this section and their bivariate associations with the oral health measures.

4.3.1.1 Oral health status

The prevalence of poor self-rated oral health was 17.2% in the whole sample. Few of the respondents were edentate (16.7%). Regarding the oral health-related quality of life assessment (OHRQoL), 8.3% of the respondents experienced at least one oral impact on their daily performances in the past six months (Table 4.2). Eating was the performance mostly affected (6.0%), following by smiling without embarrassment (2.4%) (Table 4.3).

Results of the bivariate logistic regression analysis showed that poor self-rated oral health was negatively associated with being edentate (OR=0.81; 95%CI:0.67-0.99). In other words, respondents with poor self-rated oral health were more likely to be dentate rather than edentate. Compared to those with good self-rated oral health, individuals who rated their oral health as poor were 8.22 (95%CI:6.82-9.92) times more likely to experience at least one impact on their daily performances. Also, compared to the respondents who were dentate, those who were edentate were 1.56 (95%CI:1.25-1.96) times more likely to experience one oral impact on daily performances (Table 4.2).

Table 4.2: Oral health outcomes by oral health characteristics of ELSA 'baseline sample' wave 3 (2006-2007), % (95%CI) distribution and bivariate OR (95%CI)

Variables at wave 3	% (95%CI)	Poor self-rated oral health	Edentate	OIDP[1]
Self-rated oral health				
Good	82.7 (81.7-83.6)	n/a	1	1
Poor	17.3 (16.4-18.2)	n/a	0.81 (0.67-0.99)*	8.22 (6.82-9.92)***
Edentulousness				
Dentate	83.3 (82.4-84.2)	1	n/a	1
Edentate	16.7 (15.8-17.6)	0.81 (0.67-0.99)*	n/a	1.56 (1.25-1.96)***
OIDP **Mean (sd)** 0.1 (0.4)				
No impact	91.7 (91.0-92.3)	1	1	n/a
At least one impact	8.3 (7.7-9.0)	8.22 (6.82-9.92)***	1.56 (1.25-1.96)***	n/a

Figures are weighted for non-response at wave 3
[1]Oral Impacts on Daily Performances
**p<0.05; ***p<0.001*
N=6,977

Table 4.3: Prevalence of Oral Impacts on Daily Performances ELSA 'baseline sample' wave 3 (2006-07), % (95%CI) distribution

Daily performances	% (95%CI)
Physical performances	
Difficulty eating food	6.0 (5.5-6.7)
Difficulty speaking clearly	1.3 (1.0-1.6)
Psychological performances	
Problems smiling without embarrassment	2.4 (2.1-2.8)
Problems with emotional instability	0.4 (0.3-0.6)
Social performance	
Problems enjoying company of others	0.3 (0.2-0.5)
Any impact on daily performances	8.3 (7.7-9.0)

N=6,977

4.3.1.1.1 Socio-demographic and socio-economic characteristics and their associations with the oral health outcomes

In the baseline sample, 47.1% were men and 52.9% were women (Table 4.4). The mean age of the studied population was 65.8 years. The largest proportion of the sample was in the youngest age group with those aged 50-64 representing 51.8% of the sample. Over 70.0% of the respondents lived with a partner. In terms of educational attainment, nearly 30.0% of the sample did not achieve any educational qualifications. At the time of the interviews, 34.2% of the respondents were in paid employment and 14.5% reported being unemployed, permanently sick or disabled, or looking after family (the 'other' category).

Self-rated oral health

Women were less likely to report poor self-rated oral health when compared to men (OR=0.86; 95%CI:0.76-0.98). When compared to the youngest age group (aged 50-64), older individuals (aged 75 and over) were less likely to report poor self-rated oral health (OR=0.77; 95%CI:0.65-0.92). The odds of reporting poor oral health was higher amongst the respondents who were living alone compared to those living with partners (OR=1.38; 95%CI:1.20-1.58). Respondents without education, out of the labour market for being unemployed, permanently sick or disabled, or looking after family, and in the poorer quintiles of wealth were more likely to report poor oral health. For instance, for those respondents in the poorest quintile of wealth the odds of reporting poor oral health was 2.40 (95%CI:1.94-2.96) times higher than those in the wealthiest quintile.

Edentulousness

Women were 1.34 (95%CI:1.17-1.54) times more likely to be edentate than men. Being in the oldest age group, and living alone were positively related to edentate status (OR=8.56; 95%CI:7.17-10.22 and OR=2.51, 95%CI:2.19-2.87, respectively). For all the socio-economic position markers (education, labour market status and wealth), being in the lowest level of socio-economic position was associated with higher odds of being edentate compared to those respondents in the highest socio-economic position. With respect to wealth indicator, respondents in the poorest quintile of wealth were 9.16 (95%CI:7.04-11.90) times more likely to be edentate than those in the wealthiest quintile of wealth.

Oral Impacts on Daily Performances (OIDP)

There was no association between gender and oral impact on daily performances. Respondents aged 65 and over were more likely to report at least one oral impact on daily performances. Compared to the respondents who were living with a partner, those who lived alone had higher odds of having experienced an oral impact (OR=1.41; 95%CI:1.16-1.70). Regarding the socio-economic position markers, OIDP was positively associated with no educational achievement (OR=1.36; 95%CI:1.13-1.65), being out of the labour market (OR=2.16; 95%CI:1.65-2.82), and being in the poorest quintile of wealth (OR=2.60; 95%CI:1.95-3.47).

Table 4.4: Oral health outcomes by socio-demographic and socio-economic characteristics of ELSA 'baseline sample' wave 3 (2006-07), % (95%CI) distribution and bivariate OR (95%CI)

Covariates at wave 3	% (95%CI)	Poor self-rated oral health	Edentate	OIDP[1]
Age **Mean (sd)** 65.8 (10.3)				
50-64	51.8 (50.6-53.0)	1	1	1
65-74	26.7 (25.6-27.7)	0.86 (0.73-0.99)*	3.20 (2.66-3.84)***	1.34 (1.09-1.65)**
75+	21.6 (20.6-22.6)	0.77 (0.65-0.92)**	8.56 (7.17-10.22)***	1.32 (1.05-1.67)*
Gender				
Men	47.1 (45.9-48.3)	1	1	1
Women	52.9 (51.7-54.1)	0.86 (0.76-0.98)*	1.34 (1.17-1.54)***	1.01 (0.84-1.20)
Cohabiting status				
Living with partner	70.6 (69.5-71.7)	1	1	1
No living with partner	29.4 (28.3-30.5)	1.38 (1.20-1.58)***	2.51 (2.19-2.87)***	1.41 (1.16-1.70)***
Educational status				
Education	69.1 (67.9-70.2)	1	1	1
No education	30.9 (29.8-32.1)	1.45 (1.26-1.66)***	3.74 (3.22-4.29)***	1.36 (1.13-1.65)**
Labour market status				
In paid employment	34.2 (33.0-35.3)	1	1	1
Retired	51.3 (50.1-52.5)	0.93 (0.80-1.07)	5.11 (4.18-6.24)***	1.57 (1.27-1.95)***
Other	14.5 (13.7-15.4)	1.44 (1.19-1.75)***	3.35 (2.61-4.31)***	2.16 (1.65-2.82)***
Wealth quintile				
Wealthiest quintile	21.5 (20.5-22.5)	1	1	1
4^{th}	21.0 (20.1-22.0)	1.26 (1.01-1.57)*	2.10 (1.57-2.81)***	1.54 (1.13-2.08)**
3^{rd}	20.1 (19.1-21.1)	1.43 (1.16-1.77)**	3.48 (2.65-4.56)***	1.39 (1.02-1.88)*
2^{nd}	19.7 (18.8-20.7)	1.91 (1.55-2.35)***	5.43 (4.17-7.08)***	1.83 (1.37-2.46)***
Poorest quintile	17.6 (16.7-18.6)	2.40 (1.94-2.96)***	9.16 (7.04-11.90)***	2.60 (1.95-3.47)***

Figures are weighted for non-response at wave 3
[1]Oral Impacts on Daily Performances
**p<0.05; **p<0.01; ***p<0.001*
N=6,977

4.3.1.1.2 Health and health-related behaviours and their association with oral health status

At baseline, 31.2% of the respondents reported poor self-rated general health, 33.1% had limiting long-standing illness, and 19.3% suffered from depression (4 or more depressive symptoms). Overall 15.2% of the sample was a current smoker at the time of interview (Table 4.5).

Self-rated oral health

Poor self-rated oral heath was positively associated with poor self-rated general health (OR=3.03; 95%CI:2.65-3.45), limiting long-standing illness (OR=2.00; 95%CI:1.75-2.28), depression (OR=2.46; 95%CI:2.13-2.85), and being a current smoker (OR=2.24; 95%CI:1.86-2.70) (Table 4.5).

Edentulousness

Respondents who rated their general health as poor were 2.58 (95%CI:2.25-2.95) times more likely to be edentate than those with good general health. Limiting long-standing illness and depression were positively associated with edentate status (OR=2.05; 95%CI:1.79-2.34 and OR=1.63; 95%CI:1.40-1.91, respectively). Ex-smokers and current smokers were more likely to be edentate compared with never-smoked participants with odds ratios of 1.69 (95% = 1.45-1.98) and 2.69 (95%CI:2.21-3.27), respectively (Table 4.5).

Oral Impacts on Daily Performances (OIDP)

Poor self-rated general health was associated with OIDP (OR=2.77; 95%CI:2.31-3.31). Limiting long-standing illness and depression were positively related to OIDP with odds ratios of 2.05 (95%CI:1.79-2.34) and 1.63 (95%CI:1.40-1.91) respectively. Respondents who were current smokers were more likely to have an oral impact compared to respondents who never smoked (OR=2.22; 95%CI:1.74-2.85) (Table 4.5).

Table 4.5: Oral health outcomes by health and health related behaviour characteristics of ELSA 'baseline sample' wave 3 (2006-07), % (95%CI) distribution and bivariate OR (95%CI)

Covariates at wave 3	% (95%CI)	Poor self-rated oral health	Edentate	OIDP[1]
Self-rated general health				
Good	68.8 (67.7-69.9)	1	1	1
Poor	31.2 (30.1-32.3)	3.03 (2.65-3.45)***	2.58 (2.25-2.95)***	2.77 (2.31-3.31)***
Limiting long-standing illness				
No	66.9 (65.8-68.1)	1	1	1
Yes	33.1 (31.9-34.2)	2.00 (1.75-2.28)***	2.05 (1.79-2.34)***	2.59 (2.16-3.11)***
Depression (≥4 symptoms)				
No	80.7 (79.7-81.6)	1	1	1
Yes	19.3 (18.4-20.3)	2.46 (2.13-2.85)***	1.63 (1.40-1.91)***	2.99 (2.48-3.62)***
Smoking status				
Never smoked	37.8 (36.6-38.9)	1	1	1
Ex-smoker	47.0 (45.8-48.2)	1.22 (1.05-1.41)**	1.69 (1.45-1.98)***	1.22 (0.99-1.51)
Current smoker	15.2 (14.3-16.1)	2.24 (1.86-2.70)***	2.69 (2.21-3.27)***	2.22 (1.74-2.85)***

Figures are weighted for non-response at wave 3
[1]Oral Impacts on Daily Performances
***p<0.01; ***p<0.001*
N=6,977

4.3.1.2 Distribution of structural and functional social capital

As social capital is the key exposure variable, this section goes into some details of the distribution of the different social capital measures and their bivariate associations with oral health.

Table 4.6 shows the distribution of the structural and functional components of social capital that were used in all the analyses in the thesis.

Table 4.6: Distribution of individual structural and functional dimensions of social capital wave 3 (2006-07), % (95%CI) distribution

Social capital variables	% (95%CI)	Social capital variables	% (95%CI)	Mean (sd)
Membership status		**Number of close ties**		9.0 (7.7)
Active member	30.7 (29.6-31.8)	Highest tertile (≥10)	27.5 (26.5-28.6)	15.7 (10.4)
Passive member	36.3 (35.2-37.5)	Middle tertile (7-9)	25.5 (24.5-26.6)	7.9 (0.8)
Not a member	26.9 (25.8-28.0)	Lowest tertile (≤6)	32.3 (31.2-33.5)	4.3 (1.6)
Not answered	6.1 (5.6-6.7)	Not answered	14.6 (13.8-15.5)	-
Volunteering status		**Social support**		23.2 (7.4)
Volunteering	26.9 (25.9-28.0)	Highest tertile (≥28)	28.6 (27.5-29.7)	31.5 (2.5)
Not volunteering	73.1 (72.0-74.1)	Middle tertile (22-27)	31.7 (30.6-32.8)	24.7 (1.7)
		Lowest tertile (≤21)	35.2 (34.1-36.4)	15.4 (4.6)
		Not answered	4.6 (4.1-5.1)	-

Figures are weighted for non-response at wave 3
N= 6,977

4.3.1.2.1 Structural social capital

Membership in organisations

In terms of membership status, slightly more than one-quarter of respondents (26.9%) were not members of any organisation; 36.3% stated that they were a member but had not attended any committee meetings during the previous year, whereas less than one third (30.7%) were active members. There were 6.1% of the baseline participants who did not answer the questions on membership. These participants were included as a 'not answered' category and included in the regression analyses. They differed from the respondents in the missingness analysis (section 4.2) because they had responded to most of the other questions in the self-completion questionnaire and interview, unlike those who were excluded from the analysis.

Membership status by characteristics of ELSA 'baseline sample' wave 3 (2006-07)

The association between membership status and socio-demographic, socio-economic, health and behavioural factors are displayed in Table 4.7. This table shows the results of the multinomial logistic regression on the different categories of membership status as the dependent variable. The first set of results gives the estimates of the risk (Relative Risk Ratio-RRR) of being a passive member of any organisation compared to being an active member (the reference group). The second set gives the estimates of not being a member compared to being an active member; and the last set of estimates are for not answering the question on membership status versus active member.

The odds of being a passive member (ie. someone who was a member of an organisation but who did not attend any committee meetings in a year), compared to those who actively participated in any organisation, was greater for respondents who were older (aged 75 and over), women, those who were living without a partner, had no educational achievement, were in the three poorest quintiles of wealth, reported poor self-rated general health, experienced at least four depressive symptoms and were smokers. Respondents who were not members had common characteristics with the passive members but also were more likely to be out of the labour market and suffering from limiting long-standing illness when compared to the active members. Those who did not answer the membership questions were more likely to be older, women, in the lowest socio-economic position, with poor health, ex-smoker and smoker.

Compared to the youngest age group (50-64), respondents between the ages of 65-74 were less likely to be passive members (RRR=0.78; 95%CI:0.68-0.90) or not members of any organisation (0.78; 95%CI:0.67-0.90). In other words, respondents aged 65-74 years were more likely to be active members of any organisation compared to the youngest age group. Even though the results did not reach the statistical significance, the relative risk ratio of being a passive member versus an active member was lower for retired respondents (RRR=0.88; 95%CI:0.78-1.00) compared to those in paid employment. In other words, retired respondents were more likely to be active members rather than passive members.

Table 4.7: Membership status by characteristics of ELSA 'baseline sample' wave 3 (2006-07): unadjusted multinomial logistic regression, RRR (95%CI)[1]

	Membership status at wave 3 (2006-07)		
Covariates at wave 3 (2006-07)	**Passive member vs. active member** RRR (95%CI)[1]	**Not a member vs. active member** RRR (95%CI)[1]	**Not answered vs. active member** RRR (95%CI)[1]
Age-groups			
50-64	1	1	1
65-74	0.78 (0.68-0.90)***	0.78 (0.67-0.90)**	1.39 (1.07-1.81)*
75+	1.32 (1.13-1.54)***	1.33 (1.12-1.57)**	2.70 (2.07-3.52)***
Gender			
Men	1	1	1
Women	1.28 (1.14-1.44)***	1.31 (1.15-1.49)***	1.62 (1.30-2.02)***
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.17 (1.03-1.33)*	1.40 (1.21-1.60)***	1.22 (0.96-1.55)
Educational status			
Education	1	1	1
No education	1.91 (1.65-2.22)***	3.72 (3.19-4.33)***	5.89 (4.67-7.43)***
Labour market status			
In paid employment	1	1	1
Retired	0.88 (0.78-1.00)	0.99 (0.86-1.14)	1.50 (1.16-1.95)**
Other	1.01 (0.83-1.23)	1.81 (1.48-2.21)***	2.27 (1.61-3.19)***
Wealth quintile			
Wealthiest	1	1	1
4	1.16 (0.99-1.37)	2.45 (1.98-3.05)***	1.58 (1.05-2.36)*
3	1.46 (1.23-1.73)***	3.75 (3.02-4.66)***	3.28 (2.27-4.75)***
2	1.75 (1.46-2.09)***	5.06 (4.07-6.30)***	3.23 (2.19-4.75)***
Poorest	1.79 (1.46-2.20)***	8.02 (6.35-10.13)***	6.78 (4.66-9.88)***
Self-rated general health			
Good	1	1	1
Poor	1.22 (1.07-1.40)**	1.99 (1.73-2.28)***	2.37 (1.89-2.97)***
Long-standing illness			
No	1	1	1
Yes	1.08 (0.95-1.22)	1.64 (1.43-1.88)***	1.58 (1.26-1.98)***
Depression			
No	1	1	1
Yes	1.56 (1.32-1.84)***	2.48 (2.09-2.93)***	2.38 (1.83-3.10)***
Smoking status			
Never smoked	1	1	1
Ex-smoker	1.06 (0.94-1.20)	1.12 (0.97-1.29)	1.50 (1.17-1.92)**
Current smoker	1.25 (1.01-1.54)*	3.24 (2.65-3.96)***	2.69 (1.92-3.76)***

[1]Unadjusted relative risk ratios from multinomial logistic regression; **P<0.5; ** p<0.01; *** p<0.001*
N=6,977

The membership status variable was derived by differentiating respondents into active, passive and not members of organisation (as described in the methodology chapter, section 3.3). The classification of respondents into these three categories was only done for the overall membership in any organisation rather than specific types of organisations because the question related to the frequency of participation in the organisations was only asked for the overall membership question. As explained in the methodology chapter, it is important to measure intensity of participation in organisations, in order to measure this aspect of social capital accurately. Despite the limitation of the measures of participation in specific types of organisations, the distribution of organisational membership is examined in greater detail in Tables 4.8 to 4.10. These tables examine the distribution of component types of organisational membership by age, gender and oral health, to assess similarities and differences across different membership types.

Types of organisational membership by age groups

As shown in Table 4.8, the most common types of organisational membership (for all age groups) were membership of a church or other religious groups (20.3%); social clubs (19.9%); sports clubs, gyms, exercise classes (20.2%) or other organisations, clubs or societies (23.2%). The lowest percentages of members were reported for membership in political party, trade union or environmental groups (13.8%) and education, arts or music groups (11.2%).

There was a general pattern with age: membership increased among those aged 65-74 and decreased among the oldest respondents (75+). A closer examination by type of organisation showed that this pattern was similar for membership in education, arts or music groups or evening classes; social clubs, and other organisations, clubs or societies. The pattern was somewhat reversed for membership of a tenants or neighbourhood organisation and for membership of a church or religious groups, where those aged 75 and over were more likely to be members. There was a linear trend by age for membership of a political party, trade union or environmental groups; sports, gym clubs, exercise classes with a decreasing rate of membership as individuals became older.

Overall, levels of engagement in social activities were high. Around 71.0% of respondents were members of at least one organisation.

Table 4.8: Organisational membership by age groups: ELSA 'baseline sample' wave 3 (2006-07), % (95%CI) distribution

	Age-groups				
Type of organisation	**50-64 N=3,355[1]** % (95%CI)	**65-74 N=1,816[1]** % (95%CI)	**75+ N=1,401[1]** % (95%CI)	**Total N=6,572[1]** % (95%CI)	**p-value**
Political party, trade union or environmental group	17.3 (16.1-18.7)	10.5 (9.1-12.0)	9.2 (7.8-10.8)	13.8 (13.0-14.7)	<0.01
Tenants groups, residents groups, neighbourhood watch	14.3 (13.1-15.6)	20.9 (19.1-22.8)	21.1 (19.0-23.3)	17.5 (16.6-18.4)	<0.01
Church or other religious groups	15.3 (14.1-16.6)	24.3 (22.4-26.4)	27.7 (25.4-30.2)	20.3 (19.3-21-3)	<0.01
Charitable associations	16.9 (15.7-18.2)	18.6 (16.9-20.4)	17.8 (15.8-19.9)	17.5 (16.6-18.5)	0.31
Education, arts or music groups or evening classes	11.1 (10.1-12.1)	13.1 (11.7-14.7)	9.2 (7.8-10.8)	11.2 (10.5-12.0)	<0.01
Social clubs	17.5 (16.2-18.9)	23.4 (21.4-25.4)	21.4 (19.3-23.8)	19.9 (18.9-20.9)	<0.01
Sports clubs, gyms, exercise classes	24.9 (23.4-26.4)	19.3 (17.6-21.2)	9.7 (8.3-11.4)	20.2 (19.3-21.2)	<0.01
Other organisations, clubs or societies	22.9 (21.4-24.3)	26.6 (24.6-28.7)	19.6 (17.6-21.8)	23.2 (22.2-24.2)	<0.01
Any organisation, clubs or societies	71.2 (69.6-72.8)	73.7 (71.6-75.8)	68.6 (66.0-71.1)	71.3 (70.2-72.5)	<0.01

Figures are weighted for non-response at wave 3; [1] Bases unweighted

Types of organisational membership by gender

The results displayed in Table 4.9 show that the proportion of respondents who were members of an organisation varied by gender and type of organisation. Overall, most men and women were members of at least one organisation (72.8% and 70.0%, respectively). However men were more likely than women to be a member of any organisation *($p = 0.01$).* Greater percentages of men than women reported being a member of political party, trade union or environmental group, social clubs or other organisations, clubs or societies. Women were more likely than men to belong to a charitable association, church or other religious groups, and education, arts or music groups or evening classes.

Table 4.9: Organisational membership by gender: ELSA 'baseline sample' wave 3 (2006-07), % (95%CI) distribution

	Gender		
Type of organisation	**Men N=2,987**[1] % (95%CI)	**Women N=3,585**[1] % (95%CI)	**p-value**
Political party, trade union or environmental group	17.3 (15.9-18.7)	10.7 (9.7-11.7)	<0.01
Tenants groups, residents groups, neighbourhood watch	18.1 (16.8-19.6)	16.8 (15.6-18.1)	0.10
Church or other religious groups	15.4 (14.1-16.7)	24.8 (23.3-26.2)	<0.01
Charitable associations	15.7 (14.4-17.0)	19.2 (17.9-20.5)	<0.01
Education, arts or music groups or evening classes	8.3 (7.4-9.3)	13.9 (12.8-15.0)	<0.01
Social clubs	22.3 (20.8-23.8)	17.7 (16.4-19.0)	<0.01
Sports clubs, gyms, exercise classes	19.4 (18.0-20.9)	21.0 (19.6-22.3)	0.04
Other organisations, clubs or societies	26.7 (25.1-28.3)	20.0 (18.7-21.3)	<0.01
Any organisation, clubs or societies	72.8 (71.1-74.5)	70.0 (68.4-71.5)	0.01

Figures are weighted for non-response at wave 3; [1] Bases unweighted
N=6,572

Types of organisational membership by oral health status

The distribution of the respondents' oral health status by the different types of organisational membership is examined in Table 4.10. In relation to self-rated oral health and edentulousness, there was a general pattern of association between membership of any organisation and oral health. Poor self-rated oral health was higher among respondents who did not participate in any organisation compared to those who participated *($p<0.01$).* A similar result was found in relation to edentulousness. In relation to OIDP, there was no overall difference between respondents who were or not members of any organisation *($p<0.11$).* However, in terms of specific types of organisations, respondents who reported an OIDP were less likely to be members of church or religious groups; education, arts or music groups or evening classes; sports clubs; and other organisations, clubs or societies.

It is interesting to note that even though the results were not significant, a reverse pattern was found in term of membership of social clubs. The percentages of respondents who reported poor self-rated oral health, who were edentate and who experienced at least one oral impact were higher among those who were members compared to not being a member of social club.

Table 4.10: Organisational membership by oral health status: ELSA 'baseline sample' wave 3 (2006-07), % (95%CI) distribution

	Oral health status at wave 3		
Type of organisation	**Poor self-rated oral health N=1,105[1]** % (95%CI)	**Edentate N=1,013[1]** % (95%CI)	**OIDP N=521[1]** % (95%CI)
Political party, trade union or environmental group			
No	17.6 (16.6-18.6)	17.3 (16.3-18.4)	8.3 (7.6-9.1)
Yes	15.7 (13.4-18.3)	7.5 (5.9-9.6)	7.1 (5.6-9.0)
p-value	0.18	<0.01	0.25
Tenants groups, residents groups, neighbourhood watch			
No	18.0 (16.9-19.1)	17.1 (16.1-18.2)	8.1 (7.3-8.9)
Yes	14.1 (12.2-16.3)	10.6 (8.9-12.6)	8.3 (6.8-10.1)
p-value	<0.01	<0.01	0.79
Church or other religious groups			
No	18.6 (17.5-19.7)	16.6 (15.6-17.7)	8.5 (7.8-9.3)
Yes	12.3 (10.7-14.2)	13.5 (11.7-15.5)	6.6 (5.3-8.0)
p-value	<0.01	<0.01	0.02
Charitable associations			
No	18.0 (17.0-19.1)	17.3 (16.2-18.4)	8.5 (7.7-9.3)
Yes	13.9 (12.1-16.1)	9.8 (8.3-11.7)	6.4 (5.1-7.9)
p-value	<0.01	<0.01	0.01
Education, arts or music groups or evening classes			
No	17.9 (16.9-19.0)	17.1 (16.1-18.1)	8.4 (7.6-9.1)
Yes	12.4 (10.3-14.9)	7.2 (5.6-9.3)	6.2 (4.7-8.2)
p-value	<0.01	<0.01	0.04
Social clubs			
No	16.9 (15.8-18.0)	15.6 (14.6-16.7)	7.8 (7.0-8.6)
Yes	19.1 (16.9-21.4)	17.4 (15.3-19.6)	9.5 (8.0-11.3)
p-value	0.07	0.15	0.05
Sports clubs, gyms, exercise classes			
No	18.5 (17.4-19.6)	18.4 (17.3-19.5)	8.7 (7.9-9.5)
Yes	12.7 (11.0-14.6)	6.5 (5.3-8.0)	5.9 (4.7-7.3)
p-value	<0.01	<0.01	<0.01
Other organisations, clubs or societies			
No	18.6 (17.5-19.7)	17.8 (16.7-19.0)	8.5 (7.7-9.4)
Yes	13.1 (11.5-15.0)	9.8 (8.4-11.4)	6.8 (5.7-8.2)
p-value	<0.01	<0.01	0.03
Any organisation, clubs or societies			
No	21.9 (19.9-23-9)	24.5 (22.4-26.6)	9.04 (7.7-10.6)
Yes	15.5 (14.4-16.6)	12.6 (11.6-13.6)	7.7 (7.0-8.6)
p-value	<0.01	<0.01	0.11

Figures are weighted for non-response at wave 3; [1]Bases unweighted
N=6,572

Volunteering status

Nearly three-quarter of the respondents (73.1%) were not engaged in voluntary work. As the question on volunteering was asked in the main interview rather than the self-completion questionnaire, there were no missing data on volunteering in the analytical sample (Table 4.6).

Volunteering status by characteristics of ELSA 'baseline sample' wave 3 (2006-07)

Table 4.11 examines the association between the covariates and volunteering status in a binary logistic regression. Most of the covariates were statistically significant predictors of volunteering status. Exceptions included gender and the labour market status. However the results suggest that compared to men, women were more likely to participate in voluntary activities (OR=0.90; 95%CI:0.81-1.00) but the association was marginally significant. Also, for those respondents who were retired, the estimated odds of not being a volunteer was lower (OR=0.91; 95%CI:0.81-1.03) compared to those in paid employment (but this association was not significant). The oldest respondents (75+) were most likely not to participate in voluntary work compared to the younger age group. Moreover, for respondents aged 65-74 the odds of not volunteering was 0.81 (95%CI:0.72-0.92) times the odds for the youngest age group. In other words, respondents aged 65-74 were more likely to take part in voluntary work compared to the youngest respondents. Respondents who did not volunteer were more likely to live without a partner, to have no educational qualifications, and to be poorer. They also reported significantly worse general health and were more likely to be an ex-smoker or current smoker.

Table 4.11: Volunteering status by characteristics of ELSA 'baseline sample' wave 3 (2006-07): Unadjusted logistic regression, OR (95%CI)[1]

	Volunteering status at wave 3 (2006-07)
Covariates at wave 3 (2006-07)	**Not volunteering vs. volunteering** Odds ratio (95%CI)[1]
Age-groups	
50-64	1
65-74	0.81 (0.72-0.92)**
75+	1.44 (1.24-1.66)***
Gender	
Men	1
Women	0.90 (0.81-1.00)
Cohabiting status	
Living with partner	1
No living with partner	1.43 (1.27-1.63)***
Educational status	
Education	1
No education	3.13 (2.71-3.62)***
Labour market status	
In paid employment	1
Retired	0.91 (0.81-1.03)
Other	1.13 (0.95-1.35)
Wealth quintile	
Wealthiest	1
4	1.67 (1.44-1.94)***
3	2.38 (2.03-2.79)***
2	3.17 (2.67-3.77)***
Poorest	4.19 (3.46-5.09)***
Self-rated general health	
Good	1
Poor	2.16 (1.90-2.45)***
Long-standing illness	
No	1
Yes	1.51 (1.34-1.70)***
Depression	
No	1
Yes	2.01 (1.72-2.35)***
Smoking status	
Never smoked	1
Ex-smoker	1.23 (1.09-1.37)***
Current smoker	2.63 (2.16-3.19)***

[1]Unadjusted odds ratios from logistic regression; **P<0.5; ** p<0.01; ***p<0.001*
N=6,977

4.3.1.2.2 Functional social capital

Number of close ties

The number of close ties variable was measured by a count of the number of children, relatives including partner, and friends the respondents felt close to. The scores ranged from 0 to 91 with a mean of 9.0 (sd=7.7). For the analysis, this count of close ties was divided into tertiles. Respondents in the highest tertile of close ties score had 10 or more close ties with a mean of 15.7 (sd=10.4). Those in the lowest tertile of close ties had a range from 0 to 6 closes ties with a mean of 4.3 (sd=1.6). There was a high proportion of the baseline participants who did not answer any of the questions related to close ties. These participants represented 14.6% of the baseline sample and were included as a ‘not answered’ category for the analysis (Table 4.6).

Number of close ties by characteristics of ELSA ‘baseline sample’ wave 3 (2006-07)

Table 4.12 examines the association between the covariates and number of close ties in a multinomial logistic regression on tertiles of close ties. Respondents who had the lowest number of close ties (<7 close ties) were more likely to be older (75+); not living with a partner; out of the labour market for being unemployed, sick or looking after family; in the poorer quintiles of wealth; with poor health, and to be a current smoker. However respondents aged 65-74 were less likely to be in the lowest tertile of close ties versus the highest (RRR=0.85; 95%CI:0.73-0.99) compared to the youngest age group. In other words, respondents aged 65-74 were more likely to have more close ties compared to the youngest respondents. The relative risk ratio comparing middle tertile (7-9) to the highest tertile (≥10) of close ties was not statistically significant in all covariates investigated. Those who did not answer the questions in relation to the number of close ties were more likely to be older, living alone, with no education, retired or out of the labour market, poorer, with worse health and to be a current smoker.

Table 4.12: Number of close ties by characteristics of ELSA 'baseline sample' wave 3 (2006-07): Unadjusted multinomial logistic regression, RRR (95%CI)[1]

	Number of close ties at wave 3 (2006-07)		
Covariates at wave 3 (2006-07)	**Middle tertile vs. highest tertile** RRR (95%CI)[1]	**Lowest tertile vs. highest tertile** RRR (95%CI)[1]	**Not answered vs. highest tertile** RRR (95%CI)[1]
Age-groups			
50-64	1	1	1
65-74	0.93 (0.80-1.08)	0.85 (0.73-0.99)*	1.78 (1.47-2.14)***
75+	0.84 (0.70-1.00)	1.27 (1.08-1.49)**	2.52 (2.07-3.08)***
Gender			
Men	1	1	1
Women	1.14 (1.00-1.30)	0.89 (0.78-1.00)	0.86 (0.74-1.01)
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.12 (0.96-1.30)	2.15 (1.87-2.47)***	1.61 (1.35-1.92)***
Educational status			
Education	1	1	1
No education	0.95 (0.82-1.11)	1.13 (0.98-1.30)	2.19 (1.85-2.58)***
Labour market status			
In paid employment	1	1	1
Retired	0.88 (0.76-1.01)	1.11 (0.97-1.28)	2.19 (1.81-2.65)***
Other	0.90 (0.73-1.11)	1.25 (1.02-1.52)*	2.06 (1.59-2.68)***
Wealth quintile			
Wealthiest	1	1	1
4	0.99 (0.82-1.20)	1.17 (0.97-1.41)	1.33 (1.04-1.72)*
3	0.99 (0.82-1.21)	1.38 (1.14-1.67)**	1.62 (1.26-2.09)***
2	1.05 (0.86-1.29)	1.53 (1.26-1.86)***	2.11 (1.64-2.70)***
Poorest	0.99 (0.79-1.24)	1.77 (1.44-2.18)***	2.60 (2.01-3.37)***
Self-rated general health			
Good	1	1	1
Poor	1.12 (0.96-1.30)	1.58 (1.38-1.82)***	2.07 (1.75-2.45)***
Long-standing illness			
No	1	1	1
Yes	0.92 (0.79-1.06)	1.16 (1.02-1.33)*	1.53 (1.30-1.80)***
Depression			
No	1	1	1
Yes	1.19 (0.99-1.43)	1.67 (1.42-1.97)***	1.91 (1.57-2.33)***
Smoking status			
Never smoked	1	1	1
Ex-smoker	0.96 (0.83-1.11)	1.04 (0.90-1.19)	1.17 (0.99-1.39)
Current smoker	1.12 (0.91-1.38)	1.41 (1.16-1.72)**	1.33 (1.04-1.71)*

[1]Unadjusted relative risk ratios from multinomial logistic regression; **P<0.5; ** p<0.01; ***p<0.001*
N=6,977

Emotional social support

The emotional social support scale from all types of relationship (partner, children, relatives, and friends) ranged from 0 (representing complete lack of social support) to 36 (the highest social support score) with a mean of 23.2 (sd=7.4). For the purposes of the analysis, social support was categorised into tertiles. Respondents in the highest tertile of social support scored between 28 and 36 in social support with a mean of 31.5 (sd=2.5), whereas those in the lowest tertile had a score that ranged from 0 to 21 with a mean of

15.4 (sd=4.6). The ‘not answered’ category accounted for 4.6% of the baseline participants who did not answer any questions on social support (Table 4.6).

Emotional social support by characteristics of ELSA ‘baseline sample’ wave 3 (2006-07)

The results of the unadjusted multinomial regression on social support presented in Table 4.13 show that compared to the youngest group, respondents aged 75 and over were more likely to have their social support scores in the lowest tertile than in the highest tertile (RRR=2.19; 95CI%:1.86-2.58). Furthermore those who had no educational qualification, who were retired and out of the labour market, in the poorer quintiles of wealth, reporting poor self-rated general health, with limiting long-standing illness, depressed and current smoker were at greater risk of having their social support scores in the lowest tertile than in the highest tertile. However, compared to men, women were 0.85 (95%CI:0.76-0.96) less likely to be in the lowest tertile of social support. Moreover the respondents who were living alone had an increased risk of being in the lowest tertile of social support compared to those who lived with a partner (RRR=234.28; 95%CI:130.38-421.00). This extremely high relative risk ratio was because there were very few respondents with high social support who lived alone (n=12). This suggests that the main source of social support was from the partner - 99.4% of respondents with high social support were living with partner.

The relative risk ratio comparing respondents in the middle tertile versus the highest tertile of social support was greater for the oldest respondents, those living without a partner, retired, poorest, with poorer health and for current smokers.

With the exception of gender and smoking status, the estimates of the risk of not answering the social support question in comparison to highest tertile was higher for the older, those living alone, in the lowest socio-economic position, and respondents who reported poorer health.

Table 4.13: Social support by characteristics of ELSA 'baseline sample' wave 3 (2006-07): Unadjusted multinomial logistic regression, RRR (95%CI)[1]

	Social support at wave 3 (2006-07)		
Covariates at wave 3 (2006-07)	**Middle tertile vs. highest tertile** RRR (95%CI)[1]	**Lowest tertile vs. highest tertile** RRR (95%CI)[1]	**Not answered vs. highest tertile** RRR (95%CI)[1]
Age-groups			
50-64	1	1	1
65-74	1.08 (0.93-1.25)	1.12 (0.97-1.29)	2.54 (1.85-3.48)***
75+	1.49 (1.25-1.77)***	2.19 (1.86-2.58)***	5.51 (3.99-7.60)***
Gender			
Men	1	1	1
Women	0.98 (0.87-1.11)	0.85 (0.76-0.96)*	1.05 (0.82-1.34)
Cohabiting status			
Living with partner	1	1	1
No living with partner	60.1 (33.34-108.21)***	234.28 (130.38-421.00)***	97.84 (52.17-183.50)***
Educational status			
Education	1	1	1
No education	1.09 (0.94-1.25)	1.37 (1.20-1.57)***	2.32 (1.80-2.99)***
Labour market status			
In paid employment	1	1	1
Retired	1.24 (1.08-1.42)**	1.55 (1.36-1.77)***	4.02 (2.81-5.74)***
Other	1.02 (0.83-1.24)	1.37 (1.13-1.65)**	3.00 (1.91-4.70)***
Wealth quintile			
Wealthiest	1	1	1
4	0.95 (0.79-1.13)	1.15 (0.96-1.39)	1.07 (0.72-1.60)
3	0.89 (0.74-1.07)	1.42 (1.18-1.70)***	1.56 (1.07-2.28)*
2	1.16 (0.96-1.40)	2.01 (1.66-2.44)***	2.08 (1.41-3.07)***
Poorest	1.90 (1.52-2.37)***	4.00 (3.22-4.98)***	3.36 (2.21-5.09)***
Self-rated general health			
Good	1	1	1
Poor	1.37 (1.19-1.58)***	2.09 (1.82-2.39)***	2.18 (1.68-2.82)***
Long-standing illness			
No	1	1	1
Yes	1.25 (1.09-1.44)**	1.79 (1.57-2.04)***	1.90 (1.47-2.45)***
Depression			
No	1	1	1
Yes	1.72 (1.43-2.08)***	3.16 (2.66-3.76)***	2.76 (2.04-3.74)***
Smoking status			
Never smoked	1	1	1
Ex-smoker	1.03 (0.90-1.18)	1.03 (0.91-1.18)	1.06 (0.82-1.39)
Current smoker	1.28 (1.04-1.57)*	1.69 (1.40-2.05)***	0.97 (0.63-1.48)

[1]Unadjusted relative risk ratios from multinomial logistic regression; **P<0.5; ** p<0.01; ***p<0.001*
N=6,977

This section investigated the bivariate associations between the main exposures, outcomes and covariates used in this thesis. The results confirmed the association between oral health risk factors and the three oral health outcomes. Furthermore, higher levels of risk factors were associated with lower levels of social capital. The next section examines the associations between the social capital and oral health measures, adjusted for these risk factors.

4.3.2 Multivariable analysis for the cross-sectional association between social capital and oral health

The cross-tabulation between the social capital and oral health outcome variables are displayed in Table 4.14. There is a consistent and significant pattern of association-ELSA respondents with lower social capital reported higher proportions of poor oral health. However, the cross-tabulation does not take into account potential confounders or mediators of the association between social capital and oral health. Hence, logistic regression models predicting poor oral health were used in subsequent analyses. The results of the logistic regression for the association between social capital and oral health sequentially adjusted for relevant covariates are displayed in Tables 4.15 to 4.26.

Table 4.14: Oral health outcomes by social capital measures at wave 3 (2006-07), % (95%CI) distribution

Social capital at wave 3	weighted n	Poor self-rated oral health % of weighted n (95% CI)	Edentate % of weighted n (95% CI)	OIDP[1] % of weighted n (95% CI)
Membership status				
Active member	2,115	14.1 (12.7-15.7)	10.0 (8.8-11.4)	7.7 (6.7-9.0)
Passive member	2,505	16.6 (15.2-18.2)	14.7 (13.4-16.2)	7.8 (6.7-8.9)
Not a member	1,856	21.9 (19.9-23-9)	24.5 (22.4-26.6)	9.0 (7.7-10.6)
Not answered	421	17.1 (13.7-21.2)	27.3 (23.1-32.0)	11.5 (8.6-15.1)
p-value[2]		<0.01	<0.01	0.04
Volunteering status				
Volunteering	1,857	14.5 (13.0-16.2)	9.3 (8.0-10.7)	6.9 (5.9-8.2)
Not volunteering	5,040	18.3 (17.2-19.5)	19.4 (18.3-20.6)	8.9 (8.0-9.7)
p-value[2]		<0.001	<0.01	0.01
Number of close ties				
Highest tertile (≥10)	1,899	14.2 (12.7-15.9)	13.8 (12.3-15.5)	6.1 (5.1-7.3)
Middle tertile (7-9)	1,759	15.5 (13.8-17.3)	13.2 (11.6-14.9)	6.4 (5.3-7.7)
Lowest tertile (≤6)	2,229	20.4 (18.7-22.2)	18.2 (16.6-19.9)	10.3 (9.0-11.7)
Not answered	1,010	19.5 (17.1-22.2)	24.8 (22.1-27.7)	11.6 (9.7-13.8)
p-value[2]		<0.01	<0.01	<0.01
Social support				
Highest tertile (≥28)	1,969	13.8 (12.3-15.5)	12.3 (10.9-13.9)	5.3 (4.4-6.5)
Middle tertile (22-27)	2,185	15.2 (13.7-16.9)	15.2 (13.7-16.9)	8.4 (7.2-9.7)
Lowest tertile (≤21)	2,428	22.2 (20.5-23.9)	19.8 (18.2-21.5)	10.5 (9.3-11.8)
Not answered	315	16.0 (12.1-20.9)	29.9 (24.8-35.5)	10.0 (6.9-14.2)
p-value[2]		<0.01	<0.01	<0.01
Weighted N	6,897	1,194	1,150	574
Unweighted N	6,977	1,175	1,124	566

Figures are weighted for non-response at wave 3
[1]Oral Impacts on Daily Performances
[2]Pearson Chi-square

4.3.2.1 Social capital and self-rated oral health

4.3.2.1.1 Membership status and self-rated oral health

In Table 4.15, the unadjusted model (Model 1) showed that respondents who were not members of any organisation were more likely to report poor self-rated oral health than those who were active member (OR=1.70; 95%CI:1.43-2.01). After adjusting for age and the other socio-demographic factors (gender and cohabiting status), the significant association remained unchanged (Models 2 and 3). When adjusted for the socio-economic factors (Model 4), the association between not being a member and poor self-rated oral health was attenuated; the odds ratio decreased from 1.69 (95%CI:1.43-2.01) to 1.38 (95%CI:1.15-1.65). Wealth and education contributed the most for the attenuation of the odds ratio. When each of the socio-economic factors were analysed separately (Appendix A, Table A.1), wealth reduced the odds ratio in Model 3 from 1.69 to 1.47 (95%CI:1.23-1.75) and education reduced the odds ratio to 1.54 (95%CI:1.30-1.83) whereas employment status did not substantially reduce the estimate.

The introduction of the health factors in the model also further attenuated the association (Model 5). Compared to active members, respondents who were not members of any organisation were 1.26 (95%CI:1.05-1.51) times more likely to report poor self-rated oral health. Depression was the variable that reduced the odds ratio the most, from 1.38 in Model 4 to 1.29 (95%CI:1.08-1.55). Self-rated general health reduced the odds ratio to 1.31 (95%CI:1.10-1.58) (Appendix A, Table A.1). In the fully adjusted model (Model 6), when including smoking status, the odds of poor self-rated oral health for not being a member was 1.21 (95%CI:1.01-1.46) times the odds for active members but remained significant.

The unadjusted odds ratio for passive members on poor self-rated oral health (Model 1) also showed a significant association even though much weaker than for not members of organisation (OR=1.21; 95%CI:1.02-1.42). The size of the association was not reduced when adjusted for socio-demographic factors (Model 2 and 3), but the association was explained with further adjustment for socio-economic factors (OR=1.14; 95%CI:0.96-1.35) (Model 4). Both wealth and education contributed to explain the association between passive member and poor self-rated oral health.

Stepwise models showed that the attenuation of the associations arose particularly from the inclusion of socio-economic and health factors. Socio-demographic and behavioural factors did not influence the association between membership status and poor self-rated oral health.

Membership status, socio-economic and health factors were associated in the following way: respondents with poor self-rated oral health were more likely not to participate in any organisation, be in the poorest socio-economic group and report poor health. Consequently the observed association might well be a selection effect. Poor self-rated oral health might lead to lower social capital (not a member of any organisation), rather than no membership status leading to poor self-rated oral health. Individuals that are healthier are better able to cope and to participate in social activities. On the other hand, poor health of individuals could also contribute to their withdrawal from social participation subsequently reducing their social networks. In other words, the direction of causality is difficult to determine, in that social capital and enhanced health may be mutually reinforcing.

Table 4.15: Association between membership status and poor self-rated oral health at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: **Self-rated oral health**	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 3 Odds ratio (95% CI)
Membership status			
Active member	1	1	1
Passive member	1.21 (1.02-1.42)*	1.22 (1.03-1.44)*	1.22 (1.03-1.44)*
Not a member	1.70 (1.43-2.01)***	1.71 (1.44-2.03)***	1.69 (1.43-2.01)***
Not answered	1.25 (0.94-1.68)	1.31 (0.98-1.76)	1.34 (1.00-1.80)*
Age-groups			
50-64		1	1
65-74		0.87 (0.75-1.02)	0.84 (0.71-0.98)*
75 +		0.76 (0.64-0.91)**	0.67 (0.56-0.80)***
Gender			
Men			1
Women			0.80 (0.70-0.92)**
Cohabiting status			
Living with partner			1
No living with partner			1.53 (1.32-1.77)***

**p<0.05; **p<0.01; ***p<0.001*

Table 4.15…continued: Association between membership status and poor self-rated oral health at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Self-rated oral health	Model 4 Odds ratio (95% CI)	Model 5 Odds ratio (95% CI)	Model 6 Odds ratio (95% CI)
Membership status			
Active member	1	1	1
Passive member	1.14 (0.96-1.35)	1.11 (0.93-1.32)	1.10 (0.93-1.31)
Not a member	1.38 (1.15-1.65)***	1.26 (1.05-1.51)*	1.21 (1.01-1.46)*
Not answered	1.07 (0.79-1.45)	0.95 (0.70-1.29)	0.92 (0.68-1.25)
Age-groups			
50-64	1	1	1
65-74	0.81 (0.67-0.98)*	0.84 (0.69-1.03)	0.87 (0.71-1.06)
75 +	0.62 (0.50-0.78)***	0.61 (0.48-0.77)***	0.65 (0.51-0.82)***
Gender			
Men	1	1	1
Women	0.77 (0.67-0.88)***	0.79 (0.68-0.91)**	0.81 (0.70-0.93)**
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.30 (1.11-1.52)**	1.21 (1.04-1.42)*	1.20 (1.02-1.40)*
Educational status			
Education	1	1	1
No education	1.27 (1.09-1.98)**	1.16 (0.99-1.36)	1.14 (0.97-1.34)
Employment status			
In paid employment			
Retired	1	1	1
Other	1.04 (0.85-1.26)	0.81 (0.65-1.00)	0.80 (0.65-0.99)*
	1.35 (1.10-1.66)**	0.87 (0.70-1.09)	0.85 (0.68-1.07)
Wealth quintile			
Wealthiest	1	1	1
4	1.21 (0.97-1.51)	1.10 (0.88-1.37)	1.09 (0.87-1.36)
3	1.31 (1.05-1.63)*	1.13 (0.91-1.41)	1.12 (0.90-1.40)
2	1.62 (1.31-2.02)***	1.31 (1.04-1.63)*	1.26 (1.00-1.54)*
Poorest	1.85 (1.47-2.34)***	1.33 (1.04-1.70)*	1.24 (0.96-1.59)
Self-rated health			
Good		1	1
Poor		2.46 (2.08-2.90)***	2.41 (2.04-2.85)***
Long-standing illness			
No		1	1
Yes		1.11 (0.94-1.32)	1.12 (0.95-1.33)
Depression			
No		1	1
Yes		1.60 (1.36-1.89)***	1.59 (1.35-1.88)***
Smoking status			
Never smoked			1
Ex-smoker			1.13 (0.97-1.32)
Current smoker			1.51 (1.23-1.84)***

**p<0.05; **p<0.01; ***p<0.001*

4.3.2.1.2 Volunteering status and self-rated oral health

The results of the bivariate and multivariable logistic regression for the association between poor self-rated oral health and volunteering status are displayed in Table 4.16.

There was a significant association between volunteering status and poor self-rated oral health. Respondents who did not volunteer were more likely to report poor self-rated oral health when compared to those who were engaged in voluntary work (OR=1.32, 95%CI:1.11-1.50) (Model 1). The size of the association remained unchanged when adjusted for socio-demographic factors (OR =1.29; 95%CI:1.11-1.50) (Models 2 and 3).

After adjusting for socio-economic factors (Model 4), the association between not volunteering and poor self-rated oral health was attenuated from 1.26 to 1.09 (95%CI:0.93-1.28) and became statistically non-significant. In detailed analysis (Appendix A, Table A.1), the association was explained when wealth was accounted for (OR=1.14; 95%CI:0.98-1.34). Education also reduced the odds ratio but the association remained significant (OR=1.18; 95%CI:1.02-1.38). Adjustment for health factors (Model 5), and smoking status (Model 6), further reduced the odds ratio and there was little difference in the odds of poor self-rated oral health for non-volunteers versus volunteers.

Table 4.16: Association between volunteering status and poor self-rated oral health at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: **Self-rated oral health**	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 3 Odds ratio (95% CI)
Volunteering status			
Volunteering	1	1	1
Not volunteering	1.32 (1.13-1.53)***	1.33 (1.15-1.55)***	1.29 (1.11-1.50)***
Age-groups			
50-64		1	1
65-74		0.87 (0.74-1.01)	0.83 (0.71-0.97)*
75 +		0.76 (0.64-0.91)**	0.67 (0.56-0.80)***
Gender			
Men			1
Women			0.82 (0.72-0.94)**
Cohabiting status			
Living with partner			1
No living with partner			1.54 (1.33-1.78)***

**p<0.05; **p<0.01; ***p<0.001*

Table 4.16…continued: Association between volunteering status and poor self-rated oral health at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Self-rated oral health	Model 4 Odds ratio (95% CI)	Model 5 Odds ratio (95% CI)	Model 6 Odds ratio (95% CI)
Volunteering status			
Volunteering	1	1	1
Not volunteering	1.09 (0.93-1.28)	0.96 (0.82-1.13)	0.94 (0.80-1.10)
Age-groups			
50-64	1	1	1
65-74	0.80 (0.66-0.97)*	0.83 (0.68-1.02)	0.86 (0.70-1.05)
75 +	0.62 (0.50-0.77)***	0.61 (0.48-0.76)***	0.65 (0.51-0.82)***
Gender			
Men	1	1	1
Women	0.77 (0.67-0.89)***	0.79 (0.68-0.91)**	0.81 (0.70-0.93)**
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.29 (1.11-1.51)**	1.21 (1.03-1.42)*	1.19 (1.02-1.40)*
Educational status			
Education	1	1	1
No education	1.30 (1.11-1.52)**	1.19 (1.01-1.40)*	1.17 (1.00-1.38)*
Employment status			
In paid employment	1	1	1
Retired	1.04 (0.85-1.26)	0.80 (0.65-0.99)*	0.79 (0.64-0.98)*
Other	1.37 (1.12-1.59)**	0.87 (0.70-1.09)	0.85 (0.68-1.07)
Wealth quintile			
Wealthiest	1	1	1
4	1.24 (0.99-1.54)	1.13 (0.91-1.41)	1.12 (0.90-1.40)
3	1.35 (1.09-1.67)**	1.17 (0.94-1.46)	1.15 (0.92-1.44)
2	1.69 (1.36-2.10)***	1.37 (1.09-1.71)**	1.31 (1.04-1.64)*
Poorest	1.95 (1.55-2.45)***	1.40 (1.10-1.78)**	1.29 (1.01-1.65)*
Self-rated health			
Good		1	1
Poor		2.46 (2.08-3.91)***	2.41 (2.04-2.85)***
Long-standing illness			
No		1	1
Yes		1.12 (0.94-1.32)	1.13 (0.95-1.33)
Depression			
No		1	1
Yes		1.63 (1.38-1.92)***	1.61 (1.36-1.91)***
Smoking status			
Never smoked			1
Ex-smoker			1.12 (0.96-1.31)
Current smoker			1.54 (1.26-1.88)***

**p<0.05; **p<0.01; ***p<0.001*

4.3.2.1.3 Number of close ties and self-rated oral health

In term of number of close ties, the unadjusted model (Model 1) showed that respondents who were in the lowest tertile of close ties were more likely to report poor oral health when compared to those in the highest tertile (OR=1.54; 95%CI:1.29-2.82) (Table 4.17). Age did not attenuate the estimates (Model 2). However, after adjusting simultaneously for gender and cohabiting status, the odds ratio for lowest tertile of close ties was attenuated to 1.45 (95%CI:1.22-1.73) but remained statistically significant. Gender alone did not confound the association between close ties and self-rated oral health (Model 3). After introducing the socio-economic factors (Model 4), the effect size remained largely unchanged.

The introduction of the health factors (Model 5) reduced the odds ratio to 1.31 (95%CI:1.10-1.57) but the association remained statistically significant. When the health factors were entered separately into the Model 4 (Appendix A, Table A.1) self-rated general health reduced the odds ratio from 1.42 to 1.33 (95%CI:1.12-1.59), while depression reduced the odds ratio to 1.36 (95%CI:1.15-1.63). In the fully adjusted model that included smoking status (Model 6), the odds ratio remained the same compared to Model 5. Thus respondents in the lowest tertile of number of close ties were 1.31 (95%CI:1.09-1.57) times more likely to report poor oral health compared with those who were in the highest tertile of number of close ties.

Table 4.17: Association between number of close ties and poor self-rated oral health at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: **Self-rated oral health**	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 3 Odds ratio (95% CI)
Number of close ties			
Highest tertile	1	1	1
Middle tertile	1.10 (0.91-1.33)	1.11 (0.91-1.32)	1.09 (0.90-1.31)
Lowest tertile	1.54 (1.29-2.82)***	1.55 (1.31-1.84)***	1.45 (1.22-1.73)***
Not answered	1.46 (1.18-1.80)***	1.54 (1.24-1.90)***	1.49 (1.20-1.84)***
Age-groups			
50-64		1	1
65-74		0.85 (0.73-0.99)*	0.82 (0.70-0.95)*
75 +		0.74 (0.62-0.88)**	0.66 (0.54-0.79)***
Gender			
Men			1
Women			0.84 (0.73-0.96)*
Cohabiting status			
Living with partner			1
No living with partner			1.49 (1.28-1.72)***

**p<0.05; **p<0.01; ***p<0.001*

Table 4.17…continued: Association between number of close ties and poor self-rated oral health at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: **Self-rated oral health**	Model 4 Odds ratio (95% CI)	Model 5 Odds ratio (95% CI)	Model 6 Odds ratio (95% CI)
Number of close ties			
Highest tertile	1	1	1
Middle tertile	1.10 (0.91-1.33)	1.06 (0.87-1.28)	1.05 (0.87-1.28)
Lowest tertile	1.42 (1.19-1.69)***	1.31 (1.10-1.57)**	1.31 (1.09-1.56)**
Not answered	1.33 (1.08-1.65)**	1.19 (0.95-1.48)	1.19 (0.95-1.48)
Age-groups			
50-64	1	1	1
65-74	0.80 (0.66-0.97)*	0.84 (0.69-1.03)	0.86 (0.70-1.06)
75 +	0.61 (0.49-0.77)***	0.60 (0.48-0.76)***	0.64 (0.51-0.81)***
Gender			
Men	1	1	1
Women	0.79 (0.68-0.90)**	0.80 (0.69-0.92)**	0.82 (0.71-0.95)**
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.24 (1.06-1.45)**	1.17 (1.00-1.38)*	1.16 (0.99-1.36)
Educational status			
Education	1	1	1
No education	1.31 (1.12-1.53)***	1.19 (1.01-1.39)*	1.16 (0.99-1.37)
Employment status			
In paid employment	1	1	1
Retired	1.02 (0.84-1.24)	0.80 (0.65-0.98)*	0.79 (0.64-0.98)*
Other	1.34 (1.09-1.65)**	0.87 (0.69-1.08)	0.84 (0.67-1.06)
Wealth quintile			
Wealthiest	1	1	1
4	1.24 (0.99-1.54)	1.12 (0.90-1.40)	1.10 (0.88-1.38)
3	1.34 (1.08-1.67)**	1.15 (0.93-1.44)	1.13 (0.91-1.41)
2	1.68 (1.36-2.09)***	1.34 (1.07-1.67)**	1.28 (1.02-1.60)*
Poorest	1.94 (1.55-2.44)***	1.38 (1.08-1.75)**	1.26 (0.98-1.61)
Self-rated health			
Good		1	1
Poor		2.42 (2.05-2.86)***	2.37 (2.00-2.80)***
Long-standing illness			
No		1	1
Yes		1.12 (0.95-1.33)	1.13 (0.96-1.34)
Depression			
No		1	1
Yes		1.61 (1.36-1.90)***	1.59 (1.34-1.88)***
Smoking status			
Never smoked			1
Ex-smoker			1.13 (0.96-1.31)
Current smoker			1.53 (1.25-1.87)***

**p<0.05; **p<0.01; ***p<0.001*

4.3.2.1.4 Social support and self-rated oral health

ELSA respondents who were in the lowest tertile of social support were more likely to report poor self-rated oral health when compared to those in the highest tertile (Table 4.18). The unadjusted model (Model 1) showed that respondents who were in the lowest tertile of social support were 1.77 (95%CI:1.50-2.08) times more likely to rate their oral health as poor compared to those in the highest tertile of social support. Including age in the model (Model 2) increased the odds ratio to 1.84 (95%CI:1.55-2.17), which would indicate suppression (or negative confounding) as older respondents were more likely to rate their oral health as good and yet they reported lower social support (see Tables 4.4 and 4.14). The size of the association was attenuated particularly when cohabiting status was separately introduced in the model, reducing the odds ratio to 1.62 (95%CI:1.33-1.96) (Model 3).

When socio-economic factors were controlled for (Model 4), the association between social support and self-rated oral health remained unchanged. The observed association was somewhat weakened when adjusting for health factors (Model 5. This pattern of results remained similar when accounted for smoking status (Model 6). The odds of reporting poor oral health was 1.36 (95%CI:1.11-1.66) times higher for the respondents who had the lowest tertile of social support compared with those who had the highest tertile of social support.

Table 4.18: Association between social support and poor self-rated oral health at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: **Self-rated oral health**	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 3 Odds ratio (95% CI)
Social support			
Highest tertile	1	1	1
Middle tertile	1.11 (0.93-1.33)	1.13 (0.95-1.36)	1.07 (0.89-1.29)
Lowest tertile	1.77 (1.50-2.08)***	1.84 (1.55-2.17)***	1.62 (1.33-1.96)***
Not answered	1.18 (0.83-1.68)	1.29 (0.91-1.84)	1.21 (0.85-1.73)
Age-groups			
50-64		1	1
65-74		0.85 (0.73-0.99)*	0.83 (0.71-0.97)*
75 +		0.72 (0.60-0.86)***	0.68 (0.57-0.82)***
Gender			
Men			1
Women			0.86 (0.75-0.99)*
Cohabiting status			
Living with partner			1
No living with partner			1.24 (1.05-1.47)*

**p<0.05; **p<0.01; ***p<0.001*

Table 4.18…continued: Association between social support and poor self-rated oral health at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Self-rated oral health	Model 4 Odds ratio (95% CI)	Model 5 Odds ratio (95% CI)	Model 6 Odds ratio (95% CI)
Social support			
Highest tertile	1	1	1
Middle tertile	1.08 (0.89-1.30)	1.00 (0.83-1.21)	1.00 (0.82-1.21)
Lowest tertile	1.59 (1.31-1.93)***	1.36 (1.12-1.66)**	1.36 (1.11-1.66)**
Not answered	1.13 (0.79-1.61)	0.99 (0.69-1.42)	1.00 (0.70-1.44)
Age-groups			
50-64	1	1	1
65-74	0.81 (0.66-0.98)*	0.84 (0.69-1.03)	0.87 (0.71-1.06)
75 +	0.63 (0.50-0.79)***	0.61 (0.49-0.77)***	0.65 (0.52-0.83)***
Gender			
Men	1	1	1
Women	0.81 (0.71-0.93)**	0.82 (0.71-0.94)**	0.84 (0.73-0.97)*
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.04 (0.87-1.24)	1.05 (0.88-1.26)	1.03 (0.86-1.24)
Educational status			
Education	1	1	1
No education	1.33 (1.14-1.55)***	1.19 (1.02-1.40)*	1.17 (1.00-1.37)
Employment status			
In paid employment	1	1	1
Retired	1.03 (0.85-1.26)	0.81 (0.65-1.00)	0.80 (0.65-0.99)*
Other	1.35 (1.10-1.66)**	0.88 (0.70-1.10)	0.86 (0.68-1.07)
Wealth quintile			
Wealthiest	1	1	1
4	1.24 (1.00-1.55)*	1.12 (0.90-1.40)	1.11 (0.89-1.39)
3	1.35 (1.09-1.68)**	1.16 (0.93-1.44)	1.13 (0.91-1.41)
2	1.70 (1.37-2.11)***	1.35 (1.08-1.69)**	1.29 (1.03-1.62)*
Poorest	1.96 (1.56-2.46)***	1.39 (1.09-1.77)**	1.27 (0.99-1.62)
Self-rated health			
Good		1	1
Poor		2.43 (2.06-2.87)***	2.38 (2.01-2.81)***
Long-standing illness			
No		1	1
Yes		1.11 (0.94-1.31)	1.12 (0.95-1.33)
Depression			
No		1	1
Yes		1.58 (1.34-1.87)***	1.57 (1.32-1.85)***
Smoking status			
Never smoked			1
Ex-smoker			1.13 (0.97-1.32)
Current smoker			1.53 (1.26-1.87)***

**p<0.05; **p<0.01; ***p<0.001*

In summary, there was evidence that three out of the four social capital measures were cross-sectionally associated with self-rated oral health even after adjusting for socio-demographic, socio-economic, health and behavioural factors. Only volunteering status was not significantly associated with self-rated oral health after adjustment for these covariates.

4.3.2.2 Social capital and edentulousness

4.3.2.2.1 Membership status and edentulousness

Table 4.19 shows the results of the logistic regression for the association between edentulousness and membership. Not a member of any organisation was associated with a greater likelihood of being edentate; OR=2.90 (95%CI:2.42-3.61) in Model 1. The size of the association slightly increased when age was included in the regression equation (Model 2). The odds of being edentate was 3.03 (95%CI:2.50-3.68) times higher for the respondents who were not members compared to those who were active members. This increase in the size of the effect of membership on edentate status possibly occurred because respondents aged 65-74 were more likely to be a member of any organisation (compared to the youngest age group - see Table 4.7) and also more likely to be edentate (see Table 4.4). This differential association between older age group, membership and edentate status possibly explains the negative confounding when age was entered in Model 2. The addition of cohabiting status to the Model 1 reduced the size of the association between not being a member and edentate reducing the odds ratio from 2.90 to 2.79 (95%CI:2.32-3.36), whereas the inclusion of gender did not change the size of the association. The association showed little attenuation when gender and cohabiting status were accounted for in the age-adjusted model (Model 3).

When socio-economic factors were introduced into the Model 3, the odds ratio decreased from 2.97 (95%CI:2.45-3.61) to 1.97 (95%CI:1.60-2.42) but the association still remained statistically significant (Model 4). Separate analyses (Appendix A, Table A.2) for each of the socio-economic factors showed that education and wealth decreased the odds ratio from 2.97 (95%CI:2.45-3.61) to respectively, 2.42 (95%CI:1.98-2.96) and 2.21 (95%CI:1.80-2.71). Further adjustment for smoking status (Model 6) reduced the odds ratio to 1.79 (95%CI:1.45-2.21) but the association between not being a member and edentate status remained significant. Cohabiting status, education, wealth and smoking status thus, partially explained the association between social capital and oral health.

A positive association was also found between passive members and edentate status. The size of the association was somewhat weaker than those observed for respondents who were not members of any organisation. Passive members were 1.55 (95%CI:1.29-1.86) times more likely to be edentate when compared to their counterparts who were active members (Model 1). Age did not reduce the odds ratio much (Model 2) and neither did gender or cohabiting status (Model 3): the odds ratio hardly reduced from Model 1 to Models 2 or 3. Passive members were still associated with edentate status after adjusting for socio-economic (Model 4) and health factors (Model 5) but the association was mostly explained when smoking status was accounted for (OR=1.21; 95%CI:0.99-1.48) (Model 6).

Table 4.19: Association between membership status and edentate status at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Edentate status	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 3 Odds ratio (95% CI)
Membership status			
Active member	1	1	1
Passive member	1.55 (1.29-1.86)***	1.49 (1.23-1.80)***	1.45 (1.20-1.76)***
Not a member	2.90 (2.42-3.48)***	3.03 (2.50-3.68)***	2.97 (2.45-3.61)***
Not answered	3.37 (2.58-4.39)***	2.68 (2.03-3.55)***	2.69 (2.04-3.56)***
Age-groups			
50-64		1	1
65-74		3.35 (2.79-4.04)***	3.22 (2.67-3.88)***
75 +		8.57 (7.17-10.26)***	7.44 (6.20-8.94)***
Gender			
Men			1
Women			1.11 (0.96-1.29)
Cohabiting status			
Living with partner			1
No living with partner			1.59 (1.36-1.85)***

**p<0.05; **p<0.01; ***p<0.001*

Table 4.19…continued: Association between membership status and edentate status at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Edentate status	Model 4 Odds ratio (95% CI)	Model 5 Odds ratio (95% CI)	Model 6 Odds ratio (95% CI)
Membership status			
Active member	1	1	1
Passive member	1.25 (1.02-1.52)*	1.24 (1.02-1.51)*	1.21 (0.99-1.48)
Not a member	1.97 (1.60-2.42)***	1.93 (1.57-2.38)***	1.79 (1.45-2.21)***
Not answered	1.71 (1.27-2.29)***	1.66 (1.23-2.24)**	1.54 (1.13-2.09)**
Age-groups			
50-64	1	1	1
65-74	2.60 (2.03-3.34)***	2.66 (2.07-3.41)***	2.93 (2.26-3.80)***
75 +	5.77 (4.49-7.42)***	5.75 (4.48-7.39)***	6.84 (5.25-8.92)***
Gender			
Men	1	1	1
Women	1.05 (0.90-1.23)	1.09 (0.93-1.27)	1.20 (1.03-1.41)*
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.09 (0.93-1.29)	1.11 (0.94-1.31)	1.08 (0.91-1.28)
Educational status			
Education	1	1	1
No education	1.68 (1.43-1.97)***	1.65 (1.40-1.94)***	1.61 (1.37-1.90)***
Employment status			
In paid employment	1	1	1
Retired	1.42 (1.07-1.89)*	1.30 (0.97-1.73)	1.24 (0.93-1.66)
Other	1.37 (1.02-1.83)*	1.20 (0.90-1.61)	1.14 (0.85-1.53)
Wealth quintile			
Wealthiest	1	1	1
4	1.61 (1.19-2.17)**	1.58 (1.17-2.13)**	1.55 (1.14-2.09)**
3	2.29 (1.72-3.06)***	2.20 (1.65-2.94)***	2.13 (1.59-2.85)***
2	3.81 (2.86-3.06)***	3.57 (2.68-4.77)***	3.37 (2.52-4.51)***
Poorest	4.73 (3.53-6.35)***	4.38 (3.25-5.89)***	3.87 (2.86-5.23)***
Self-rated health			
Good		1	1
Poor		1.50 (1.26-1.79)***	1.44 (1.21-1.73)***
Long-standing illness			
No		1	1
Yes		1.07 (0.90-1.27)	1.09 (0.91-1.30)
Depression			
No		1	1
Yes		0.82 (0.68-0.99)*	0.80 (0.66-0.97)*
Smoking status			
Never smoked			1
Ex-smoker			1.55 (1.31-1.85)***
Current smoker			2.61 (2.08-3.29)***

**p<0.05; **p<0.01; ***p<0.001*

4.3.2.2.2 Volunteering status and edentulousness

In Table 4.20, the unadjusted model (Model 1) showed that respondents who did not engage in volunteering were 2.35 (95%CI:1.98-2.80) times more likely to be edentate that those who volunteered. Controlling for socio-demographic factors (Models 2 and 3), the association remained largely the same. However, after accounting for socio-economic factors (Model 4), the odds ratio decreased from 2.27 (1.90-2.71) to 1.60 (95%CI:1.32-1.93). Education (OR=1.87; 95%CI:1.56-2.25) and wealth (OR=1.77; 95%CI:1.47-2.13) contributed the most to the attenuation of the estimate (Appendix A, Table A.2). The addition of health factors in the model further reduced the size of the association (Model 5). Self-rated general health reduced the association rather than limiting long-standing illness or depression (OR=1.52; 95%CI:1.26-1.53) (Appendix A, Table A.2). In the fully adjusted model (Model 6), the odds ratio reduced to 1.45 (95%CI:1.19-1.75) but remained statistically significant.

Table 4.20: Association between volunteering status and edentate status at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Edentate status	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 3 Odds ratio (95% CI)
Volunteering status			
Volunteering	1	1	1
Not volunteering	2.35 (1.98-2.80)***	2.29 (1.92-2.74)***	2.27 (1.90-2.71)***
Age-groups			
50-64		1	1
65-74		3.34 (2.78-4.02)***	3.20 (2.66-3.85)***
75 +		8.41 (7.04-10.05)***	7.31 (6.09-8.78)***
Gender			
Men			1
Women			1.16 (1.00-1.35)*
Cohabiting status			
Living with partner			1
No living with partner			1.55 (1.33-1.80)***

**p*<0.05; ***p*<0.01; ****p*<0.001*

Table 4.20…continued: Association between volunteering status and edentate status at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Edentate status	Model 4 Odds ratio (95% CI)	Model 5 Odds ratio (95% CI)	Model 6 Odds ratio (95% CI)
Volunteering status			
Volunteering	1	1	1
Not volunteering	1.60 (1.32-1.93)***	1.53 (1.26-1.85)***	1.45 (1.19-1.75)***
Age-groups			
50-64	1	1	1
65-74	2.55 (2.00-3.27)***	2.61 (2.04-3.34)***	2.89 (2.23-3.74)***
75 +	5.60 (4.38-7.17)***	5.60 (4.37-7.17)***	6.71 (5.16-8.73)***
Gender			
Men	1	1	1
Women	1.07 (0.92-1.25)	1.11 (0.95-1.30)	1.22 (1.04-1.43)*
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.06 (0.90-1.25)	1.07 (0.91-1.27)	1.05 (0.89-1.24)
Educational status			
Education	1	1	1
No education	1.75 (1.49-2.04)***	1.71 (1.46-2.01)***	1.67 (1.42-1.96)***
Employment status			
In paid employment	1	1	1
Retired	1.44 (1.09-1.91)*	1.31 (0.99-1.74)	1.26 (0.94-1.68)
Other	1.42 (1.07-1.90)*	1.24 (0.93-1.66)	1.17 (0.87-1.58)
Wealth quintile			
Wealthiest	1	1	1
4	1.65 (1.22-2.22)**	1.62 (1.20-2.19)**	1.59 (1.17-2.15)**
3	2.41 (1.81-3.20)***	2.31 (1.73-3.08)***	2.23 (1.67-2.98)***
2	3.94 (2.97-5.25)***	3.71 (2.78-4.95)***	3.47 (2.59-4.65)***
Poorest	5.12 (3.82-6.84)***	4.73 (3.52-6.34)***	4.12 (3.05-5.56)***
Self-rated health			
Good		1	1
Poor		1.49 (1.25-1.77)***	1.42 (1.19-1.70)***
Long-standing illness			
No		1	1
Yes		1.08 (0.90-1.28)	1.09 (0.92-1.30)
Depression			
No		1	1
Yes		0.85 (0.70-1.02)	0.82 (0.68-0.99)*
Smoking status			
Never smoked			1
Ex-smoker			1.55 (1.31-1.84)***
Current smoker			2.72 (2.16-3.42)***

**p<0.05; **p<0.01; ***p<0.001*

4.3.2.2.3 Number of close ties and edentulousness

Respondents in the lowest tertile of close ties were more likely to be edentate compared to those in the highest tertile of close ties (OR=1.38; 95%CI:1.16-1.65) (Model 1; Table 4.21). In the model adjusted for socio-demographic factors (Model 3) the association was attenuated but still remained significant (OR=1.24; 95%CI:1.02-1.49). Participants with less than 7 close ties (in the lowest tertile) were more likely to be edentate compared to those who had 10 or more close ties (in the highest tertile). Cohabiting status rather than gender reduced the odds ratio the most from 1.33 to 1.24 (95%CI:1.03-1.50). In addition, the odds ratio reduced even more with further adjustments for socio-economic, health factors and smoking and was no longer significant (OR=1.14; 95%CI:0.93-1.39) (Model 6).

Table 4.21: Association between number of close ties and edentate status at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Edentate status	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 3 Odds ratio (95% CI)
Number of close ties			
Highest tertile	1	1	1
Middle tertile	0.94 (0.77-1.15)	1.00 (0.82-1.23)	0.98 (0.80-1.20)
Lowest tertile	1.38 (1.16-1.65)***	1.33 (1.11-1.60)**	1.24 (1.02-1.49)*
Not answered	2.06 (1.68-2.52)***	1.59 (1.29-1.97)***	1.57 (1.27-1.95)***
Age-groups			
50-64		1	1
65-74		3.14 (2.61-3.78)***	2.99 (2.48-3.60)***
75 +		8.16 (6.82-9.75)***	7.06 (5.87-8.49)***
Gender			
Men			1
Women			1.15 (0.99-1.33)
Cohabiting status			
Living with partner			1
No living with partner			1.56 (1.34-1.82)***

**p<0.05; **p<0.01; ***p<0.001*

Table 4.21…continued: Association between number of close ties and edentate status at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Edentate status	Model 4 Odds ratio (95% CI)	Model 5 Odds ratio (95% CI)	Model 6 Odds ratio (95% CI)
Number of close ties			
Highest tertile	1	1	1
Middle tertile	0.98 (0.79-1.21)	0.97 (0.78-1.19)	0.95 (0.76-1.17)
Lowest tertile	1.19 (0.97-1.44)	1.16 (0.95-1.41)	1.14 (0.93-1.39)
Not answered	1.27 (1.02-1.59)*	1.23 (0.99-1.54)	1.23 (0.98-1.54)
Age-groups			
50-64	1	1	1
65-74	2.50 (1.96-3.20)***	2.57 (2.01-3.29)***	2.86 (2.21-3.70)***
75 +	5.57 (4.35-7.13)***	5.58 (4.36-7.15)***	6.74 (5.18-8.76)***
Gender			
Men	1	1	1
Women	1.06 (0.91-1.24)	1.10 (0.94-1.29)	1.22 (1.04-1.43)*
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.04 (0.88-1.23)	1.05 (0.89-1.24)	1.03 (0.87-1.22)
Educational status			
Education	1	1	1
No education	1.84 (1.57-2.15)***	1.79 (1.53-2.10)***	1.73 (1.48-2.03)***
Employment status			
In paid employment	1	1	1
Retired	1.40 (1.06-1.85)*	1.27 (0.95-1.68)	1.21 (0.91-1.63)
Other	1.39 (1.04-1.85)*	1.20 (0.90-1.61)	1.14 (0.85-1.53)
Wealth quintile			
Wealthiest	1	1	1
4	1.72 (1.28-2.31)***	1.68 (1.24-2.26)**	1.64 (1.21-2.21)*
3	2.53 (1.90-3.36)***	2.41 (1.81-3.21)***	2.31 (1.73-3.09)***
2	4.21 (3.17-5.59)***	3.91 (2.93-5.21)***	3.63 (2.71-4.86)***
Poorest	5.48 (4.10-7.33)***	4.99 (3.72-6.70)***	4.30 (3.19-5.80)***
Self-rated health			
Good		1	1
Poor		1.51 (1.27-1.80)***	1.44 (1.20-1.72)***
Long-standing illness			
No		1	1
Yes		1.08 (0.91-1.29)	1.10 (0.92-1.31)
Depression			
No		1	1
Yes		0.86 (0.71-1.03)	0.82 (0.68-1.00)
Smoking status			
Never smoked			1
Ex-smoker			1.56 (1.31-1.85)***
Current smoker			2.81 (2.23-3.53)***

**p<0.05; **p<0.01; ***p<0.001*

4.3.2.2.4 Social support and edentulousness

In Table 4.22, there was some evidence of an association between lower social support and edentate status. Respondents who were in the lowest tertile of social support were 1.76 (95%CI:1.47-2.09) times more likely to be edentate when compared to respondents in the highest tertile (Model 1). The inclusion of age reduced the odds ratio (OR=1.42; 95%CI:1.18-1.70) (Model 2). Adjustment for gender and cohabiting status reduced the association to non-significance (OR=1.07; 95%CI:0.86-1.33) (Model 3). While gender did not attenuate the association, cohabiting status fully explained it. When comparing the middle tertile of social support (7 to 9 close ties) to the highest tertile (10 or more close ties), the unadjusted odds ratio (Model 1) was 1.28 (95%CI:1.06-1.54), but the association was fully explained by socio-demographic factors (OR=0.99; 95%CI:0.81-1.21) (Model 3).

Table 4.22: Association between social support and edentate status at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Edentate status	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 3 Odds ratio (95% CI)
Social support			
Highest tertile	1	1	1
Middle tertile	1.28 (1.06-1.54)**	1.15 (0.95-1.39)	0.99 (0.81-1.21)
Lowest tertile	1.76 (1.47-2.09)***	1.42 (1.18-1.70)***	1.07 (0.86-1.33)
Not answered	3.03 (2.27-4.06)***	1.88 (1.37-2.59)***	1.61 (1.17-2.22)**
Age-groups			
50-64		1	1
65-74		3.14 (2.61-3.78)***	3.01 (2.50-3.63)***
75 +		8.06 (6.73-9.65)***	7.20 (5.99-8.65)***
Gender			
Men			1
Women			1.14 (0.98-1.32)
Cohabiting status			
Living with partner			1
No living with partner			1.55 (1.29-1.85)***

**p<0.05; **p<0.01; ***p<0.001*

Table 4.22…continued: Association between social support and edentate status at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Edentate status	Model 4 Odds ratio (95% CI)	Model 5 Odds ratio (95% CI)	Model 6 Odds ratio (95% CI)
Social support			
Highest tertile	1	1	1
Middle tertile	0.99 (0.80-1.22)	0.97 (0.78-1.20)	0.96 (0.78-1.19)
Lowest tertile	1.06 (0.84-1.32)	1.01 (0.80-1.27)	1.01 (0.80-1.27)
Not answered	1.43 (1.02-2.01)*	1.39 (0.99-1.94)	1.43 (1.01-2.01)*
Age-groups			
50-64	1	1	1
65-74	2.49 (1.94-3.18)***	2.55 (1.99-3.27)***	2.85 (2.20-3.68)***
75 +	5.56 (4.34-7.12)***	5.56 (4.33-7.13)***	6.71 (5.15-8.74)***
Gender			
Men	1	1	1
Women	1.06 (0.91-1.24)	1.06 (0.93-1.28)	1.21 (1.03-1.42)*
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.03 (0.85-1.25)	1.06 (0.88-1.29)	1.04 (0.86-1.27)
Educational status			
Education	1	1	1
No education	1.85 (1.58-2.16)***	1.80 (1.53-2.10)***	1.73 (1.48-2.03)***
Employment status			
In paid employment	1	1	1
Retired	1.41 (1.06-1.86)*	1.27 (0.96-1.69)	1.22 (0.91-1.64)
Other	1.41 (1.05-1.87)*	1.21 (0.91-1.62)	1.15 (0.85-1.54)
Wealth quintile			
Wealthiest	1	1	1
4	1.73 (1.28-2.33)***	1.69 (1.25-2.28)***	1.65 (1.22-2.23)**
3	2.55 (1.91-3.39)***	2.42 (1.82-3.22)***	2.32 (1.74-3.09)***
2	4.25 (3.20-5.65)***	3.94 (2.95-5.25)***	3.65 (2.73-4.89)***
Poorest	5.57 (4.17-7.45)***	5.06 (3.77-6.78)***	4.35 (3.23-5.87)***
Self-rated health			
Good		1	1
Poor		1.53 (1.28-1.83)***	1.46 (1.22-1.74)***
Long-standing illness			
No		1	1
Yes		1.07 (0.90-1.28)	1.09 (0.92-1.30)
Depression			
No		1	1
Yes		0.86 (0.71-1.04)	0.83 (0.68-1.00)
Smoking status			
Never smoked			1
Ex-smoker			1.56 (1.31-1.85)***
Current smoker			2.82 (2.24-3.55)***

**p<0.05; **p<0.01; ***p<0.001*

In summary, there was evidence that the structural social capital measures (membership status and volunteering) were cross-sectionally associated with edentulousness even after adjusting for socio-demographic, socio-economic, health and behavioural factors. However, the functional social capital measures (number of close ties and social support) were not significantly associated with edentulousness after adjustment for these covariates.

4.3.2.3 Social capital and Oral Impacts on Daily Performances (OIDP)

4.3.2.3.1 Membership status and OIDP

There was no significant association between Oral Impacts on Daily Performances (OIDP) and membership status (Table 4.23). Although the unadjusted odds ratio suggested that respondents who were not members of any organisation were more likely to report at least one OIDP compared to those who were active members, the association was not statistically significant (OR=1.17; 95%CI:0.93-1.47) (Model 1).

Table 4.23: Association between membership status and OIDP[1] at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 3 Odds ratio (95% CI)
Membership status			
Active member	1	1	1
Passive member	0.99 (0.79-1.23)	0.99 (0.80-1.24)	0.99 (0.79-1.23)
Not a member	1.17 (0.93-1.48)	1.18 (0.93-1.50)	1.16 (0.92-1.47)
Not answered	1.53 (1.07-2.19)*	1.48 (1.03-2.12)*	1.49 (1.03-2.14)*
Age-groups			
50-64		1	1
65-74		1.34 (1.09-1.65)**	1.30 (1.05-1.60)*
75 +		1.30 (1.03-1.64)*	1.17 (0.92-1.50)
Gender			
Men			1
Women			0.94 (0.78-1.13)
Cohabiting status			
Living with partner			1
No living with partner			1.36 (1.11-1.66)*

[1]Oral Impacts on Daily Performances; **p<0.05; **p<0.01; ***p<0.001*

Table 4.23…continued: Association between membership status and OIDP[1] at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 4 Odds ratio (95% CI)	Model 5 Odds ratio (95% CI)	Model 6 Odds ratio (95% CI)
Membership status			
Active member	1	1	1
Passive member	0.95 (0.76-1.18)	0.90 (0.72-1.13)	0.90 (0.72-1.12)
Not a member	0.96 (0.75-1.24)	0.84 (0.65-1.08)	0.79 (0.60-1.02)
Not answered	1.25 (0.86-1.41)	1.11 (0.76-1.63)	1.07 (0.73-1.57)
Age-groups			
50-64	1	1	1
65-74	1.16 (0.91-1.49)	1.24 (0.96-1.60)	1.29 (1.00-1.68)*
75 +	1.02 (0.77-1.36)	1.05 (0.78-1.40)	1.16 (0.86-1.56)
Gender			
Men	1	1	1
Women	0.89 (0.74-1.07)	0.89 (0.73-1.07)	0.91 (0.75-1.11)
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.14 (0.92-1.40)	1.04 (0.84-1.28)	1.01 (0.81-1.24)
Educational status			
Education	1	1	1
No education	1.02 (0.82-1.28)	0.94 (0.75-1.17)	0.92 (0.74-1.16)
Employment status			
In paid employment	1	1	1
Retired	1.35 (1.03-1.77)*	1.03 (0.78-1.37)	1.02 (0.76-1.36)
Other	1.89 (1.42-2.51)**	1.17 (0.87-1.59)	1.13 (0.84-1.54)
Wealth quintile			
Wealthiest	1	1	1
4	1.52 (1.12-2.06)**	1.38 (1.01-1.87)*	1.36 (1.00-1.85)
3	1.34 (0.98-1.83)	1.15 (0.84-1.58)	1.13 (0.82-1.55)
2	1.75 (1.28-2.39)***	1.39 (1.01-1.92)*	1.32 (0.95-1.82)
Poorest	2.20 (1.59-3.05)***	1.55 (1.10-2.19)*	1.39 (0.99-1.97)
Self-rated health			
Good		1	1
Poor		1.62 (1.28-2.06)***	1.58 (1.24-2.00)***
Long-standing illness			
No		1	1
Yes		1.51 (1.19-1.92)**	1.54 (1.21-1.96)***
Depression			
No		1	1
Yes		2.03 (1.64-2.52)***	2.01 (1.62-2.50)***
Smoking status			
Never smoked			1
Ex-smoker			1.09 (0.88-1.35)
Current smoker			1.75 (1.34-2.28)***

[1]Oral Impacts on Daily Performances; **p<0.05; **p<0.01; ***p<0.001*

4.3.2.3.2 Volunteering status and OIDP

Table 4.24 shows that in the unadjusted model (Model 1), compared to those who volunteered, participants who did not volunteer were more likely to report at least one oral impact (OR=1.30; 95%CI:1.06-1.60). The size of the association remained the same after adjusting for age, gender and cohabiting status (Model 3) (OR=1.28; 95%CI:1.04-1.57). Stepwise models showed that the inclusion of socio-economic factors explained most the association (OR=1.14; 95%CI:0.92-1.41) (Model 4). Wealth was the confounder that explained the association the most, reducing the odds ratio from 1.28 to 1.15 (95%CI:0.93-1.42) (Appendix A, Table A.3). To some extent, education also contributed to the decrease in odds ratio (OR=1.22; 95CI% = 1.00-1.51) whereas employment status did not reduced the association between volunteering and OIDP (Appendix A, Table A.3).

Table 4.24: Association between volunteering status and OIDP[1] at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 3 Odds ratio (95% CI)
Volunteering status			
Volunteering	1	1	1
Not volunteering	1.30 (1.06-1.60)*	1.30 (1.06-1.60)*	1.28 (1.04-1.57)*
Age-groups			
50-64		1	1
65-74		1.36 (1.11-1.68)**	1.32 (1.07-1.63)**
75 +		1.31 (1.04-1.64)*	1.19 (0.93-1.51)
Gender			
Men			1
Women			0.95 (0.79-1.15)
Cohabiting status			
Living with partner			1
No living with partner			1.34 (1.10-1.65)**

[1]Oral Impacts on Daily Performances
**p<0.05; **p<0.01; **p<0.001*

Table 4.24…continued: Association between volunteering status and OIDP[1] at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 4 Odds ratio (95% CI)	Model 5 Odds ratio (95% CI)	Model 6 Odds ratio (95% CI)
Volunteering status			
Volunteering	1	1	1
Not volunteering	1.14 (0.92-1.41)	0.99 (0.80-1.24)	0.96 (0.77-1.20)
Age-groups			
50-64	1	1	1
65-74	1.18 (0.92-1.52)	1.25 (0.97-1.62)	1.31 (1.01-1.70)*
75 +	1.03 (0.78-1.36)	1.06 (0.79-1.41)	1.17 (0.87-1.57)
Gender			
Men	1	1	1
Women	0.90 (0.74-1.08)	0.89 (0.73-1.07)	0.91 (0.75-1.11)
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.13 (0.92-1.39)	1.04 (0.84-1.28)	1.01 (0.82-1.24)
Educational status			
Education	1	1	1
No education	1.01 (0.82-1.26)	0.93 (0.74-1.16)	0.91 (0.73-1.14)
Employment status			
In paid employment	1	1	1
Retired	1.36 (1.04-1.78)*	1.03 (0.78-1.37)	1.02 (0.76-1.36)
Other	1.89 (1.42-2.52)***	1.17 (0.87-1.59)	1.13 (0.83-1.53)
Wealth quintile			
Wealthiest	1	1	1
4	1.50 (1.11-2.03)**	1.35 (1.00-1.84)*	1.33 (0.98-1.81)
3	1.31 (0.96-1.79)	1.13 (0.83-1.55)	1.11 (0.81-1.52)
2	1.70 (1.25-2.32)**	1.36 (0.98-1.87)	1.28 (0.93-1.77)
Poorest	2.16 (1.56-2.97)***	1.51 (1.08-2.12)*	1.35 (0.96-1.90)
Self-rated health			
Good		1	1
Poor		1.62 (1.28-2.06)***	1.58 (1.24-2.00)***
Long-standing illness			
No		1	1
Yes		1.51 (1.19-1.92)**	1.53 (1.21-1.94)***
Depression			
No		1	1
Yes		2.01 (1.62-2.50)***	1.99 (1.60-2.47)***
Smoking status			
Never smoked			1
Ex-smoker			1.09 (0.88-1.36)
Current smoker			1.72 (1.32-2.23)***

[1]Oral Impacts on Daily Performances
**p<0.05; **p<0.01; **p<0.001*

4.3.2.3.3 Number of close ties and OIDP

In Table 4.25, unadjusted analysis showed that having the lowest number of close ties was associated with reporting at least one OIDP (OR=1.75; 95%CI:1.37-2.24) (Model 1). The odds ratio was attenuated slightly after adjustment for socio-demographic factors (OR=1.70; 95%CI:1.32-2.17) (Model 3) and for socio-economic factors (OR=1.65; 95%CI:1.28-2.11) (Model 4). After adding health factors to the model (Model5), the odds ratio was reduced from 1.65 to 1.53 (95%CI:1.19-1.97). Self-rated general health and depression were the health factors that reduced the association rather than long-standing illness (OR=1.55; 95%CI:1.21-1.99 and OR=1.56; 95%CI:1.22-2.00, respectively) (Appendix A, Table A.3). An additional adjustment for smoking status did not reduce further the size of the association between number of close ties and OIDP (OR=1.52; 95%CI:1.18-1.96) and this association remained significant (Model 6).

Table 4.25: Association between number of close ties and OIDP[1] at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 3 Odds ratio (95% CI)
Number of close ties			
Highest tertile	1	1	1
Middle tertile	1.05 (0.80-1.38)	1.06 (0.81-1.40)	1.05 (0.80-1.38)
Lowest tertile	1.75 (1.37-2.24)***	1.76 (1.38-2.25)***	1.70 (1.33-2.17)***
Not answered	2.01 (1.52-2.66)***	1.93 (1.46-2.57)***	1.91 (1.44-2.53)***
Age-groups			
50-64		1	1
65-74		1.32 (1.07-1.63)**	1.28 (1.04-1.59)*
75 +		1.23 (0.97-1.55)	1.13 (0.85-1.45)
Gender			
Men			1
Women			0.98 (0.82-1.18)
Cohabiting status			
Living with partner			1
No living with partner			1.27 (1.03-1.56)*

[1]Oral Impacts on Daily Performances
**p<0.05; **p<0.01; **p<0.001*

Table 4.25…continued: Association between number of close ties and OIDP[1] at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 4 Odds ratio (95% CI)	Model 5 Odds ratio (95% CI)	Model 6 Odds ratio (95% CI)
Number of close ties			
Highest tertile	1	1	1
Middle tertile	1.06 (0.80-1.40)	1.03 (0.78-1.36)	1.02 (0.78-1.35)
Lowest tertile	1.65 (1.28-2.11)***	1.53 (1.19-1.97)**	1.52 (1.18-1.96)**
Not answered	1.75 (1.32-2.32)***	1.58 (1.18-2.11)**	1.58 (1.18-2.12)**
Age-groups			
50-64	1	1	1
65-74	1.18 (0.92-1.52)	1.26 (0.97-1.63)	1.31 (1.01-1.71)*
75 +	1.01 (0.76-1.33)	1.04 (0.78-1.39)	1.15 (0.85-1.54)
Gender			
Men	1	1	1
Women	0.92 (0.77-1.12)	0.91 (0.75-1.11)	0.94 (0.78-1.14)
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.07 (0.87-1.32)	0.99 (0.80-1.22)	0.96 (0.78-1.19)
Educational status			
Education	1	1	1
No education	1.02 (0.82-1.26)	0.92 (0.74-1.15)	0.90 (0.72-1.13)
Employment status			
In paid employment	1	1	1
Retired	1.32 (1.00-1.72)*	1.02 (0.76-1.35)	1.00 (0.75-1.33)
Other	1.81 (1.36-2.41)***	1.14 (0.84-1.55)	1.10 (0.81-1.49)
Wealth quintile			
Wealthiest	1	1	1
4	1.49 (1.10-2.03)**	1.33 (0.98-1.81)	1.31 (0.96-1.78)
3	1.30 (0.95-1.76)	1.10 (0.81-1.51)	1.07 (0.78-1.47)
2	1.67 (1.23-2.27)**	1.31 (0.95-1.80)	1.23 (0.89-1.69)
Poorest	2.12 (1.54-2.92)***	1.46 (1.05-2.05)*	1.30 (0.92-1.83)
Self-rated health			
Good		1	1
Poor		1.58 (1.24-2.00)***	1.53 (1.20-1.94)***
Long-standing illness			
No		1	1
Yes		1.53 (1.20-1.94)***	1.55 (1.22-1.97)***
Depression			
No		1	1
Yes		1.96 (1.58-2.44)***	1.94 (1.55-2.41)***
Smoking status			
Never smoked			1
Ex-smoker			1.09 (0.88-1.36)
Current smoker			1.71 (1.32-2.22)***

[1]Oral Impacts on Daily Performances
**p<0.05; **p<0.01; **p<0.001*

4.3.2.3.4 Social support and OIDP

Lower levels of social support were significantly associated with oral impact on daily performances (Table 4.26). Compared to the respondents who reported high levels of social support (in the highest tertile), respondents who were in the lowest and middle tertiles of social support were more likely to report at least one OIDP (OR=2.07; 95%CI:1.62-2.64 and OR=1.61; 95%CI:1.24-2.09, respectively) (Model 1). The odds ratios for both lowest and middle tertiles of social support on OIDP were attenuated after adjusting for socio-demographic and socio-economic factors (Models 3 and 4). Adjustment for health factors substantially reduced the odds ratios of the lowest and middle tertiles of social support on OIDP (OR=1.63; 95%CI:1.23-2.17 and OR=1.47; 95%CI:1.12-1.93, respectively) (Model 5). Depression was the covariate that explained the association the most, followed by self-rated general health (Appendix A, Table A.3). The introduction of smoking status into the regression equation (Model 6) did not further reduce the estimate. Thus, even after accounting for all the covariates, the analysis showed that lower social support remained significantly associated with OIDP (OR=1.63; 95%CI:1.23-2.17).

Table 4.26: Association between social support and OIDP[1] at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 3 Odds ratio (95% CI)
Social support			
Highest tertile	1	1	1
Middle tertile	1.61 (1.24-2.09)***	1.60 (1.23-2.07)***	1.58 (1.21-2.06)**
Lowest tertile	2.07 (1.62-2.64)***	2.04 (1.59-2.61)***	1.99 (1.51-2.63)***
Not answered	1.96 (1.25-3.08)**	1.85 (1.17-2.92)**	1.82 (1.15-2.88)*
Age-groups			
50-64		1	1
65-74		1.33 (1.08-1.63)**	1.32 (1.06-1.63)**
75 +		1.22 (0.96-1.55)	1.20 (0.94-1.63)
Gender			
Men			1
Women			1.00 (0.83-1.21)
Cohabiting status			
Living with partner			1
No living with partner			1.04 (0.82-1.31)

[1]Oral Impacts on Daily Performances
p<0.05; **p<0.01;*p<0.001*

Table 4.26…continued: Association between social support and OIDP[1] at wave 3 (2006-07): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 4 Odds ratio (95% CI)	Model 5 Odds ratio (95% CI)	Model 6 Odds ratio (95% CI)
Social support			
Highest tertile	1	1	1
Middle tertile	1.58 (1.21-2.07)**	1.47 (1.12-1.93)**	1.46 (1.12-1.92)**
Lowest tertile	1.95 (1.47-2.58)***	1.63 (1.23-2.17)**	1.63 (1.23-2.17)**
Not answered	1.72 (1.08-2.73)**	1.49 (0.93-2.40)	1.52 (0.95-2.44)
Age-groups			
50-64	1	1	1
65-74	1.19 (0.92-1.53)	1.25 (0.97-1.63)	1.31 (1.01-1.71)*
75 +	1.04 (0.78-1.38)	1.06 (0.79-1.42)	1.17 (0.87-1.57)
Gender			
Men	1	1	1
Women	0.94 (0.78-1.14)	0.92 (0.76-1.12)	0.95 (0.78-1.16)
Cohabiting status			
Living with partner	1	1	1
No living with partner	0.87 (0.69-1.10)	0.87 (0.68-1.10)	0.84 (0.67-1.07)
Educational status			
	1	1	1
Education	1.04 (0.84-1.29)	0.94 (0.75-1.17)	0.92 (0.73-1.15)
No education			
Employment status			
In paid employment	1	1	1
Retired	1.34 (1.02-1.76)*	1.04 (0.78-1.39)	1.03 (0.77-1.37)
Other	1.87 (1.40-2.49)***	1.19 (0.88-1.61)	1.14 (0.84-1.55)
Wealth quintile			
Wealthiest	1	1	1
4	1.53 (1.13-2.07)**	1.36 (1.00-1.85)*	1.34 (0.98-1.82)
3	1.34 (0.98-1.83)	1.14 (0.83-1.56)	1.11 (0.81-1.51)
2	1.74 (1.27-2.36)***	1.36 (0.99-1.87)	1.27 (0.92-1.76)
Poorest	2.19 (1.59-3.01)***	1.51 (1.08-2.11)*	1.34 (0.95-1.88)
Self-rated health			
Good		1	1
Poor		1.60 (1.26-2.02)***	1.55 (1.22-1.96)***
Long-standing illness			
No		1	1
Yes		1.50 (1.19-1.91)**	1.53 (1.21-1.94)***
Depression			
No		1	1
Yes		1.94 (1.56-2.41)***	1.91 (1.54-2.38)***
Smoking status			
Never smoked			1
Ex-smoker			1.10 (0.88-1.36)
Current smoker			1.71 (1.32-2.23)***

[1]Oral Impacts on Daily Performances
p<0.05; **p<0.01;*p<0.001*

In summary, there was evidence that the functional social capital measures (number of close ties and social support) were cross-sectionally associated with Oral Impacts on Daily Performances (OIDP) even after adjusting for socio-demographic, socio-economic, health and behavioural factors. However, the structural social capital measures (membership and volunteering status) were not significantly associated with OIDP after adjustment for these covariates.

4.3.3 Effect modifications in the association between social capital and oral health

The last hypothesis examined in this chapter investigates whether social capital buffered the association between oral health risk factors and poor oral health. This was examined through testing for effect modification of the social capital measures by the oral health risk factors.

Evidence for modification of the association of social capital with oral health by gender, wealth, and age groups are presented in Tables 4.27 and 4.28. This section examines the question whether lack of social capital has a 'main effect' on oral health or whether social capital buffers the effect of risk factors (like older age, gender, living alone, in the lowest socio-economic position and poor general health) on poor oral health.

In general, there was little evidence of effect modification. Out of 144 number of interaction effects examined, only three were statistically significant and these are discussed below. There was no evidence of effect modification of oral health risk factors for the outcome of edentulousness.

4.3.3.1 Effect modification for poor self-rated oral health

Effect modification of volunteering by gender

There was a significant interaction between volunteering and gender *(p=0.01).* Men who did not volunteer, reported poorer oral health than men who volunteered (OR=1.10; 95%CI:0.85-1.41). However, in contrast to the association among men, women who were not involved in voluntary work were less likely to report poor oral health compared to the women who volunteered (OR=0.83; 95%CI:0.67-1.02). The association of volunteering with poor self-rated oral health thus appears to have differential effects by gender - good for men and bad for women (Table 4.27). As men had a higher risk of poor self-rated oral health compared to women (see Table 4.4), volunteering appears to buffer the negative effects of male gender on poor oral health, but paradoxically, volunteering also appears to be a stressor for women's oral health.

Effect modification of volunteering by wealth

A significant interaction was found between volunteering and wealth *(p<0.01).*

Among respondents who were in the poorest quintile of wealth, those who were not volunteers were 1.63 (95%CI:1.00-2.68) times more likely to report poor oral health compared to those who were volunteers. No statistically significant difference was found among the wealthier respondents whether they volunteered or not. These findings suggest that this measure of social capital might act as a buffer against the health damaging effects of poverty, as poor volunteers had around 40.0% lower odds of poor self-rated oral health compared to poor non-volunteers (Table 4.27).

For this analysis of effect modification, the highest four quintiles of wealth were combined against the poorest quintile. This was because the odds of poor oral health were very similar in the highest four quintiles of wealth among volunteers and non-volunteers. When the interaction was run with all five quintiles of wealth, the overall p-value for the interaction remained significant *(p<0.05).*

Table 4.27: Association of social capital with self-rated poor oral health stratified by gender and wealth, OR (95%CI)[1]

	Interaction group 1	Interaction group 2	p-value for interaction
Volunteering	**Men**	**Women**	**0.01, 1df[2] (overall)**
Volunteering	1	1	
Not volunteering	1.10 (0.85-1.41)	0.83 (0.67-1.02)	0.01[3]
Volunteering	**Wealth (Wealthiest)**	**Wealth (Poorest)**	**<0.01, 1df[2] (overall)**
Volunteering	1	1	
Not volunteering	0.88 (0.74-1.04)	1.63 (1.00-2.68)	0.02[3]

[1]Fully-adjusted model as described in Table 4.16
[2]p-value for overall F-adjusted Wald test
[3]p-value for interaction term (t-test)

4.3.3.2 Effect modification for Oral Impacts on Daily Performances (OIDP)

Effect modification of social support by age

In the age group specific analysis, the association of social support with OIDP was greater in the youngest age group. Low social support among respondents aged 50-64 years old was associated with higher odds of reporting at least one oral impact on daily performances, compared to respondents with high social support in the same age-group (OR=2.40; 95%CI:1.56-3.68). In contrast, among those aged 65 years old and over, respondents who had low social support were not at higher risk of OIDP compared to those with high social support (Table 4.28). These findings should be interpreted with caution due to the small number of respondents who reported any OIDP (see Table 4.2). This interaction appears to contradict the buffering hypothesis as the older age-groups were more likely to report OIDP and yet social capital does not appear to buffer any negative effects of age on OIDP.

For this analysis of effect modification, the older age groups (65-74 and 75+ years) were combined into a single category to have similar numbers of respondents in the younger (55-64 years) and older age groups. The odds of OIDP amongst the oldest two age groups were similar among respondents who had high and low social support. When the interaction was run with all three age-group categories, the overall p-value for the interaction with social support remained significant *($p<0.05$).*

Table 4.28: Association of social capital with Oral Impacts on Daily Performances (OIDP) stratified by age groups, OR (95%CI)[1]

	Interaction group 1	Interaction group 2	p-value for interaction
Social support	**50-64**	**≥65**	**0.01, 3df (overall)[2]**
Highest tertile	1	1	
Medium tertile	1.87 (1.23-2.83)	1.20 (0.83-1.71)	0.09[3]
Lowest tertile	2.40 (1.56-3.68)	1.18 (0.80-1.75)	<0.01[3]
Not Answered	2.33 (0.96-5.64)	1.16 (0.66-2.02)	0.17[3]

[1]Fully-adjusted model as described in Table 4.26
[2]p-value for overall F-adjusted Wald test
[3]p-value for interaction term (t-test)

4.3.3.3 Summary of effect modification analysis

This section found only two interactions in support of the buffering hypothesis. Volunteering appeared to buffer the effect of the risk factors of poverty and male gender on poor self-rated oral health. However, there was no evidence of a buffering effect for the other 142 number of interaction analyses examined, which suggests that these two buffering findings could have arisen due to chance. Furthermore, the buffering hypothesis was contradicted by the negative association of volunteering with poor self-rated oral health among women, as well as the lack of association of social support with oral impact in the older age groups. Thus there was little overall evidence in support of the buffering hypothesis and stronger evidence of a main effect of low social capital on poor oral health.

4.4 Summary of the findings of the cross-sectional association between social capital and oral health

The objective of this chapter was to assess the association between social capital and different oral health outcomes (self-rated oral health, edentulousness and oral impact on daily performances) among ELSA respondents aged 50 years old and over, and whether these associations were explained by socio-demographic, socio-economic, health and behavioural factors. Social capital was differentiated by its structural (membership status and volunteering) and functional (number of close ties and social support) characteristics. The cross-sectional analysis has provided a pattern of associations and provided some evidence in support of the main hypotheses of the chapter.

There was evidence that lack of social capital was associated with poor oral health (hypothesis 1.1). Furthermore, the analysis identified to some extent how different dimensions of social capital were related to different aspects of oral health (hypothesis 1.2). This is summarised in Table 4.29, which shows the size of the association (OR; 95%CI) between social capital and oral health after adjusting for socio-demographic, socio-economic, health and behavioural factors (hypothesis 1.3). The results confirm the hypothesis that structural social capital is a better predictor of edentate status than functional social capital. On the other hand, low number of close ties and low social support, that is, the functional components of social capital, were associated with oral impacts on daily performances. Weaker associations were found between all measures of social capital and self-rated oral health

The analyses of the effect modification between social capital and oral health risk factors found little evidence of a buffering effect of social capital on oral health (hypothesis 1.4). Among all the interactions tested between social capital measures and oral health risk factors, there was evidence for only two significant interaction effects. Poor respondents (in the lowest wealth quintile) who volunteered were less likely to report poor oral health compared to poor respondents who did not volunteer. Among wealthier respondents, volunteering was not associated with poor oral health. Men who volunteered reported better oral health than men who did not volunteer, although this association between volunteering and better oral health reversed among women. Overall little evidence to support the buffering hypothesis was found but stronger evidence of a main effect of lower social capital on poor oral health.

Most of the associations between social capital and oral health measures reduced when socio-economic (wealth and education in particular) and health factors (depression and self-rated general health in particular) were adjusted for in the logistic regression models.

Adjusting for smoking status did not explain much of the associations between all the measures of social capital and self-rated oral health and OIDP. However, with edentate status, there was some suggestion of a behavioural pathway from structural aspects of social capital (membership and volunteering), as adjusting for smoking status attenuated the association.

Table 4.29: Summary of the fully adjusted associations between social capital and oral health (from Model 6), OR (95%CI)

Dep. Variables: **Oral health**	**Poor self-rated oral health** Odds ratio (95%CI)	**Edentate** Odds ratio (95%CI)	**OIDP** Odds ratio (95%CI)
Membership status			
Not a member	1.21 (1.01-1.46)*	1.79 (1.45-2.21)***	0.79 (0.60-1.02)
Volunteering status			
Not volunteering	0.94 (0.80-1.10)[1]	1.45 (1.19-1.75)***	0.96 (0.77-1.20)
Close ties			
Lowest tertile	1.31 (1.09-1.56)**	1.14 (0.93-1.39)	1.52 (1.18-1.96)**
Social support			
Lowest tertile	1.36 (1.11-1.66)**	1.01 (0.80-1.27)	1.63 (1.23-2.17)**

[1]Significant interaction between volunteering and poorest wealth quintiles
**p<0.05; **p<0.01; ***p<0.001*

All the analyses presented in this chapter were based on cross-sectional data from ELSA wave 3. One of the limitations of cross-sectional designs is that the temporal sequence between exposure and outcome cannot be examined. It may be that low social capital may precede poor oral health or poor oral health results in low social capital. The next chapter will examine the temporal associations between social capital and oral health, using longitudinal data from waves 3 and 5 of ELSA.

CHAPTER 5

LONGITUDINAL ASSOCIATION BETWEEN SOCIAL CAPITAL

AND

ORAL HEALH

WAVE 3 (2006-07) – WAVE 5 (2010-11)

5.1 Introduction

The results of the previous chapter revealed that the functional social capital measures, fewer close ties and lower social support, were significantly associated with subjective oral health (poor self-rated oral health and Oral Impacts on Daily Performances (OIDP)), even after accounting for an array of selected covariates. On the other hand, the structural social capital measures, not a member of any organisations and not volunteering, were related to edentate status. Not a member of any organisations was also associated with poor self-rated oral health.

The cross-sectional design employed in the previous chapter prevented an evaluation of the temporal order between the social capital exposures and the oral health outcomes. Similarly, most, if not all, studies on social capital and oral health have used cross-sectional data and therefore it remains unclear whether social capital represents a consequence or an antecedent of oral health.

In the present chapter, the longitudinal association between social capital and oral health is examined with the assumption that lower social participation, fewer close ties and lower social support at baseline (2006-07) are associated with subsequent poorer oral health status four years later (2010-11), independently of the baseline covariates (2006-07). Furthermore, in order to examine whether lower levels of social capital is a consequence of poor oral health, these associations were also analysed in reverse temporal order, i.e. poor oral health at wave 3 predicting lower social capital at wave 5.

The key hypotheses to be tested in this chapter are:

1. There is a bi-directional association between social capital and oral health.
2. After adjusting for covariates, structural social capital at baseline is associated with change in objective measure of oral health. Similarly, functional social capital at baseline is associated with change in subjective oral health.

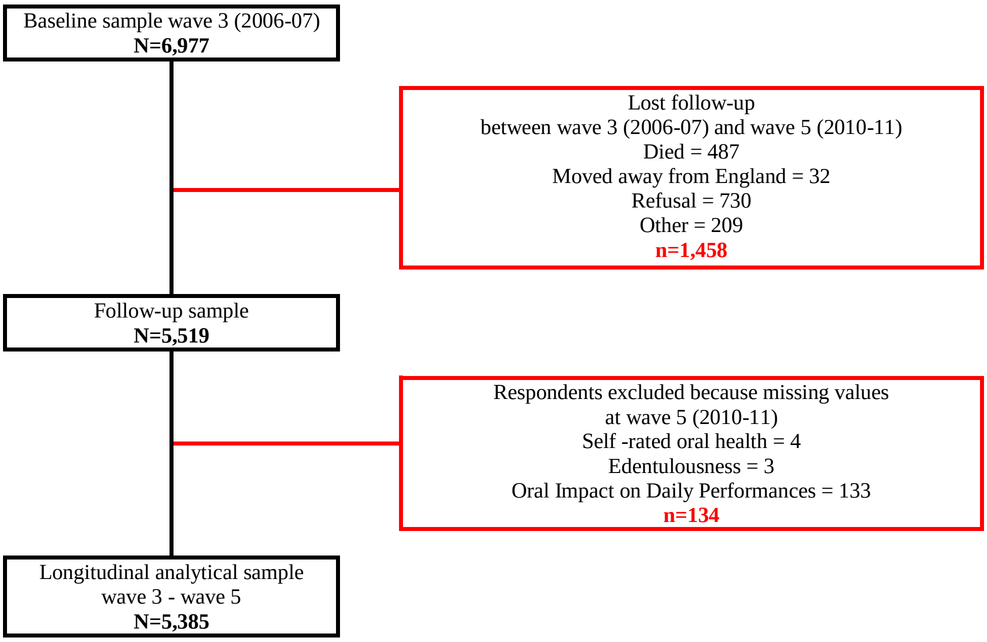
To assess the longitudinal associations between social capital and oral health, models were fitted as follows: the social capital predictor variables at wave 3 (2006-07) were related to the oral health outcome variables at wave 5 (2010-11), adjusted for covariates at wave 3 (2006-07) (Model 1 to Model 6) and the outcome variables at wave 3 (2006-07) (Model 7). Autoregressive models (Model 7) help to “remove” the cross-sectional part of the association, in order to estimate the real influence of the predictor variables on the outcome variables (Twisk, 2003). This chapter describes the association between the baseline explanatory variables at wave 3 (2010-11) and oral health at wave 5 (2006-07). More details are given in the methodology chapter, section 3.4.

This chapter is structured as follows: section 5.2 presents the description of the longitudinal analytical sample including predictors of missingness from wave 3 to wave 5. The results section 5.3 is divided into four sub-sections. First, the longitudinal estimates of the association between social capital at wave 3 and oral health at wave 5 are presented (section 5.3.1). Section 5.3.2 examines interaction effects between the social capital measures and other covariates. Then the results of the longitudinal analysis are compared to the findings from the cross-sectional analysis (section 5.3.3). Section 5.3.4 examines the reverse temporal association between oral health at wave 3 predicting social capital at wave 5.

5.2 Longitudinal analytical sample

The baseline sample for this longitudinal analysis is the analytical sample used in the cross-sectional analysis (see Chapter 4, section 4.2, Figure 4.1). This is the 'baseline sample wave 3' from which 1,458 participants were lost to follow-up between waves 3 and 5. Out of these participants lost to follow up, 33.4% died in between waves, 50.1% refused the interview at wave 5, 5.4% were not well enough to participate and 2.2% emigrated. A further 134 participants were excluded because of missing values on any of the outcomes of interest (self-rated oral health, edentulousness, and oral impact on daily performances) at wave 5. This resulted in the longitudinal analytical sample of 5,385 participants. The origins of the longitudinal analytical sample is displayed in Figure 5.1.

Figure 5.1: Analytical sample for the longitudinal analysis



Characteristics of attrition to baseline sample: longitudinal sample non-participation at wave 5 (2010-11)

From the 6, 977 respondents that constituted the baseline sample wave 3 (2006-07), 1,458 respondents (21.0%) did not participate in wave 5 (2010-11). In order to examine the predictors of the longitudinal sample, a logistic regression on attrition at wave 5 was conducted with wave 3 predictors (Table 5.1). Participants who dropped out were more likely to be men, aged 65 and over, without educational qualifications, in the lower quintiles of wealth, with limiting long-standing illness, and edentate. They also were less likely to be a member of an organisation and be involved in voluntary work. Thus, there is some evidence of selection bias due to the non-random drop out from the baseline sample wave 3. Attrition during the study period may have contributed to a more selective study sample and may result in biased parameter estimates and incorrect inferences. The implications of this selection bias for the longitudinal analysis will be discussed in Chapter 7, section 7.5.2.

Table 5.1: Characteristics of attrition (n=1458) to baseline sample (N=6977), % distribution and OR (95%CI)

Covariates W3	W5 missingness %	n missing/N	Odds ratio (95%CI)	Covariates W3	W5 missingness %	n missing/N	Odds ratio (95%CI)
Socio-demographic and socio-economic factors							
Gender				**Educational status**			
Men	22.7%	715/3144	1	Education	17.8%	889/5001	1
Women	19.4%	743/3833	0.77 (0.67-0.88)***	No education	28.8%	569/1976	1.22 (1.05-1.41)**
Age-group				**Labour market status**			
50-64	16.6%	582/3501	1	In paid employment	16.7%	386/2310	1
65-74	19.1%	370/1939	1.21 (1.00-1.47)	Retired	23.2%	855/3682	0.89 (0.73-1.09)
≥75	32.9%	506/1537	2.18 (1.78-2.67)***	Others	22.0%	217/985	0.90 (0.72-1.13)
Cohabiting status				**Wealth quintile**			
Living with partner	19.4%	942/4846	1	Wealthiest quintile	13.9%	220/1585	1
No living with partner	24.2%	515/2131	0.96 (0.82-1.14)	4^{th}	17.6%	262/1486	1.17 (0.95-1.44)
				3^{rd}	21.7%	307/1413	1.28 (1.04-1.57)*
				2^{nd}	23.5%	317/1349	1.38 (1.11-1.71)**
				Poorest quintile	30.8%	352/1144	1.66 (1.32-2.08)***
Health and behavioural factors							
Self-rated health				**Depression**			
Good	18.1%	879/4850	1	No	19.9%	1126/5658	1
Poor	27.2%	579/2127	1.08 (0.92-1.26)	Yes	25.2%	332/1319	1.03 (0.87-1.22)
Long-standing illness				**Smoking status**			
No	18.3%	851/4655	1	Never smoked	18.4%	490/2668	1
Yes	26.1%	607/2322	1.18 (1.02-1.37)*	Ex-smoker	21.6%	715/3309	1.00 (0.87-1.22)
				Current smoker	25.3%	253/1000	1.10 (0.90-1.34
Oral health status							
Self-rated oral health				**OIDP**			
Good	20.5%	1192/5802	1	No impact	20.8%	1335/6411	1
Poor	22.6%	266/1175	1.04 (0.87-1.22)	At least one impact	21.7%	123/566	0.87 (0.69-1.10)
Edentulousness							
Dentate	18.6%	1090/5853	1				
Edentate	32.7%	368/1124	1.31 (1.11-1.54)**				
Social capital indicators							
Membership status				**Number of close ties**			
Active member	15.4%	342/2226	1	Highest tertile	19.5%	374/1919	1
Passive member	20.2%	512/2534	1.16 (0.98-1.37)	Middle tertile	17.4%	312/1798	0.86 (0.72-1.02)
Not a member	26.4%	478/1812	1.37 (1.14-1.65)**	Lowest tertile	22.4%	507/2259	1.04 (0.87-1.23)
Not answered	31.1%	126/405	1.60 (1.23-2.09)***	Not answered	26.5%	265/1001	1.04 (0.85-1.26)
Volunteering status				**Social support**			
Volunteering	13.8%	272/1973	1	Highest tertile	19.2%	379/1971	1
Not volunteering	23.7%	1186/5004	1.40 (1.18-1.65)***	Middle tertile	19.4%	429/2210	0.95 (0.80-1.12)
				Lowest tertile	22.6%	562/2483	0.95 (0.78-1.15)
				Not answered	28.1%	88/313	1.06 (0.78-1.43)

[1]Oral Impact on Daily Performances

**p<0.05; **p<0.01; ***p<0.001*

5.3 Results of the longitudinal analysis

5.3.1 Social capital at wave 3 (2006-07) predictor of oral health at wave 5 (2010-11)

Tables 5.2 to 5.13 show the results of the logistic regression models of the three oral health measures at wave 5 (2010-11) predicted by the four different measures of social capital at wave 3 (2006-07). The models within each table are nested; Model 1 contains the bivariate association between social capital and oral health; Model 2 was adjusted for age; Model 3 added in the socio-demographic factors which are gender and cohabiting status; to adjust the effects of individual socio-economic factors, education, employment status and wealth were added in Model 4; then self-rated general health, limiting long-standing illness and depression were accounting for in Model 5; smoking status was added in Model 6; and finally, Model 7 was adjusted for the baseline dependent oral health outcome.

5.3.1.2 Social capital at wave 3 (2006-07) and self-rated oral health at wave 5 (2010-11)

Tables 5.2 to 5.5 display the results of the logistic regression for the association between baseline social capital (at wave 3) and self-rated oral health at follow-up (wave 5). In the bivariate models (Model 1) in all the tables, baseline social capital (both structural and functional components) was significantly related to poor self-rated oral health. Not a member or a passive member of an organisation (respectively, OR=1.60; 95%CI:1.32-1.92 and OR=1.21; 95%CI:1.01-1.44); not volunteering (OR=1.48; 95%CI:1.25-1.73); having less than 6 close ties (in the lowest tertile of close ties) (OR=1.52; 95%CI:1.26-1.84) and having the lowest perceived social support (OR=1.79; 95%CI:1.50-2.16) were all associated to poor self-rated oral health at wave 5.

Adjusting for socio-demographic factors (Models 2 and 3) did not substantially change these odds ratios for membership and volunteering status (Tables 5.2 And 5.3). Adjusting for age increased slightly the size of the association between lowest tertile of social support and self-rated oral health. The odds ratio increased from 1.79 to 1.84 (95%CI:1.53-2.21) (Model 2; Table 5.5). Moreover, additional adjustments for gender and cohabiting status reduced the odds ratios for both lowest tertile of close ties and lowest tertile of social support (OR=1.43; 95%CI:1.18-1.74 and OR=1.68; 95%CI:1.36-2.08) (Model 3; Tables 5.4 and 5.5). Adjusting for socio-economic factors (Model 4) resulted in a decrease in the odds ratios for not a member of an organisation (OR=1.36;

95%CI:1.11-1.66) and not volunteering (OR=1.30; 95%CI:1.10-1.54) (Tables 5.2 and 5.3) but the association remained significant whereas the association between passive member and self-rated oral health became non-significant (OR=1.18; 95%CI:0.99-1.42) (Model 4; Table 5.2). A detailed analysis (Appendix B, Table B.1) suggested that it was wealth and education that contributed the most to this reduction in the odds ratios.

Adjusting for the health factors (Model 5) resulted in a further decrease in the odds ratios for all the social capital measures. While the findings were still significant for membership, close ties and social support, the association between volunteering and self-rated oral health was no longer statistically significant (OR=1.16; 95%CI:0.98-1.39) (Model 5; Table 5.2). A detailed analysis (Appendix B, Table B.1) suggested that depression and self-rated general health contributed the most to this reduction in the odds ratios.

Adjustment for smoking (Model 6) did not change the odds ratios much for close ties and social support (Tables 5.3 and 5.4). However, not a member of any organisation was no longer associated with poor self-rated oral health after taking smoking into account (OR=1.18; 95%CI:0.94-1.45) (Table 5.2). Thus, when adjusting for socio-demographic, socio-economic, health and behavioural factors (Model 6), membership and volunteering were no longer associated with self-rated oral health (Tables 5.2 and 5.3).

While the associations of low levels of close ties and social support with poor self-rated oral health remained significant in Model 6, after adjusting for baseline self-rated oral health variable (Model 7), this association became non-significant for lowest tertile of close ties (OR=1.19; 95%CI:0.96-1.40) but remained significant for lowest tertile of social support (OR=1.27; 95%CI:1.01-1.60) (Tables 5.4 and 5.5). Once the model was adjusted for baseline self-rated oral health, only lowest social support at wave 3 (2006-07) was related with change in self-rated oral health.

Of the covariates, being male, reporting poor general health, being depressed, being a current smoker, having reported poor self-rated oral health at wave 3 were all associated with poor self-rated oral health at wave 5.

Table 5.2: Association between membership status at wave 3 (2006-07) and poor self-rated oral health at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: **Poor self-rated oral health**	Model 1 Odds ratio (95% CI	Model 2 Odds ratio (95% CI	Model 3 Odds ratio (95% CI	Model 4 Odds ratio (95% CI
Membership status				
Active member	1	1	1	1
Passive member	1.21 (1.01-1.44)*	1.21 (1.01-1.44)*	1.22 (1.02-1.46)*	1.18 (0.99-1.42)
Not a member	1.60 (1.32-1.92)***	1.59 (1.32-1.92)***	1.59 (1.31-1.92)***	1.36 (1.11-1.66)**
Not answered	1.46 (1.05-2.03)*	1.49 (1.07-2.08)*	1.54 (1.10-2.14)*	1.30 (0.92-1.82)
Age-groups				
50-64		1	1	1
65-74		0.90 (0.76-1.06)	0.87 (0.73-1.03)	0.84 (0.68-1.04)
75 +		0.80 (0.66-0.98)*	0.72 (0.59-0.89)	0.68 (0.53-0.87)**
Gender				
Men			1	1
Women			0.78 (0.67-0.90)**	0.73 (0.63-0.85)***
Cohabiting status				
Living with partner			1	1
No living with partner			1.48 (1.26-1.73)***	1.31 (1.10-1.55)**
Education				
Education				1
No education				1.17 (0.98-1.40)
Employment status				
In paid employment				1
Retired				1.10 (0.90-1.36)
Other				1.61 (1.28-2.02)***
Wealth quintile				
Wealthiest				1
4				1.18 (0.94-1.48)
3				1.26 (0.99-1.59)
2				1.33 (1.04-1.68)*
Poorest				1.62 (1.25-2.10)***

*$p< 0.05$; **$p< 0.01$; ***$p< 0.001$

Table 5.2…continued: Association between membership status at wave 3 (2006-07) and poor self-rated oral health at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: **Poor self-rated oral health**	Model 5 Odds ratio (95% CI	Model 6 Odds ratio (95% CI	Model 7 Odds ratio (95% CI
Membership status			
Active member	1	1	1
Passive member	1.16 (0.97-1.40)	1.16 (0.96-1.40)	1.11 (0.91-1.34)
Not a member	1.23 (1.00-1.51)*	1.18 (0.94-1.45)	1.09 (0.83-1.36)
Not answered	1.16 (0.82-1.65)	1.11 (0.78-1.59)	1.06 (0.72-1.55)
Age-groups			
50-64	1	1	1
65-74	0.91 (0.74-1.13)	0.94 (0.76-1.17)	0.99 (0.79-1.25)
75 +	0.71 (0.55-0.91)**	0.76 (0.59-0.99)*	0.88 (0.67-1.16)
Gender			
Male	1	1	1
Female	0.73 (0.63-0.85)***	0.75 (0.64-0.88)***	0.77 (0.65-0.91)**
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.19 (0.99-1.41)	1.16 (0.93-1.38)	1.09 (0.88-1.31)
Education			
Education	1	1	1
No education	1.04 (0.87-1.25)	1.02 (0.85-1.23)	1.00 (0.82-1.22)
Employment status			
In paid employment	1	1	1
Retired	0.88 (0.70-1.10)	0.87 (0.69-1.08)	0.92 (0.72-1.17)
Other	1.05 (0.83-1.34)	1.03 (0.80-1.31)	1.08 (0.83-1.41)
Wealth quintile			
Wealthiest	1	1	1
4	1.07 (0.85-1.35)	1.06 (0.84-1.34)	1.06 (0.83-1.36)
3	1.09 (0.86-1.38)	1.07 (0.84-1.36)	1.03 (0.81-1.35)
2	1.03 (0.81-1.32)	0.99 (0.77-1.27)	0.92 (0.71-1.20)
Poorest	1.14 (0.87-1.50)	1.04 (0.79-1.38)	0.98 (0.73-1.31)
Self-rated general health			
Good	1	1	1
Poor	2.28 (1.90-2.74)***	2.24 (1.87-2.70)***	1.76 (1.44-2.14)***
Long-standing illness			
No	1	1	1
Yes	1.20 (1.00-1.44)	1.20 (1.00-1.44)	1.17 (0.96-1.42)
Depression			
No	1	1	1
Yes	1.81 (1.50-2.17)***	1.79 (0.99-1.39)***	1.66 (1.36-2.03)***
Smoking status			
Never smoked		1	1
Ex-smoker		1.17 (0.99-1.37)	1.15 (0.96-1.38)
Current smoker		1.68 (1.34-2.11)***	1.57 (1.23-2.00)***
Self-rated oral health			
Good			1
Poor			7.01 (5.92-8.32)***

**p*< 0.05; ***p*< 0.01; ****p*< 0.001

Table 5.3: Association between volunteering status at wave 3 (2006-07) and poor self-rated oral health at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: **Poor self-rated oral health**	Model 1 Odds ratio (95% CI	Model 2 Odds ratio (95% CI	Model 3 Odds ratio (95% CI	Model 4 Odds ratio (95% CI
Volunteering status				
Volunteering	1	1	1	1
Not volunteering	1.47 (1.25-1.73)***	1.47 (1.25-1.73)***	1.43 (1.21-1.69)***	1.30 (1.10-1.54)**
Age-groups				
50-64		1	1	1
65-74		0.90 (0.76-1.07)	0.87 (0.74-1.03)	0.84 (0.68-1.03)
75 +		0.80 (0.65-0.98)*	0.72 (0.59-0.89)**	0.68 (0.53-0.87)**
Gender				
Male			1	1
Female			0.81 (0.70-0.93)**	0.74 (0.64-0.86)***
Cohabiting status				
Living with partner			1	1
No living with partner			1.46 (1.24-1.71)***	1.29 (1.09-1.53)**
Education				
Education				1
No education				1.18 (0.99-1.41)
Employment status				
In paid employment				1
Retired				1.11 (0.90-1.37)
Other				1.63 (1.30-2.05)***
Wealth quintile				
Wealthiest				1
4				1.18 (0.94-1.48)
3				1.26 (1.00-1.60)*
2				1.33 (1.05-1.68)*
Poorest				1.65 (1.28-2.13)***

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 5.3…continued: Association between volunteering status at wave 3 (2006-07) and poor self-rated oral health at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: **Poor self-rated oral health**	Model 5 Odds ratio (95% CI	Model 6 Odds ratio (95% CI	Model 7 Odds ratio (95% CI
Volunteering status			
Volunteering	1	1	1
Not volunteering	1.16 (0.98-1.39)	1.13 (0.95-1.35)	1.17 (0.97-1.41)
Age-groups			
50-64	1	1	1
65-74	0.91 (0.73-1.13)	0.94 (0.76-1.17)	0.99 (0.79-1.25)
75 +	0.71 (0.55-0.91)**	0.76 (0.59-0.99*)	0.88 (0.67-1.16)
Gender			
Male	1	1	1
Female	0.74 (0.63-0.87)***	0.76 (0.65-0.89)**	0.78 (0.66-0.92)**
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.18 (0.99-1.40)	1.15 (0.97-1.37)	1.08 (0.90-1.31)
Education			
Education	1	1	1
No education	1.05 (0.87-1.26)	1.02 (0.85-1.23)	0.99 (0.81-1.20)
Employment status			
In paid employment	1	1	1
Retired	0.88 (0.70-1.10)	0.87 (0.69-1.08)	0.92 (0.73-1.17)
Other	1.06 (0.83-1.35)	1.03 (0.81-1.32)	1.09 (0.84-1.42)
Wealth quintile			
Wealthiest	1	1	1
4	1.08 (0.85-1.36)	1.06 (0.84-1.34)	1.05 (0.82-1.34)
3	1.09 (0.86-1.39)	1.07 (0.84-1.36)	1.03 (0.80-1.33)
2	1.04 (0.81-1.33)	0.99 (0.77-1.27)	0.90 (0.69-1.18)
Poorest	1.16 (0.89-1.52)	1.05 (0.80-1.38)	0.96 (0.72-1.29)
Self-rated general health			
Good	1	1	1
Poor	2.26 (1.88-2.72)***	2.22 (1.85-2.68)***	1.73 (1.42-2.11)***
Long-standing illness			
No	1	1	1
Yes	1.20 (1.00-1.44)*	1.20 (1.00-1.44)	1.17 (0.96-1.42)
Depression			
No	1	1	1
Yes	1.82 (1.51-2.18)***	1.80 (1.49-2.16)***	1.65 (1.35-2.02)***
Smoking status			
Never smoked		1	1
Ex-smoker		1.17 (0.99-1.37)	1.15 (0.96-1.38)
Current smoker		1.69 (1.35-2.11)***	1.55 (1.21-1.98)***
Self-rated oral health			
Good			1
Poor			7.06 (5.96-8.37)***

*p< 0.05; **p< 0.01; ***p< 0.001

Table 5.4: Association between number of close ties at wave 3 (2006-07) and poor self-rated oral health at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Poor self-rated oral health	Model 1 Odds ratio (95% CI	Model 2 Odds ratio (95% CI	Model 3 Odds ratio (95% CI	Model 4 Odds ratio (95% CI
Number of close ties				
Highest tertile	1	1	1	1
Middle tertile	1.17 (0.95-1.43)	1.16 (0.95-1.42)	1.16 (0.94-1.42)	1.16 (0.95-1.43)
Lowest tertile	1.52 (1.26-1.84)***	1.52 (1.26-1.84)***	1.43 (1.18-1.74)***	1.40 (1.16-1.70)**
Not answered	1.46 (1.15-1.86)**	1.51 (1.18-1.92)**	1.45 (1.14-1.85)**	1.33 (1.04 -1.70)*
Age-groups				
50-64		1	1	1
65-74		0.88 (0.75-1.04)	0.90 (0.71-1.01)	0.84 (0.68-1.04)
75 +		0.78 (0.64-0.96)*	0.71 (0.58-0.88)**	0.68 (0.53-0.87)**
Gender				
Male			1	1
Female			0.82 (0.71-0.95)**	0.75 (0.65-0.87)***
Cohabiting status				
Living with partner			1	1
No living with partner			1.43 (1.21-1.68)***	1.25 (1.05-1.48)*
Education				
Education				1
No education				1.23 (1.03-1.46)*
Employment status				
In paid employment				1
Retired				1.08 (0.87-1.34)
Other				1.60 (1.27-2.00)***
Wealth quintile				
Wealthiest				1
4				1.20 (0.96-1.50)
3				1.29 (1.03-1.63)*
2				1.38 (1.09-1.74)**
Poorest				1.70 (1.32-2.20)***

*p<0.05; **p< 0.01; ***p< 0.001

Table 5.4…continued: Association between number of close ties at wave 3 (2006-07) and poor self-rated oral health at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: **Poor self-rated oral health**	Model 5 Odds ratio (95% CI	Model 6 Odds ratio (95% CI	Model 7 Odds ratio (95% CI
Number of close ties			
Highest tertile	1	1	1
Middle tertile	1.13 (0.92-1.40)	1.13 (0.92-1.40)	1.13 (0.90-1.41)
Lowest tertile	1.30 (1.06-1.58)*	1.29 (1.06-1.58)*	1.19 (0.96-1.47)
Not answered	1.17 (0.91-1.50)	1.16 (0.90-1.50)	1.09 (0.83-1.42)
Age-groups			
50-64	1	1	1
65-74	0.91 (0.74-1.13)	0.95 (0.76-1.18)	0.99 (0.79-1.26)
75 +	0.71 (0.55-0.92)**	0.77 (0.59-0.99)*	0.89 (0.68-1.17)
Gender			
Male	1	1	1
Female	0.75 (0.64-0.87)***	0.77 (0.70-0.90)**	0.78 (0.66-0.92)**
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.15 (0.96-1.37)	1.12 (0.94-1.34)	1.06 (0.88-1.29)
Education			
Education	1	1	1
No education	1.08 (0.90-1.29)	1.05 (0.87-1.25)	1.01 (0.83-1.23)
Employment status			
In paid employment	1	1	1
Retired	0.87 (0.69-1.08)	0.85 (0.68-1.07)	0.91 (0.72-1.16)
Other	1.05 (0.82-1.34)	1.02 (0.80-1.30)	1.08 (0.83-1.41)
Wealth quintile			
Wealthiest	1	1	1
4	1.09 (0.86-1.37)	1.07 (0.85-1.35)	1.06 (0.83-1.36)
3	1.11 (0.87-1.40)	1.08 (0.85-1.37)	1.05 (0.82-1.35)
2	1.06 (0.83-1.35)	1.01 (0.79-1.29)	0.93 (0.71-1.21)
Poorest	1.18 (0.90-1.54)	1.06 (0.81-1.40)	0.98 (0.73-1.32)
Self-rated general health			
Good	1	1	1
Poor	2.25 (1.87-2.70)***	2.21 (1.84-2.66)***	1.74 (1.42-2.12)***
Long-standing illness			
No	1	1	1
Yes	1.21 (1.01-1.45)*	1.21 (1.01-1.45)*	1.18 (0.97-1.43)
Depression			
No	1	1	1
Yes	1.81 (1.51-2.18)***	1.79 (1.49-2.15)***	1.66 (1.36-2.03)***
Smoking status			
Never smoked		1	1
Ex-smoker		1.17 (0.99-1.39)	1.15 (0.96-1.38)
Current smoker		1.70 (1.36-2.13)***	1.58 (1.24-2.01)***
Self-rated oral health			
Good			1
Poor			7.01 (5.91-8.31)***

*p< 0.05; **p< 0.01; ***p< 0.001

Table 5.5: Association between social support at wave 3 (2006-07) and poor self-rated oral health at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: **Poor self-rated oral health**	Model 1 Odds ratio (95% CI	Model 2 Odds ratio (95% CI	Model 3 Odds ratio (95% CI	Model 4 Odds ratio (95% CI
Social support				
Highest tertile	1	1	1	1
Middle tertile	1.14 (0.93-1.39)	1.15 (0.94-1.40)	1.10 (0.90-1.35)	1.12 (0.91-1.37)
Lowest tertile	1.79 (1.50-2.16)***	1.84 (1.53-2.21)***	1.68 (1.36-2.08)***	1.66 (1.34-2.05)***
Not answered	1.07 (0.71-1.62)	1.13 (0.75-1.72)	1.07 (0.71-1.65)	1.03 (0.67-1.56)
Age-groups				
50-64		1	1	1
65-74		0.89 (0.75-1.05)	0.88 (0.74-1.03)	0.85 (0.68-1.05)
75 +		0.76 (0.62-0.93)	0.74 (0.60-0.91)**	0.69 (0.54-0.88)**
Gender				
Male			1	1
Female			0.84 (0.73-0.98)*	0.78 (0.67-0.90)**
Cohabiting status				
Living with partner			1	1
No living with partner			1.17 (0.96-1.41)	1.02 (0.84-1.24)
Education				
Education				1
No education				1.24 (1.04-1.48)
Employment status				
In paid employment				1
Retired				1.10 (0.89-1.36)
Other				1.61 (1.28-2.02)***
Wealth quintile				
Wealthiest				1
4				1.21 (0.96-1.52)
3				1.30 (1.03-1.64)*
2				1.39 (1.10-1.77)**
Poorest				1.70 (1.32-2.20)***

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 5.5…continued: Association between social support at wave 3 (2006-07) and poor self-rated oral health at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Poor self-rated oral health	Model 5 Odds ratio (95% CI	Model 6 Odds ratio (95% CI	Model 7 Odds ratio (95% CI
Social support			
Highest tertile	1	1	1
Middle tertile	1.05 (0.85-1.29)	1.04 (0.85-1.28)	1.05 (0.85-1.32)
Lowest tertile	1.41 (1.13-1.75)**	1.41 (1.13-1.75)**	1.27 (1.01-1.60)*
Not answered	0.88 (0.57-1.36)	0.89 (0.58-1.37)	0.89 (0.56-1.41)
Age-groups			
50-64	1	1	1
65-74	0.92 (0.74-1.14)	0.96 (0.77-1.19)	1.00 (0.79-1.26)
75 +	0.72 (0.56-0.93)*	0.78 (0.60-1.00)	0.90 (0.68-1.18)
Gender			
Male	1	1	1
Female	0.76 (0.65-0.89)**	0.79 (0.67-0.92)**	0.79 (0.67-0.94)*
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.01 (0.83-1.23)	0.98 (0.81-1.20)	0.97 (0.79-1.20)
Education			
Education	1	1	1
No education	1.08 (0.90-1.29)	1.05 (0.88-1.26)	1.02 (0.84-1.23)
Employment status			
In paid employment	1	1	1
Retired	0.86 (0.70-1.09)	0.87 (0.69-1.08)	0.92 (0.73-1.17)
Other	1.06 (0.83-1.36)	1.03 (0.81-1.32)	1.09 (0.84-1.42)
Wealth quintile			
Wealthiest	1	1	1
4	1.08 (0.86-1.38)	1.07 (0.85-1.35)	1.06 (0.83-1.36)
3	1.11 (0.87-1.40)	1.08 (0.85-1.37)	1.05 (0.82-1.35)
2	1.07 (0.84-1.36)	1.01 (0.79-1.29)	0.93 (0.72-1.21)
Poorest	1.18 (0.91-1.55)	1.06 (0.81-1.40)	0.99 (0.74-1.32)
Self-rated general health			
Good	1		1
Poor	2.27 (1.88-2.72)***	2.22 (1.85-2.67)***	1.75 (1.43-2.13)***
Long-standing illness			
No	1	1	1
Yes	1.19 (0.99-1.42)	1.19 (0.99-1.43)	1.16 (0.96-1.41)
Depression			
No	1	1	1
Yes	1.78 (1.48-2.14)***	1.76 (1.46-2.11)***	1.64 (1.34-2.00)***
Smoking status			
Never smoked		1	1
Ex-smoker		1.18 (0.99-1.39)	1.15 (0.96-1.38)
Current smoker		1.71 (1.37-2.14)***	1.58 (1.24-2.01)***
Self-rated oral health			
Good			1
Poor			6.95 (5.86-8.24)***

*p< 0.05; **p< 0.01; ***p< 0.001

5.3.1.3 Social capital at wave 3 (2006-07) and edentulousness at wave 5 (2010-11)

The results of the longitudinal associations between the social capital measures and edentulousness are displayed in Tables 5.6 to 5.9. The results of the bivariate models (Models 1) show that lower social capital in all aspects was associated to edentate status. Respondents who were not members of any organisation (OR=2.28; 95%CI:1.87.2.69); who did not volunteer (OR=1.84; 95%CI:1.53-2.21); had less than 6 close ties (OR=1.28; 95%CI:1.05-1.57) and lowest score of social support (OR=1.57; 95%CI:1.29-1.92) at wave 3 were all more likely to be edentate at wave 5.

In the age-adjusted model respondents who were not members at wave 3 were 2.51 (95%CI:2.04-2.09) times more likely to be edentate at wave 5 compared to those who were active members at wave 3 (Model 2; Table 5.6). The increase in odds ratio from Model 1 (unadjusted) to Model 2 occurred because age suppressed the association between membership and edentate status. Respondents aged 65-70 were more likely to be active member but also were more likely to be edentate (see Tables 4.4 and 4.11 in Chapter 4). On the other hand, the inclusion of age in the regression model of social support on edentate status (Model 2; Table 5.9) resulted in a decrease in the odds ratio compared to the unadjusted model (OR=1.34; 95%CI:1.10-1.65) (Model 1). Adjusting for gender and cohabiting status largely reduced the odds ratios and the association between social support and edentate status was no longer significant (OR=1.13; 95%CI:0.88-1.44) (Model 3; Table 5.9). Cohabiting status explained the association rather than gender. However, for the other measures of social capital there was little change in the odds ratios when adjusting for socio-demographic factors (Models 2 and 3; Tables 5.6; 5.7; 5.8).

Adjusting for socio-economic factors (Model 4) substantially reduced the odds ratios for not a member (OR=1.63; 95%CI:1.30-2.04) and not volunteering (OR=1.35; 95%CI:1.10-1.65) but the association remained significant (Tables 5.6 and 5.7). Among the socio-economic factors, wealth and education contributed the most to weaken the association (Appendix B, Table B.2). A minimal decrease in the odds ratio was observed for lowest tertile of close ties but the association was no longer significant (OR=1.19; 95%CI:0.96-1.48) (Table 5.8).

Adjusting for health factors (Model 5) did not change the odds ratios much, while adjusting for health behaviour (Model 6) reduced the odds ratios for membership and volunteering to a limited extent (Tables 5.6 and 5.7). In Model 6, for all social capital explanatory variables measured at wave 3, only not being a member of any organisation and not volunteering were still significantly associated with edentate status at wave 5 (OR=1.48; 95%CI:1.18-1.87 and OR=1.24; 95%CI:1.01-1.52, respectively) (Tables 5.6 and 5.7). However, when baseline edentate status was adjusted for (Model 7), none of the social capital variables at wave 3 was associated with change in edentate status at wave 5. The reduction in the odds ratio for membership and volunteering could be due to the fact that the change between wave 3 and wave 5 in edentate status was modest in size (only 2.5% of the sample became edentate from wave 3 to wave 5). Moreover those participants who were edentate at wave 3 were de facto, also edentate at wave 5, and so could not change from being edentate at wave 3 to dentate at wave 5. Respondents aged 65 and over, retired, in the lowest quintile of wealth, with limiting long-standing illness, and smoker at wave 3 were all more likely to be edentate at wave 5.

Table 5.6: Association between membership status at wave 3 (2006-07) and edentate status at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: **Edentate status**	Model 1 Odds ratio (95% CI	Model 2 Odds ratio (95% CI	Model 3 Odds ratio (95% CI	Model 4 Odds ratio (95% CI
Membership status				
Active member	1	1	1	1
Passive member	1.20 (0.98-1.46)	1.20 (0.98-1.48)	1.18 (0.96-1.46)	1.03 (0.83-1.28)
Not a member	2.28 (1.87-2.79)***	2.51 (2.04-3.09)***	2.45 (1.99-3.03)***	1.63 (1.30-2.04)***
Not answered	3.10 (2.28-4.22)***	2.82 (2.04-3.91)***	2.81 (2.03-3.89)***	1.75 (1.24-2.47)**
Age-groups				
50-64		1	1	1
65-74		3.32 (2.72-4.06)***	3.24 (2.65-3.96)***	2.32 (1.80-2.98)***
75 +		7.12 (5.81-8.73)***	6.50 (5.28-8.02)***	4.46 (3.42-5.82)***
Gender				
Male			1	1
Female			1.25 (1.05-1.48)*	1.15 (0.97-1.38)
Cohabiting status				
Living with partner			1	1
No living with partner			1.37 (1.15-1.63)***	0.92 (0.76-1.11)
Education				
Education				1
No education				1.76 (1.47-2.11)***
Employment status				
In paid employment				1
Retired				1.84 (1.37-2.47)***
Other				1.54 (1.12-2.10)**
Wealth quintile				
Wealthiest				1
4				1.35 (0.99-1.85)
3				2.12 (1.57-2.86)***
2				3.20 (2.38-4.32)***
Poorest				4.10 (3.00-5.61)***

*p< 0.05; **p< 0.01; ***p< 0.001

Table 5.6…continued: Association between membership status at wave 3 (2006-07) and edentate status at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Edentate status	Model 5 Odds ratio (95% CI	Model 6 Odds ratio (95% CI	Model 7 Odds ratio (95% CI
Membership status			
Active member	1	1	1
Passive member	1.04 (0.83-1.29)	1.02 (0.82-1.26)	0.79 (0.54-1.16)
Not a member	1.60 (1.28-2.01)***	1.48 (1.18-1.87)**	0.87 (0.57-1.32)
Not answered	1.74 (1.23-2.47)**	1.60 (1.13-2.28)**	1.88 (1.02-3.47)*
Age-groups			
50-64	1	1	1
65-74	2.37 (1.84-3.05)***	2.63 (2.03-3.41)***	1.71 (1.10-2.65)*
75 +	4.48 (3.43-5.85)***	5.30 (4.02-7.00)***	2.55 (1.57-4.14)***
Gender			
Male	1	1	1
Female	1.19 (0.99-1.42)	1.31 (1.09-1.58)**	1.26 (0.91-1.74)
Cohabiting status			
Living with partner	1	1	1
No living with partner	0.93 (0.77-1.12)	0.89 (0.74-1.08)	0.92 (0.65-1.31)
Education			
Education	1	1	1
No education	1.74 (1.45-2.08)***	1.70 (1.41-2.04)***	1.32 (0.94-1.86)
Employment status			
In paid employment	1	1	1
Retired	1.67 (1.24-2.26)**	1.62 (1.20-2.20)**	1.94 (1.18-3.19)*
Other	1.33 (0.96-1.83)	1.27 (0.91-1.76)	1.08 (0.61-1.93)
Wealth quintile			
Wealthiest	1	1	1
4	1.31 (0.96-1.81)	1.30 (0.95-1.79)	1.16 (0.69-1.93)
3	2.03 (1.50-2.74)***	1.99 (1.47-2.67)***	1.81 (1.10-2.97)*
2	2.99 (2.21-4.04)***	2.84 (2.09-3.85)***	1.59 (0.95-2.66)
Poorest	3.79 (2.76-5.20)***	3.35 (2.43-4-63)***	1.89 (1.08-3.32)*
Self-rated general health			
Good	1	1	1
Poor	1.35 (1.10-1.66)**	1.31 (1.06-1.61)*	1.03 (0.70-1.50)
Long-standing illness			
No	1	1	1
Yes	1.31 (1.08-1.60)**	1.32 (1.08-1.61)**	1.56 (1.08-2.24)**
Depression			
No	1	1	1
Yes	0.75 (0.61-0.95)*	0.73 (0.58-0.92)**	0.80 (0.53-1.21)
Smoking status			
Never smoked		1	1
Ex-smoker		1.61 (1.32-1.96)***	1.30 (0.92-1.83)
Current smoker		2.75 (2.12-3.57)***	2.20 (1.38-3.52)**
Edentulousness			
Dentate			1
Edentate			287.36 (206.04-400.76)***

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 5.7: Association between volunteering status at wave 3 (2006-07) and edentate status at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Edentate status	Model 1 Odds ratio (95% CI	Model 2 Odds ratio (95% CI	Model 3 Odds ratio (95% CI	Model 4 Odds ratio (95% CI
Volunteering status				
Volunteering	1	1	1	1
Not volunteering	1.84 (1.53-2.21)***	1.89 (1.57-2.29)***	1.88 (1.56-2.28)***	1.35 (1.10-1.65)**
Age-groups				
50-64		1	1	1
65-74		3.31 (2.71-4.03)***	3.23 (2.64-3.94)***	2.29 (1.78-2.94)***
75 +		6.96 (5.69-8.51)***	6.37 (5.18-7.84)***	4.36 (3.35-5.67)***
Gender				
Male			1	1
Female			1.30 (1.10-1.54)**	1.18 (0.98-1.40)
Cohabiting status				
Living with partner			1	1
No living with partner			1.33 (1.12-1.59)**	0.89 (0.74-1.08)
Education				
Education				1
No education				1.85 (1.55-2.20)***
Employment status				
In paid employment				1
Retired				1.86 (1.38-2.49)***
Other				1.60 (1.17-2.19)**
Wealth quintile				
Wealthiest				1
4				1.39 (1.01-1.89)*
3				2.22 (1.65-3.00)***
2				3.33 (2.47-4.48)***
Poorest				4.43 (3.25-6.03)***

*p< 0.05; **p< 0.01; ***p< 0.001

Table 5.7…continued: Association between volunteering status at wave 3 (2006-07) and edentate status at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Edentate status	Model 5 Odds ratio (95% CI	Model 6 Odds ratio (95% CI	Model 7 Odds ratio (95% CI
Volunteering status			
Volunteering	1	1	1
Not volunteering	1.31 (1.07-1.61)**	1.24 (1.01-1.52)*	0.92 (0.64-1.31)
Age-groups			
50-64	1	1	1
65-74	2.34 (1.82-3.02)***	2.61 (2.01-3.38)***	1.72 (1.11-2.68)*
75 +	4.40 (3.37-5.73)***	5.24 (3.97-6.90)***	2.62 (1.61-4.26)***
Gender			
Male	1	1	1
Female	1.20 (1.01-1.44)*	1.33 (1.11-1.60)**	1.27 (0.91-1.76)
Cohabiting status			
Living with partner	1	1	1
No living with partner	0.90 (0.74-1.08)	0.87 (0.71-1.05)	0.90 (0.64-1.28)
Education			
Education	1	1	1
No education	1.82 (1.52-2.18)***	1.77 (1.47-2.12)***	1.37 (0.98-1.92)
Employment status			
In paid employment	1	1	1
Retired	1.68 (1.25-2.27)**	1.63 (1.20-2.21)**	1.94 (1.18-3.20)*
Other	1.37 (0.99-1.89)	1.30 (0.93-1.80)	1.10 (0.62-1.95)
Wealth quintile			
Wealthiest	1	1	1
4	1.35 (0.99-1.34)	1.33 (0.97-1.83)	1.15 (0.69-1.92)
3	2.12 (1.57-2.86)***	2.06 (1.53-2.79)***	1.82 (1.11-2.99)*
2	3.10 (2.29-4.19)***	2.93 (2.16-3.97)***	1.61 (0.96-2.70)
Poorest	4.07 (2.97-5.58)***	3.56 (2.59-4.91)***	1.94 (1.11-3.38)*
Self-rated general health			
Good	1	1	1
Poor	1.34 (1.10-1.65)**	1.30 (1.06-1.60)*	1.05 (0.72-1.53)
Long-standing illness			
No	1	1	1
Yes	1.32 (1.09-1.61)**	1.33 (1.09-1.62)**	1.55 (1.08-2.22)*
Depression			
No	1	1	1
Yes	0.78 (0.62-0.97)*	0.75 (0.60-0.93)*	0.81 (0.53-1.22)
Smoking status			
Never smoked		1	1
Ex-smoker		1.62 (1.33-1.97)***	1.32 (0.93-1.86)
Current smoker		2.87 (2.21-3.71)***	2.24 (1.41-3.58)**
Edentulousness			
Dentate			1
Edentate			277.89 (200.32-385.47)***

*p< 0.05; **p< 0.01; ***p< 0.001

Table 5.8: Association between number of close ties at wave 3 (2006-07) and edentate status at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Edentate status	Model 1 Odds ratio (95% CI	Model 2 Odds ratio (95% CI	Model 3 Odds ratio (95% CI	Model 4 Odds ratio (95% CI
Number of close ties				
Highest tertile	1	1	1	1
Middle tertile	0.93 (0.76-1.16)	0.99 (0.79-1.25)	0.97 (0.77-1.22)	0.95 (0.75-1.20)
Lowest tertile	1.28 (1.05-1.57)*	1.30 (1.05-1.60)*	1.24 (1.01-1.54)*	1.19 (0.96-1.48)
Not answered	2.03 (1.61-2.57)***	1.66 (1.30-2.12)***	1.66 (1.30-2.12)***	1.33 (1.03-1.72)*
Age-groups				
50-64		1	1	1
65-74		3.11 (2.55-3.80)***	3.02 (2.47-3.69)***	2.26 (1.76-2.91)***
75 +		6.66 (5.44-8.14)***	6.07 (4.94-7.48)***	4.31 (3.31-5.61)***
Gender				
Male			1	1
Female			1.32 (1.11-1.56)**	1.19 (0.99-1.42)
Cohabiting status				
Living with partner			1	1
No living with partner			1.33 (1.12-1.58)**	0.87 (0.72-1.05)
Education				
Education				1
No education				1.91 (1.60-2.28)***
Employment status				
In paid employment				1
Retired				1.80 (1.34-2.42)***
Other				1.55 (1.13-2.13)**
Wealth quintile				
Wealthiest				1
4				1.43 (1.04-1.95)*
3				2.29 (1.71-3.09)***
2				3.48 (2.59-4.68)***
Poorest				4.61 (3.39-6.27)***

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 5.8…continued: Association between number of close ties at wave 3 (2006-07) and edentate status at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Edentate status	Model 5 Odds ratio (95% CI	Model 6 Odds ratio (95% CI	Model 7 Odds ratio (95% CI
Number of close ties			
Highest tertile	1	1	1
Middle tertile	0.94 (0.74-1.20)	0.93 (0.73-1.18)	0.90 (0.58-1.37)
Lowest tertile	1.17 (0.94-1.46)	1.15 (0.92-1.44)	0.92 (0.61-1.36)
Not answered	1.28 (0.99-1.66)	1.26 (0.98-1.64)	1.43 (0.90-2.28)
Age-groups			
50-64	1	1	1
65-74	2.32 (1.80-2.99)***	2.59 (2.00-3.36)***	1.69 (1.09-2.62)*
75 +	4.36 (3.34-5.69)***	5.22 (3.96-6.88)***	2.52 (1.55-4.09)***
Gender			
Male	1	1	1
Female	1.21 (1.02-1.45)*	1.34 (1.12-1.62)**	1.29 (0.93-1.79)
Cohabiting status			
Living with partner	1	1	1
No living with partner	0.88 (0.72-1.06)	0.85 (0.70-1.03)	0.91 (0.64-1.30)
Education			
Education	1	1	1
No education	1.88 (1.57-2.25)***	1.81 (1.51-2.16)***	1.33 (0.95-1.85)
Employment status			
In paid employment	1	1	1
Retired	1.63 (1.21-2.20)**	1.58 (1.17-2.15)**	1.91 (1.16-3.15)*
Other	1.33 (0.96-1.84)	1.26 (0.91-1.75)	1.07 (0.60-1.90)
Wealth quintile			
Wealthiest	1	1	1
4	1.38 (1.01-1.89)*	1.36 (0.99-1.36)	1.14 (0.68-1.90)
3	2.18 (1.62-2.94)***	2.11 (1.56-2.85)***	1.79 (1.09-2.93)*
2	3.23 (2.39-4.35)***	3.02 (2.23-4.09)***	1.55 (0.92-2.58)
Poorest	4.22 (3.08-5.77)***	3.65 (2.65-5.02)***	1.90 (1.09-3.31)*
Self-rated general health			
Good	1		1
Poor	1.35 (1.10-1.66)**	1.30 (1.06-1.60)*	1.03 (0.71-1.51)
Long-standing illness			
No	1	1	1
Yes	1.32 (1.09-1.61)**	1.33 (1.09-1.62)**	1.54 (1.07-2.21)*
Depression			
No	1	1	1
Yes	0.78 (0.62-0.97)*	0.75 (0.60-0.93)*	0.80 (0.53-1.21)
Smoking status			
Never smoked		1	1
Ex-smoker		1.62 (1.33-1.96)***	1.31 (0.93-1.85)
Current smoker		2.92 (2.25-3.78)***	2.23 (1.40-3.55)**
Edentulousness			
Dentate			1
Edentate			281.54 (202.63-391.19)***

*$p< 0.05$; **$p< 0.01$; ***$p< 0.001$

Table 5.9: Association between social support at wave 3 (2006-07) and edentate status at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: Edentate status	Model 1 Odds ratio (95% CI	Model 2 Odds ratio (95% CI	Model 3 Odds ratio (95% CI	Model 4 Odds ratio (95% CI
Social support				
Highest tertile	1	1	1	1
Middle tertile	1.20 (0.98-1.49)	1.14 (0.92-1.42)	1.04 (0.83-1.31)	1.06 (0.84-1.34)
Lowest tertile	1.57 (1.29-1.92)***	1.34 (1.10-1.65)**	1.13 (0.88-1.44)	1.13 (0.88-1.45)
Not answered	2.65 (1.87-3.75)***	1.83 (1.28-2.63)**	1.68 (1.16-2.43)**	1.48 (1.01-2.18)*
Age-groups				
50-64		1	1	1
65-74		3.12 (2.56-3.81)***	3.05 (2.50-3.72)***	2.24 (1.74-2.88)***
75 +		6.64 (5.43-8.13)***	6.20 (5.04-7.63)***	4.30 (3.30-5.60)***
Gender				
Male			1	1
Female			1.29 (1.09-1.53)**	1.17 (0.98-1.40)
Cohabiting status				
Living with partner			1	1
No living with partner			1.30 (1.06-1.60)*	0.85 (0.68-1.06)
Education				
Education				1
No education				1.92 (1.61-2.29)***
Employment status				
In paid employment				1
Retired				1.83 (1.36-2.46)***
Other				1.58 (1.16-2.17)**
Wealth quintile				
Wealthiest				1
4				1.43 (1.05-1.95)*
3				2.32 (1.72-3.12)***
2				3.52 (2.62-3.73)***
Poorest				4.67 (3.44-6.36)***

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 5.9…continued: Association between social support at wave 3 (2006-07) and edentate status at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: **Edentate status**	Model 5 Odds ratio (95% CI	Model 6 Odds ratio (95% CI	Model 7 Odds ratio (95% CI
Social support			
Highest tertile	1	1	1
Middle tertile	1.04 (0.82-1.32)	1.03 (0.81-1.30)	1.20 (0.79-1.83)
Lowest tertile	1.08 (0.84-1.39)	1.08 (0.84-1.40)	0.97 (0.61-1.53)
Not answered	1.42 (0.97-2.01)	1.45 (0.98-2.15)	1.40 (0.68-2.89)
Age-groups			
50-64	1	1	1
65-74	2.29 (1.78-2.96)***	2.56 (1.98-3.33)***	1.71 (1.10-2.65)*
75 +	4.34 (3.33-5.67)***	5.19 (3.93-6.85)***	2.57 (1.58-4.17)***
Gender			
Male	1	1	1
Female	1.20 (1.00-1.43)*	1.33 (1.11-1.60)**	1.27 (0.91-1.77)
Cohabiting status			
Living with partner	1	1	1
No living with partner	0.87 (0.70-1.08)	0.84 (0.67-1.05)	0.93 (0.62-1.39)
Education			
Education	1	1	1
No education	1.88 (1.58-2.25)***	1.81 (1.51-2.16)***	1.35 (0.97-1.89)
Employment status			
In paid employment	1	1	1
Retired	1.66 (1.23-2.23)**	1.61 (1.19-2.18)**	1.93 (1.17-3.18)*
Other	1.35 (0.98-1.87)	1.28 (0.92-1.78)	1.09 (0.62-1.95)
Wealth quintile			
Wealthiest	1	1	1
4	1.38 (1.01-1.89)*	1.36 (0.99-1.87)	1.14 (0.68-1.90)
3	2.20 (1.63-2.96)***	2.12 (1.57-2.87)***	1.81 (1.11-2.97)*
2	3.25 (2.41-4.38)***	3.04 (2.25-4.11)***	1.59 (0.95-2.66)
Poorest	4.26 (3.11-5.82)***	3.68 (2.67-5.06)***	1.92 (1.10-3.34)*
Self-rated general health			
Good	1	1	1
Poor	1.37 (1.12-1.68)**	1.31 (1.07-1.61)**	1.05 (0.72-1.53)
Long-standing illness			
No	1	1	1
Yes	1.31 (1.08-1.60)**	1.32 (1.08-1.61)**	1.54 (1.07-2.22)*
Depression			
No	1	1	1
Yes	1.31 (1.08-1.60)*	0.75 (0.60-0.93)*	0.81 (0.54-1.2)
Smoking status			
Never smoked		1	1
Ex-smoker		1.63 (1.34-1.98)***	1.32 (0.94-1.87)
Current smoker		2.94 (2.27-3.81)***	2.22 (1.40-3.54)**
Edentulousness			
Dentate			1
Edentate			279.60 (201.38-388.21)***

**p*< 0.05; ***p*< 0.01; ****p*< 0.001

5.3.1.4 Social capital at wave 3 (2006-07) and Oral Impacts on Daily Performances (OIDP) at wave 5 (2010-11)

The results of the longitudinal associations between the social capital measures and OIDP are displayed in Tables 5.10 to 5.13. The bivariate analysis (Model 1) in Tables 5.10 and 5.11 revealed that neither membership, nor volunteering status at wave 3 were significantly associated with OIDP at wave 5 (OR=1.12; 95%CI:0.89-1.42) and (OR=1.12; 95%CI:0.92-1.37), respectively. On the other hand, fewer close ties and lower social support were significantly associated with OIDP at wave 5. For example, having 7 to 9 close ties at wave 3 (in the middle tertile of close ties) was associated with increased odds of experiencing an oral impact at wave 5 (OR=1.33; 95%CI:1.03-1.74) compared to having more than 9 close ties at wave 3 (in the highest tertile of close ties). Similarly, respondents who had 6 or fewer close ties at wave 3 (in the lowest tertile of close ties) were 1.76 (95%CI:1.38-2.25) times more likely to report an oral impact at wave 5 (Table 5.12).

Table 5.13 shows that lower social support was strongly associated with OIDP. For instance those respondents with the lowest tertile of social support were 2.42 (95%CI:1.89-3.10) times more likely to report at least one OIDP when compared to those respondents who perceived a high level of social support. A significant association was also found between middle tertile of social support and OIDP (OR=1.61; 95%CI:1.24-2.10). Moreover, these associations remained strong even after the adjustment for socio-demographic and socio-economic factors (Models 3 and 4; Tables 5.12 and 5.13). Adjusting for the health factors (Model 5) resulted in a substantial decrease in the odds ratios for lowest tertile of close ties (OR=1.56; 95%CI:1.22-2.00) and lowest tertile of social support (OR=2.12; 95%CI:1.60-2.81) but did not affect both the middle tertiles (Tables 5.12 and 5.13). Accounting for smoking status (Model 6) did not change the odds ratios much.

In order to estimate the influence of the social capital exposures on change in oral health-related quality of life, baseline OIDP variable was added to the regression model (Model 7). The odds ratios for lowest tertile of close ties (OR=1.44; 95%CI:1.11-1.86) and the lower tertiles of social support (OR=1.94; 95%CI:1.45=2.59 and 1.41; 95%CI:1.06-1.87, respectively) were further reduced but the associations remained significant (Tables 5.12 and 5.13). In contrast, a very limited decrease of the odds ratio for middle tertile of close ties resulted to a marginally non-significant association (OR=1.31; 95%CI:0.99-1.72)

(Table 5.12). These findings have shown that the lowest tertile of close ties and the lower tertiles of social support were related to change in OIDP between wave 3 and wave 5, whereas the middle tertile of social support was not.

Of the covariates measured at wave 3, poor self-rated general health, limiting long-standing illness, ex-smoker and current smoker, and having experienced at least an oral impact on daily performance at wave 3 were positively associated with OIDP at wave 5.

Table 5.10: Association between membership status at wave 3 (2006-07) and OIDP[1] at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 1 Odds ratio (95% CI	Model 2 Odds ratio (95% CI	Model 3 Odds ratio (95% CI	Model 4 Odds ratio (95% CI
Membership status				
Active member	1	1	1	1
Passive member	0.93 (0.75-1.16)	0.93 (0.75-1.16)	0.93 (0.75-1.16)	0.90 (0.72-1.13)
Not a member	1.12 (0.89-1.42)	1.12 (0.89-1.42)	1.11 (0.88-1.40)	0.95 (0.74-1.21)
Not answered	1.07 (0.70-1.63)	1.09 (0.71-1.66)	1.11 (0.72-1.69)	0.93 (0.60-1.43)
Age-groups				
50-64		1	1	1
65-74		0.99 (0.80-1.22)	0.95 (0.77-1.17)	0.83 (0.64-1.08)
75 +		0.88 (0.68-1.13)	0.79 (0.61-1.03)	0.67 (0.50-0.92)*
Gender				
Male			1	1
Female			0.87 (0.72-1.05)	0.83 (0.68-1.00)*
Cohabiting status				
Living with partner			1	1
No living with partner			1.46 (1.20-1.78)***	1.23 (0.99-1.51)
Education				
Education				1
No education				1.09 (0.87-1.36)
Employment status				
In paid employment				1
Retired				1.36 (1.04-1.78)*
Other				1.59 (1.19-2.12)**
Wealth quintile				
Wealthiest				1
4				0.85 (0.63-1.14)
3				1.16 (0.86-1.55)
2				1.49 (1.12-1.98)**
Poorest				1.67 (1.21-2.29)**

[1]Oral Impact on Daily Performances
*p< 0.05; **p< 0.01; ***p< 0.001

Table 5.10…continued: Association between membership status at wave 3 (2006-07) and OIDP[1] at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 5 Odds ratio (95% CI	Model 6 Odds ratio (95% CI	Model 7 Odds ratio (95% CI
Membership status			
Active member	1	1	1
Passive member	0.89 (0.71-1.11)	0.88 (0.71-1.11)	0.89 (0.71-1.13)
Not a member	0.86 (0.67-1.11)	0.82 (0.63-1.06)	0.87 (0.63-1.13)
Not answered	0.85 (0.66-1.32)	0.80 (0.51-1.24)	0.75 (0.47-1.19)
Age-groups			
50-64	1	1	1
65-74	0.89 (0.68-1.15)	0.92 (0.71-1.20)	0.89 (0.68-1.18)
75 +	0.70 (0.51-0.95)*	0.75 (0.54-1.02)	0.76 (0.54-1.05)
Gender			
Male	1	1	1
Female	0.83 (0.68-1.00)	0.88 (0.73-1.07)	0.88 (0.72-1.08)
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.13 (0.91-1.40)	1.11 (0.89-1.38)	1.13 (0.90-1.42)
Education			
Education	1	1	1
No education	0.99 (0.79-1.24)	0.97 (0.77-1.22)	0.99 (0.78-1.25)
Employment status			
In paid employment	1	1	1
Retired	1.12 (0.85-1.47)	1.09 (0.83-1.44)	1.08 (0.81-1.44)
Other	1.07 (0.79-1.45)	1.04 (0.77-1.41)	1.01 (0.73-1.39)
Wealth quintile			
Wealthiest	1	1	1
4	0.78 (0.57-1.05)	0.77 (0.57-1.04)	0.71 (0.52-0.98)*
3	1.02 (0.76-1.37)	1.00 (0.75-1.35)	0.97 (0.71-1.31)
2	1.21 (0.90-1.63)	1.16 (0.86-1.56)	1.11 (0.81-1.51)
Poorest	1.25 (0.90-1.73)	1.13 (0.81-1.57)	0.99 (0.70-1.40)
Self-rated general health			
Good	1	1	1
Poor	1.68 (1.33-2.10)***	1.63 (1.29-2.05)***	1.53 (1.20-1.94)**
Long-standing illness			
No	1	1	1
Yes	1.49 (1.19-1.86)***	1.48 (1.19-1.85)**	1.31 (1.04-1.65)*
Depression			
No	1	1	1
Yes	1.54 (1.22-1.93)***	1.51 (1.20-1.90)***	1.28 (1.00-1.63)
Smoking status			
Never smoked		1	1
Ex-smoker		1.54 (1.24-1.92)***	1.53 (1.23-1.92)***
Current smoker		2.01 (1.52-2.66)***	1.78 (1.32-2.40)***
OIDP[1]			
No impact			1
At least 1 impact			7.09 (5.62-8.95)***

[1]Oral Impact on Daily Performances
*p< 0.05; **p< 0.01; ***p< 0.001

Table 5.11: Association between volunteering status at wave 3 (2006-07) and OIDP[1] at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 1 Odds ratio (95% CI	Model 2 Odds ratio (95% CI	Model 3 Odds ratio (95% CI	Model 4 Odds ratio (95% CI
Volunteering status				
Volunteering	1	1	1	1
Not volunteering	1.12 (0.92-1.37)	1.13 (0.93-1.38)	1.10 (0.90-1.34)	1.00 (0.81-1.23)
Age-groups				
50-64		1	1	1
65-74		0.99 (0.81-1.22)	0.96 (0.78-1.18)	0.84 (0.65-1.08)
75 +		0.88 (0.68-1.13)	0.79 (0.61-1.02)	0.67 (0.50-0.91)*
Gender				
Male			1	1
Female			0.87 (0.73-1.05)	0.82 (0.68-0.99)*
Cohabiting status				
Living with partner			1	1
No living with partner			1.46 (1.19-1.78)***	1.23 (0.99-1.51)
Education				
Education				1
No education				1.08 (0.87-1.34)
Employment status				
In paid employment				1
Retired				1.37 (1.05-1.79)*
Other				1.60 (1.20-2.13)**
Wealth quintile				
Wealthiest				1
4				0.84 (0.62-1.14)
3				1.15 (0.86-1.54)
2				1.47 (1.11-1.96)**
Poorest				1.65 (1.21-2.26)**

[1]Oral Impact on Daily Performances

*$p< 0.05$; **$p< 0.01$; ***$p< 0.001$

Table 5.11…continued: Association between volunteering status at wave 3 (2006-07) and OIDP[1] at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 5 Odds ratio (95% CI	Model 6 Odds ratio (95% CI	Model 7 Odds ratio (95% CI
Volunteering status			
Volunteering	1	1	1
Not volunteering	0.92 (0.74-1.13)	0.89 (0.72-1.10)	0.89 (0.71-1.11)
Age-groups			
50-64	1	1	1
65-74	0.89 (0.68-1.15)	0.92 (0.71-1.20)	0.89 (0.67-1.17)
75 +	0.70 (0.51-0.95)*	0.75 (0.54-1.02)	0.75 (0.54-1.05)
Gender			
Male	1	1	1
Female	0.82 (0.68-0.99)*	0.87 (0.72-1.06)	0.87 (0.71-1.07)
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.14 (0.91-1.41)	1.12 (0.90-1.39)	1.14 (0.91-1.44)
Education			
Education	1	1	1
No education	0.98 (0.79-1.23)	0.96 (0.76-1.20)	0.98 (0.77-1.23)
Employment status			
In paid employment	1	1	1
Retired	1.12 (0.85-1.47)	1.09 (0.83-1.44)	1.08 (0.81-1.44)
Other	1.07 (0.79-1.44)	1.03 (0.76-1.40)	1.00 (0.73-1.38)
Wealth quintile			
Wealthiest	1	1	1
4	0.77 (0.77-1.05)	0.76 (0.56-1.03)	0.72 (0.52-0.98)
3	1.02 (0.76-1.36)	0.99 (0.74-1.34)	0.96 (0.71-1.31)
2	1.21 (0.90-1.62)	1.15 (0.85-1.55)	0.96 (0.71-1.31)
Poorest	1.23 (0.89-1.70)	1.11 (0.79-1.54)	0.98 (0.69-1.38)
Self-rated general health			
Good	1	1	1
Poor	1.67 (1.33-2.10)***	1.64 (1.30-2.06)***	1.54 (1.21-1.96)***
Long-standing illness			
No	1	1	1
Yes	1.49 (1.19-1.86)***	1.48 (1.18-1.85)**	1.31 (1.04-1.65)*
Depression			
No	1	1	1
Yes	1.53 (1.22-1.92)***	1.50 (1.19-1.89)***	1.27 (0.99-1.62)
Smoking status			
Never smoked		1	1
Ex-smoker		1.54 (1.24-1.91)***	1.53 (1.23-1.92)***
Current smoker		1.99 (1.50-2.63)***	1.77 (1.32-2.39)***
OIDP[1]			
No impact			1
At least 1 impact			7.08 (5.62-8.93)***

[1]Oral Impact on Daily Performances
**p*< 0.05; ***p*< 0.01; ****p*< 0.001

Table 5.12: Association between number of close ties at wave 3 (2006-07) and OIDP[1] at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 1 Odds ratio (95% CI	Model 2 Odds ratio (95% CI	Model 3 Odds ratio (95% CI	Model 4 Odds ratio (95% CI
Number of close ties				
Highest tertile	1	1	1	1
Middle tertile	1.33 (1.03-1.74)*	1.33 (1.02-1.73)*	1.32 (1.02-1.72)*	1.34 (1.05-1.75)*
Lowest tertile	1.76 (1.38-2.25)***	1.77 (1.39-2.26)***	1.68 (1.31-2.14)***	1.64 (1.28-2.10)***
Not answered	1.49 (1.09-2.04)*	1.51 (1.11-2.07)**	1.47 (1.08-2.01)*	1.35 (0.98-1.85)
Age-groups				
50-64		1	1	1
65-74		0.99 (0.81-1.23)	0.97 (0.78-1.19)	0.85 (0.66-1.11)
75 +		0.86 (0.67-1.11)	0.79 (0.61-1.03)	0.68 (0.50-0.92)*
Gender				
Male			1	1
Female			0.89 (0.74-1.08)	0.84 (0.69-1.02)
Cohabiting status				
Living with partner			1	1
No living with partner			1.38 (1.13-1.69)**	1.16 (0.94-1.44)
Education				
No Education				1
Education				1.08 (0.87-1.34)
Employment status				
In paid employment				1
Retired				1.36 (1.04-1.78)*
Other				1.58 (1.18-2.10)**
Wealth quintile				
Wealthiest				1
4				0.83 (0.62-1.13)
3				1.13 (0.85-1.51)
2				1.46 (1.10-1.94)**
Poorest				1.63 (1.19-2.22)**

[1]Oral Impact on Daily Performances
**p*< 0.05; ***p*< 0.01; ****p*< 0.001

Table 5.12…continued: Association between number of close ties at wave 3 (2006-07) and OIDP[1] at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 5 Odds ratio (95% CI	Model 6 Odds ratio (95% CI	Model 7 Odds ratio (95% CI
Number of close ties			
Highest tertile	1	1	1
Middle tertile	1.33 (1.03-1.74)*	1.33 (1.02-1.74)*	1.31 (0.99-1.72)
Lowest tertile	1.56 (1.22-2.00)***	1.56 (1.22-2.00)***	1.44 (1.11-1.86)*
Not answered	1.22 (0.88-1.68)	1.21 (0.88-1.67)	1.07 (0.77-1.50)
Age-groups			
50-64	1	1	1
65-74	0.91 (0.70-1.18)	0.94 (0.72-1.23)	0.91 (0.69-1.20)
75 +	0.70 (0.51-0.96)*	0.75 (0.55-1.03)	0.77 (0.55-1.07)
Gender			
Male	1	1	1
Female	0.84 (0.69-1.01)	0.89 (0.73-1.08)	0.88 (0.72-1.08)
Cohabiting status			
Living with partner	1	1	1
No living with partner	1.09 (0.87-1.35)	1.07 (0.86-1.33)	1.11 (0.88-1.39)
Education			
No Education	1	1	1
Education	0.98 (0.79-1.23)	0.95 (0.76-1.19)	0.97 (0.77-1.22)
Employment status			
In paid employment	1	1	1
Retired	1.12 (0.85-1.48)	1.10 (0.83-1.45)	1.08 (0.81-1.45)
Other	1.07 (0.79-1.45)	1.03 (0.76-1.40)	1.01 (0.73-1.39)
Wealth quintile			
Wealthiest	1	1	1
4	0.76 (0.56-1.03)	0.75 (0.55-1.01)	0.71 (0.52-0.97)*
3	0.99 (0.74-1.33)	0.97 (0.72-1.30)	0.94 (0.70-1.29)
2	1.18 (0.88-1.58)	1.12 (0.83-1.50)	1.08 (0.80-1.47)
Poorest	1.20 (0.87-1.66)	1.08 (0.77-1.50)	0.96 (0.68-1.36)
Self-rated general health			
Good	1	1	1
Poor	1.62 (1.29-2.04)***	1.59 (1.26-2.00)***	1.50 (1.18-1.92)**
Long-standing illness			
No	1	1	1
Yes	1.52 (1.22-1.90)***	1.51 (1.21-1.89)***	1.33 (1.06-1.68)*
Depression			
No	1	1	1
Yes	1.50 (1.20-1.89)***	1.47 (1.17-1.85)**	1.26 (0.98-1.60)
Smoking status			
Never smoked		1	1
Ex-smoker		1.54 (1.24-1.92)***	1.52 (1.22-1.91)***
Current smoker		1.96 (1.48-2.59)***	1.74 (1.29-2.34)***
OIDP[1]			
No impact			1
At least 1 impact			7.03 (5.56-8.87)***

[1]Oral Impact on Daily Performances
**p*< 0.05; ***p*< 0.01; ****p*< 0.001

Table 5.13: Association between social support at wave 3 (2006-07) and OIDP[1] at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 1 Odds ratio (95% CI	Model 2 Odds ratio (95% CI	Model 3 Odds ratio (95% CI	Model 4 Odds ratio (95% CI
Social support				
Highest tertile	1	1	1	1
Middle tertile	1.61 (1.24-2.10)***	1.62 (1.24-2.11)***	1.62 (1.23-2.11)***	1.63 (1.24-2.13)***
Lowest tertile	2.42 (1.89-3.10)***	2.46 (1.92-3.15)***	2.44 (1.85-3.22)***	2.41 (1.83-3.19)***
Not answered	1.26 (0.73-2.20)	1.31 (0.75-2.27)	1.30 (0.75-2.27)	1.23 (0.71-2.15)
Age-groups				
50-64		1	1	1
65-74		0.99 (0.80-1.22)	0.99 (0.80-1.22)	0.86 (0.66-1.11)
75 +		0.81 (0.63-1.05)	0.81 (0.63-1.06)	0.69 (0.51-0.94)
Gender				
Male			1	1
Female			0.95 (0.79-1.14)	0.89 (0.74-1.08)
Cohabiting status				
Living with partner			1	1
No living with partner			1.01 (0.81-1.27)	0.90 (0.67-1.08)
Education				
Education				1
No education				1.09 (0.88-1.36)
Employment status				
In paid employment				1
Retired				1.38 (1.06-1.81)*
Other				1.59 (1.20-2.13)**
Wealth quintile				
Wealthiest				1
4				0.85 (0.63-1.14)
3				1.14 (0.86-1.53)
2				1.48 (1.12-1.97)**
Poorest				1.62 (1.18-2.21)**

[1]Oral Impact on Daily Performances
*p< 0.05; **p< 0.01; ***p< 0.001

Table 5.13…continued: Association between social support at wave 3 (2006-07) and OIDP[1] at wave 5 (2010-11): sequentially adjusted logistic regression models, OR (95%CI)

Dep. Variable: OIDP[1]	Model 5 Odds ratio (95% CI	Model 6 Odds ratio (95% CI	Model 7 Odds ratio (95% CI
Social support			
Highest tertile	1	1	1
Middle tertile	1.55 (1.18-2.04)**	1.55 (1.18-2.03)**	1.41 (1.06-1.87)*
Lowest tertile	2.12 (1.60-2.81)***	2.14 (1.62-2.84)***	1.94 (1.45-2.59)***
Not answered	1.10 (0.63-1.94)	1.13 (0.64-1.99)	1.02 (0.57-1.84)
Age-groups			
50-64	1	1	1
65-74	0.91 (0.70-1.18)	0.94 (0.72-1.23)	0.91 (0.69-1.21)
75 +	0.71 (0.52-0.97)	0.76 (0.55-1.04)	0.77 (0.56-1.08)
Gender			
Male	1	1	1
Female	0.89 (0.73-1.08)	0.94 (0.78-1.15)	0.93 (0.76-1.14)
Cohabiting status			
Living with partner	1	1	1
No living with partner	0.84 (0.67-1.07)	0.83 (0.65-1.06)	0.88 (0.69-1.13)
Education			
Education	1	1	1
No education	0.99 (0.79-1.23)	0.96 (0.77-1.20)	0.97 (0.77-1.23)
Employment status			
In paid employment	1	1	1
Retired	1.15 (0.87-1.51)	1.12 (0.85-1.48)	1.11 (0.83-1.48)
Other	1.10 (0.82-1.50)	1.07 (0.79-1.45)	1.04 (0.75-1.43)
Wealth quintile			
Wealthiest	1	1	1
4	0.77 (0.57-1.04)	0.75 (0.56-1.02)	0.70 (0.52-0.96)*
3	1.01 (0.75-1.35)	0.98 (0.73-1.31)	0.95 (0.70-1.28)
2	1.20 (0.90-1.61)	1.14 (0.85-1.53)	1.08 (0.80-1.47)
Poorest	1.21 (0.87-1.67)	1.08 (0.77-1.50)	0.95 (0.67-1.35)
Self-rated general health			
Good	1	1	1
Poor	1.63 (1.29-2.04)***	1.59 (1.26-2.00)***	1.49 (1.17-1.90)**
Long-standing illness			
No	1	1	1
Yes	1.46 (1.17-1.83)**	1.46 (1.17-1.83)**	1.30 (1.03-1.64)*
Depression			
No	1	1	1
Yes	1.45 (1.15-1.82)**	1.42 (1.13-1.78)**	1.21 (0.95-1.55)
Smoking status			
Never smoked		1	1
Ex-smoker		1.55 (1.24-1.92)***	1.53 (1.23-1.92)***
Current smoker		1.97 (1.49-2.61)***	1.76 (1.31-2.37)***
OIDP			
No impact			1
At least 1 impact			6.89 (5.46-8.70)***

[1]Oral Impact on Daily Performances
*p< 0.05; **p< 0.01; ***p< 0.001

5.3.1.5 Summary of the findings of the longitudinal association between baseline social capital (2006-07) and oral health at wave 5 (2010-11)

To summarise, this section examined the longitudinal association of social capital at wave 3 (2006-07) with oral health at wave 5 (2010-11). A different pattern of association was found between structural and functional measures of social capital and oral health. After adjusting for all the covariates (Model 6), baseline structural social capital was associated with edentate status at wave 5, while baseline functional social capital was associated with self-rated oral health and oral impacts at wave 5. After adjusting for the baseline dependent oral health measure (Model 7), structural social capital was no longer associated with edentate status, although functional social capital remained associated with self-rated oral health and oral impacts on daily performances. Thus baseline functional social capital was related to change in self-rated oral health and change in oral health-related quality of life between waves 3 and 5 (Table 5.14).

The size of the association between social capital and oral health differed when adjusting for different covariates. The socio-economic factors of wealth and education explained most of the association between baseline structural social capital and the oral health measures at follow-up. This suggests that these socio-economic factors could be important confounders of the association between structural social capital and oral health. On the other hand, cohabiting status at baseline also partially explained the association between functional social capital and future oral health. Cohabiting status thus could be a confounder of the association between functional social capital and oral health.

Table 5.14: Summary of the longitudinal associations between baseline social capital (2006-07) and oral health at wave 5 (2010-11), OR (95%CI)

Dep. Variables	Poor self-rated oral health		Edentate status		OIDP[1]	
	Model 6	Model 7	Model 6	Model 7	Model 6	Model 7
	Odds ratio (95%CI)		Odds ratio (95%CI)		Odds ratio (95%CI)	
Membership						
Not a member	1.18 (0.94-1.45)	1.09 (0.83-1.36)	**1.48 (1.18-1.87)***	0.87 (0.57-1.32)	0.82 (0.63-1.06)	0.87 (0.63-1.13)
Volunteering						
Not volunteering	1.13 (0.95-1.35)	1.17 (0.97-1.41)	**1.24 (1.01-1.52)***	0.92 (0.64-1.31)	0.89 (0.72-1.10)	0.89 (0.71-1.11)
Close ties						
Lowest tertile	**1.29 (1.06-1.58)***	1.19 (0.96-1.47)	1.15 (0.92-1.44)	0.92 (0.61-1.36)	**1.56 (1.22-2.00)*****	**1.44 (1.11-1.86)***
Social support						
Lowest tertile	**1.41 (1.13-1.75)****	**1.27 (1.01-1.60)***	1.08 (0.84-1.40)	0.97 (0.61-1.53)	**2.14 (1.62-2.84)*****	**1.94 (1.45-2.59*****

[1]Oral Impacts on Daily Performances
Model 6: Adjusted for baseline covariates
Model 7: Model 6 + baseline oral health dependent variable
*p< 0.05; **p< 0.01; ***p< 0.001

5.3.2 Effect modification between social capital and oral health risk factors

Findings from the cross-sectional analysis showed statistically significant interactions with gender and wealth for the association between volunteering and poor self-rated oral health (Chapter 4, section 4.3.3). In the longitudinal analysis, only the interaction term between wealth and volunteering significantly predicted poor self-rated oral health *($p<0.01$)* (Table 5.15).

Among poorer respondents (in the poorest group in terms of wealth), those who were not volunteers at wave 3 were 2.48 (95%CI:1.40-4.43) times more likely to report poor oral health at wave 5 compared to those who were volunteers. In contrast, among the wealthier respondents there was no difference in self-rated oral health between those who volunteered and those who did not. Similar results were found in the cross-sectional analysis, although the association was weaker (OR=1.63; 95%CI:1.00-2.68) (Chapter 4, section 4.3.3, Table 4.27).

Table 5.15: Association of social capital at wave 3 (2006-07) with self-rated poor oral health at wave 5 (2010-11) stratified by wealth at wave 3, OR (95%CI)

	Interaction group 1	Interaction group 2	p-value for interaction
Volunteering	**Wealth (Wealthiest)**	**Wealth (Poorest)**	**<0.01, 1df (overall)[2]**
Volunteering	1	1	
Not volunteering	1.09 (0.90-1.34)	2.48 (1.40-4.43)	<0.01[3]

[1]Fully-adjusted model as described in Table 5.3
[2]p-value for overall F-adjusted Wald test
[3]p-value for interaction term (t-test)

5.3.3 Comparison of cross-sectional and longitudinal analyses

This section recapitulates the main findings of the cross-sectional and longitudinal association between social capital and oral health. To allow any comparisons the models presented in Tables 5.16; 5.17 and 5.18 correspond to those adjusted for selected covariates (socio-demographic, socio-economic, health and smoking status). To facilitate the comparison, only the results related to the lowest levels of social capital are displayed in the tables.

5.3.3.1 Social capital and poor self-rated oral health

The cross-sectional analysis in Table 5.16 revealed that respondents who were not members of any organisation had increased odds of reporting poor oral health compared to the respondents who were active members. However, the association was weak and not significant in the longitudinal analysis. Stronger association between functional social capital and self-rated oral health were found in the cross-sectional and longitudinal analyses. The odds ratios for both types of analyses were similar in size. Not volunteering was not associated with poor self-rated oral health in both cross-sectional and longitudinal analyses (Table 5.16).

Table 5.16: Comparison of cross-sectional and longitudinal odds ratios of poor self-rated oral health by baseline social capital, OR (95%CI)

	Cross-sectional association wave 3	Longitudinal association wave 3 - wave 5
Social capital at wave 3	**SROH at wave 3** Odds ratio (95% CI)[1]	**SROH at wave 5** Odds ratio (95% CI)[1]
Membership status		
Not a member	**1.21 (1.01-1.46)***	1.18 (0.94-1.45)
Volunteering status		
Not volunteering	0.94 (0.80-1.10)	1.13 (0.95-1.35)
Number of close ties		
Lowest tertile	**1.31 (1.09-1.56)****	**1.29 (1.06-1.58)***
Social support		
Lowest tertile	**1.36 (1.11-1.66)****	**1.41 (1.13-1.75)****

[1]Odds ratios (and 95% CI) are from Model 6 (fully adjusted) in Tables 4.15 to 4.18 (for wave 3 SROH) and Models 6 in Tables 5.2 to 5.5 (for wave 5 SROH)
**p<0.05; **p<0.01*

5.3.3.2 Social capital and edentate status

For edentate status as the outcome (Table 5.17), there was some difference in the cross-sectional and longitudinal odds ratios of social capital measures. Not a member of an organisation and not volunteering were associated with an increase in the odds of being edentate in the cross-sectional and the longitudinal analyses. However in the longitudinal analysis, the associations were somewhat weakened. Neither close ties, nor social support were related to edentate status in both analyses.

Table 5.17: Comparison of cross-sectional and longitudinal odds ratios of edentate status by baseline social capital, OR (95%CI)

	Cross-sectional association wave 3	**Longitudinal association wave 3 - wave 5**
Social capital at wave 3	**Edentate status at wave 3** Odds ratio (95% CI)[1]	**Edentate status at wave 5** Odds ratio (95% CI)[1]
Membership status		
Not a member	**1.79 (1.45-2.21)*** **	**1.48 (1.18-1.87)** **
Volunteering status		
Not volunteering	**1.45 (1.19-1.75)*** **	**1.24 (1.01-1.52)***
Number of close ties		
Lowest tertile	1.14 (0.93-1.39)	1.15 (0.92-1.44)
Social support		
Lowest tertile	1.01 (0.80-1.27)	1.08 (0.84-1.40)

[1]Odds ratios (and 95% CI) are from Model 6 in Tables 4.19 to 4.22 (for wave 3 Edentate) and Model 6 in Tables 5.6 to 5.9 (for wave 5 Edentate); **p<0.05; **p<0.01;***p<0.001*

5.3.3.3 Social capital and Oral Impacts on Daily Performances (OIDP)

Regarding the oral impacts on daily performances outcome (Table 5.18), neither membership status, nor volunteering were associated with OIDP in either the cross-sectional or the longitudinal analyses. However, having fewer close ties and lower social support (both the middle and the lowest tertiles), were associated with OIDP in both the cross-sectional and longitudinal analyses. Furthermore, in contrast to the other comparative results, the association between the lowest tertile of social support and OIDP were much stronger for the longitudinal analysis (OR=2.14; 95%CI:1.62-2.84) compared to the cross-sectional analysis (OR=1.63; 95%CI:1.23-2.17). This suggests that low social support may predict oral impacts and that the direction of the association observed in the cross-sectional analysis may be from low social support to OIDP.

Table 5.18: Comparison of cross-sectional and longitudinal odds ratios of OIDP[1] by baseline social capital, OR (95%CI)

Social capital at wave 3	Cross-sectional association wave 3 OIDP at wave 3 Odds ratio (95% CI)[2]	Longitudinal association wave 3 - wave 5 OIDP at wave 5 Odds ratio (95% CI)[2]
Membership status		
Not a member	0.79 (0.60-1.02)	0.82 (0.63-1.06)
Volunteering status		
Not volunteering	0.96 (0.77-1.20)	0.89 (0.72-1.10)
Number of close ties		
Lowest tertile	**1.52 (1.18-1.96)****	**1.56 (1.22-2.00)*****
Social support		
Lowest tertile	**1.63 (1.23-2.17)****	**2.14 (1.62-2.84)*****

[1]Oral Impacts on Daily Performances
[2]Odds ratios (and 95% CI) are from Model 6 in Tables 4.23 to 4.26 (for wave 3 OIDP) and Model 6 in Tables 5.10 to 5.13 (for wave 5 OIDP)
***p<0.01; ***p<0.01*

5.3.4 Reverse temporal association: Does oral health at wave 3 (2006-07) predict social capital at wave 5 (2010-11)?

An important issue in any empirical study of social capital and health is the direction of causality between these two variables. Many studies assume a unique pathway of effect, that is, from social capital to health. In the previous sections, it was assumed that low social capital has negative effects on respondents' oral health status, though it may also be that the causality, or more particularly the temporal order is reversed. Conversely, it is reasonable to consider that individuals with poor oral health are less able to participate in social activities or volunteer. Moreover, social capital and oral health may influence each other. The debate on this issue is still ongoing and many studies do not explicitly address this question. Other studies have examined this problem in relation to the causal direction between social capital and general health. These include using instrumental variables analysis to disentangle the causal direction. These studies have shown that social capital may enhance health status (Folland, 2007; d'Hombres et al., 2010).

This section attempts to address the potential issue of reverse causality using longitudinal models such that the individual's social capital measures at wave 5 were dependent on their oral health measures at wave 3, adjusted for their social capital measures at wave 3 and the same set of baseline covariates as used in the previous analyses. While this section does not consider any causal analysis models, it reverses the temporal ordering between social capital and oral health in the previous analyses. Evidence of a longitudinal association between baseline oral health and social capital would suggest that the direction of the association is from poor oral health to lack of social capital.

5.3.4.1 Oral health at wave 3 (2006-07) predictors of membership status at wave 5 (2010-11)

Table 5.19 shows the results of the multinomial logistic regression for the association between oral health indicators at wave 3 (2006-07), namely self-rated oral health, edentulousness and Oral Impacts on Daily Performances (OIDP) and membership status at wave 5 (2010-11) (active, passive or not a member of any organisation). In order to reduce the number of tables presented, only one set of relative risk ratios (RRRs) for the extreme categories of membership status was presented in each of the three models (Models 1, 6 and 7). These RRRs were estimated for respondents who were not members of any organisation versus those who were active members of at least one organisation (reference group).

The Model 1 presents the unadjusted RRR showing the bivariate association between baseline oral health and membership status at follow-up. Model 6 was adjusted for selected covariates. Model 7 was further adjusted for the baseline membership status, thus this model examines the association between baseline oral health and change in membership status between waves 3 and 5.

In the bivariate analyses (Model 1) the relative risk ratio was significantly different from 1 for all oral health measures. Respondents who reported poor oral health and at least one oral impact on daily performances were more likely not to be members of any organisation compared to those respondents who reported good oral health and did not experience any OIDP (RRR=1.63; 95%CI:1.34-1.99 and RRR=1.48, 95%CI:1.14-1.94, respectively). A stronger association was found for edentate status. Compared to respondents who were dentate, edentate respondents were 3.12 (95%CI:2.48-3.93) times more likely not to be members of any organisation.

In Model 6, the following baseline covariates were controlled for socio-demographic (gender, age and cohabiting status); socio-economic (education, employment status and wealth); health (self-rated general health, limiting long-standing illness and depression); and smoking status. The estimates for the risk of not being a member in comparison to an active member reduced and the associations between self-rated oral health, oral impact and membership were fully explained (RRR=1.13; 95%CI:0.91-1.40 and RRR=0.97; 95%CI:0.72-1.30, respectively). On the other hand, in Model 6, the risk of not being members versus active members was 1.71 (95%CI:1.32-2.21) higher among edentate respondents. These results reveal that only wave 3 edentate status remained associated with not belonging to any organisation at wave 5 after controlling for baseline covariates. Furthermore, once the model was adjusted for the baseline membership status (Model 7), edentate status was also related to change in membership status between waves 3 and 5 (RRR=1.40; 95%CI:1.03-1.92). In other words, being edentate at wave 3 reduced the chances to participate in social activities at wave 5.

Table 5.19: Association between oral health at wave 3 (2006-07) and membership status at wave 5 (2010-11): multinomial logistic regression models, RRR (95%CI)

	Membership status at wave 5 (2010-11)		
	Model 1	**Model 6**	**Model 7**
Oral health at wave 3 (2006-07)	**Not a member vs active member** RRR (95% CI)	**Not a member vs active member** RRR (95% CI)	**Not a member vs active member** RRR (95% CI)
Self-rated oral health			
Good	1	1	1
Poor	1.63 (1.34-1.99)***	1.13 (0.91-1.40)	0.99 (0.76-1.28)
Edentulousness			
Dentate	1	1	1
Edentate	3.12 (2.48-3.93)***	1.71 (1.32-2.21)***	1.40 (1.03-1.92)*
OIDP			
No impact	1	1	1
At least 1 impact	1.48 (1.14-1.94)**	0.97 (0.72-1.30)	1.20 (0.84-1.71)

Model 1: contains the bivariate association between oral health measures at wave 3 (separately) and membership status at wave 5
Model 6: contains model 1 adjusted for socio-demographic, socio-economic, health, smoking status
Model 7: contains model 6 adjusted for baseline membership status
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
N=4,851

5.3.4.2 Oral health at wave 3 (2006-07) predictors of volunteering status at wave 5 (2010-11)

The bivariate longitudinal models in Table 5.20 (Model 1) reveal that reporting poor oral health, being edentate and having experienced at least one OIDP at wave 3 were associated with not being a volunteer at wave 5. For instance, the odds of not being a volunteer at wave 5 was 2.40 (95%CI:1.95-2.95) times greater among the respondents who were edentate compared to the dentate at wave 3.

Model 6 takes account of the effects of baseline covariates on the association between oral health measures at wave 3 and volunteering at wave 5. Neither self-rated oral health nor oral impacts at wave 3 were associated to volunteering at wave 5 (OR=1.19; 95%CI:0.99-1.43 and OR=1.05; 95%CI:0.82-1.34) (Model 6). Noting that, however, the association between self-rated oral health and volunteering was marginally non-significant. In the autoregressive model, which adjusted for volunteering status at wave 3

(Model 7), a significant association was found between self-rated oral health and volunteering. Self-rated oral health at wave 3 was related to change in volunteering across waves 3 and 5 (OR=1.31; 95%CI:1.07-1.62).

Table 5.20: Association between oral health at wave 3 (2006-07) and volunteering status at wave 5 (2010-11): binary logistic regression models, OR (95%CI)

	Volunteering status at wave 5 (2010-11)		
	Model 1	**Model 6**	**Model 7**
Oral health at wave 3 (2006-07)	**Not volunteering vs. volunteering** Odds ratio (95% CI)	**Not volunteering vs. volunteering** Odds ratio (95% CI)	**Not volunteering vs. volunteering** Odds ratio (95% CI)
Self-rated oral health			
Good	1	1	1
Poor	1.53 (1.29-1.81)***	1.19 (0.99-1.43)	1.31 (1.07-1.62)*
Edentulousness			
Dentate	1	1	1
Edentate	2.40 (1.95-2.95)***	1.36 (1.09-1.70)**	1.20 (0.93-1.55)
OIDP			
No impact	1	1	1
At least 1 impact	1.43 (1.14-1.80)**	1.05 (0.82-1.34)	1.16 (0.87-1.54)

Model 1: contains the bivariate association between oral health measures at wave 3 (separately) and volunteering status at wave 5
Model 6: contains model 1 adjusted for socio-demographic, socio-economic, health, smoking status
Model 7: contains model 6 adjusted for baseline volunteering status
*$p< 0.05$; **$p< 0.01$; ***$p< 0.001$
N=5,338

5.3.4.3 Oral health at wave 3 (2006-07) predictors of number of close ties at wave 5 (2010-11)

The reference group for the outcome variable in Table 5.21 are respondents in the highest tertile of close ties (having more than 9 close ties), so the models predict the odds of having less than 7 close ties (lowest tertile) versus highest tertile at wave 5.

In the unadjusted models (Model 1), significant associations were found between all indicators of oral health and the lowest tertile of close ties. This suggests that poor oral health at wave 3 might contribute to reduce the group of close relationships among older people at wave 5. For example, compared to those respondents who reported good oral health at wave 3, respondents who reported poor oral health were more likely to have less than 7 close ties at wave 5 (RRR=1.73; 95%CI:1.42-2.11). Even after adjusting for baseline covariates (Model 6) the association remained significant for self-rated oral health and oral impacts (RRR=1.46; 95%CI:1.18-1.80 and RRR=1.38; 95%CI:1.03-1.84, respectively), while edentate status at wave 3 were no longer significantly associated with close ties at wave 5. Model 7 adjusted for baseline close ties, and examined the effect of self-rated oral health on change in the number of close ties. Compared to respondents who reported good oral health, those who reported poor oral health were more likely to have less than 7 close ties (lowest tertile) (RRR=1.38; 95%CI:1.09-1.75).

Table 5.21: Association between oral health at wave 3 (2006-07) and number of close ties at wave 5 (2010-11): multinomial logistic regression models, RRR (95%CI)

	Number of close ties at wave 5 (2010-11)		
	Model 1	**Model 6**	**Model 7**
Oral health at wave 3 (2006-07)	**Lowest tertile vs highest tertile** RRR (95% CI)	**Lowest tertile vs highest tertile** RRR (95% CI)	**Lowest tertile vs highest tertile** RRR (95% CI)
Self-rated oral health			
Good	1	1	1
Poor	1.73 (1.41-2.11)***	1.46 (1.18-1.80)***	1.38 (1.09-1.75)**
Edentulousness			
Dentate	1	1	1
Edentate	1.37 (1.10-1.71)**	1.20 (0.94-1.53)	1.15 (0.88-1.52)
OIDP			
No impact	1	1	1
At least 1 impact	1.62 (1.22-2.13)**	1.38 (1.03-1.84)*	1.24 (0.89-1.73)

Model 1: contains the bivariate association between oral health measures at wave 3 (separately) and number of close ties at wave 5
Model 6: contains model 1 adjusted for socio-demographic, socio-economic, health, smoking status, and number of close ties variables at wave 3
Model 7: contains model 6 adjusted for baseline number of close ties
**$p< 0.01$; ***$p< 0.001$
N=4,372

5.3.4.4 Oral health at wave 3 (2006-07) predictors of social support at wave 5 (2010-11)

Model 1 in Table 5.22 shows that respondents with poor self-rated oral health who were edentate and had reported at least one oral impact at wave 3 were more likely to have lower social support at wave 5. These oral health measures were more strongly associated with the risk of having the least social support (respondents who were in the lowest tertile of social support). For instance, respondents with poor self-rated oral health had a higher risk of having lower social support than those who reported good oral health (RRR=1.85; 95%CI:1.53-2.25). A stronger association was found for OIDP. The risk of being in the lowest tertile of social support versus the highest tertile was 2.32 (95%CI:1.75-3.09) times greater in respondents who had an oral impact than those who had no oral impact. The estimates of the association between the most subjective measures of oral health (self-rated oral health and OIDP) and social support were substantially reduced after adjusting for the baseline covariates but the associations were still statistically significant (Model 6). On the other hand, the association between edentate status and social support was explained after adjustment for baseline covariates. In Model 7, after accounting for baseline social support, only the association between OIDP and social support persisted (RRR=1.47; 95%CI:1.00-2.15).

Table 5.22: Association between oral health at wave 3 (2006-07) and social support at wave 5 (2010-11): multinomial logistic regression models, RRR (95%CI)

	Social support at wave 5 (2010-11)		
	Model 1	**Model 6**	**Model 7**
Oral health at wave 3 (2006-07)	**Lowest tertile vs highest tertile** RRR (95% CI)	**Lowest tertile vs highest tertile** RRR (95% CI)	**Lowest tertile vs highest tertile** RRR (95% CI)
Self-rated oral health			
Good	1	1	1
Poor	1.85(1.53-2.25)***	1.45 (1.16-1.81)**	1.27 (0.97-1.68)
Edentulousness			
Dentate	1	1	1
Edentate	1.66 (1.34-2.06)***	1.06 (0.81-1.38)	0.98 (0.72-1.35)
OIDP			
No impact	1	1	1
At least 1 impact	2.32 (1.75-3.09)***	1.83 (1.33-2.53)***	1.47 (1.00-2.15)*

Model 1: contains the bivariate association between oral health measures at wave 3 (separately) and social support at wave 5
Model 6: contains model 1 adjusted for socio-demographic, socioeconomic, health, smoking status
Model 7: contains model 6 adjusted for baseline social support
*p< 0.05; **p< 0.01; ***p< 0.001
N=4,903

A summary of the findings related to the reverse temporal order analysis will be presented in the next section when comparing these results to the previous longitudinal analysis.

5.4 Summary of the findings of the longitudinal associations between social capital and oral health

In the longitudinal analysis of social capital measures at wave 3 (2006-07) predicting oral health-related outcomes at wave 5 (2010-11), after adjusting for baseline covariates, different patterns of associations were found by type of social capital and oral health measures. Structural social capital (membership and volunteering) predicted future edentate status better than functional social capital (number of close ties and social support), but not of change in edentate status between waves 3 and 5. Functional social capital was related to self-rated oral health and oral impacts on daily performances. Furthermore, one of the functional measures of social capital, social support, was related to change in self-rated oral health and change in OIDP between baseline and follow-up.

In addition, there was evidence of effect modification between wealth and volunteering - ELSA respondents with lower wealth who volunteered at wave 3 had significantly lower odds of poor self-rated oral health compared to others who were also poor but did not volunteer. Volunteering did not affect the odds of poor self-rated oral health for ELSA respondents who were wealthier.

In the reverse temporal association of oral health at wave 3 predicting social capital at wave 5, ELSA respondents who had poor self-rated oral health were more likely to have fewer close ties and lower social support. Moreover, self-rated oral health was related to change in volunteering and close ties. Respondents who experienced at least one oral impact at wave 3 had a higher risk of lower number of close ties and lower social support, but OIDP was only related to change in social support. Being edentate was associated with not being a member of any organisation and volunteering and also associated to change in membership but not in volunteering.

It may be useful to summarise and compare these differential associations between different types of social capital and different oral health measures (Tables 5.23 and 5.24). When the models were adjusted for baseline covariates (Model 6 in Table 5.23) there was evidence of bi-directional associations between social capital and oral health. Furthermore, the relative risk ratios were of similar size in each direction. However, when the models were additionally adjusted for the baseline dependent variable (Model 7 in Table 5.24), differences in these bi-directional associations emerged. Poor self-rated oral health and edentulousness were associated with change in structural social capital, rather than social capital at baseline predicting change in these oral health measures. In contrast, the associations between lower functional social capital and change in self-rated oral health and OIDP were stronger when the direction of association was going from social capital to oral health rather than the opposite direction. Thus there appears to be differential temporal associations between different dimensions of social capital and oral health. Functional social capital appears to predict oral health-related quality of life, whereas poor oral health appears to predict social participation and the number of close ties. Chapter 7 discusses the implications for these differential temporal associations for the overall research question.

Table 5.23: Comparison of longitudinal associations between social capital w3 ⊙ oral health w5; and oral health w3 ⊙ social capital w5 (Model 6[1]), RRR (95%CI)

	Poor self-rated oral health	Edentate status	OIDP
	Model 6[1] RRR (95%CI)	Model 6[1] RRR (95%CI)	Model 6[1] RRR (95%CI)
Membership status Not a member	⊙ 1.18 (0.94-1.45) ← 1.13 (0.91-1.40)	⊙ **1.48 (1.18-1.87)*** ← **1.71 (1.32-2.21)*****	⊙ 0.82 (0.63-1.06) ← 0.97 (0.72-1.30)
Volunteering status Not volunteering	⊙ 1.13 (0.95-1.35) ← 1.19 (0.99-1.43)	⊙ **1.24 (1.01-1.52)*** ← **1.36 (1.09-1.70)***	⊙ 0.89 (0.72-1.10) ← 1.05 (0.82-1.34)
Close ties Lowest tertile	⊙ **1.29 (1.06-1.58)*** ← **1.46 (1.18-1.80)*****	⊙ 1.15 (0.92-1.44) ← 1.20 (0.94-1.53)	⊙ **1.56 (1.22-2.00)***** ← **1.38 (1.03-1.84)***
Social support Lowest tertile	⊙ **1.41 (1.13-1.75)**** ← **1.45 (1.16-1.81)****	⊙ 1.08 (0.84-1.40) ← 1.06 (0.81-1.38)	⊙ **2.14 (1.62-2.84)***** ← **1.83 (1.33-2.53)*****

⊙ Association between social capital at wave 3 and oral health at wave 5
← Association between oral health at wave 3 and social capital at wave 5
[1]Model adjusted for baseline covariates (but excluding baseline dependent variable)
*p< 0.05; **p< 0.01; ***p< 0.001

Table 5.24: Comparison of longitudinal associations between social capital w3 ⊙ oral health w5; and oral health w3 ⊙ social capital w5 (Model 7[1]), RRR (95%CI)

	Poor self-rated oral health	Edentate status	OIDP
	Model 7[1] RRR (95%CI)	Model 7[1] RRR (95%CI)	Model 7[1] RRR (95%CI)
Membership status Not a member	⊙ 1.09 (0.83-1.36) ← 0.99 (0.76-1.28)	⊙ 0.87 (0.57-1.32) ← **1.40 (1.03-1.92)***	⊙ 0.87 (0.63-1.13) ← 1.20 (0.84-1.71)
Volunteering status Not volunteering	⊙ 1.17 (0.97-1.41) ← **1.31 (1.07-1.62)***	⊙ 0.92 (0.64-1.31) ← 1.20 (0.93-1.55)	⊙ 0.89 (0.61-1.11) ← 1.16 (0.87-1.54)
Close ties Lowest tertile	⊙ 1.19 (0.96-1.47) ← **1.38 (1.09-1.75)****	⊙ 0.92 (0.61-1.36) ← 1.15 (0.88-1.52)	⊙ **1.44 (1.11-1.86)*** ← 1.24 (0.89-1.73)
Social support Lowest tertile	⊙ **1.27 (1.01-1.60)*** ← 1.27 (0.97-1.68)	⊙ 0.97 (0.61-1.53) ← 0.98 (0.72-1.35)	⊙ **1.94 (1.45-2.59)***** ← **1.47 (1.00-2.15)***

⊙ Association between social capital at wave 3 and oral health at wave 5
← Association between oral health at wave 3 and social capital at wave 5
[1]Model adjusted for baseline covariates and dependent variable
*p< 0.05; ** p< 0.01; *** p< 0.001

The next chapter explores the longitudinal association of social capital and oral health in greater detail by examining whether change in social capital over a 4 year period, between wave 3 (2006-07) and wave 5 (2010-11) were associated with change in oral health over the same period.

CHAPTER 6

ANALYSIS OF CHANGE IN ORAL HEALTH BY CHANGE IN SOCIAL CAPITAL BETWEEN WAVE 3 (2006-07) AND WAVE 5 (2010-11)

6.1 Introduction

A life course perspective analyses the transitions that occur within individual trajectories and how they make adjustments to change in their social environment. It is well documented that older adults who adjust to later life transitions by remaining socially active are happier and healthier than those who disengage from social activity (Cornwell et al., 2008). Research has demonstrated that social capital varies over time and is sensitive to life course transitions (Wrzus et al., 2013). For instance, life events that include bereavement and retirement might affect the structural and functional dimensions of social capital (Li and Ferraro, 2006; Cornwell et al., 2008). Social theories such as socio-emotional selectivity (Carstensen, 1991) and social convoy (Kahn and Antonucci, 1980) suggest that more peripheral relationships decrease throughout adulthood, whilst close ties with family and friends persist across the life course. Even though network size may decrease and membership in organisations may change, both theories lead to the hypotheses that the social support of older adults remains the same or actually increase over the life course (Wrzus et al., 2013).

Factors that determine health or susceptibility to disease are inherent in the dynamic interplay between the ageing process and the social and cultural change in society. Temporal variation in oral health may occur either when aetiological mechanisms of the disease, or when one or more distal causal factors, change in a favourable or unfavourable direction. For example, studies amongst older adults showed that life events such as tooth loss, financial strain (Slade, 1998) and self-reported need for oral treatment, and social and personal stressful circumstances (Locker and Jokovic, 1997) were associated with change in self-rated oral health.

The previous chapter examined the longitudinal association between measures of social capital at baseline wave 3 (2006-07) and the three oral health outcome variables at 4-year follow-up wave 5 (2010-11). The results showed that having fewer close ties, and lower social support were associated with poor self-rated oral health and oral impacts on daily performances, whereas not a member of any organisation and not volunteering were associated with edentate status, even after adjusting for a number of covariates at wave 3. However, after adjusting for the baseline dependent variable, structural social capital did not predict change in edentate status, while having few close ties and low social support predicted an increased risk of oral impact on quality of life. Furthermore lower social support was associated with an increased risk of poor self-rated oral health. The chapter also looked at the reverse temporal association of oral health at wave 3 predicting social capital at wave 5. The results showed some evidence that ELSA respondents with poorer oral health at wave 3 (poor self-rated oral health, being edentate, and OIDP) were more likely to have lower social capital at wave 5, even after adjustment for all the covariates at wave 3. Thus the temporal sequence of the association between social capital and oral health remains unclear. The results indicated that lower social capital predicted poorer oral health and vice versa.

In order to help establish whether lower social capital causes poor oral health, it is important to take confounding factors into account that could influence both social capital and oral health. While the analyses so far have adjusted for a number of covariates, there may be other confounders that are not measured in ELSA or not included in the analyses. One of the methods of reducing such unobserved confounding is the analysis of change in social capital and change in oral health (or modelling of change). By examining the association between the difference in social capital and the difference in oral health, all time invariant confounders such as gender, ethnicity and birth year are eliminated from the analysis (Allison, 2009). If respondents, who had a decrease in social capital between waves 3 and 5 of ELSA, also reported a worsening of their oral health status over the same period, this would suggest stronger evidence that social capital affects oral health. Similarly, one could expect that respondents who report a positive change in social capital would also report an improvement in their oral health status.

Although the longitudinal course of social capital and oral health is likely to be marked by fluctuation over time, no study has explored how the patterns of change in social capital relate to patterns of change in oral health across time. This chapter aims to fill this gap in our knowledge and examines the change in oral health-related outcomes that occurred over a four-year period, between wave 3 (2006-07) and wave 5 (2010-11) in the subset of the ELSA longitudinal analytical sample as defined in the previous chapter (Chapter 5, section 5.2). The research objective addresses the nature, size and direction of change in the three oral health outcomes and how they are associated with change in social capital. Do ELSA respondents whose social capital reduced between waves 3 and 5, also report a worsening of their oral health over the same period, and do those whose social capital increased report an improvement in their oral health?

The key hypothesis to be tested in this chapter is that positive change in social capital is associated with improvement in oral health. Similarly, negative change in social capital is associated with worsening oral health.

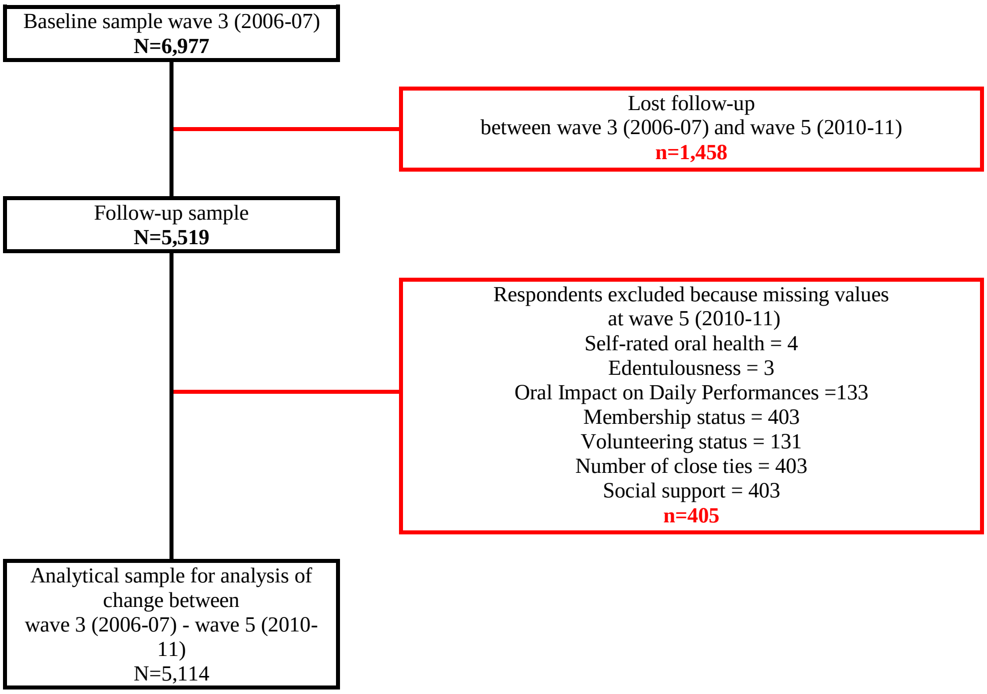
The longitudinal ELSA data allowed the creation of variables that demonstrate temporal change in aspects of oral health and social capital. This has been detailed in the chapter methodology, section 3.4, but a summary is provided below. The dependent variables of this chapter are change in individual's self-rated oral health, Oral Impacts on Daily Performances (OIDP) and edentulousness. Responses from both waves were combined to create new variables demonstrating change over time for self-rated oral health, OIDP and edentulousness. All these three indicators are generally referred to in this chapter as measures of oral health even though they measure different aspects of oral health as described in the methodology chapter, section 3.3. The variables of change in self-rated oral health and OIDP have three categories: no change in oral health; worsening of oral health (from good oral health / no oral impact at wave 3); improvement of oral health (from poor oral health / oral impact at wave 3). The variable change in edentulousness has two categories: no change in edentulousness; now edentate (from dentate at wave 3). As with the oral health dependent variables, responses from waves 3 and 5 were combined to create 'change over time' variables for the measures of social capital namely, membership status, volunteering, number of close ties and social support (no change, positive change, negative change). To explore whether there is any association between each of the social capital 'change over time' variables and each of the oral health 'change over time' variables, multinomial and binary logistic regression models were performed as follows: unadjusted models showing the association between change in social capital and change in oral health status; models adjusted for age; and fully adjusted models with socio-demographic (gender, cohabiting status); socio-economic (education, employment, wealth), health-related factors (self-rated general health, limiting long-standing illness, and depression), and smoking status at baseline (wave 3, 2006-07). Subjects whose oral health had remained the same over the past 4 years were used as a reference group and compared with those whose oral health had improved and those whose oral health has worsened. The methodology for examining the association between change in social capital and change in oral health has already been described in depth in the methodology chapter (section 3.4).

This chapter is structured in the following way: the next section (section 6.2) presents the longitudinal analytical sample and describes the characteristics of those respondents who did not answer the social capital questions at wave 5 but who were otherwise present at wave 5. Section 6.3 presents the characteristics of ELSA respondents who changed social capital between waves 3 and 5 (positive change, negative change, and stable). Section 6.4 presents the characteristics of the respondent whose oral health changed over the 4-year period. The results of the multinomial and binary logistic regression models of change are given in section 6.5 as prevalence (%) and relative risk ratios (RRRs) with 95% confidence intervals (95%CIs).

6.2 Analysis of change analytical sample

The sample used for analysis of change in social capital and change in oral health was a subset of the longitudinal dataset used in the previous chapter (see section 5.2, Figure 5.1) From the follow-up sample (N=5,519), that is, those who were present at both waves (wave 3 and wave 5), 405 participants were excluded because of missing data either on social capital measures or/and on oral heath outcome variables at wave 5 (Figure 6.1). This included 403 participants who did not return the self-completion questionnaire (which contains questions on membership status, close ties and social support) at wave 5 (2010-11). So, the respondents who did not return the self-completion questionnaire almost completely overlap with the respondents with missing data on the oral health measures and volunteering status. The number of participants thus included for the analysis of change is N=5,114, which is 271 less than the number of participants in the analytical sample for the longitudinal chapter (N=5,385) (see Chapter 5, section 5.2) and 1,863 less than the number of participants in the baseline sample wave 3 for the cross-sectional chapter (N=6,977) (see Chapter 4, section 4.2).

Figure 6.1: Analytical sample for analysis of change



Description of missingness: respondents who were excluded because of missing values at wave 5

The analysis of missingness in this section differs from the analysis of missingness in the longitudinal chapter (Chapter 5, section 5.2) because the participants in this analysis of change took part in ELSA wave 5, while the earlier chapter analysed missingness in terms of loss to follow-up from wave 3 to wave 5. As 7.3% of the follow-up analytical sample have missing data at wave 5, it is important to examine whether there are any predictors of this pattern of missingness, as this may bias the results.

Table 6.1 examines the wave 3 characteristics of those who were otherwise in ELSA wave 5, but did not return the self-completion questionnaire and did not answer the oral health and volunteering questions. These 'missing' participants who were excluded from analyses, were more likely to be men, aged 75 and over, with no educational qualification, suffering from depression, current smoker and those individuals with lower social support or those who did not answer to the social support measure at wave 3. There are some commonalities between these wave 3 predictors and the ones shown in the previous analysis of predictors of missing data for the follow-up analytical sample (see Chapter 5, section 5.2). The wave 3 predictors that were common to both sets of missing data analysis included age over 75 years, men, and no education. However, there were additional unique predictors of missingness for the analytical sample in this chapter, which included depression, current smoker and lower social support.

Table 6.1: Respondents with missing data on the self-completion questionnaire, oral health and volunteering status at wave 5 (2010-11) by characteristics at wave 3 (2006-07), % distribution and OR (95%CI)

Covariates W3	W5 missingness %	n missing/N	Odds ratio (95%CI)	Covariates W3	W5 missingness %	n missing/N	Odds ratio (95%CI)
Socio-demographic and socio-economic factors							
Gender				**Educational status**			
Men	7.9%	191/2,429	1	Education	6.0%	246/4,112	1
Women	6.9%	214/3,090	0.76 (0.61-0.95)*	No education	11.3%	159/1,407	1.34 (1.04-1.71)*
Age-group				**Labour market status**			
50-64	5.5%	160/2,919	1	In paid employment	5.4%	103/1,924	1
65-74	5.0%	78/1,569	1.00 (0.71-1.43)	Retired	8.2%	233/2,827	0.75 (0.53-1.07)
≥75	16.2%	167/1.031	3.49 (2.47-4.92)***	Others	9.0%	69/768	0.99 (0.69-1.43)
Cohabiting status				**Wealth quintile**			
Living with partner	6.4%	250/3,904	1	Wealthiest quintile	5.6%	76/1,365	1
No living with partner	9.6%	155/1,615	0.89 (0.67-1.17)	4th	6.1%	74/1,224	0.94 (0.67-1.32)
				3rd	7.7%	85/1,106	1.05 (0.75-1.48)
				2nd	7.3%	75/1.032	0.90 (0.63-1.30)
				Poorest quintile	12.0%	95/792	1.17 (0.80-1.71)
Health and behavioural factors							
Self-rated health				**Depression**			
Good	6.1	243/3,971	1	No	6.4%	289/4,532	1
Poor	10.5%	162/1,548	1.09 (0.83-1.32)	Yes	11.8%	116/987	1.53 (1.17-1.99)**
Long-standing illness				**Smoking status**			
No	6.3%	241/3,804	1	Never smoked	5.8%	126/2,178	1
Yes	9.6%	164/1,715	1.09 (0.84-1.40)	Ex-smoker	7.8%	201/2,594	1.19 (0.94-1.52)
				Current smoker	10.4%	78/747	1.69 (1.22-2.34)**
Oral health status							
Self-rated oral health				**OIDP**			
Good	7.1%	326/4,610	1	No impact	7.2%	364/5,076	1
Poor	8.7%	79/909	1.10 (0.83-1.48)	At least one impact	9.3%	41/443	0.98 (0.67-1.42)
Edentulousness							
Dentate	6.4%	305/4,763	1				
Edentate	13.2%	100/756	1.29 (0.98-1.70)				
Social capital indicators							
Membership status				**Number of close ties**			
Active member	5.9%	111/1,884	1	Highest tertile	6.1%	94/1,545	1
Passive member	7.4%	149/2,022	1.06 (0.80-1.39)	Middle tertile	5.9%	88/1,486	0.95 (0.69-1.29)
Not a member	8.8%	117/1,334	1.01 (0.74-1.38)	Lowest tertile	8.2%	144/1,752	1.10 (0.82-1.48)
Not answered	10.0%	28/279	1.04 (0.65-1.67)	Not answered	10.7%	79/736	1.23 (0.88-1.73)
Volunteering status				**Social support**			
Volunteering	5.4%	92/1,701	1	Highest tertile	4.7%	75/1,592	1
Not volunteering	8.2%	313/3,818	1.15 (0.88-1.51)	Middle tertile	7.5%	134/1,781	1.53 (1.12-2.09)**
				Lowest tertile	8.4%	162/1,921	1.40 (0.99-1.98)
				Not answered	15.1%	34/225	2.36 (1.47-3.79)***

*$p<0.05$; **$p<0.01$; ***$p<0.001$

N=5,519; n=405

6.3 Correlates of change in social capital between wave 3 (2006-07) and wave 5 (2010-11)

Table 6.2 displays the pattern of change of ELSA respondents for each social capital indicator between wave 3 (2006-07) and wave 5 (2010-11). Volunteering status was the most stable over time, with 80.5% of the respondents not changing in terms of volunteering status. There was around a 10.0% alteration in either negative or positive change in volunteering status between the waves. With membership status and close ties, a slightly greater percentage of respondents experienced a negative change (18.0% and 18.3%, respectively) compared to positive change (13.9% and 14.0%, respectively). However, for social support, this pattern was somewhat reversed. More respondents reported an increase in social support (around 17.0%) while a decrease in social support was observed for around 15.0% of the respondents. It appears that as ELSA respondents get older, their social networks tend to decrease on average (in terms of close ties and membership status), but their social support tends to improve. This observed pattern might support the socio-emotional selectivity theory (Carstensen, 1991) and social convoy model (Kahn and Antonucci, 1980) (see literature review, section 2.6).

Table 6.2: Percentage of respondent who change their social capital between wave 3 (2006-07) and wave 5 (2010-11)

Pattern of change	Membership	Volunteering	Number of close ties	Social support
No change	58.8%	80.5%	44.1%	61.6%
Negative change	18.0%	10.0%	18.3%	14.9%
Positive change	13.9%	9.5%	14.0%	16.5%
Not answered	9.3%	N/A	23.5%	7.1%

N=5,114

Tables 6.3 to 6.6 show the descriptive characteristics of the ELSA respondents who changed their social capital from wave 3 (2006-07) to wave 5 (2010-11). The columns in each of these tables show the percentage of respondents who did not change their social capital; who decreased their social capital; who increased their social capital, and who did not answer any of the social capital questions between waves 3 to 5, by selected categories of the wave 3 covariates (the categories of the highest risk for poor oral health). The final column in the tables shows the p-value (Pearson chi-square test) of whether the distribution of the wave 3 covariates significantly differs between the columns.

6.3.1 Correlates of change in membership status

Table 6.3 shows the distribution of change in the membership status by selected categories of the wave 3 covariates. Nearly 32.0% of the whole sample experienced a change in membership between waves 3 and 5. Respondents who had a negative change (18.0%, n=923) were those who went from active members to passive or not members of any organisation, or who went from passive to not members. In contrast, respondents who had a positive change (13.9%, n=709) were those who went from passive to active members, or from not members to either passive or active members. Respondents who had a negative change were more likely to be older (age 75+), have poor self-rated general health and limiting long-standing illness. Respondents who had a positive change were more likely to be younger (age 55-64), employed, in the highest wealth quintile, and to be a non-smoker. Respondents who did not answer the social capital questions at either wave (9.3%, n=476) were more likely to be older, to have no education, retired, poorest, poor self-rated general health, limiting long-standing illness, and depressed.

Table 6.3: Correlates of change in membership status between wave 3 (2006-07) and wave 5 (2010-11), % distribution

Covariates at wave 3	No change n=3,006	Negative change n=923	Positive change n=709	Not answered n=476	p-value (df)[1]
Female	55.7%	54.9%	57.0%	61.1%	0.12 (3)
Age 75 +	15.3%	19.8%	13.7%	25.8%	<0.01 (6)
No cohabiting	27.9%	28.8%	28.1%	32.8%	0.18 (3)
No education	23.1%	21.8%	20.0%	44.3%	<0.01 (3)
Retired	50.5%	52.8%	46.5%	54.2%	<0.01 (6)
Poorest wealth quintile	12.6%	13.5%	11.7%	22.9%	<0.01(12)
Poor self-rated health	25.5%	30.0%	23.8%	37.8%	<0.01 (3)
Long-standing illness	29.1%	33.4%	28.2%	35.5%	<0.01 (3)
Depression	16.3%	16.1%	17.5%	22.5%	<0.01 (3)
Smoker	13.1%	12.9%	9.9%	18.3%	<0.01 (6)

[1]Pearson chi-square
N=5,114

6.3.2 Correlates of change in volunteering status

Regarding volunteering status, a negative change in volunteering refers to those respondents who were volunteering at wave 3 but did not volunteer at wave 5 (10.0%, n=511). On the other hand, those respondents who were not volunteering at wave 3 but were involved in voluntary work at wave 5, were described as having a positive change over the 4-year period (9.5%, n=486). Overall 19.5% of the sample changed their volunteering status from wave 3 to wave 5.

The distribution of change in volunteering status by selected covariates displayed in Table 6.4 shows that respondents who were older, more educated, retired and with long-standing illness at wave 3 were more likely to stop volunteering between waves 3 and 5.

A positive change in volunteering was associated with being younger, more educated, employed, and wealthier.

Table 6.4: Correlates of change in volunteering status between wave 3 (2006-07) and wave 5 (2010-11), % distribution

Covariates at wave 3	No change n=4,117	Negative change n=511	Positive change n=486	p-value (df)[1]
Female	55.6%	58.3%	59.9%	0.12 (2)
Age 75 +	17.3%	21.9%	8.2%	<0.01 (4)
No cohabiting	28.4%	29.9%	28.8%	0.75 (2)
No education	26.0%	18.6%	24.4%	<0.01 (2)
Retired	50.7%	56.4%	45.1%	<0.01 (4)
Poorest wealth quintile	14.3%	12.1%	9.7%	<0.01 (8)
Poor self-rated health	27.7%	24.5%	24.9%	0.15 (2)
Long-standing illness	30.5%	33.7%	25.1%	0.01 (2)
Depression	17.1%	16.8%	17.1%	0.99 (2)
Smoker	14.0%	8.8%	9.9%	<0.01 (4)

[1]Pearson chi-square
N=5,114

6.3.3 Correlates of change in number of close ties

Of the 5,114 respondents, 32.3% had either an increase or decrease in number of close ties. A positive change in the number of close ties related to an increase in close ties for ELSA respondents between waves 3 and 5 (14.0%, n=718). Similarly each categorical unit decrease in number of close ties referred to a negative change between waves 3 and 5 (18.3%, n=937).

Individuals aged 75 and over, with no education achievement, and employed were more likely to reduce the number of close ties between the two waves. Those who reported an increase in the number of close ties were more likely not to suffer from limiting long-standing illness. Those who did not answer the question (23.5%, n=1,204) were more likely to be older, with no education, retired, from the poorest wealth quintile, with poor health in terms of self-rated general health, limiting long-standing illness and depression (Table 6.5).

Table 6.5: Correlates of change in number of close ties between wave 3 (2006-07) and wave 5 (2010-11), % distribution

Covariates at wave 3	No change n=2,255	Negative change n=937	Positive change n=718	Not answered n=1,204	p-value (df)[1]
Female	57.7%	58.6%	56.7	51.4	<0.01 (3)
Age 75 +	13.0%	17.3%	12.5	26.4	<0.01 (6)
No cohabiting	28.9%	25.5%	25.4	32.1	<0.01 (3)
No education	19.7%	23.4%	20.9	36.1	<0.01 (3)
Retired	47.0%	44.8%	50.1	62.7	<0.01 (6)
Poorest wealth quintile	13.0%	12.3%	12.0	16.8	<0.01 (12)
Poor self-rated health	25.9%	23.3%	24.0	34.1	<0.01 (3)
Long-standing illness	29.8%	29.6%	24.1	35.7	<0.01 (3)
Depression	16.8%	14.4%	16.2	20.0	<0.01 (3)
Smoker	13.2%	12.9%	12.1	13.5	0.47 (6)

[1]Pearson chi-square
N=5,114

6.3.4 Correlates of change in social support

Nearly one third (31.4%) of respondents in the analysis of change sample reported a change in social support from baseline to 4-year follow-up. Respondents who were older and living with a partner were more likely to have a decrease in social support (negative change 14.9%, n=760). Those who reported a positive change (16.5%, n=843) were least likely to have poor self-rated health at wave 3. Those who did not answer the question (7.1%, n=362) were more likely to be older, with no education, retired, and with poorer health (Table 6.6).

Table 6.6: Correlates of change in social support between wave 3 (2006-07) and wave 5 (2010-11), % distribution

Covariates at wave 3	No change n=3,149	Negative change n=760	Positive change n=843	Not answered n=362	p-value (df)[1]
Female	56.9%	54.9%	53.9%	58.6%	0.27 (3)
Age 75 +	15.1%	20.5%	14.9%	29.3%	<0.01 (6)
No cohabiting	32.2%	14.6%	27.1%	29.8%	<0.01 (3)
No education	22.0%	27.2%	25.9%	35.6%	<0.01 (3)
Retired	48.8%	53.3%	49.6%	64.9%	<0.01 (6)
Poorest wealth quintile	13.2%	12.4%	15.2%	16.3%	0.37 (12)
Poor self-rated health	26.8%	28.8%	24.7%	32.0%	0.04 (3)
Long-standing illness	29.7%	31.6%	29.1%	35.9%	0.07 (3)
Depression	17.5%	14.9%	16.6%	18.8%	0.28 (3)
Smoker	13.0%	13.8%	13.5%	11.1%	0.02 (6)

[1]Pearson chi-square
N=5,114

In general, the results demonstrated that ELSA respondents who increased their social capital between waves 3 and 5 were younger, wealthier and had better self-rated general health. Similarly, those who had worse social capital across waves were older, poorer and had worse general health. Respondents who did not answer the social capital questions at both waves were more likely to be older, to have no education, and to be retired.

6.4 Correlates of change in oral health between wave 3 (2006-07) and wave 5 (2010-11)

The pattern of change in oral health of the ELSA respondents is shown in Table 6.7. Overall a low percentage (less than 10.0%) of respondents experienced change in their oral health during the 4-year follow-up. 8.5% of respondents reported a worsening in self-rated oral health whereas 8.1% reported an improvement. In the sample 6.6% reported a decline in their oral health-related quality of life (OIDP) and 4.7% reported an improvement. From wave 3 to wave 5, 2.1% of the sample became edentate.

Table 6.7: Percentage of respondents who changed the oral health between wave 3 (2006-07) and wave 5 (2010-11)

Pattern of change	Self-rated oral health	Edentulousness	OIDP
No change	83.4%	97.9%	88.4%
Worsening in oral health	8.5%	2.1%	6.6%
Improvement in oral health	8.1%	n/a	4.7%

N=5,114

6.4.1 Correlates of change in self-rated oral health between wave 3 (2006-07) and wave 5 (2010-11)

Nearly 17.0% of the sample reported a change in their self-rated oral health. In Table 6.8 respondents in the three groups of self-rated oral health (no change, worsening and improvement) were similar in terms of socio-demographic characteristics and education ($p>0.05$). However, respondents who had a worsening in self-rated oral health (8.5%, n=435) were more likely to be retired, with long-standing illness, depressed and smokers. Respondents who had an improvement in self-rated oral health (8.1%, n=414) were more likely to be in paid employment, and in the poorest quintile of wealth.

Table 6.8: Correlates of change in self-rated oral health between wave 3 (2006-07) and wave 5 (2010-11), % distribution

Covariates at wave 3	No change in SROH n=4,265	Worsening of SROH n=435	Improvement of SROH n=414	p-value (df)[1]
Female	56.4%	52.6%	58.0%	0.24 (2)
Age 75 +	16.9%	18.4%	15.7%	0.75 (4)
No cohabiting	28.1%	30.1%	31.6%	0.24 (2)
No education	23.8%	27.1%	28.0%	0.06 (2)
Retired	50.7%	51.7%	49.5%	<0.01 (4)
Poorest wealth quintile	12.3%	17.9%	18.4%	<0.01 (8)
Poor self-rated health	24.4%	40.7%	40.3%	<0.01 (2)
Limiting long-standing illness	28.5%	40.9%	38.2%	<0.01 (2)
Depression	15.3%	27.4%	24.1%	<0.01 (2)
Smoker	12.0%	19.1%	17.6%	<0.01 (2)

[1]Pearson chi-square
N=5,114

6.4.2 Correlates of change in edentulousness between wave 3 (2006-07) and wave 5 (2010-11)

Regarding edentulousness, 2.1% (n=108) of the sample became edentate. These respondents were more likely to be older, living alone, with no educational qualification, retired, in the poorest quintile of wealth, with poor health and smokers.

Table 6.9: Correlates of change in edentulousness between wave 3 (2006-07) and wave 5 (2010-11), % distribution

Covariates at wave 3	No change in edentulousness n=5,006	Became edentate n=108	p-value (df)[1]
Female	56.2%	59.3%	0.52 (1)
Age 75 +	16.7%	24.1%	<0.01 (2)
No cohabiting	28.4%	37.0%	0.04 (1)
No education	24.2%	33.3%	0.03 (1)
Retired	50.3%	69.4%	<0.01 (2)
Poorest wealth quintile	13.5%	19.4%	0.01 (4)
Poor self-rated health	26.8%	38.9%	<0.01 (1)
Limiting long-standing illness	30.1%	40.7%	0.01 (1)
Depression	16.9%	23.1%	0.08 (1)
Smoker	12.9%	21.3%	0.03 (2)

[1]Pearson chi-square
N=5,114

6.4.3 Correlates of change in Oral Impacts on Daily Performances between wave 3 (2006-07) and wave 5 (2010-11)

Overall, 12.8% of the sample reported a change in their oral health-related quality of life. There was no difference between the groups of change in OIDP in terms of gender and age (*$p>0.05$*). However compared to those who did not report a change in their oral health-related quality of life, those who reported a change in OIDP (either a worsening or an improvement) were more likely to be living alone, with no education, retired, in the poorest wealth quintile, with worse health and smokers. In general, those who reported an improvement in OIDP (4.7%, n=242) were more strongly correlated with these characteristics.

It may appear strange that an improvement in OIDP is associated with low socio-economic position and poor health. However, the respondents who reported an improvement in OIDP would have reported an OIDP at baseline, which was associated with lower socio-economic position and poor health. Hence an improvement in OIDP is more likely among respondents with lower socio-economic position and poor health at baseline.

Table 6.10: Correlates of change in Oral Impact on Daily Performances between wave 3 (2006-07) and wave 5 (2010-11), % distribution

Covariates at wave 3	No change in OIDP n=4,533	Worsening of oral health n= 339	Improvement of oral health n=242	p-value (df)[1]
Female	56.2%	54.0%	60.3%	0.31 (2)
Age 75 +	16.9%	15.3%	18.6%	0.23 (4)
No cohabiting	27.8%	34.2%	35.1%	<0.01 (2)
No education	23.9%	27.1%	30.2%	0.04 (2)
Retired	13.3%	15.6%	18.6%	<0.01 (4)
Poorest wealth quintile	12.9%	17.1%	21.5%	<0.01 (8)
Poor self-rated health	25.3%	40.1%	43.0%	<0.01 (2)
Limiting long-standing illness	28.6%	41.3%	48.3%	<0.01 (2)
Depression	15.7%	24.5%	31.0 %	<0.01 (2)
Smoker	12.1%	19.8%	21.9%	<0.01 (4)

[1]Pearson chi-square
N=5,114

6.5 Analysis of change in oral health by change in social capital between wave 3 (2006-07) and wave 5 (2010-11)

This section presents the analysis of change results as prevalence (%) and relative risk ratios (RRRs) of worsening and improving oral health between wave 3 (2006-07) and wave 5 (2010-11) by change in social capital over the same period. The prevalence percentage refers to those individuals whose oral health status had changed within each social capital measure investigated. Multinomial and binary logistic regression models were run, first showing the unadjusted RRR / OR, and then adjusted for age and finally adjusted for all significant covariates measured at wave 3 (age, gender, cohabiting status, education, employment status, wealth, self-rated general health, limiting long-standing illness, depression, and smoking status). Results of the crude, age-adjusted and fully adjusted models are shown in Tables 6.11 to 6.16.

6.5.1 Analysis of change in social capital on change in self-rated oral health between wave 3 (2006-07) and wave 5 (2010-11)

In the 4 years between waves 3 and 5, 8.5% of the ELSA respondents reported that their oral health had worsened and 8.1% that it had improved. The crude unadjusted results in Table 6.11 show that only those respondents whose social support had decreased by wave 5 (2010-11) were at an increased risk of deteriorating their self-rated oral health. Compared to those who did not change their self-rated oral health and those whose social support was stable over the 4-year period, respondents who had a negative change in social support were 1.47 (95%CI:1.14-1.90) times more likely to report worse oral health over the same period.

Following simultaneous adjustment for all covariates, negative change in social support maintained its significant association with an increased risk of deteriorating self-rated oral health. The effect remained practically the same (RRR=1.46; 95%CI:1.11-1.91) (Table 6.12). Although confidence intervals did not consistently exclude 1, the direction of effects suggested a deteriorating self-rated oral health associated with a negative change in membership status (RRR=1.20; 95%CI:0.93-1.55).

Table 6.11: Analysis of change in social capital on change in self-rated oral health between wave 3 (2006-07) and wave 5 (2010-11): unadjusted multinomial logistic regression models, % distribution and RRR (95%CI)

Change over time social capital	Change in self-rated oral health					
	Worsening of oral health vs no change			Improvement of oral health vs no change		
	Prevalence	n/N	RRR (95%CI)	Prevalence	n/N	RRR (95%CI)
Membership status						
No change	8.1%	243/3,006	1	8.1%	243/3,006	1
Positive change	7.5%	53/709	0.92 (0.68-1.26)	8.8%	61/709	1.06 (0.79-1.43)
Negative change	9.6%	89/923	1.20 (0.93-1.55)	7.3%	67/923	0.91 (0.68-1.20)
Not answered	10.5%	50/476	1.35 (0.98-1.87)	8.6%	43/476	1.16 (0.83-1.64)
Volunteering status						
No change	8.8%	361/4,117	1	8.1%	335/4,117	1
Now volunteering	8.0%	39/486	0.90 (0.63-1.27)	7.2%	35/486	0.87 (0.60-1.25)
Now not volunteering	6.9%	35/511	0.77 (0.55-1.10)	8.6%	44/511	1.04 (0.75-1.45)
Number of close ties						
No change	8.5%	190/2,255	1	7.8%	175/2,255	1
Positive change	7.2%	52/718	0.84 (0.61-1.15)	6.6%	47/718	0.82 (0.59-1.15)
Negative change	8.6%	80/937	1.03 (0.78-1.35)	8.9%	82/937	1.14 (0.87-1.50)
Not answered	9.4%	113/1,204	1.15 (0.90-1.46)	9.1%	110/1,204	1.21 (0.94-1.56)
Social support						
No change	8.2%	258/3,149	1	7.8%	243/3,149	1
Positive change	6.4%	54/843	0.78 (0.57-1.05)	8.9%	75/843	1.14 (0.87-1.50)
Negative change	11.5%	87/760	1.47 (1.14-1.90)**	8.7%	66/760	1.18 (0.89-1.58)
Not answered	9.9%	36/362	1.25 (0.86-1.81)	8.3%	30/362	1.10 (0.74-1.64)
Total	8.5%	435/5,114		8.1%	414/5,114	

Ref: no change in self-rated oral health
***p<0.01*

Table 6.12: Analysis of change in social capital on change in self-rated oral health between wave 3 (2006-07) and wave 5 (2010-11): adjusted multinomial logistic regression models, RRR (95%CI)

Change over time social capital	Change in self-rated oral health			
	Worsening of oral health vs no change		Improvement of oral health vs no change	
	RRR (95%CI)[1]	RRR (95%CI)[2]	RRR (95%CI)[1]	RRR (95%CI)[2]
Membership status				
No change	1	1	1	1
Positive change	0.92 (0.68-1.26)	0.95 (0.69-1.30)	1.06 (0.79-1.42)	1.08 (0.80-1.45)
Negative change	1.20 (0.93-1.55)	1.15 (0.89-1.50)	0.91 (0.69-1.21)	0.88 (0.66-1.17)
Not answered	1.34 (0.97-1.85)	1.20 (0.86-1.67)	1.19 (0.86-1.67)	1.01 (0.71-1.44)
Volunteering status				
No change	1	1	1	1
Now volunteering	0.91 (0.64-1.28)	0.97 (0.68-1.37)	0.86 (0.59-1.23)	0.90 (0.62-1.30)
Now not volunteering	0.76 (0.53-1.10)	0.79 (0.55-1.14)	1.04 (0.75-1.45)	1.10 (0.79-1.54)
Number of close ties				
No change	1	1	1	1
Positive change	0.84 (0.61-1.15)	0.86 (0.62-1.19)	0.82 (0.59-1.15)	0.84 (0.60-1.18)
Negative change	1.02 (0.78-1.35)	1.07 (0.81-1.41)	1.15 (0.87-1.51)	1.18 (0.89-1.55)
Not answered	1.13 (0.88-1.45)	1.04 (0.81-1.34)	1.25 (0.97-1.61)	1.14 (0.88-1.49)
Social support				
No change	1	1	1	1
Positive change	0.78 (0.57-1.05)	0.79 (0.58-1.07)	1.15 (0.87-1.50)	1.14 (0.87-1.50)
Negative change	1.46 (1.13-1.90)**	1.46 (1.11-1.90)**	1.20 (0.90-1.59)	1.19 (0.89-1.60)
Not answered	1.24 (0.85-1.79)	1.21 (0.83-1.77)	1.14 (0.76-1.70)	1.11 (0.74-1.67)

[1]Age-adjusted; [2]Fully adjusted
Ref: no change in self-rated oral health
***p<0.01*

6.5.2 Analysis of change in social capital on change in edentulousness between wave 3 (2006-07) and wave 5 (2010-11)

Table 6.13 shows the association between change in social capital between waves 3 and 5, and change in edentulousness, that is, from being dentate to edentate over the 4-year period. Around 2.1% of ELSA respondents who were dentate at wave 3 became edentate by wave 5. The rates of becoming edentate did not vary much between the categories of change in social capital. However, ELSA respondents who did not answer the social capital questions at both waves had higher risks of becoming edentate. The crude association was significant for membership status (OR=2.06; 95%CI:1.18-3.59), and borderline for the number of close ties (OR=1.57; 95%CI:0.99-2.49). After adjusting for the wave 3 covariates (Table 6.14), respondents who did not answer the membership questions at both waves still had higher risks of becoming edentate (OR=1.69; 95%CI:0.95-3.00), although the association was marginally not significant. The small proportion of respondents who became edentate suggests that there may not be enough power to detect significant differences between change in the social capital categories.

Table 6.13: Analysis of change in social capital on change in edentulousness between wave 3 (2006-07) and wave 5 (2010-11): unadjusted binary logistic regression models, % distribution and OR (95%CI)

Change over time social capital	**Change in edentulousness**		
	Now edentate vs no change		
	Prevalence	n/N	OR (95%CI)
Membership status			
No change	1.8%	53/3,006	1
Positive change	2.1%	15/709	1.20 (0.67-2.15)
Negative change	2.5%	23/923	1.42 (0.87-2.34)
Not answered	3.6%	17/476	2.06 (1.18-3.59)*
Volunteering status			
No change	2.0%	84/4,117	1
Now volunteering	2.7%	13/486	1.32 (0.73-2.38)
Now not volunteering	2.2%	11/511	1.06 (0.56-1.99)
Number of close ties			
No change	1.8%	41/2,255	1
Positive change	2.0%	14/718	1.07 (0.58-1.98)
Negative change	2.0%	19/937	1.12 (0.65-1.94)
Not answered	2.8%	34/1,204	1.57 (0.99-2.49)
Social support			
No change	2.1%	67/3,149	1
Positive change	1.7%	14/843	0.78 (0.43-1.39)
Negative change	2.2%	17/760	1.05 (0.61-1.80)
Not answered	2.8%	10/362	1.31 (0.67-2.56)
Total	2.1%	108/5,114	

Ref: no change in edentulousness
*$p<0.05$

Table 6.14: Analysis of change in social capital on change in edentulousness between wave 3 (2006-07) and wave 5 (2010-11): adjusted binary logistic regression models, OR (95%CI)

Change over time social capital	Change in edentulousness	
	Now edentate vs no change	
	OR (95%CI)[1]	OR (95%CI)[2]
Membership status		
No change	1	1
Positive change	1.23 (0.69-2.20)	1.29 (0.72-2.31)
Negative change	1.38 (0.84-2.26)	1.36 (0.83-2.25)
Not answered	1.91 (1.09-3.34)*	1.69 (0.95-3.00)
Volunteering status		
No change	1	1
Now volunteering	1.45 (0.80-2.62)	1.56 (0.86-2.86)
Now not volunteering	1.02 (0.54-1.94)	1.09 (0.58-2.08)
Number of close ties		
No change	1	1
Positive change	1.05 (0.57-1.95)	1.06 (0.57-1.97)
Negative change	1.10 (0.63-1.91)	1.15 (0.66-1.99)
Not answered	1.35 (0.85-2.16)	1.27 (0.79-2.04)
Social support		
No change	1	1
Positive change	0.77 (0.43-1.37)	0.77 (0.43-1.39)
Negative change	0.99 (0.57-1.69)	0.98 (0.57-1.71)
Not answered	1.09 (0.55-2.15)	1.04 (0.52-2.06)

[1]Age-adjusted; [2]Fully adjusted
Ref: no change in edentulousness
*$p<0.05$

6.5.3 Analysis of change in social capital on change in Oral Impacts on Daily Performances (OIDP) between wave 3 (2006-07) and wave 5 (2010-11)

The results in Table 6.15 show the association (unadjusted RRRs) between change in the social capital and change in OIDP. Only 6.6% of the analytical sample reported worsening of their oral health-related quality of life (OHRQoL) - they went from having no oral impact on their daily life to at least experiencing one OIDP between waves 3 and 5 of ELSA. Furthermore, 4.7% of the analytical sample reported an improvement in their OHRQoL, going from having at least one OIDP at wave 3 to no OIDP at wave 5. The small percentage of people who changed their OHRQoL between waves 3 and 5 suggests that it may not be possible to detect significant differences in change in OIDP between the social capital categories.

The results show little association between change in social capital and change in OIDP. However, although the association was marginally not significant, ELSA respondents who reported a positive change in membership status were less likely to have worsening oral health related quality of life (RRR= 0.70; 95%CI= 0.48-1.00) even after adjusting for the covariates (RRR=0.70; 95%CI:0.48-1.02) (Table 6.16). In other words, those who started participating more actively in organisations were more likely to improve their OHRQoL. Also, ELSA respondents who did not answer the social capital questions were more likely to have a positive improvement in OIDP (RRR=1.75; 95%CI:1.20-2.55). However, on closer examination, it appears that this was not due to decreased rates of OIDP between wave 3 and wave 5 among those who did not answer the social capital questions, but due to the increased rates of OIDP among those who remained stable in terms of membership status. Thus, the apparent improvement in oral health-related quality of life among the ELSA respondents who did not answer the social capital questions was mainly due to the worsening of oral health among the stable group. After adjusting for all the covariates, the RRR reduced to 1.48 (1.02-2.19) and still remained significant (Table 6.16).

Table 6.15: Analysis of change in social capital on change in Oral Impacts on Daily Performances (OIDP) between wave 3 (2006-07) and wave 5 (2010-11): unadjusted multinomial logistic regression models, % distribution and RRR (95%CI)

Change over time social capital	**Change in Oral Impacts on Daily Performances**					
	Worsening of oral health vs no change			Improvement of oral health vs no change		
	Prevalence	n/N	RRR (95%CI)	Prevalence	n/N	RRR (95%CI)
Membership status						
No change	6.8%	205/3,006	1	4.6%	139/3,006	1
Positive change	4.9%	35/709	0.70 (0.48-1.00)	3.1%	22/709	0.65 (0.41-1.02)
Negative change	7.0%	65/923	1.04 (0.78-1.39)	4.8%	44/923	1.03 (0.73-1.47)
Not answered	7.1%	34/476	1.09 (0.75-1.59)	7.8%	37/476	1.75 (1.20-2.55)**
Volunteering status						
No change	6.8%	278/4,117	1	4.6%	190/4,117	1
Now volunteering	6.4%	31/486	0.94 (0.64-1.39)	4.9%	24/486	1.07 (0.69-1.65)
Now not volunteering	5.9%	30/511	0.87 (0.59-1.28)	5.5%	28/511	1.19 (0.79-1.79)
Number of close ties	6.3%	142/2,255	1	4.7%	105/2,255	1
No change	8.1%	58/718	1.30 (0.95-1.79)	4.2%	30/718	0.91 (0.60-1.38)
Positive change	5.6%	52/937	0.87 (0.62-1.20)	3.7%	35/937	0.78 (0.53-1.16)
Negative change	7.2%	87/1,204	1.18 (0.89-1.55)	6.0%	72/1,204	1.32 (0.97-1.79)
Not answered						
Social support						
No change	6.6%	209/3,149	1	4.6%	145/3,149	1
Positive change	7.2%	61/843	1.09 (0.81-1.47)	4.4%	37/843	0.96 (0.66-1.39)
Negative change	5.9%	45/760	0.89 (0.64-1.24)	4.9%	37/760	1.05 (0.73-1.52)
Not answered	6.6%	24/362	1.02 (0.66-1.58)	6.4%	23/362	1.41 (0.89-2.22)
Total	6.6%	339/5,114		4.7%	242/5,514	

Ref: no change in OIDP
***p<0.01*

Table 6.16: Analysis of change in social capital on change in Oral Impacts on Daily Performances (OIDP) between wave 3 (2006-07) and wave 5 (2010-11): adjusted multinomial logistic regression models, RRR (95%CI)

Change over time social capital	**Change in Oral Impacts on Daily Performances**			
	Worsening of oral health vs no change		Improvement of oral health vs no change	
	RRR (95%CI)[1]	RRR (95%CI)[2]	RRR (95%CI)[1]	RRR (95%CI)[2]
Membership status				
No change	1	1	1	1
Positive change	0.70 (0.48-1.00)	0.70 (0.48-1.02)	0.65 (0.41-1.03)	0.65 (0.41-1.03)
Negative change	1.04 (0.78-1.39)	0.99 (0.74-1.33)	1.03 (0.72-1.45)	0.98 (0.69-1.40)
Not answered	1.10 (0.76-1.61)	0.97 (0.66-1.44)	1.72 (1.17-2.50)**	1.48 (1.01-2.19)*
Volunteering status				
No change	1	1	1	1
Now volunteering	0.93 (0.63-1.37)	0.97 (0.66-1.43)	1.10 (0.71-1.70)	1.19 (0.76-1.85)
Now not volunteering	0.87 (0.59-1.29)	0.89 (0.60-1.31)	1.18 (0.78-1.77)	1.24 (0.82-1.88)
Number of close ties				
No change	1	1	1	1
Positive change	1.30 (0.95-1.79)	1.35 (0.97-1.86)	0.90 (0.60-1.37)	0.96 (0.63-1.46)
Negative change	0.87 (0.63-1.21)	0.90 (0.65-1.25)	0.79 (0.53-1.16)	0.81 (0.55-1.20)
Not answered	1.20 (0.91-1.59)	1.10 (0.83-1.47)	1.26 (0.92-1.73)	1.17 (0.85-1.62)
Social support				
No change	1	1	1	1
Positive change	1.09 (0.81-1.47)	1.11 (0.82-1.50)	0.95 (0.66-1.38)	0.98 (0.67-1.42)
Negative change	0.89 (0.64-1.25)	0.90 (0.64-1.27)	1.03 (0.71-1.50)	1.03 (0.71-1.52)
Not answered	1.03 (0.66-1.61)	1.03 (0.66-1.61)	1.32 (0.84-2.10)	1.27 (0.79-2.03)

[1]Age-adjusted; [2]Fully adjusted
Ref: no change in OIDP
*$p<0.05$; **$p<0.01$

6.6 Summary of the findings of the analysis of change

This chapter examined the association between change in social capital on change in oral health over a 4-year follow-up period (ELSA wave 3 (2006-07) and wave 5 (2010-11). Out of the twelve models of change investigated (four social capital indicators by three measures of oral health), the findings revealed that there were only one statistically significant and one marginally significant association between the social capital measures and oral health outcomes.

It was shown that a negative change in social support was related to a worsening self-rated oral health across the two waves. ELSA respondents who reported a negative change in social support were 1.47 (95%CI:1.14-1.90) times more likely to report a worsening in their oral health compared to those with stable social support and oral health. Moreover, this association did not change and remained statistically significant even after adjusting for the baseline covariates. Nearly 15.0% (N=760) of the analytical sample (N=5,114) reported a negative change in social support. The analysis of the determinants of change in social support showed that respondents who were older, and living with partner at wave 3 were more likely to have a decrease in social support. It may be that some of this decrease in social support may be due to older ELSA respondents who were cohabiting at wave 3 and had lost their partners by wave 5. This loss in their social capital could have had a negative impact on their self-rated oral health.

In addition, those respondents who had a positive change in membership status were less likely to have a worsening of the oral health-related quality of life (OIDP), even though the relative risk ratio was of borderline significance in the unadjusted model (RRR=0.70; 95%CI:0.48-1.00) and marginally no significant in the fully adjusted model (RRR=0.70; 95%CI:0.48-1.02). Around 14.0% of the analytical sample (N=5114) had a positive change in membership status (going from either no membership to membership or from passive to active membership). These respondents were more likely to be younger (age 55-64), in employment, in the highest wealth quintile, and to be a non-smoker at wave 3. It may be that some of this increase in social capital may be due to these younger, wealthy, and employed ELSA respondents retiring and having the time to join and take more actively part in organisations such as charitable and religious associations, leisure groups amongst other. This increase in social capital could have had a positive impact on their oral health-related quality of life.

However, the results described above need to be interpreted with caution. As already mentioned, nearly all the other analyses of change did not show any associations in the hypothesised directions. Furthermore, the results may be biased by problems with missing data as described in section 6.2, and hence the analyses may lead to type 1 and type 2 errors resulting in incorrect inferences.

A full discussion and interpretation of these results in relation to potential biases generated by missing data will be detailed in the discussion chapter, section 7.5.2.

CHAPTER 7

DISCUSSION

7.1 Introduction

The overall aim of this thesis was to investigate whether social capital was a determinant of oral health in older adults. Cross-sectional and longitudinal data from a population study of older adults living in England were analysed to address this research question. The findings from this analysis are summarised and compared to other studies on social capital and oral health, under each of the key hypotheses. Direct comparisons with other studies described in the literature review are limited because of the heterogeneity in the study populations and measurements of social capital. Hence, the findings of the thesis are only compared to results from other studies on individual level social capital and oral health among older adults. The relevance of the findings is then discussed in relation to causal pathways, followed by the strengths and limitations of the study. The relevance of the findings for policy and practitioners is highlighted before the conclusion.

7.2 Principal findings

Hypothesis 1.1: Lower levels of social capital are associated with poorer oral health among older adults

Chapters 4 and 5 demonstrated evidence in support of this hypothesis using cross-sectional and longitudinal data. The size of the statistically significant associations varied from odds ratios of 1.21 (95%CI:1.01-1.46) to 2.14 (95%CI:1.62-2.84) in the fully adjusted logistic regression models for different dimensions of social capital and different measures of oral health (Table 7.1). The literature review identified 14 studies on social capital and oral health among older adults. Of these 14 studies, 11 were individual-level studies (Hanson et al., 1994; Maupome and MacEntee, 1998; McGrath and Bedi, 2002; Avlund et al., 2003; Merchant et al., 2003; Sabbah et al., 2011; Wu et al., 2011; Rodrigues et al., 2012; Arcury et al., 2013; Takeuchi et al., 2013; Tsakos et al., 2013), and 3 were multilevel studies (Aida et al., 2009; Aida et al., 2010; Aida et al., 2011b). These studies were described in Chapter 2, section 2.7, and were summarised in Tables 2.1 and 2.2. All of these studies showed significant associations between some aspects of social capital and oral health, with odds ratios ranging from 1.23 (95%CI:1.01-1.48) to 2.90 (95%CI:1.20-7.20) (Tables 2.1 and 2.2), although most of the odd ratios were under 1.5. However, all but two of these studies (Avlund et al., 2003; Merchant et al., 2003) used cross-sectional data, which limits any inference on whether social capital is a determinant of oral health among older adults. One of the longitudinal studies was conducted only amongst medical professional (Merchant et al., 2003) while the other longitudinal study was amongst adults aged 80 years and above (Avlund et al., 2003).

Table 7.1: Summary of the associations between social capital and oral health in the cross-sectional, longitudinal and modeling of change analyses: adjusted for socio-demographic, socio-economic, health and behavioural covariates, OR (95%CI)

Dependent variables	Self-rated oral health				Edentulousness				OIDP			
	Cross-sectional[1]	Longitudinal[1]		Change[2]	Cross-sectional[1]	Longitudinal[1]		Change[2]	Cross-sectional[1]	Longitudinal[1]		Change[2]
		Model 6	Model 7			Model 6	Model 7			Model 6	Model 7	
Membership	**1.21** **(1.01-1.46)**	1.18 (0.94-1.45)	1.09 (0.83-1.36)	1.15 (0.89-1.50)	**1.79** **(1.45-2.21)**	**1.48** **(1.18-1.47)**	0.87 (0.57-1.32)	1.36 (0.83-2.25)	0.79 (0.60-1.02)	0.82 (0.63-1.06)	0.87 (0.63-1.13)	0.98 (0.69-1.40)
Volunteeering	0.94 (0.80-1.10)	1.13 (0.95-1.35)	1.17 (0.97-1.41)	0.79 (0.55-1.14)	**1.45** **(1.19-1.75)**	**1.24** **(1.01-1.52)**	0.92 (0.64-1.31)	1.09 (0.58-2.08)	0.96 (0.77-1.20)	0.89 (0.72-1.10)	0.89 (0.71-1.11)	1.24 (0.82-1.88)
Close ties	**1.31** **(1.09-1.56)**	**1.29** **(1.06-1.58)**	1.19 (0.96-1.47)	1.07 (0.81-1.41)	1.14 (0.93-1.39)	1.15 (0.92-1.44)	0.92 (0.61-1.36)	1.15 (0.66-1.99)	**1.52** **(1.18-1.96)**	**1.56** **(1.22-2.00)**	**1.44** **(1.11-1.86)**	0.81 (0.55-1.20)
Social support	**1.36** **(1.11-1.66)**	**1.41** **(1.13-1.75)**	**1.27** **(1.01-1.60)**	**1.46** **(1.11-1.90)**	1.01 (0.80-1.27)	1.08 (0.84-1.40)	0.97 (0.61-1.53)	0.98 (0.57-1.71)	**1.63** **(1.23-2.17)**	**2.14** **(1.62-2.84)**	**1.94** **(1.45-2.59)**	1.03 (0.71-1.52)

[1]Low social capital predicting poor oral health
[2]Negative change in social capital predicting worsening of oral health
Model 6 adjusted for baseline covariates (but excluding baseline dependent variable)
Model 7 adjusted for baseline covariate and baseline dependent variable

Hypothesis 1.2: Structural aspects of social capital are associated with objective oral health measures while functional aspects of social capital are associated with subjective oral health measures

The literature review on social capital and oral health showed that studies on the association between social capital and oral health could be differentiated on the basis of types of social capital and different oral health outcomes. Many of these existing studies used multiple measures of social capital and oral health with the same study reporting positive and null findings depending on the type of social capital and oral health measure used. Among the studies that examined this association among older adults, there were 12 studies that reported positive associations between the structural dimension of social capital and objective measures of oral health (Hanson et al., 1994; Maupome and MacEntee, 1998; McGrath and Bedi, 2002; Avlund et al., 2003; Merchant et al., 2003; Aida et al., 2009; Aida et al., 2010; Sabbah et al., 2011; Rodrigues et al., 2012; Arcury et al., 2013; Takeuchi et al., 2013; Tsakos et al., 2013), while 8 studies reported null associations (Hanson et al., 1994; Maupome and MacEntee, 1998; Merchant et al., 2003; Aida et al., 2009; Aida et al., 2010; Aida et al., 2011b; Sabbah et al., 2011; Tsakos et al., 2013). The associations reported in studies between the functional dimension of social capital and objective measures of oral health were more mixed. There were 5 studies reporting positive associations (Avlund et al., 2003; Merchant et al., 2003; Aida et al., 2011b; Sabbah et al., 2011; Tsakos et al., 2013) while 5 studies reported null associations (Hanson et al., 1994; Maupome and MacEntee, 1998; Aida et al., 2010; Sabbah et al., 2011; Tsakos et al., 2013).

In this study, the cross-sectional association between the structural dimension of social capital (membership and volunteering) and objective measure of oral health (edentulousness) was significant in the model adjusted for covariates, in contrast to the non-significant association between the functional dimension of social capital (number of close ties and social support) and objective measures of oral health. This pattern was also confirmed in the longitudinal analysis.

There were just 3 studies using subjective measures of oral health among older adults (Wu et al., 2011; Arcury et al., 2013; Tsakos et al., 2013). All of these studies reported null associations between either structural or functional dimensions of social capital and subjective oral health outcomes, while Tsakos et al. (2013) also reported a positive but weak association between functional social capital and self-rated oral health. In this thesis, the functional dimension of social capital was associated with self-rated oral health and oral health-related quality of life with odds ratios ranging from 1.27 (95%CI:1.01-1.60) to 2.14 (95%CI:1.62-2.84) in the cross-sectional and longitudinal analyses (Table 7.1). Thus there appears to be stronger evidence of an association between functional social capital and subjective oral health than previously reported. The potential reasons for these divergent associations between structural / functional social capital and subjective / objective oral health are discussed below.

Hypothesis 1.3: The association between social capital and oral health remains significant even after adjusting for socio-demographic, socio-economic and health risk factors

Socio-demographic, socio-economic and health factors were conceptualised to be confounders of the association between social capital and oral health. Most of the associations between social capital and oral health measures reduced when socio-economic (wealth and education, in particular) and health factors (depression and self-rated general health, in particular) were adjusted for in the logistic regression models. This suggests that the reason why social capital and oral health are associated may not be due to the confounding effect of (older) age and (single) cohabiting status. The association between social capital and oral health appears to be confounded by wealth, education, depression and general health. However, there remained statistically significant associations between structural measures of social capital and objective oral health and between functional measures of social capital and subjective oral health, even after taking into account these confounders (see Table 7.1).

Other studies also reported significant associations between social capital and oral health among older adults after taking into account a range of confounding factors (Aida et al., 2010; Sabbah et al., 2011; Arcury et al., 2013; Takeuchi et al., 2013; Tsakos et al., 2013). However, most of these studies have limited information on the socio-economic position of older adults and none measured wealth, a key determinant of health among older adults (Demakakos et al., 2008). Furthermore all but two of the previous studies used cross-sectional data, with the two existing longitudinal studies having limited socio-economic measures (Avlund et al., 2003; Merchant et al., 2003). The analyses presented in this thesis thus demonstrated stronger evidence that social capital could affect oral health among older adults by taking into a wider range of relevant socio-economic factor confounders and also by using longitudinal data.

Hypothesis 1.4: Social capital buffers the association between oral health risk factors and poor oral health

The idea that social capital interacts with other forms of capital, which then has a multiplicative effect on well-being, comes from Bourdieu (1986). Furthermore, others have suggested some forms of social capital like social support could act as a buffer against life stressors (Cohen and Wills, 1985; Sheiham and Nicolau, 2005; Uchino, 2006). In the cross-sectional and longitudinal analyses, there was only one consistently significant interaction and that was between volunteering and wealth. Among the poorest ELSA respondents, volunteering appeared to buffer the negative effect of low wealth on self-rated oral health. Among wealthier respondents, volunteering did not have any such protective effect. However, there was no evidence of a buffering effect for the other 141 interaction analyses examined, which suggests that the buffering finding related to volunteering among the poorest could have arisen due to chance. Most of the studies on social capital and oral health among older adults did not report any interaction analyses between social capital and other oral health risk factors. Two studies examined the interaction of social capital with age and gender, but did not report any significant findings (Sabbah et al., 2011; Tsakos et al., 2013). There were no studies that reported testing whether social capital buffered the effects of low socio-economic position on oral health.

Hypothesis 2.1: There is a bi-directional association between social capital and oral health

Poor oral health can also result in lower levels of social capital. There are no previous longitudinal studies that investigated if poor oral health was a predictor of lower social capital. ELSA respondents who had poor self-rated oral health or at least one oral impact at baseline were more likely to have fewer close ties and lower social support at follow-up. Furthermore, being edentate was associated with not being a member of any organisation and volunteering. There were six significant bi-directional associations between social capital and oral health and the size of the odds ratios were similar in both directions. These odds ratios ranged from 1.24 (95%CI:1.01-1.52) to 2.14 (95%CI:1.62-2.84) for the longitudinal associations between social capital at baseline and oral health at follow-up, and from 1.36 (95%CI:1.09-1.70) to 1.83 (95%CI:1.33-2.53) for the longitudinal associations between oral health at baseline and social capital at follow-up (see Chapter 5, section 5.4, Table 5.23). These bi-directional associations make it difficult to infer whether social capital is a determinant of oral health, as the temporal sequence between social capital and oral health is unclear.

Hypothesis 2.2: After adjusting for covariates, structural social capital at baseline is associated with change in objective measures of oral health. Similarly, functional social capital at baseline is associated with change in subjective oral health

The cross-sectional associations between structural social capital and objective oral health and between functional social capital and subjective oral health were not replicated when change in the oral health measures was analysed. Neither membership status nor volunteering status explained the change in edentate status. Less than 3.0% of the longitudinal analytical sample changed from dentate to edentate status between the waves, so there may have been limited power to detect significant differences between respondents with different levels of structural social capital. However, limited statistical power may not be the key issue as the direction of association was contrary to the expected association in the hypothesis. Older adults with low structural social capital had lower odds of becoming edentate compared to those with higher structural social capital, albeit this association was non-significant. This suggests that low levels of structural social capital are unlikely to result in an increase in edentulousness. There are a number of cross-sectional studies from Japan that link social capital with objective measures of oral health such as the number of remaining natural teeth among older adults (Aida et al., 2009; Aida et al., 2010; Aida et al., 2011b; Takeuchi et al., 2013). While the population of these studies differs from this thesis, we should place greater emphasis on the results from this longitudinal analysis if we are interested in whether structural social capital is a determinant of the number of remaining teeth among older adults. The lack of evidence from this longitudinal analysis suggests that the association between structural social capital and objective measures of oral health such as edentate status may not be causal.

This thesis did not find any association between functional social capital and edentate status. A similar null association between functional social capital measures and edentulousness was found using cross-sectional data among older adults in the US (Tsakos et al., 2013).

The thesis found that baseline functional social capital was related to change in the subjective measures of oral health, namely self-rated oral health and oral health-related quality of life. Evidence of such a longitudinal association has not been shown before, and this strengthens the idea that functional social capital may be a determinant of subjective oral health. The potential pathways that lead from functional social capital to subjective oral health are discussed below.

Hypothesis 2.3: Positive change in social capital is associated with improvement in oral health. Similarly, negative change in social capital is associated with deterioration in oral health

The results of this analysis provide some evidence in support of hypotheses 2.1 and 2.2, that some of the baseline measures of social capital were associated with change in oral health, even after taking into account a number of potential confounding factors. However, there may be other confounding factors that have not been measured in the study which have not been taken into account in the longitudinal analysis. For example, respondents with personality traits such as negative affect are more likely to rate their oral health as poor and be dissatisfied with their social networks. One of the methods of reducing such unobserved confounding is through analysing whether change in social capital was associated with change in oral health. This approach eliminates time-invariant confounders, although the possibility of time-varying confounders still remains (Twisk, 2003).

There was weaker evidence for this hypothesis compared to the longitudinal results where there were significant associations between baseline social capital and change in oral health in 3 out of 12 models. Out of the 12 models of change investigated for this hypothesis, there was only 1 statistically significant association between the change in the social capital measures and the change in the oral health outcomes. A negative change in social support was related to worsening self-rated oral health among older adults. In addition, older adults who became a member of an organisation were less likely to have a worsening of the oral health-related quality of life, although the relative risk ratio was marginally not significant in the fully adjusted model. Furthermore, in the previous cross-sectional and longitudinal analyses, membership in any organisation was not associated with oral health-related quality of life. This suggests that this particular marginal association should not be over-interpreted. Furthermore, nearly all the other analyses of change did not show any associations in the hypothesised directions. Thus we must be cautious in a simple interpretation of the results as evidence in support of social capital as a determinant of oral health among older adults. The only consistent finding across the different types of analysis was the association between social support and self-rated oral health. Potential reasons for this finding are discussed in section 7.4.

Hypothesis 3.1 and Hypothesis 3.2: Psychological and behavioural factors explain some of the association between social capital and oral health

There needs to be plausible mechanisms linking social capital with oral health if social capital is a determinant of oral health. There are two main types of explanatory pathways that are suggested in the oral health literature - those related to psychological pathways, and those related to health behaviours (Sabbah et al., 2011; Tsakos et al., 2013). Given the complexity of the potential pathways, there is a need to discuss the broader literature on pathways linking social capital and health, which is then synthesised with the evidence from this thesis.

The psychological pathways linking social capital to oral health are further distinguished into main effects and stress buffering pathways. The potential for social capital to mitigate the harmful effects of stress and act as a buffer against stressors has already been discussed in hypothesis 1.4 above where there was weak evidence for this pathway. The main effect psychological pathways are through change in social relationships such as the loss of close ties, resulting in psychological distress, isolation and loneliness. Such stressors could in turn decrease host resistance and increase susceptibility to oral diseases (Persson et al., 2003; Sheiham and Nicolau, 2005; Boyapati and Wang, 2007; Nicolau et al., 2007). This could be through the process of allostatic load, a concept developed by McEwen (2001) in which repeated external stressors lead to a cumulative damage to the biological systems, which in turn could lead to periodontal disease (Nicolau et al., 2007). Psychological distress can also lead to health compromising behaviours such as smoking and the increased consumption of comfort food high in sugars (Nicolau et al., 2007; Sisson, 2007), which increases the risk of tooth loss due to caries and/or periodontal disease.

Social networks can be important for the health of older adults as such networks could facilitate discussions and decisions about their health (Cornwell et al., 2009). Older adults who are actively engaged with others in their social network may retain a higher degree of self-efficacy in the maintenance of good health and a greater sense of meaning and control over their lives. Engagement with others in the network helps an older person to maintain their social skills, self-esteem and self-confidence, leading to positive psychological health (Burr and Lee, 2012). A study of Finnish adults found that sense of coherence was related to better oral health-related quality of life (Savolainen et al., 2005). Support from network members may help older adults with access to good quality dental health services through recommendations from a person’s social network, helping to make and keep appointments with the dental care system, or help with financial resources to pay for dental care or transportation to access services (McGrath and Bedi, 2002). Older men in Sweden (aged 68 years) were more likely to visit a dentist once in two years if they had high emotional, material and informational support (Rickardsson and Hanson, 1989).

Social interaction and support from network members can lead to higher compliance with positive health behaviours (Cacioppo and Hawkley, 2003). A person’s behaviour may be influenced by their peers in their social network. For example, quitting smoking behaviour is highly related to the smoking behaviours in a person’s peer network (Christakis and Fowler, 2008). Thus, social networks could also lead to negative health behaviours such as smoking and diets high in sugar, which increases the risk of caries and periodontal disease.

Although the analysis of the pathways between social capital and oral health was beyond the scope of this thesis, the existence of potential pathways can be inferred from the change in the odds ratios for the social capital measures when psychological and behavioural measures were included in the regression models. When depression was entered into the regression models predicting self-rated oral health and oral health-related quality of life, there was a reduction of approximately 5.0% to 12.0% in the odds ratios for the social capital measures. Depression could be both a confounder of the association between social capital and oral health, as well as could lie on the causal pathway. Hence it is discussed under this hypothesis as well as the hypothesis 1.3 related to confounders.

The ELSA study contains a limited set of psychological and behavioural measures that can be analysed as potential pathways between social capital and oral health. Key behavioural factors such as visits to the dentist were not measured in the baseline analytical sample. Hence, only smoking status was analysed as a potential behavioural mediator. Adjusting for smoking status did not explain much of the associations between all the measures of social capital and self-rated oral health and oral health-related quality of life. However smoking status was adjusted for, only after adjusting for socio-economic and health factors, as per the conceptual framework of this thesis. This series of adjustments necessarily limits the explanatory role of smoking as the socio-economic and health factors already attenuate much of the odds ratios. Furthermore, there was some suggestion that smoking status could explain some of the associations between structural aspects of social capital (membership and volunteering) and edentulousness, as adjusting for smoking status attenuated the odds ratios by approximately 5.0% to 7.0%. Thus this thesis found some evidence that both depression and smoking status may explain some of the association between social capital and oral health.

Most other published studies on social capital and oral health among older adults did not show direct evidence of the intermediate pathways. When studies included aspects of behavioural factors in regression models, they were often grouped together with other potential confounding factors like general health (Aida et al., 2011b), which makes it hard to distinguish between the role that behavioural factors play and the confounding effects of poor general health. One study showed some evidence for a behavioural pathway between the number of close friends and edentulism (Tsakos et al., 2013). Adjusting for smoking status and dental attendance reduced the difference between older adults with high and low numbers of close friends to non-significance. However, the role of these behavioural factors as a potential pathway is questioned by another study that found that adjusting for smoking status and dental visits did not significantly change the higher odds of periodontal disease among older adults with fewer friends (Sabbah et al., 2011), although it should be noted that this study used a different clinical oral health measure compare to the previous study (Tsakos et al., 2013).

7.3 Understanding the potential causal processes underlying social capital as a determinant of oral health

The key research question of the thesis was whether social capital was a determinant of oral health among older adults. Indicators of social capital such as social participation, volunteering, close ties and social support, have been associated with health outcomes in previous studies, but association does not imply causation. A number of the studies on this topic were small-scale studies and with non-representative samples. In addition, the majority of the studies analysed in the literature review had been cross-sectional in design and failed to utilise methods to strengthen causal inference, such as fixed effects analysis and instrumental variables estimation.

7.3.1 Temporal order

The most basic requirement for causal inference is temporal order. Cross-sectional study designs do not allow any temporal order. If an association is found between two variables, the cross-sectional design may be prone to reverse causation. The possibility of reverse causation is particularly inflated in the case of behavioural indicators of social capital such as social participation or voluntary work, which may be dependent on good health. Cross-sectional studies may be helpful in generating new hypotheses. However, Kawachi et al. (2013a) argued that inference from cross-sectional studies is reaching an end point and it is time to focus more on longitudinal and panel data.

Although oral health may be associated with social capital, it may be that those with poorer oral health are less likely to engage in social participation or voluntary work, or that some other factors, such as poor general health, is driving the association. Consequently, any cross-sectional association might well be a selection effect. Older adults with poorer oral health may be more likely to be in the group with lower structural social capital, rather than social capital causing improvement in oral health.

7.3.2 Experimental research

One way of the standard methods of identifying causality is to conduct experimental research. However, this would mean allocating older adults into high and low social capital groups and observing the impact on their oral health. Such an approach is often impractical, especially in the context of older adults, who may face barriers to participation in such experiments. Furthermore, there are ethical problems associated with exposing a group of older adults to a reduction in their social capital. These methodological and ethical problems make the use of experiments to determine the effect of social capital on the health of older adults very problematic. Instead, inference needs to be made from observational studies, while acknowledging the biases inherent in such studies.

An alternative to experimental studies is longitudinal observational studies, where change in the oral health of individuals with high and low levels of social capital is observed over time and compared. Such longitudinal methods still face the problem of individuals with high social capital may have different characteristics to those with low social capital, but it is possible to statistically account for such differences in regression models as long as these characteristics have been observed and measured.

Kawachi et al. (2013a) argued that a greater understanding of the causal influence of social capital on health is enabled by delineating the specific mechanisms through which social capital influences different health outcomes. There is no reason why social capital should predict all health outcomes. Sampson (2003) also pointed out that a concept that predicts everything ends up predicting nothing at all. Following this argument, it is clear that we should not expect social capital to predict all the different objective and subjective measures of oral health. Edentulousness is a measure of lifetime history of dental disease and dental care and the link to current levels of social capital among older adults is tenuous at best. However, we may expect stronger associations between the functional measures of social capital and the subjective measures of oral health through plausible psychosocial mechanisms. Thus, in this thesis, it is informative that we have some evidence for the latter but little evidence for the former.

7.3.3 Common method bias

The association of subjective measures of social capital and oral health may be subject to common method bias. This is another challenge to causal inference, which arises from the self-reported methods used to measure social capital and oral health. 'Common method variance' is the formal term used to describe systematic error variance shared among variables introduced as a function of the same method of ascertainment (self-report) or shared source (the same individual) (Kawachi et al., 2013a). This is particularly problematic for the way social capital is usually measured, i.e. via self-reported perceptions of social support, and self-reported perceptions of closeness. The strong emotional component of the social capital questions may bias the subjective rating of oral health and oral health-related quality of life. The suggested solutions for this problem include using objective measures of oral health as opposed to self-rated oral health. However, this is not to suggest that objective measures of oral health are better than subjective measures. Both have their strengths and weaknesses and measure different aspects of oral health. As we have argued earlier, the objective measure of edentulousness is not an appropriate oral health measure in relation to the social capital of older adults.

7.3.4 Endogeneity

The problem of endogeneity is another key issue for causal inference in relation to social capital and oral health. The statistical adjustment for covariates will not eliminate potential endogeneity biases, as there may be unobserved and unmeasured factors that cause the association between social capital and oral health. In public health, some researchers have attempted to address the endogeneity problem through the use of instrumental variable estimation and fixed-effect analysis (Fujiwara and Kawachi, 2008; Sirven and Debrand, 2008b; d'Hombres et al., 2010; Kim et al., 2011; Riumallo-Herl et al., 2014). The idea of instrumental variable estimation is to find variables that cause exogenous variation in the treatment of interest (in this thesis, change in the level of social capital) without directly influencing the outcome variable of interest (oral health). However, it is rare to come across such instrumental variables, especially in secondary data. Studies have used religious belief (Sirven and Debrand, 2008b); corruption, population density, regional citizenship rates and religious fractionalization (Kim et al., 2011); crime victimisation (Riumallo-Herl et al., 2014); aggregate measures of social capital at the community level (d'Hombres et al., 2010; Riumallo-Herl et al., 2014) as instrumental variables. Nonetheless, Deaton (2009) has criticised the mindless application of instrumental variable estimation in the social sciences to identify causal relations. Many so-called ‘instrumental variables’ are not truly exogenous, or could affect the outcome through different pathways from the ‘causal’ factor, thus violating the assumptions of instrumental variable analysis.

The second approach to strengthening causal inference is the use of fixed-effects regression to address time-invariant unobserved confounders (Kawachi et al., 2013a). This approach examines the effects of change in the level of the social capital over time on change in the oral health outcome. The time-invariant characteristics of an individual are differenced out through this approach and thus this approach eliminates time-invariant unobserved confounders. However, this is accompanied by a much reduced sample size as only individuals who change their oral health and social capital are analysed. Hence, this thesis adopted the approach of analysing the change in oral health outcome categories, by the change in the social capital categories, keeping as the reference group the individuals who did not change. Such a regression model of change is similar to a fixed-effects regression, but this approach also helps with the interpretation of the results, through comparison to the reference group of individuals who do not change.

One of the innovations in this thesis was the analyses of the bi-directional associations between social capital and oral health among older adults using longitudinal data. These analyses have not been carried out previously. The thesis found evidence of bi-directional associations. However the presence of such bi-directional associations does not necessarily imply the existence of a causal association between social capital and oral health or reverse causal processes. Any association between social capital and oral health must be interpreted carefully, although most of the previous studies rarely consider the possibility of bi-directional associations.

The analysis of change chapter revealed that a decrease in social support (which occurred mainly among older ELSA respondents who were living with a partner at baseline) was associated with an increase in poor self-rated oral health. This association is plausible as older adults with a partner are at risk of losing social support if their partner dies. The loss of a partner could result in negative well-being and depression (Singh and Misra, 2009), which in turn could negatively affect how older adults rate their oral health.

Looking at the longitudinal associations from oral health to social capital, poor self-rated oral health and edentulousness at baseline were associated with lower social participation at follow-up. However, poor oral health-related quality of life (OHRQoL) was not associated with such a change in social participation. This suggests that the association between self-rated oral health and edentulousness, and social participation may not be causal as such an association is also likely to affect OHRQoL. It is extremely unlikely that poor self-rated oral health can have a direct effect on social participation without going through the mechanism of one of the oral health functioning problems related to eating, smiling and socialising. Similarly, the social participation of edentate older adults could only be affected if they also report similar problems with oral health-related quality of life. The lack of any association between OHRQoL and social participation suggests that the causal direction from oral health to social participation is unlikely. Thus the longitudinal association between self-rated oral health and edentulousness, and social participation may be caused by other unobserved confounding factors. These confounders could include time-varying health status whereby deterioration in health could result in both poorer oral health and lower social participation.

Although this thesis did not demonstrate any causal associations between social capital and oral health among older adults, it did show that the direction of causality from poor oral health to lower social capital is less plausible than functional social capital as a determinant of subjective oral health. Furthermore, the change in functional social capital corresponds to plausible change in an older person's life course, which could result in deterioration in subjective oral health status.

7.4 Social capital and oral health over the life course

7.4.1 Resilience in oral health among older adults

There is a need for a life course perspective when examining whether social capital is a determinant of oral health. There are many social, psychosocial, behavioural and health factors that operate from childhood into later life that influences oral health (Thomson et al., 2004; Sanders and Spencer, 2005). This section of the discussion examines the role of various exposures of an individual across their life span, in order to understand the association of social capital and oral health in older ages.

The oral health measures used in this thesis ranged from subjective perception of oral health (self-rated oral health), to a lifelong exposure to oral health risk factors (edentulousness). Self-rated oral health is partly influenced by oral diseases, but it also reflects current perceptions of oral health and well-being and is likely to be influenced by current exposures (Benyamini et al., 2004; Locker et al., 2005). On the other hand, a person may have become edentate many years prior to the survey. Furthermore, it is difficult to find predictors for edentulousness that cover the entire life span (Thorstensson and Johansson, 2010). Thus it may not be useful to relate current levels of social capital to this measure of life course history of oral health. This may explain the lack of association between the functional dimension of social capital and edentate status found in this study. Current levels of perceived emotional support from network members cannot influence historical life time exposures that result in the loss of teeth.

This thesis also examined oral health-related quality of life among older adults. Previous studies have suggested a strong negative association between edentulousness or low remaining number of teeth and oral health-related quality of life (Nitschke and Muller, 2004; Steele et al., 2004; Hugo et al., 2009; Gerritsen et al., 2010). This thesis found similar negative associations. Older respondents who were edentate had 1.56 (95%CI:1.25-1.96) times increased odds of at least one oral impact on their daily performances. Edentulousness can have a negative impact on social life and daily activities. For example, people who are edentate may avoid participation in social activities because they are embarrassed to speak, smile, or eat in the company of other people (Rodrigues et al., 2012). This in turn could lead to lower social participation. In this thesis, respondents who were edentate at baseline were more likely to reduce their participation in social activities through a reduction in membership in organisations. However, it is also clear from the example above, that the pathway between edentulousness and social participation is through oral health-related quality of life and this thesis found no evidence of an association between baseline oral health-related quality of life and social participation at follow-up.

Both edentulousness and oral health-related quality of life were positively associated with increasing age. However, self-rated oral health was negatively associated with age. Older respondents were less likely to rate their oral health as poor compared to younger respondents. This apparent paradox of better subjective oral health in older adults has been reported in other studies (Locker et al., 2005; Slade and Sanders, 2011). The paradoxical association between increasing age and better subjective oral health contradicts the assumption that older age is associated with poorer health.

One of the explanations for this paradox is the resilience of older adults to their poor clinical status (Slade and Sanders, 2011). Qualitative investigations of the early adulthood experiences of the elderly in Australia suggested that financial hardship experienced during the Great Depression and Second World War instilled a sense of resilience in this cohort (Sendziuk, 2007). A qualitative study of older adults in Canada found that the elderly held a positive perception of oral health and had adapted to their tooth loss (MacEntee et al., 1997). Their adaptation occurred partly because dental disease was viewed as a normal consequence of ageing. Another qualitative study of older adults in New Zealand also suggested the resilience is an important concept when examining age-related change in oral health (McKenzie-Green et al., 2009). The sense of resilience in this older cohort with different life course experiences may not be replicated in younger cohorts born after the Second World War. Future cohorts of older people may not adapt so readily to the absence of natural teeth (MacEntee et al., 1997).

The resilience of older adults to their edentate status has also been suggested as one of the reasons why there was a lack of association between social support and edentulousness (Tsakos et al., 2013). Cohorts of older adults include a high proportion of edentate people, and consequently edentulousness may be considered as an acceptable and normal part of ageing. Furthermore, older adults that grew up in a period of limited access to general health care, limited access to dental care and no access to fluoride, are more likely to be edentate than younger adults (Ricketts, 1999). Such cohort differences in life course exposures resulting in edentulousness could explain the apparent paradox of better self-rated oral health among older adults.

7.4.2 Social capital: life course and ageing processes

Social capital at the individual level is embedded within a person's life course. It is important to recognise the social and historical processes over a person's lifetime that result in the accumulation and change in social capital (O'Rand, 2006; Elder and Shanahan, 2007). As social capital is not static across a person's life course, the patterns of change in social capital may have important consequences for health.

There are relatively few studies of life course patterns of social capital (Lin, 2001). Life course trajectories of social capital may contribute to broader patterns of social inequalities, as well as persistent gender and ethnic inequalities (Bourdieu, 1986). There is conflicting evidence on the association of social capital with ageing. Some studies have suggested that social capital accumulates with age (Bridges and Villemez, 1986), others have argued that social capital tends to decline with age (Coleman, 1990; Wellman et al., 1997; Kalmijn, 2003), and other studies have suggested both accumulation and decline with ageing (Erickson, 2003; Lambert et al., 2006). Furthermore, it is possible that change in social capital may coincide with losses and gains in personal networks (van Tilburg, 1998). For example, social networks involving work colleagues may be replaced by friendships with members of a voluntary or other social organisations after retirement (Broese van Groenou et al., 2013). A declining network size may also be the result of an individual's lack of capacity to replace lost relationships, for example, due to poor physical and mental health. Evidence for such a lack of replacement of lost relationships as people age was found in a longitudinal study of Dutch older adults (Broese van Groenou et al., 2013).

One of the life course theories of social interaction suggests that older individuals are less likely to engage in social interaction for the sake of information sharing as they age (Carstensen, 1995). This socio-emotional selectivity theory suggests that older adults tend to value close ties because of their perceived emotional satisfaction from such ties, over instrumental network ties. The reduction in social networks with age may therefore reflect the reduction of information-based ties, such as ties related to work colleagues. In this thesis, employment and retirement status did not explain the association between social capital and oral health. Others suggested that emotional ties such as close friendships tend to persist across the life course (Fung et al., 2001). In this thesis, there was some suggestion for such differences from the cross-sectional association of age with organisational membership (see section 4.3.1.2, Table 4.8). The oldest ELSA respondents (aged 75+) were less likely to participate in instrumental social activities such as being a member of political groups, but more likely to participate in church or religious groups, which may be more emotionally satisfying. Other studies confirmed that despite a general decline in social participation across the life course (McDonald and Mair, 2010), older adults tend to experience increases in religious attendance from age 57 to 85 (Cornwell et al., 2008).

Socio-emotional selectivity may also explain why the strongest associations between social capital and oral health found in this thesis was between social support and current levels of oral health. The perceived emotional satisfaction from close ties becomes more important as individuals age, suggesting an increasing importance of social support for the well-being of older adults. In contrast, participation in social activities may not bring such emotional rewards, especially for older adults, suggesting a weaker association between structural social capital and current levels of oral health.

Socio-emotional selectivity has also been suggested as the reason why there is an increase in voluntary activities after retirement. Such voluntary activities may help in the maintenance of stable socio-emotional networks as people age (Li and Ferraro, 2006). This thesis did not find any evidence of an association between volunteering and oral health. This result may appear to be surprising, given the 'overwhelmingly' positive impact of volunteering on general health (Casiday et al., 2008). The thesis found that poor self-rated oral health predicted a decrease in volunteering activities. So the link between oral health and volunteering may not be the same as the association from volunteering to general health. Voluntary activities may not confer oral health benefits, but may have a positive impact on other dimensions of health such as those related to psychological well-being.

Some studies distinguished between different types of social relationships and close ties as people age. Huxhold et al. (2013) suggested that as individuals reach the age of 65, they reduce their social activities involving friends. The nature of activities with family members also changes, as people get older, as the family is the primary source of support for older adults (Antonucci et al., 2007). Social support from family members could become increasingly important for older adults as a buffer against the negative effects of age-related decline (Bierman and Statland, 2010). Friends could remain the main source of close ties among older adults, whereas family members could increasingly become crucial providers of social support. In this thesis, the different sources of close ties and social support were not distinguished. This is because the network approach of social capital used in this thesis did not focus on the source of social relationships, but instead focused on the resources that are embedded within a person's social network (Lin, 2001). The network approach examines the web of social relationships that surround a person, rather than specific strands of social support and close ties.

7.5 Strengths and limitations of the study

7.5.1 Strengths of the study

7.5.1.1 Study setting and quality of data

ELSA dataset is from a large national sample of older adults, aged 50 years and older, living in England that provides information on oral health, general health, social capital and a wide variety of potential confounders and mediators of the association between social capital and oral health. The literature review concluded that existing studies of social capital and oral health were limited in terms of being mainly based on cross-sectional studies, with few studies using large population-based samples.

7.5.1.2 Longitudinal data

The strengths of this thesis derive primarily from the use of the ELSA data to examine whether social capital is a determinant of oral health among older adults. This enabled the use of longitudinal data to analyse change in social capital and oral health among older adults. The strengths of such longitudinal data to enable stronger inference in relation to the key research question of the thesis have already been discussed above.

7.5.1.3 Different dimensions of social capital

The literature review identified a key gap in previous studies in that many studies tend to lump together different dimensions of social capital. In this thesis, the detailed questions on social capital from the ELSA dataset were carefully selected to cover the different dimensions of social capital described in the literature review. In particular, the dataset contains measures of social capital in line with the harmonised set of social capital questions developed by the ONS (Harper and Kelly, 2003). Some of the previous studies on social capital and oral health rely on proxy indicators of social networks and social support such as marital status and living alone, which do not accurately measure these concepts. In contrast, the structural and functional dimensions of social capital were measured more accurately in this thesis through detailed questions.

7.5.1.4 Diversity of oral health measures

The thesis analysed three measures of oral health that reflect different aspects of current and historical oral health. These include edentulousness, a crude and broad oral health measure that reflects the accumulation of oral disease over the life course and the experience of dental treatment. Edentulousness is irreversible, so it is a robust measure of total tooth mortality (Tsakos et al., 2011). OIDP is a measure to capture oral health-related quality of life, a multidimensional concept that incorporates oral health morbidity, disability and impairment, social, psychological and physical functioning. Furthermore this measure has been validated for use among English older adults (Tsakos et al., 2001). Self-rated oral health is an overall evaluation that reflects a contemporary account of both subjective and objective aspects of oral health. This incorporates a broader multidimensional subjective assessment of oral health, rather than just clinical morbidity (Benyamini et al., 2004; Locker et al., 2005).

7.5.1.5 Theoretical and analytical framework

This thesis adopted a robust theory driven framework, originating from the social determinants of health conceptual model. This was reflected in the analytical strategy, in which the different statistical models were sequentially adjusted for potential confounders and mediators, enabling a better understanding of the processes by which social capital is associated with oral health. The theoretical framework also suggested a potential feedback loop from poor oral health to lower social capital, which was investigated in this thesis. Most other studies did not consider such feedback loop of reverse causation. Furthermore, interaction effects were explicitly modelled, to take account of the different theories on the stressor and buffering effects of social capital.

7.5.1.6 Controlling for relevant confounders

Another strength of the thesis is the range of potential confounders that were controlled for in the longitudinal analysis and the analysis of change. The ELSA dataset contains detailed measures of potential confounders of the association between social capital and oral health among older adults. In particular, this thesis used household wealth as one of the measures of socio-economic position among older adults. Wealth is a better measure of long-term economic status of older people compared to income or education (Banks et al., 2006; Demakakos et al., 2010a). As socio-economic factors are potential key confounders of the association between social capital and oral health, it is important to measure this accurately among older people. However, few existing studies of social capital and oral health take account of this key confounder.

7.5.2 Limitations of the study

There are a number of limitations to the analyses presented in the thesis. These will be discussed using the standard epidemiological concepts of chance, bias and confounding.

7.5.2.1 Chance (random error)

As already discussed, one of the strengths of the thesis was the large sample size which leads to lower probability of a finding that is due to chance. However, for some of the analyses, such as in the chapter on the analysis of change, there were few older adults who changed their oral health status and levels of social capital. For example, there was a low incidence of older adults who reported no oral impact on daily performances to at least one impact. Thus there may have been insufficient power to detect statistically significant associations with change in oral health for this particular set of analysis.

One of the key assumptions of longitudinal analysis is that there is meaningful change in the levels of exposure and outcome over the time period (Kawachi et al., 2013a). Within the context of this thesis, the four-year gap between the waves of ELSA data collection may not have been long enough to detect the effect of change in social capital on change in oral health. As a result, the lack of significant associations between change in the functional dimension of social capital and change in oral health-related quality of life may have been due to the relatively short follow-up period.

7.5.2.2 Bias (systematic error)

Bias refers to systematic errors introduced to the results due to inaccuracies in the process of sample selection, data collection, measurement and loss to follow-up. The sample selection and data collection procedures for ELSA have been well documented and validated, and are beyond the scope of this thesis using ELSA for secondary data analysis.

Information bias

Information bias can be generated through inaccurate measures of the exposure and outcome. The different dimensions of social capital measured in this thesis correspond to the harmonised set of questions developed by the Office for National Statistics, which have subsequently been validated (Harper and Kelly, 2003). This reduces the possibility of measurement bias in social capital. Despite the detailed questions on social capital that are rarely available in most studies on health, there was one aspect of social capital used in this thesis that could have been measured better. The ELSA wave 3 questions on volunteering did not differentiate between formal and informal volunteering, despite previous studies demonstrating differential associations with physical and mental health (Hinterlong et al., 2007; Nazroo and Matthews, 2012).

When constructing the variable measuring social participation, ELSA respondents were asked if they were a member of a list of organisations, clubs or societies. Those who responded ‘yes’ but had subsequently not responded to the following question about the number of committee meetings they attended in a year were assumed to attend zero meetings and hence classified as ‘passive members’. This is the methodology adopted by Scherger et al. (2011). While there is some possibility of misclassification bias, further analysis of this group of ‘missing’ passive members compared to the group of respondents who reported zero attendance at committee meetings revealed no significant differences in terms of oral health.

The measures of oral health were based on self-reports. There was a lack of clinical oral health outcomes of teeth and periodontal status. In addition, a respondent was described as being edentate if they had no natural teeth and wore dentures, or had no natural teeth and did not wear dentures. However, people who wear dentures may have different oral health problems due to ill-fitting dentures compared to people without any natural teeth and dentures. Furthermore, the dentate group may actually contain a number of older adults with few remaining natural teeth. Such adults may actually have worse oral health functioning than some of the edentate adults with good fitting dentures. The ELSA questionnaire did not ask respondents about the number of teeth, a key indicator of functional oral health.

Self-rated oral health could be subject to measurement biases. It may reflect current oral health status, but it could also reflect the mood and emotional state of the respondent (Locker et al., 2005). Research on self-rated general health suggested that people use different frames of reference in their responses to these global evaluative questions. Some rate themselves on the basis of their physical health; others rate themselves on the basis of their mental state. Others may also decide on their rating using different reference groups, such as peer groups, or groups with certain disease states or behavioural characteristics (Benyamini et al., 2003). Self-rated oral health was dichotomised for the regression models, which could result in a loss of information. In addition, the common method bias has already been discussed above, which particularly affects the analysis of subjective measures like self-rated oral health and the functional dimension of social capital. Despite these methodological shortcomings, the self-rated oral health has been shown to be a valid, reliable and cost-effective tool to measure oral health (Locker and Miller, 1994; Gilbert et al., 1998).

While the modified instrument for oral health-related quality of life was validated (Tsakos et al., 2001), the version used in ELSA is a simplified version that did not assess the frequency and severity of oral impact on respondents' daily performances. Nevertheless, this modified instrument does allow for an estimate of the overall prevalence of oral impacts, which is the measure most other studies on oral health use.

Selection Bias

The ELSA study was designed to be representative of older adults aged 50 years and older living in England. However, for the purposes of this thesis, wave 3 of the ELSA study was used for the baseline analytical sample. Hence, there may be some selection biases associated with continuing in the ELSA study from wave 1, which limits inference to the general population of older adults. Another type of bias that could limit inference is that the analysis did not separate out cohort and ageing effects. The analyses contained different birth cohorts of older adults with the oldest generation having experienced different living and growing conditions such as limited access to fluoride and dental care. It may be difficult to generalise the results from the oldest ELSA cohort to the younger ELSA cohorts.

Missing data can also result in selection bias. In this thesis, there were a number of occasions when some of ELSA respondents had missing data. There are three main sources of missing data in the thesis. At baseline, some of the ELSA participants did not complete the self-completion module, which contained the questions on social capital (excluding volunteering), as well as some of the main interview questions. This group of participants was excluded from the analysis of social capital and oral health. Furthermore, some ELSA respondents completed some of the self-completion questions, but did not respond to specific questions on social capital. These participants were included in the analysis as a ‘not answered’ category. The third group of missingness relates to attrition from the baseline analytical sample. Some of the attrition was due to loss to follow-up between waves, while there was further attrition due to missing data on the oral health and social capital indicators at follow-up. This section discusses the selection biases related to these three types of missing data.

There were 1,833 ELSA respondents who did not respond to the main interview schedule and did not return the self-completion module in the baseline analytical sample. The analysis of this group of non-respondents compared to the respondents in the baseline sample revealed that older age, retired status, lower socio-economic position, poorer general and oral health and smokers were significant predictors of missingness. Consequently the analysis of the baseline sample may be biased because the oldest ELSA respondents who were poorer and had poorer health were more likely to be missing. As lower socio-economic status and poorer health was associated with lower social capital and poorer oral health, the direction of bias suggests that the reported associations between social capital and oral health in the cross-sectional analysis could possibly be stronger if this group of missing respondents in the baseline sample were included.

The second group of missingness relates to the ‘not answered’ category in the measures of social participation, number of close ties and social support. There were conflicting associations with oral health. Respondents who did not answer the membership questions were more likely to become edentate in the longitudinal analysis but they were also more likely to improve their oral health functioning in the analysis of change. For most of the other longitudinal and modelling of change analyses, respondents in the ‘not answered’ category were not significantly different from the reference groups. Further analyses excluding the ‘not answered’ category did not change the odds ratios for the other social capital categories. This suggests that the biases associated with the ‘not answered’ category may not have been very important in relation to the main research question.

The third type of missingness is due to attrition from the baseline analytical sample. There were 1,458 respondents who were lost to follow-up between the waves. A further 405 respondents had missing data on oral health and social capital measures at follow-up. There were common predictors for both types of longitudinal missingness. Older men (over 75 years old) with no education were more likely to be lost to follow-up. In addition, respondents who were depressed, current smokers and had lower social support at baseline sample were more likely to have missing data at follow-up. No education, depression and smoking were associated with poor oral health, as well as lower social capital. Older age was associated with edentulousness and poor oral health functioning, but not self-rated oral health. Similar to the direction of bias associated with missing respondents in the cross-sectional analysis, we would expect that the reported associations between social capital and oral health in the longitudinal and modelling of change analyses could possibly be stronger if this group of missing respondents were included.

This analysis of the selection biases associated with missing respondents in the analysis suggests that the data are not missing completely at random. Further imputational analysis assuming missing at random or missing not at random mechanisms was beyond the scope of this thesis.

7.5.2.3 Confounding

Potential confounders of the key association for this thesis included factors that could cause both lower social capital and poorer oral health. While measures of socio-economic position, general health and depression were included in the analysis, there may have been other factors that could cause the association that were not included. Oral health behavioural factors such as tooth-brushing, use of fluoride agents, sugar consumption and dental attendance are associated with oral health, but cannot cause low social capital, and so are not valid confounders. The modelling of change analysis would have eliminated time invariant confounders, but there may be time varying confounders such as deteriorating health status that could cause the association between lower social support and increasing levels of poor self-rated oral health.

7.6 Implications for research

One of the key conclusions of this thesis is that social capital is linked to subjective measures of oral health among older adults, rather than a cumulative life course measure of oral health such as edentulousness. As argued in the previous sections of the discussion, it is unlikely that current levels of social capital could predict a lifetime of poor oral health resulting in edentulousness. Unfortunately, much of the research on social capital and health has hypothesised that "*social capital is predictive of every health outcome under the sun*" (Kawachi et al., 2013a). The two key implications for research that follow, are about understanding the mechanisms that link social capital and oral health, and understanding the life course influences that might result in this association. It is important to identify the specific mechanisms linking social capital to oral health behaviours, in order to aid the development of social capital interventional activities designed to improve oral and general health. Moore et al. (2013) argued that if the mechanisms linking social capital to health differ by socio-demographic, psychosocial, or psychological factors, such knowledge may be useful in targeting groups for particular types of intervention activities.

One of the consistent findings from this thesis was the strong role of socio-economic factors in explaining the association between social capital and oral health. Wealth, in particular, is the key socio-economic factor among older adults. Further research into the association between wealth and social capital of older adults is needed, particularly if social capital is conceptualised as a buffering resource for adults living in deprived communities and households. In addition, the research demonstrated that psychosocial factors like depression also explain some of the association between social capital and subjective oral health. The direction of the association remains unclear; does depression result in poorer subjective oral health through physiological stress mechanisms, or does poorer subjective oral health result in depression? Research into the psychosocial processes linking social capital and oral health could help clarify these mechanisms.

As functional social capital among older adults are generated through processes and influences over a person’s lifespan, another key area of research is the life course patterning of these close ties and social support. This includes research into the mechanisms by which some older adults are able to generate and maintain social support and close ties in later life, as well as the risk factors for vulnerable older adults who lose such functional social capital. Furthermore, as discussed in the literature review, such research also needs take into consideration the potential negative effects of social capital (Portes, 1998). This includes research into caregiver burden for providers of functional social support among older adults with caring needs.

As demonstrated in this thesis, longitudinal data on social capital and oral health are needed to understand this association among older adults. Further longitudinal research could include longer follow-up periods, greater measurement occasions of social capital and oral health, a wider range of oral health outcomes including clinical measures, and the use of more sophisticated statistical methods to test for causal associations. These longitudinal analyses could also be extended to include potential mediating pathways - a key gap in the existing literature and this thesis. Finally the potential for poor oral health to affect social capital needs to be explicitly considered in future studies on the topic. This is a key limitation of existing studies that is highlighted by the findings from this thesis on the bi-directional associations between social capital and oral health.

7.7 Implications for policy

One of the policy conclusions of most studies on social capital and oral health is the need to go beyond traditional risk factors for oral health and consider the broader agenda of psychosocial determinants of health (Tsakos et al., 2013). In this study, lower levels of social support were associated with poorer self-rated oral health and poorer oral health quality of life. If these associations were causal, then increases in social support among the elderly could lead to improved oral health. However, interventions to increase the functional social capital dimension, such as social support, are difficult to implement, compared to interventions to stimulate structural social capital (Murayama et al., 2013).

Furthermore, the concept of social capital interventions has been criticised for being palliative and failing to address the structural determinants of health, such as social inequalities (Lynch, 2000). Social capital interventions have also been criticised because this could lead to the overloading of community resources and 'blaming the victim' (Pearce and Davey-Smith, 2003). However, such criticisms of potential social capital intervention are not evidence based, but are opinions drawn by analogy to interventions on health behaviours.

The causal evidence that improvement in social capital can lead to an improvement in health is limited to a few studies. A Brazilian study reported an increase in individual social capital as a result of a 4-month program of intergenerational activities in which the elderly shared their memories with seventh and eighth grades students in secondary school, using a randomised control design (de Souza and Grundy, 2007). The elderly in the intervention group were over twice as likely as those in the control group to report positive gains in cognitive social capital.

A social approach to health promotion using elderly volunteers in the community was conducted in Baltimore, USA (Fried et al., 2004). The program involved adult volunteers in public elementary schools and examined whether this led to individual-level improvement on the educational outcomes of children and the volunteers' health and well-being (Fried et al., 2004; Rebok et al., 2004). Results from the pilot trial showed improved quality of social interaction, physical activity, strength, walking speed and cognitive activity in the intervention group of older people (Fried et al., 2004).

An example of a successful interventional programme on social capital among the elderly is the REPRINTS study in Japan (Fujiwara et al., 2009; Murayama et al., 2013). This study showed that older volunteers who read and discussed picture books with school children improved their self-rated health and some aspects of social support and social network compared to the control group. However, both the intervention and control groups were engaged in voluntary activities; the difference being the activities in the intervention group were aimed at stimulating the volunteer's intellectual activities.

Although some authors have suggested that social capital interventions should not be considered (McKenzie et al., 2008), the above mentioned interventional studies on social capital among older adults suggest some potential positive health effects of intergenerational voluntary activities. However the complex social world where interventions are implemented need to be better understood. Social capital interventions that work in particular contexts and social groups may not work in other contexts.

Given the bi-directional associations between social capital and oral health reported in this thesis, it is also important to consider the policy implications of interventions that promote oral health among the older adults, that could in turn improve their social capital. Petersen and Yamamato (2005) reported that there are considerable barriers to oral health care among older people, even in industrialised countries. Older adults have less access to dental care because of their impaired mobility, the costs of dental treatment and their relatively negative attitudes to dental treatments. In Denmark, older adults were targeted by a public health programme aimed at increasing their empowerment and self-care capacity-building (Petersen and Nörtov, 1994). The programme resulted in an improvement in their oral health-related quality of life, oral hygiene practices and their use of dental services.

Oral diseases share common risk factors with chronic diseases (Watt and Sheiham, 2012). Public health programmes targeted to improve the general health of older adults could also integrate interventions to improve their oral health. Such programmes could target the social environments in which active older adults participate such as recreational centres, libraries, health care centres and pharmacies (Petersen and Yamamoto, 2005). For inactive older adults, these programmes could target their residential homes. Apart from such educational progammes targeted at the older adults, this common risk factor approach could also educate the professionals that care for older adults, including oral health professionals, physicians, nurses, nutritionists and social workers. Examples of such health promotion programmes includes countering the negative stereotypes of older adults, such as that it is too late to change their oral health related behaviours.

7.8 Conclusion

The thesis set out to examine whether social capital was a determinant of oral health among older adults living in England. This study showed that there was weak evidence that low social capital was a determinant of poor oral health among older adults. There was some evidence of longitudinal associations between functional dimensions of social capital and subjective oral health, but little evidence for other measures of social capital and oral health. There was also some evidence that poor oral health predicted low social capital, although this association may not be causal. The direction of causality from poor oral health to lower social capital is less plausible than functional social capital as a determinant of subjective oral health. Furthermore, the change in functional social capital corresponds to plausible change in an older person’s life course, which could result in deterioration in subjective oral health status.

One of the main attractions of social capital interventions is that they could potentially provide relatively inexpensive solutions for policy makers to tackle the economic and social costs of the ageing population. However, as this thesis has shown, there is still a long way to go before such social capital interventions can be recommended for improvement in the oral health of older adults. One key area of further research is the mechanisms and interventions by which older adults are able to generate and maintain social support and close ties in later life.

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Appendix A

Table A.1: Association between social capital and poor self-rated oral health at wave 3 (2006-07): Sequentially adjusted logistic regression models, OR (95%CI)

Self-rated oral health	Not a member	Not volunteering	Lowest tertile of close ties	Lowest tertile of social support
Model 3[1]	**1.69 (1.43-2.01)*** **	**1.29 (1.11-1.50)*** **	**1.42 (1.19-1.69)*** **	**1.62 (1.33-1.96)*** **
Model3+Education	1.54 (1.30-1.84)***	1.18 (1.02-1.38)*	1.45 (1.22-1.33)***	1.63 (1.34-1.97)***
Model3+Employment	1.65 (1.39-1.96)***	1.28 (1.10-1.49)**	1.44 (1.21-1.71)***	1.60 (1.32-1.95)***
Model3+Wealth	1.47 (1.23-1.75)***	1.14 (0.98-1.34)	1.42 (1.20-1.69)***	1.59 (1.31-1.93)***
Model 4[2]	**1.38 (1.15-1.65)*** **	**1.09 (0.93-1.28)**	**1.42 (1.19-1.69)*** **	**1.59 (1.31-1.93)*** **
Model4+Self-rtd health	1.31 (1.10-1.58)**	0.98 (0.84-1.15)	1.33 (1.12-1.59)**	1.43 (1.18-1.53)***
Model3+Long-st illness	1.35 (1.13-1.61)**	1.06 (0.91-1.24)	1.42 (1.19-1.69)***	1.52 (1.25-1.85)***
Model3+Depression	1.29 (1.08-1.55)**	1.04 (0.89-1.21)	1.36 (1.15-1.63)***	1.44 (1.18-1.75)***

[1]Model 3: contains the bivariate association between social capital and self-rated oral health adjusted for all socio-demographic factors
[2]Model 4: contains model 3 adjusted for all socio-economic factors
$*p< 0.05$; $**p< 0.01$; $***p< 0.001$

Table A.2: Association between social capital and edentulousness at wave 3 (2006-07): Sequentially adjusted logistic regression models, OR (95%CI)

Edentulousness	Not a member	Not volunteering	Lowest tertile of close ties	Lowest tertile of social support
Model 3[1]	**2.97 (2.45-3.61)*** **	**2.27 (1.90-2.71)*** **	**1.24 (1.02-1.49)***	**1.07 (0.86-1.33)**
Model3+Education	2.42 (1.98-2.96)***	1.87 (1.56-2.25)***	1.23 (1.01-1.48)*	1.08 (0.86-1.35)
Model3+Employment	2.95 (2.43-3.58)***	2.28 (1.90-2.72)***	1.23 (1.02-1.48)*	1.06 (0.86-1.33)
Model3+Wealth	2.21 (1.80-2.71)***	1.77 (1.47-2.13)***	1.19 (0.98-1.45)	1.05 (0.84-1.32)
Model 4[2]	**1.97 (1.60-2.42)*** **	**1.60 (1.32-1.93)*** **	**1.19 (0.97-1.44)**	**1.01 (0.81-1.27)**
Model4+Self-rtd health	1.91 (1.55-2.35)***	1.52 (1.30-1.84)***	1.15 (0.94-1.40)	1.00 (0.79-1.25)
Model4+Long-st illness	1.94 (1.57-2.39)***	1.57 (1.30-1.90)***	1.18 (0.97-1.44)	1.03 (0.83-1.30)
Model4+Depression	1.97 (1.60-2.43)***	1.60 (1.32-1.93)***	1.19 (0.97-1.44)	1.05 (0.84-1.32)

[1]Model 3: contains the bivariate association between social capital and edentulousness adjusted for all socio-demographic factors
[2]Model 4: contains model 3 adjusted for all socio-economic factors
$*p< 0.05$; $**p< 0.01$; $***p< 0.001$

Table A.3: Association between social capital and Oral Impacts on Daily Performances at wave 3 (2006-07): Sequentially adjusted logistic regression models, OR (95%CI)

OIDP	Not a member	Not volunteering	Lowest tertile of close ties	Lowest tertile of social support
Model 3[1]	**1.16 (0.92-1.47)**	**1.28 (1.04-1.57)***	**1.70 (1.32-2.17)*** **	**1.99 (1.51-2.63)*** **
Model3+Education	1.10 (0.87-1.410	1.22 (1.00-1.51)	1.69 (1.32-2.17)***	1.99 (1.51-2.64)***
Model3+Employment	1.12 (0.88-1.42)	1.27 (1.03-1.56)*	1.67 (1.31-2.14)***	1.97 (1.49-2.61)***
Model3+Wealth	1.00 (0.78-1.28)	1.15 (0.93-1.42)	1.67 (1.30-2.14)***	1.96 (1.49-2.59)***
Model 4[2]	**0.96 (0.75-1.24)**	**1.14 (0.92-1.41)**	**1.65 (1.28-2.122)*** **	**1.95 (1.47-2.58)*** **
Model4+Self-rtd health	0.90 (0.70-1.16)	0.94 (0.78-1.14)	1.55 (1.21-1.99)**	1.78 (1.34-2.36)***
Model4+Long-st illness	0.92 (0.71-1.19)	0.91 (0.75-1.10)	1.65 (1.29-2.12)***	1.84 (1.39-2.43)***
Model4+Depression	0.87 (0.67-1.12)	0.84 (0.70-1.02)	1.56 (1.22-2.00)***	1.71 (1.28-2.27)***

[1]Model 3: contains the bivariate association between social capital and OIDP adjusted for all socio-demographic factors
[2]Model 4: contains model 3 adjusted for all socio-economic factors
$*p< 0.05$; $**p< 0.01$; $***p< 0.001$

Appendix B

Table B.1: Association between social capital at wave 3 (2006-07) and poor self-rated oral health at wave 5 (2010-11): Sequentially adjusted logistic regression models, OR (95%CI)

Self-rated oral health	Not a member	Not volunteering	Lowest tertile of close ties	Lowest tertile of social support
Model 3[1]	**1.59 (1.31-1.92)*** **	**1.43 (1.21-1.69)*** **	**1.43 (1.18-1.74)*** **	**1.68 (1.36-2.08)*** **
Model3+Education	1.48 (1.22-1.80)***	1.35 (1.14-1.60)***	1.43 (1.18-1.73)***	1.68 (1.36-2.03)***
Model3+Employment	1.53 (1.26-1.85)***	1.42 (1.20-1.67)***	1.42 (1.17-1.72)***	1.67 (1.35-2.06)***
Model3+Wealth	1.42 (1.17-1.73)***	1.33 (1.13-1.57)**	1.41 (1.16-1.71)***	1.66 (1.34-2.05)***
Model 4[2]	**1.36 (1.11-1.66)** **	**1.30 (1.10-1.54)** **	**1.40 (1.16-1.70)** **	**1.66 (1.34-2.05)*** **
Model4+Self-rtd health	1.29 (1.05-1.58)*	1.18 (0.99-1.41)	1.31 (1.07-1.59)**	1.50 (1.20-1.86)***
Model4+Long-st illness	1.32 (1.08-1.62)**	1.27 (1.07 (1.51)**	1.40-1.16-1.71)**	1.57 (1.27-1.94)***
Model4+Depression	1.27 (1.03-1.55)*	1.23 (1.04-1.46)*	1.34 (1.10-1.63)**	1.49 (1.20-1.85)***

[1]Model 3: contains the bivariate association between social capital and self-rated oral health adjusted for all socio-demographic factors
[2]Model 4: contains model 3 adjusted for all socio-economic factors
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table B.2: Association between social capital at wave 3 (2006-07) and edentulousness at wave 5 (2010-11): Sequentially adjusted logistic regression models, OR (95%CI)

Edentulousness	Not a member	Not volunteering	Lowest tertile of close ties	Lowest tertile of social support
Model 3[1]	**2.45 (1.99-3.03)*** **	**1.88 (1.56-2.28)*** **	**1.24 (1.01-1.54)* **	**1.13 (0.88-1.44)**
Model3+Education	1.97 (1.58-2.44)***	1.55 (1.27-1.88)***	1.23 (0.99-1.52)	1.13 (0.88-1.45)
Model3+Employment	2.45 (1.98-3.02)***	1.90 (1.57-2.30)***	1.23 (0.99-1.52)	1.12 (0.87-1.43)
Model3+Wealth	1.83 (1.47-2.28)***	1.49 (1.22-1.82)***	1.19 (0.96-1.48)	1.12 (0.87-1.44)
Model 4[2]	**1.63 (1.30-2.04)*** **	**1.35 (1.10-1.65)*** **	**1.19 (0.96-1.48)**	**1.13 (0.88-1.45)**
Model4+Self-rtd health	1.58 (1.26-1.98)***	1.29 (1.05-1.58)*	1.15 (0.92-1.43)	1.07 (0.83-1.38)
Model4+Long-st illness	1.59 (1.27-1.99)***	1.32 (1.08-1.62)**	1.18 (0.95-1.47)	1.08 (0.84-1.39)
Model4+Depression	1.63 (1.30-2.05)***	1.36 (1.10-1.66)**	1.19 (0.95-1.48)	1.13 (0.88-1.46)

[1]Model 3: contains the bivariate association between social capital and edentulousness adjusted for all socio-demographic factors
[2]Model 4: contains model 3 adjusted for all socio-economic factors
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table B.3: Association between social capital at wave 3 (2006-07) and Oral Impacts on Daily Performances at wave 5 (2010-11): Sequentially adjusted logistic regression models, OR (95%CI)

OIDP	Not a member	Not volunteering	Lowest tertile of close ties	Lowest tertile of social support
Model 3[1]	**1.11 (0.88-1.40)**	**1.10 (0.90-1.34)**	**1.68 (1.31-2.14)*** **	**2.44 (1.85-3.22)*** **
Model3+Education	1.04 (0.82-1.33)	1.05 (0.85-1.28)	1.67 (1.30-2.40)***	2.44 (1.85-3.23)***
Model3+Employment	1.08 (0.85-1.36)	1.10 (0.90-1.34)	1.65 (1.29-2.12)***	2.43 (1.84-3.21)***
Model3+Wealth	0.97 (0.76-1.24)	1.00 (0.82-1.23)	1.65 (1.29-2.12)***	2.40 (1.82-3.17)***
Model 4[2]	**0.95 (0.74-1.21)**	**1.00 (0.81-1.23)**	**1.64 (1.28-2.10)*** **	**2.41 (1.83-3.19)*** **
Model4+Self-rtd health	0.90 (0.70-1.16)	0.93 (0.75-1.14)	1.55 (1.21-1.99)***	2.22 (1.68-2.95)***
Model4+Long-st illness	0.91 (0.71-1.17)	0.97 (0.79-1.20)	1.65 (1.28-2.11)***	2.27 (1.72-3.01)***
Model4+Depression	0.89 (0.69-1.14)	0.96 (0.77-1.18)	1.58 (1.23-2.03)***	2.24 (1.69-2.96)***

[1]Model 3: contains the bivariate association between social capital and OIDP adjusted for all socio-demographic factors
[2]Model 4: contains model 3 adjusted for all socio-economic factors
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$