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WORKPLACE SOCIAL CAPITAL AND EMPLOYEE HEALTH

by

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Dedicated to those who matter the most

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Department of Occupational Health, University of Turku, Finland and the Finnish Institute of Occupational Health, Turku, Finland.

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ABSTRACT

A growing number of studies suggest that social capital is a determinant of population health. However, the main body of evidence is limited by the cross-sectional nature of the studies as well as a focus mainly on geographical areas and residential neighbourhoods. Given that workplace is an important source of social relationships and networks, studies on workplace social capital are highly relevant. The aim of this study was to investigate the effect of workplace social capital on employee health in a large occupational cohort.

Data were derived from the Finnish Public Sector, which is an on-going prospective cohort study on work and health. In 2000-02, 48,592 participants responded (response rate 68%) to the baseline survey and of them 35,914 (77%) to the follow-up survey in 2004-05. A specifically designed 8-item tool was used to measure social capital with perceptions at individual level and co-workers' assessment at work unit level. Pooled data from repeated measures of self-rated health and social capital were used to study the exposure to social capital and the risk of health impairment in initially healthy employees. Participants with no previous history of depression were followed up on average 3.5 years for new self-reported physician-diagnosed depression and recorded antidepressant prescriptions derived from national health registers. Multilevel logistic regression modelling was used to analyse hierarchical data with individuals (1st level) nested in work units (2nd level). The analyses were adjusted for sociodemographic characteristics and lifestyle.

Persistent low levels of individual workplace social capital predicted poor self-rated health. The results from repeated assessments of social capital further showed that change in social capital was associated with subsequent self-rated health, which could support the causality in the association, however, the results are suggestive and no definite conclusions about the causality can be drawn. Low levels of individual workplace social capital were associated with 20-50% higher risk of new-onset depression. The relation was robust to adjustment for psychological distress for self-reported doctor-diagnosed depression but not for antidepressant treatment. Both low vertical social capital, i.e. respectful and trusting relationships between superior and employee, and low horizontal social capital, i.e. trust and reciprocity between co-workers, increased the likelihood of new-onset depression, independently of each other. There was additionally a contextual effect of workplace social capital on self-rated health but not on depression. The odds for impaired self-rated health were 30% higher for employees whose co-workers perceived social capital as low compared to those in units of high workplace social capital.

In conclusion, the longitudinal associations observed suggest that high workplace social capital may be beneficial for employee health. If the observed associations were causal, the findings would suggest that increasing workplace social capital could be a promising target for workplace interventions.

Key words: social capital, self-rated health, depression, public sector, workplace, multilevel

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TYÖYHTEISÖN SOSIAALINEN PÄÄOMA JA TYÖNTEKIJÖIDEN TERVEYS

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TIIVISTELMÄ

Monien tutkimusten mukaan sosiaalinen pääoma vaikuttaa terveyteen. Vaikka työssä käyvää väestönosaa on merkittävän osan valveillaoloajastaan työyhteisössä, siellä kertyvää sosiaalista pääomaa on toistaiseksi tutkittu vähän. Tässä tutkimuksessa selvitettiin työyhteisön sosiaalisen pääoman ja kuntatyöntekijöiden terveyden välistä yhteyttä pitkittäisasetelmassa hyödyntäen Kuntasektorin henkilöstön seurantatutkimuksen aineistoa vuosilta 2000–2005.

Yhteensä 48592 kuntatyöntekijää vastasi kyselyyn vuosina 2000–02 (vastausprosentti 68 %). Heistä 35914 (77 %) osallistui myös seurantatutkimukseen vuosina 2004–05. Tutkimuksessa kehitettiin kyselyyn perustuva työyhteisön sosiaalisen pääoman mittaumenetelmä. Työntekijän omaan arvioon perustuvan sosiaalisen pääoman lisäksi mitattiin työyhteisön sosiaalista pääomaa käyttämällä samassa työyhteisössä työskentelevien muiden työntekijöiden keskimääräistä arviota sosiaalisesta pääomasta. Terveyttä mitattiin kysymyksellä koetusta terveydestä. Masennusta arvioitiin sekä kysymällä lääkärin toteamasta masennuksesta että masennuslääkeostoilla Kelan lääkerekistereistä. Analyysiin otettiin mukaan vain ne kuntatyöntekijät, jotka olivat lähtötilanteissa terveitä eli kokivat terveytensä hyväksi tai heillä ei ollut aiempaa diagnosoitua tai lääkehoitoa vaatinutta masennusta. Tulosten analysointiin käytettiin monitasomallinnusta. Tulokset vakioitiin sosiodemografisten tekijöiden ja terveyskäyttäytymisen suhteen.

Neljän vuoden seurannassa sekä jatkuvasti vähäinen että vähenevä yksilön sosiaalinen pääoma työssä lisäsi riskiä koetun terveyden heikkenemiseen niillä kuntatyöntekijöillä, jotka eivät vaihtaneet työpaikkaa seurannan aikana ja jotka seurannan alussa kokivat terveytensä hyväksi. Tulos ei selittynyt sosiodemografisilla tekijöillä tai terveyskäyttäytymisen eroilla. Tuloksen merkittävyyttä tuki havainto, että myös työtoverien arvioon perustuva sosiaalinen pääoma ennusti oman terveyden huononemista seuranta-aikana. Niillä työntekijöillä, jotka työskentelivät sellaisissa työyhteisöissä, joissa koko seurannan ajan oli vähiten sosiaalista pääomaa, oli lähes 1.3 -kertainen riski terveyden heikentymiseen. Vähäinen omaan arvioon perustuva sosiaalinen pääoma työssä ennusti myös masennuksen ilmaantuvuutta lähtötilanteessa ei-masentuneilla lähes neljän vuoden seurannassa. Matalaan sosiaaliseen pääomaan liittyi 20–50 % suurempi todennäköisyys sairastua masennukseen seurannan aikana niin itseraportoidun lääkärin toteaman masennuksen kuin masennuslääkeostojen perusteella. Tätä tulosta ei kuitenkaan pystytty toistamaan käyttämällä oman arvion sijasta työtoverien arviota työyhteisön sosiaalisesta pääomasta. Tutkimusta sosiaalisen pääoman vaikutusta masennuksen ilmaantumiseen jatkettiin selvittämällä miten sosiaalisen pääoman eri ulottuvuudet vaikuttivat masennuksen ilmaantumiseen. Tulosten mukaan sosiaalisen pääoman vertikaalinen komponentti (työntekijöiden ja esimiesten välinen luottamus, vastavuoroisuus ja jaetut arvot ja normit, jotka edesauttavat yhteistyötä) sekä horisontaalinen komponentti (työntekijöiden välisissä suhteissa yhteistyötä, luottamuksesta ja vastavuoroisuudesta syntyvä sosiaalinen pääoma) vaikuttivat itsenäisesti masennusrisktiin. Tutkimuksen perusteella korkea työyhteisön sosiaalinen pääoma saattaa vaikuttaa edullisesti työntekijöiden terveyteen. Jos näin on, olisi tärkeää edistää työyhteisöjen sosiaalista pääomaa ja kannustaa sellaiseen toimintaan, joka lisää suvaitsevaisuutta, luottamusta ja vastavuoroisuutta sekä työntekijöiden kesken että työntekijöiden ja esimiesten välillä.

Avainsanat: sosiaalinen pääoma, koettu terveys, masennus, kuntasektori, työyhteisö, monitasomallinnus

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ABBREVIATIONS

α	Cronbach's alpha
ATC	anatomic therapeutic classification
BMI	body mass index (kg/m ²)
CI	confidence interval
CHD	coronary heart disease
DDD	defined daily dose
FPSS	Finnish Public Sector Study
MET	metabolic equivalent task
OR	odds ratio
PAF	population attributable fraction
RCT	randomized controlled trial
SD	standard deviation
SEP	socioeconomic position
SES	socioeconomic status

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following original publications, which are referred to in the text by the corresponding Roman numerals I-V. In addition, some unpublished data are presented.

- I. Anne Kouvonen, Mika Kivimäki, Jussi Vahtera, Tuula Oksanen, Marko Elovainio, Tom Cox, Marianna Virtanen, Jaana Pentti, Sarah J. Cox, Richard Wilkinson. Psychometric evaluation of a short measure of social capital at work. *BMC Public Health* 2006;6:251.
- II Tuula Oksanen, Anne Kouvonen, Mika Kivimäki, Jaana Pentti, Marianna Virtanen, Anne Linna, Jussi Vahtera. Social capital at work as a predictor of employee health: Multilevel evidence from work units in Finland. *Soc Sci Med* 2008;66:637-649.
- III Anne Kouvonen, Tuula Oksanen, Jussi Vahtera, Mai Stafford, Richard Wilkinson, Justine Schneider, Ari Väänänen, Marianna Virtanen, Sara J Cox, Jaana Pentti, Marko Elovainio, Mika Kivimäki. Low workplace social capital as a predictor of depression: The Finnish Public Sector Study. *Am J Epidemiol* 2008;167:1143-1151.
- IV Tuula Oksanen, Anne Kouvonen, Jussi Vahtera, Marianna Virtanen, Mika Kivimäki. Prospective study of workplace social capital and depression: Are vertical and horizontal components equally important? *J Epidemiol Community Health*. Published Online First: 19 Aug 2009. doi:10.1136/jech.2008.086074.
- V. Tuula Oksanen, Mika Kivimäki, Jaana Pentti, Marianna Virtanen, Timo Klaukka, Jussi Vahtera. Self-report as an indicator of incident disease. Submitted 2009.

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1. INTRODUCTION

In the 21st century, social capital has become part of our everyday language. It has entered the mainstream of scientific discourse and it is also a popular focus for policy discussion. Social capital has gained wide interest and currency among policy makers, politicians and researchers alike. Furthermore, there is a strong push from the general community to use social capital as a way not only to describe but also to understand community well-being. However, the definition and content of social capital remains relatively unfamiliar to the general public. This is hardly surprising as there is no single, universal definition for social capital. Even among the politicians and scholars who use the term, there is confusion about what social capital exactly encompasses. In broad terms, social capital can be understood as networks of social relations that are characterised by norms of trust and reciprocity and that lead to outcomes of mutual benefit. It deals with an important set of resources inherent in relationships, networks, associations and norms (Szreter and Woolcock 2004). Some scholars consider social capital to be one of the most important concepts to emerge in the past decade (Halpern 2005), whereas some express doubts that the concept tries to explain too much with too little (Lynch et al. 2000), and others criticise the concept for including virtually all the socioeconomic aspects of society repackaged in a new guise (Pearce and Davey Smith 2003, Stone and Huges 2002, Woolcock 2001). In any case, it is difficult to ignore social capital, as it remains an intuitively useful concept.

The omnipresence of health inequalities is a key concern. Even in the most affluent countries the social gradient in health runs across the society, and people who are less well off have substantially shorter life expectancies and more illnesses than the rich. According to many, in order to tackle the health inequalities a key issue is to focus on the social environment in order to generate new understanding (Marmot 1998). Indeed, scholars in health and policy research have recently turned to the notion of social capital to account for disparities in health (Kushner and Sterk 2005, Kawachi and Kennedy 1999). To date, numerous studies suggest that social capital may be a determinant of health. This assumption is based on its associations with total mortality (Wilkinson et al. 1998, Kennedy et al. 1998, Blomgren et al. 2004), cardiovascular mortality (Sundquist, Lindström et al. 2004, Ali et al. 2006), self-rated health (Kawachi et al. 1999, Kim et al. 2006), mental health (Mitchell and LaGory 2002, Sundquist, Johansson et al. 2004) and health-related behaviours (Lindström et al. 2001, Kouvonen et al. 2008).

This study has its roots in the raised awareness of and interest in the organisation of work and the characteristics of the workplace as a potential source of diversities in employee health. It has been suggested that the quality of the psychosocial environment at work could be as important determinant of health as the physical work environment (Wilkinson and Marmot 2003). For example, a meta-analysis has provided evidence that adverse psychosocial factors at work are risk factors for common mental disorders (Stansfeld and Candy 2006) and another meta-analysis has reported the association of work stress

with an excess risk of coronary heart disease (Kivimäki et al. 2006). Recently, a meta-analysis emphasised the importance of the psychosocial work environment in relation to the risk of depression (Bonde 2008). Thus, attention should be drawn to the psychosocial determinants of health of the working-aged, also targeting social capital at work. To date, the mainstream of social capital studies has focused on social capital in residential or geographical areas such as states, communities and neighbourhoods. For working populations, sources of variation in social capital are likely to be found in the settings where these people spend most of their time, i.e. in workplaces (Kawachi 1999, Putnam 2000). However, studies of social capital in workplaces are scarce.

The overarching aim of this study was to extend social capital research into the workplace and evaluate the relevance of social capital research in work settings. The burgeoning field of social capital research has given rise to many debates about methodological considerations and analytical strategies. This study seeks, using rigorous methods, to gain an understanding of the impact that workplace social capital could have on employee health in a large cohort of public sector employees. Furthermore, the emphasis in this study follows from the need for longitudinal analyses in social capital research and the attention is mainly given to examine the potential predictive value of workplace social capital on self-rated health and depression.

2. REVIEW OF THE LITERATURE

2.1. Conceptual framework

2.1.1. Definition of social capital

Social capital is a multidimensional concept (Stone and Huges 2002). One of the debates in contemporary research on social capital has been the variety of approaches used to define and measure social capital. To date, there is neither a general consensus on the definition of the concept nor a standard procedure to measure it. The differences in views reflect the wide range of disciplines involved in social capital; economics, politics, development studies, psychology, sociology, and epidemiology have all made contributions. On the one hand, as a multidisciplinary concept one of the benefits of social capital has been that it allows scholars from different disciplines to collaborate. On the other hand, the definitional mixture complicates the interpretation and the comparison of study results, in particular results from different fields of science.

Before turning to review the evidence linking social capital to health, it is expedient to provide a brief introduction to the history of social capital and the variety of its definitions. Even though the increase in academic interest in social capital can be dated to the late 1980's, the roots of the framing of the concept of social capital can be traced back to the beginning of the 20th century. The first to coin the concept of social capital was Lyda J. Hanifan, who was a state supervisor of rural schools in West Virginia, USA. In an article published in 1916, he defined social capital as:

That in life which tends to make these tangible substances count for most in the daily life of people, namely goodwill, fellowship, mutual sympathy and social intercourse among a group of individuals and families who make up a social unit. (LJ Hanifan, 1916)

He was a practical reformer who used the concept to urge the importance of community involvement for successful schooling. He also emphasised the need for skilful leadership to direct social capital towards the general improvement of the community's well-being. Thereafter, it took several decades before the use of the term in academic discourse became widespread, encouraged by the works of the principal theorists: Pierre Bourdieu (the Forms of Capital 1986), James S. Coleman (Social Capital in the Creation of Human Capital 1988) and Robert D. Putnam (Making Democracy Work 1993, Bowling Alone 2000).

The first systematic contemporary analysis of social capital was produced by the acclaimed French sociologist Pierre Bourdieu in 1985 who offered a definition (as translated in 1986 from the original French version published in 1985):

Social capital is the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or

less institutionalized relationships of mutual acquaintance and recognition.
(P Bourdieu 1986)

In Bourdieu's definition, social capital is composed of two elements: the social relationships that allow individuals to access to resources, and the amount and quality of those resources (Portes 1998). Despite the praise for the refinement and usefulness of this conceptualisation, few public health studies have incorporated the definition (Portes 1998, Capriano 2008). Many sociologists prefer to refer to an American sociologist James S. Coleman. Coleman motivated many scholars through his ideas which were published approximately parallel with Bourdieu's ideas. He illustrated that social capital created in the family and outside of it was associated with the number of drop-outs from high school. He offered a broader definition of the concept:

Social capital is defined by its function. It is not a single entity, but a variety of different entities, with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors within the structure. Like other forms of capital, social capital is productive, making possible the achievement of certain ends that in its absence would not be possible. (JS Coleman, 1988, 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 changes in the materials that facilitate production and human capital by changes in the personal skills and knowledge that help people to act in new ways. Social capital, in his view, came about through changes in the relations among persons that facilitate corporate action. According to him, the common feature was, however, that all these forms of capital enhance productivity. Coleman considered social capital an asset of and an important resource for individuals. In addition, he supported the public good aspect of social capital and concluded that social capital is a characteristic of the social structure and benefits all those who are part of the structure. Thus, the main difference between social capital and other forms of capital is the public good aspect (Kawachi et al. 1997, Putnam 1993a). Although the contribution of Coleman and Bourdieu to the theory of social capital is crucial, the definitions of the concept offered by them have proved difficult to operationalise and to measure (Mohan et al. 2005).

The real breakthrough in the wide use of the concept of social capital was stimulated by the political scientist Robert Putnam. He wrote the ground-breaking book *Making Democracy Work* (1993) where he argued that those areas which are well governed and moving ahead do so because they have high social capital; poorer cities lack in this virtue. The series of books was followed by *Bowling Alone* (2000) where he provided a huge volume of evidence for the effects of social capital, based on his observations of changes in society. He brought civic participation into the equation. In this context, the scholars of political sciences quote Alexis de Tocqueville (1805–1859), a 19th century scholar who drew attention to the foundations of American democracy. His

remarks preceded those of Putnam's, as he emphasised the role of associational life as the cornerstone of democracy. In *Bowling Alone* (2000), the central proposition was that through participation in associational life of various kinds people become members of groups and networks. Importantly, only by virtue of a membership in a group the beneficial effects of social capital are achieved. Putnam identified social associations and networks, norms of reciprocity, and trust as the key components of social capital. Putnam's definition of the concept has enjoyed wide currency. He defined social capital as:

Features of social organisation such as trust, norms and networks that can improve the efficiency of society by facilitating coordinated actions. (RD Putnam, *Making Democracy Work*, 1993)

Putnam emphasised that trust is an integral part of the definition of social capital. The view of trust as a key aspect of social capital is widely accepted and some scholars equate trust with social capital (Fukuyama 1995). However, Putnam himself re-considered this notion later on and joined Woolcock who argued that trust is not to be considered part of the concept of social capital, as it is neither a feature nor a source of social capital (Putnam 2001, Woolcock 2001, Edwards and Foley 1998). Nevertheless, as trust may be considered a close consequence it could easily be thought of as a proxy for social capital (Putnam 2001). Trust is a good example of the difficulties encountered in defining social capital: it has been considered a form of social capital (Coleman 1988), and a collective asset resulting from social capital (Lin et al. 2001). Portes has been at the forefront of stressing the need to keep the causes and consequences of social capital distinct (Portes 1998). He criticised Putnam's seminal work *Making Democracy Work* (1993a) for inherent circularity, i.e. defining a cause based on its consequences. Putnam attempted to explain the variations in the performance of local governments in Italy with differences in the levels of social capital. His central finding was that in northern Italy the governments were more efficient in their internal operations, creative in policy initiatives and in implementing those initiatives than their southern counterparts. From Putnam's view the improved performance was due to active community organisations in the north. By contrast, in the south the levels of civic participation were much lower and local governments proved inefficient, lethargic and corrupt. In other words, Portes criticised Putnam for arguing that social capital led to positive outcomes, such as promoting investment and economic development, and at the same time its existence was inferred from the very same outcomes it was hypothesised to generate (Portes 1998).

Portes has been determined to remind the supporters of social capital that besides the beneficial consequences of social capital there can also be the "dark side of social capital" with less desirable consequences (Portes and Landolt 1996, Portes 1998). Social capital may be used to exclude outsiders, place excess claims on group members, restrict on individual freedom and reinforce delinquent behaviour where this is the defining characteristic of group membership (Portes 1998). Similarly, Putnam has highlighted the negative effects of social capital, such as corruption or ethnocentrism (Putnam 1993b,

Putnam 2000). Social inequalities may be embedded in social capital, and the norms and networks that serve some groups may obstruct others.

The differences between the perspectives of the principal theorists mainly arise from the perception of social capital – whether it is considered a resource of individuals or of communities. At present, most scholars agree that it is both collective and individual; that is, institutionalised social relations with embedded resources are expected to benefit both the collective and the individuals in the collective (Kawachi et al. 2004, Stone and Hedges 2002). The minority of contemporary researchers express doubts as to the inclusion of other than micro-level aspects in the definition of social capital (Portes 1998, Edwards and Foley 1998).

Fukuyama (1995) is best known for working within an economic framework rather than a sociological one like Coleman or a political science perspective like Putnam. Indeed, strong support for including macro-level aspects of society comes from economic institutions, such as the OECD and the World Bank. The OECD defines social capital as

“Networks together with shared norms, values and understandings that facilitate co-operation within or among groups” (Cote and Healy 2001).

The World Bank includes institutions in its definition:

Social capital refers to the norms and networks that enable collective action. It encompasses institutions, relationships, and customs that shape the quality and quantity of a society's social interactions (Grootaert and Basteler 2002)

The World Bank further argues that increasing evidence points to the fact that social cohesion/capital is critical for societies in order for them to prosper economically and for development to be sustainable. Social capital is not merely the sum of the institutions that underpin a society – it is the glue that holds them together. Unlike conventional capital, social capital is “public good”. That is, it is not the private property of those who benefit from it (Putnam 1993b, Putnam 2000). Furthermore, some of the benefit from an investment in social capital goes to bystanders, while some of the benefit rebounds to the immediate benefit of the person making the investment (Putnam 2000). The benefit of belonging to a network, group or community is derived from the common interaction within social relations. Social capital can also be a by-product of other social activities (Putnam 1993a).

Although Putnam's definition of social capital is widely acknowledged, to date, there is no fixed definition of social capital. However, there is an emerging consensus across social sciences and scholars in public health that social capital refers to the civic engagement, the social/community networks and the shared norms, values, mutual trust and understanding embedded in the relationships (Kawachi 1999, Putnam 1993a, Putnam 2000, Coleman 1990, Woolcock 2001, Kawachi and Berkman 2000, Hawe and Shiell 2000). Networks form a resource for the individual and the group enabling them

to pursue shared objectives, facilitating action for mutual benefit and enhancing co-operation within or among groups. Furthermore, it is generally accepted that social capital is accumulated only by virtue of membership in a group or a social structure (Bourdieu 1986, Coleman 1988, Putnam 1993a, Putnam 2000, Portes 1998).

2.1.2. Dimensions and forms of social capital

According to many leading contemporary scholars, it is important to distinguish between the different forms and dimensions of social capital in general and because their associations with health may vary (Putnam 2000, Putnam 2001, Strezer and Woolcock 2004, Ferlander 2007, Kim and Kawachi 2006, Kawachi et al. 2004, Stone and Huges 2002). A multi-dimensional approach may help to understand the range of outcomes observed in the literature (Woolcock 2001). The first distinction between the dimensions was introduced by Bain and Hicks (1998) who disaggregated the notion of social capital into “structural” and “cognitive” components. At the simplest level, these two components can be characterised respectively as what people “do” and what people “feel” in terms of social relations. *Cognitive* social capital covers aspects related to beliefs, attitudes and values such as trust, solidarity and reciprocity that are shared among members of the same community. *Structural* social capital represents the extent and intensity of associational links or activity. It is formed through horizontal organisations and networks that have practices of collective action and mutual responsibility.

An additional important distinction is the difference between bonding and bridging social capital (Gittell and Vidal 1998, Woolcock and Narayan 2000). *Bonding* social capital refers to trust, reciprocity and co-operative relations between members of a network who are similar in terms of social identity (e.g. race, ethnicity). *Bridging* social capital refers to connections between individuals who are dissimilar with respect to social identity (Szreter & Woolcock 2004). It facilitates access to resources and opportunities for members of overlapping networks (Stone and Huges 2002). According to Putnam (2000) examples of bonding social capital include ethnic fraternal organisations, church-based women’s reading clubs and fashionable country clubs. Examples of bridging social capital include the civil rights movement, many youth service groups, and ecumenical religious organisations. Bonding facilitates cooperation within a group and is thus good for mobilising solidarity. Bridging networks are better for linkage to external assets and for information dissemination. (Putnam 2000). Bridging social capital is said to help individuals “get ahead” while bonding social capital helps them “get by” in life on a daily basis (Woolcock and Narayan 2000).

The bonding and bridging constructs partially overlap with the *vertical and horizontal* constructs of social capital, which view social capital as either vertically based, meaning that it inheres in the relationships between different levels of society (e.g. community, local government), or horizontally based, meaning that it inheres in the relationships between similar individuals or groups in the same context, for example within communities. Both bonding and bridging social capital mainly refer to the horizontal networks,

social relations or ties between equals. Thus, they ignore the vertical dimension, i.e. the different power relations often involved in social networks. Many researchers in the field have emphasised the importance of bringing state-society relations into the concept of social capital (Woolcock and Narayan 2000). At the turn of the 21st century, a new theory of social capital was put forward, distinguishing linking social capital from the more familiar bonding and bridging forms (Woolcock 1998, Szreter and Woolcock 2004). With this deployment, vertical considerations of power were brought explicitly into the concept of social capital. Linking social capital identifies the contacts between actors who are unequal in their power and access to resources. *Linking* social capital, thus, covers the vertical dimension of social capital which includes trust and reciprocity across a power gradient, for example in the work context (Lindström 2008a, Ferlander 2007). It is defined as “norms of respect and networks of trusting relationships between people who are interacting across explicit, formal or institutionalised power or authority gradients in society” (Szreter and Woolcock 2004). The capacity to leverage resources, ideas and information from formal institutions beyond the community is considered as a key function of linking social capital (World Bank 2000).

2.1.3. Distinctions from related concepts

Social capital has a long history and many antecedents. Many articles about social support and social networks published in the 1980's and the early 1990's might currently be placed under the umbrella of social capital, if re-written. Current research is faced with the challenge of trying to discover whether the concept of social capital makes a novel contribution to public health. In order to do this, social capital needs to be distinguished from related concepts. In theory, social capital is not equal to social cohesion, social support and social networks. Social capital builds on these concepts and, in fact, may capture the essence of many of these related concepts and be manifested by them. The distinctions between the related concepts and social capital are described briefly below.

Social cohesion. By definition, social cohesion refers to the extent of connectedness and solidarity among groups in society (Kawachi and Berkman 2000). Although, some researchers have treated social capital as equivalent to social cohesion (Kawachi, Kennedy, Wilkinson 1999) or as a subset of the notion of social cohesion (Kawachi and Berkman 2000, Lindström 2008b), the concept of social capital is considered to be broader. Social cohesion is a collective characteristic which is often measured at individual level by levels of trust and reciprocity (Kim et al. 2008). As such, it can be seen to represent the cognitive component of the construct of social capital (Fone et al. 2007). Because the structural component of social capital entails the inclusion of the social structures, i.e. networks and associational links, social capital also encompasses the wider community. Thus, although conceptually close, social capital is not synonymous to social cohesion. It is not consistent with accepted terminology to combine social cohesion and social capital and to transpose them completely (Almedom 2005).

Additionally, social capital is to be distinguished from the individual level concepts of social support and social networks (Lochner et al. 1999, Kawachi and Berkman 2000, Harpham et al. 2002). *Social support* refers to the function and quality of social relationships whereas *social networks* include the relationships within social structures. It is widely acknowledged that social support and good social relations make an important contribution to health (Berkman and Glass 2000, Wilkinson and Marmot 2003, House and Kahn 1985, House et al. 1998). There has been a considerable amount of research into the effects of workplace social support on health (Stansfeld and Candy 2006). According to many, the concept of social capital contributes something additional to the already well-established literature on the social networks and social support by accounting for group-level influence on individual health (Kawachi et al. 2004). In addition, in relation to distinction between social capital and social networks, the mechanisms linking social capital to health might be different from those linking social networks to individual health (Berkman and Syme 1979, Berkman and Glass 2000, Kawachi and Berkman 2001). Social capital is rather a feature of the societal structure than a reflection of individuals' social networks and mutual support (Lochner et al. 1999, Subramanian et al. 2003). This means that social capital as an ecological characteristic can be distinguished from the concepts of social networks and social support, which are attributes of the individual (Putnam 2004, Lochner et al. 1999). The potential of social capital lies in its collective dimension (Kawachi et al. 2004).

2.1.4. Measurement of social capital

One of the great weaknesses of the concept of social capital is the absence of consensus on how to measure it accurately. Accordingly, a large number of different ways have been used to operationalise and measure social capital. The level(s) of assessment and the level(s) of analysis have varied across studies. This reflects the difficulties in translating the different theoretical components of social capital into valid and measurable constructs. Above all, scholars in the field have recommended finding a sufficiently comprehensive measure that captures the latest theoretical developments in the field (Hawe and Shiell 2000, Harpham et al. 2002, Cote and Healy 2001, Kawachi et al. 2004).

Currently, the key indicators of social capital are considered including civic engagement (i.e. social and political participation, volunteering), social relations in formal and informal social networks, group membership, trust and reciprocity (Harper 2001). The measurements of social capital have included one or several of these indicators as single- and multiple-item measures, combined indexes and scales for the assessment of social capital. However, the use of unusual social capital indicators is not exceptional, mainly in relation to developing countries or unique cultures. For example, Rose (2000) used such factors as smoking status and paying the doctor to expedite one's treatment as indicators of social capital in post-communist Russia.

Single-item measures. Trust is considered a key component of social capital (Putnam 1993a, Fukuyama 1995). It is also the most widely used single item measure for the

assessment of social capital. Responses to the question: “Generally speaking, would you say that most people can be trusted, or that you can’t be too careful in dealing with people?” are frequently used to assess trust with subsequent labelling of the variable as trust, social trust, social mistrust, interpersonal trust or civic trust (Putnam 2000, Kawachi et al. 1997, Kawachi et al. 1999). Trust in government and in political institutions has been measured as an aspect of political trust (Veenstra 2000, Lindström and Janzon 2007). Single-item measures employed also include: a sense of belonging and mutual aid (Fujiwara and Kawachi 2008), reciprocity measured by the perceived helpfulness of others (Kawachi et al. 1997, Kawachi et al. 1999), and voting turnout, i.e. participation in national or regional elections (Sundquist et al. 2006, Islam et al. 2008). The problem with the use of single-item measures is that this approach fails to recognise the multidimensional character of the concept of social capital, which further reduces its theoretical reliability (Stone and Huges 2002).

Multiple-item measures, combined indexes and scales. The use of multiple-item measures helps to cover the different aspects of the construct of social capital. For example, Harpham et al. (2004) used 30 questions to cover different dimensions of social capital. The perceptions of trust, institutional trust, social cohesion, solidarity, social control and civic participation were further combined into eight scales. Fujiwara and Kawachi (2008) measured three aspects of cognitive social capital (social trust, a sense of belonging and mutual aid) and two aspects of structural social capital (volunteer work and community participation) using single-item measurements and multiple-item scales to cover each aspect. It is also common to include several core aspects of social capital in a compilation of an index. For example, questions of the extent and intensity of social participation and volunteering are frequently combined into a composite index (Blakely et al. 2006, Sundquist, Lindström et al. 2004, Ali et al. 2006). An example of a very comprehensive measurement approach is SCAT, Social Capital Assessment Tool, which was developed by the World Bank for use in developing countries (Krishna and Shrader 2000). It consists of a community profile (143 questions), a household survey (28 background questions, 39 questions of structural and 21 questions of cognitive social capital) and an organizational profile (76 questions). Its shorter form, A-SCAT, is developed especially for use in countries with a low literacy level and it is similarly interviewer administered as SCAT (Harpham et al. 2002). In the health-related field, most common measures used in epidemiological analyses have been levels of interpersonal trust and per capita membership in voluntary groups (Baum and Ziersch 2003). For example, Kawachi et al. (1997) used several separate indicators of social capital including the density of associational membership, interpersonal trust and the perceived norms of reciprocity to estimate whether state variations in social capital are related to variations in mortality rates. Another frequently quoted approach was termed as collective efficacy. Sampson et al. (1997) included five items to measure social cohesion and trust and another five items to measure informal social control. The individual responses were combined to a summary measure of neighbourhood’s collective efficacy that reflected the level of social

cohesion among neighbours combined with their willingness to intervene on behalf of the common good which was linked to reduced violence in the residential area.

The level of measurement is also currently under debate. Given that social capital is considered an individual asset and an ecological characteristic it is theoretically appropriate to encompass both approaches, i.e. both the individual level and the collective level (Kawachi et al. 2004, Szreter and Woolcock 2004). Furthermore, social capital at different levels may exert different influence on population health (Lochner et al. 1999). At present, the public health literature identifies social capital at three distinct levels: state-level (macro-level), community or small area level (meso-level) and individual level (micro-level) incorporating individual behaviours and attitudes (Macinko and Starfield 2001). Another methodological issue is that even though social capital is perceived as a community characteristic, it is has commonly been measured by asking individuals about their perceptions and aggregating their replies to obtain community-based measures of social capital. Such aggregations may not actually capture group characteristics and may represent an ecological fallacy (Shortt 2004). Lochner et al. (1999) have argued that community characteristics ought to be distinguished from individual characteristics, and measured at community level. Accordingly, researchers have tried to find alternative approaches to assess community social capital, for example by obtaining data on objective markers of social capital collected through secondary sources, such as the per capita density of organizations within a community or voting turnout (Putnam 2000). New creative examples might include directly observable features of community, such as population turnout, levels of media/communications within the community or the extent to which neighbourhood sidewalks are cleared after a storm (Whitley and McKenzie 2005, Lochner et al. 1999).

The level of analysis. In social capital research, attention is currently being focused on the advancement of analyses techniques (Szreter and Woolcock 2004, Yen and Syme 1999). Multilevel techniques are increasingly used to investigate the effects of social capital at several levels. The multi-level framework offers a comprehensive framework for understanding the ways in which places can affect people (contextual effect), or alternatively, the ways in which people can affect places (compositional effect). Furthermore, multilevel analyses offer the researchers, regardless of their main theoretical perception of the concept of social capital as individual or collective asset, a greater “analytic scope” for understanding social capital both at individual and group level. However, the use of multilevel modelling per se does not solve the inconsistencies in the definitional approaches. Instead, the increased use of multilevel models has led to a similar request for more theory-driven approaches (Diez Roux 1998).

The current status of the measurement of social capital has been subject to criticism for several reasons. First, the diversity of the application of social capital has attracted criticism arguing that the concept has been stretched and modified so far in order to cover so many kinds of relationships at so many levels that it has lost its credibility (Macinko and Starfield 2001, Portes 1998, Woolcock 1998). A concept that encompasses

too much is at risk of explaining nothing. Second, the variety of tools can also be seen as reflecting lack of research originally designed to measure social capital. Instead, contemporary researchers have tried to capture the essence of social capital by using the data available to achieve variables that can be computed from a range of items (Macinko and Starfield 2001, Shortt 2004). Third, although the development and use of validated scales has been considered essential (Harpham et al. 2002, Stone and Huges 2002, De Silva et al. 2005), only a few of the existing instruments used to measure social capital and its associations with health have been subjected to evaluation of reliability and validity (Lochner et al. 1999). De Silva et al. (2006) reviewed the existing literature on social capital and health and found only eleven studies attempting some validation of social capital tools. Given that there is no gold standard to compare with, standard psychometric testing techniques, such as estimation of traditional sub-categories of validity or internal consistency reliability, and factor analysis are available (Macinko and Starfield 2001, Harpham et al. 2002, De Silva et al. 2006). Fourth, the concept of social capital has been under close scrutiny due to the alleged weak theoretical basis for many social capital studies (Lynch et al. 2000). To achieve conceptual and empirical clarity, each key dimension of social capital should be measured (Szreter and Woolcock 2004). Operationalising a distinction between bonding, bridging and linking social capital is not an easy task given the multiple and overlapping relationships individuals have with others. In fact, there are few existing instruments for the measurement of bridging social capital and linking social capital (Kawachi et al. 2004).

2.2. Social capital and health

Recently, social capital has become one of the popular topics in public health. In this chapter, the possible reasons for the increase in interest are first discussed. Secondly, the pre-existing literature reviews on social capital and health are reviewed. Finally, an updated review focusing on prospective evidence on social capital and health is undertaken.

2.2.1. The growth of interest in social capital in public health

The explosion of interest in applying the concept of social capital to public health is a comparatively recent phenomenon. Searching on a scientific database PubMed for “*social capital and health*” revealed that social capital has entered the public health discourse within a very short time span, namely a decade. Up to 1996 there were 6 articles indexed in PubMed relating to social capital and health. Entering the same terms in PubMed at the beginning of 2009 revealed a total of 582 articles. A report from the Web of Science illustrates this growth in published articles in a concrete manner (Figure 1).

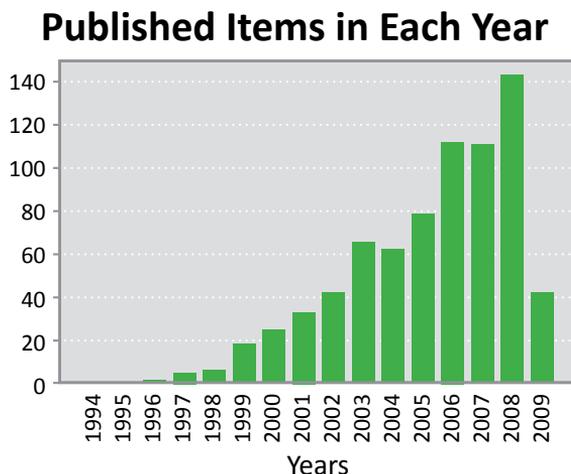


Figure 1. Web of Science: Articles on social capital and health between 1994 and May, 2009.

Why has there been such a growing interest in public health and related sciences in investigating the possible health effects of social capital? There are several possible explanations.

First, the origins of academic interest in social capital date back to the end of 1980's when contributions from sociologists Pierre Bourdieu, with regard to social theory, and James S. Coleman, with regard to the social context of education, introduced the idea into the academic discourse. Consequently, the extensive research conducted within the last two decades has linked social capital with social and economic growth, community development and health. Social capital has been claimed to be important for the functioning of democracy, for the prevention of crime, for creating partnerships and business networks and as a pre-requisite for economic development (Bourdieu 1986, Coleman 1990, Putnam 1993a, Loury 1977, Baker 2000, Hawe and Shiell 2000, Sampson et al. 1997). The real breakthrough of social capital in public health research may still be attributable to the contribution of political scientist Robert D. Putnam in the 1990's, whose work attracted wide publicity, even among the general public. His arguments about the impact of social capital on the well-being of the whole society (Putnam 1993a, Putnam 2000) and the alarming observations of a decline in social capital in the USA (Putnam 1995, Putnam 2000) have prompted a considerable body of research. Surprisingly, Putnam's assumption of an increase in social capital in the aftermath of the tragedy of September 11 has raised much less interest (Putnam 2002).

Second, Putnam's empirical findings that communities with high social capital fared better than did communities with low social capital raised interest in the international science community. However, it may be that wide interest in applying the concept to the public health agenda only arose after the first empirical demonstration that linked social capital to mortality, published in 1997 (Kawachi et al. 1997). This study remains one of the most cited articles on social capital and health with 649 citations (Web of Science, February 2009). In the study conducted in 39 US states, Kawachi and his colleagues

found that social mistrust, lack of helpfulness and lack of voluntary group membership were associated with all-cause mortality. It should be highlighted, however, that in no study have levels of and changes in social capital explained population mortality any better than traditional risk factors or other competing theories in any study (Pearce and Davey Smith 2003). In addition, as regards mortality, the explanatory power of social capital has subsequently been challenged vis-à-vis material circumstances (Mohan et al. 2005, Pearce and Davey-Smith 2003). Nevertheless, the seminal findings that variations in state-level social capital could explain (at least some of the) variance in total mortality have been backed up by a growing body of evidence suggesting that social capital is a determinant of population health. The novel contribution of social capital to public health research could lie in its collective dimension, i.e. its potential to account for group-level influence on individual health (Kawachi et al. 2004). To date, social capital has been empirically linked with total mortality (Wilkinson et al. 1998, Kennedy et al. 1998, Blomgren et al. 2004), cardiovascular mortality (Sundquist, Lindström et al. 2004, Ali et al. 2006), self-rated health (Kawachi et al. 1999, Kim et al. 2006), mental health (Mitchell and LaGory 2002, Sundquist, Johansson et al. 2004), and health-related behaviours (Lindström et al. 2001, Kouvonen et al. 2008) in studies measuring social capital with such things as social trust, social and political participation, volunteer work and group membership.

Third, the recent interest in the impact of social capital on public health may have stemmed, in part, from the omnipresence of health inequalities. Even in the most affluent countries, the social gradient in health runs across society and people who are less well off have substantially shorter life expectancies and more illnesses than the rich. The widening of some of the health gaps during the last decades of the 20th century has increased the urgency of finding solutions to this public health problem (Wilkinson and Marmot 2003). In the light of the persistence of health inequalities, it is possible that unravelling characteristics of the social environment play a role, for example social capital. It has been suggested that area-level variation in social capital may account for previously unexplained between-place variations in health outcomes (Mohan et al. 2005). Interestingly, it has even been argued that social capital provides a missing causal link between social inequality and health (Kawachi et al. 1997, Kawachi 1999, Szreter and Woolcock 2004).

The idea that variations in social capital could explain area level variations in population health goes back to Emile Durkheim (1857-1915). The seminal work of Emile Durkheim provided one theoretical framework for studying the social environment. His argumentation was that differences in social environments accounted for differences in suicide rates. He demonstrated that social disintegration can have health consequences: the rates of suicide varied inversely with the degree of integration of the social groups, of which the individual formed a part (Durkheim 1897). The sceptics have argued that thorough reading of Durkheim's study may reveal the biased nature of his observations (Kushner and Sterk 2005). Nevertheless, his general thesis was that the behaviour of the individuals in a given community can not be understood in isolation from the

characteristics of the community and the embedded relationships. Durkheim studied suicide, but his insights potentially apply to other forms of illness. Accordingly, there has been a strong tradition of ecological thinking in psychiatric epidemiology suggesting that social factors play a strong role in the aetiology and course of mental illness (Mathers 2006). Acknowledging the global burden of depression, these notions highlight the possibilities that may be achieved through investments in prospective research on the social environment and social capital, in particular.

Given the increasing amount of studies that have suggested that social capital can be a determinant of population health, the mechanisms linking social capital to health outcomes have yet to be elucidated. Several possible pathways by which social capital might influence health have been described including the diffusion of health information, healthy norms and social control over deviant health-related behaviour, increased access to local services and amenities, through psychosocial mechanisms, and crime, particularly violent crime (Kawachi et al. 1999).

2.2.2. Review of pre-existing literature reviews

The evidence that link social capital with population health derives from a large variety of disciplinary backgrounds and methodological traditions. This fact presents multiple challenges to the evaluation of studies linking social capital and health. The lack of consistency and the multiple ways of conceptualising, operationalising and measuring social capital result in limited comparability between studies. The differences in the approaches used to measure social capital may also contribute to variations in the observed relationships between social capital and individual and population health across studies (Lakon et al. 2008).

The diversity in both the study designs and the indicators used to measure social capital was noted by Kawachi et al. (2004) when they summarised empirical studies linking social capital with health. They reviewed evidence from 31 ecological studies, 15 of which were multilevel studies. They excluded all studies conducted exclusively at individual level, in order to exclude the studies of social networks and social support. With a few exceptions, the ecological studies had consistently found an association between social capital and population health outcomes, including self-rated health, mortality, teen birth rates, sexually transmitted diseases and health-related behaviour. However, all the studies but one were cross-sectional by nature. The only exception was a Dutch study of children, which found non-specific associations between social capital and children's health.

Islam et al. (2006) compiled a literature review of social capital studies published in 1995–2005, which had direct health status measures (e.g. self-rated physical and psychological health, coronary heart disease) and mortality as their outcome. They identified 42 studies, 27 of which studies were not included in the compilation of evidence by Kawachi et al. (2004) two years earlier. They divided the studies by level of analysis: single-level (i.e. individual-level or ecological-level) or multilevel (individual and ecological level).

Nearly all the 30 single-level studies found significant relationships between social capital and health although some associations were weak and some findings were mixed. The findings from 12 multilevel studies were inconsistent. They went further to combine the evidence according to the countries' degree of economic egalitarianism. The review reported positive associations between social capital and health irrespective of the degree of egalitarianism acknowledging at the same time that the main body of evidence came from cross-sectional studies.

The most recent systematic review of social capital and physical health was undertaken by Kim et al. (2008). They 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. They found fairly consistent associations between social capital (as indicated by trust) and better physical health. The evidence was stronger for self-rated health than for other physical outcomes, and stronger for individual-level trust than area-level trust. Social participation as an indicator of social capital was also found to be associated with better self-rated health at the individual level. Of all the studies included in the review only 6 were prospective, which was concluded to constitute a major gap in the evidence. They 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.

Three reviews have focused entirely on the relationship between social capital and mental health. De Silva et al. (2005) included quantitative studies published up to March 2003 and a parallel review conducted by Almedom (2005) reviewed studies published up to December 2003. Although the reviews used quite similar search strategies in the main electronic databases, De Silva et al. identified 21 social capital studies of which only 4 were included in the review by Almedom. The latter review was later completed by Almedom and Glandon (2008) by adding four studies published in 2004–2005. De Silva et al. (2005) divided the studies according to the level of measurement of social capital. Fourteen individual-level studies predominantly found an inverse association between social capital and the mental health of adults and children. The evidence came from studies which assessed the cognitive or structural dimension or a combined measure of social capital. The diversity in methodology, populations and mental health outcomes in 7 ecological studies in the review made it impossible to summarise their effects. The review concluded that the measurements of social capital did not match up to the theory as none of the studies included in the review had measured any aspect of bridging or linking social capital. They highlighted the need for the measurement of all the dimensions of social capital and the use of validated social capital measures, longitudinal designs and multilevel modelling.

Almedom (2005) described the results of 12 studies in three categories, namely children and youth, adults and senior citizens, and with reference to mental health service and care provision. The review mainly comprised thematic discussion about social capital and mental health rather than summing up the findings, as was also the case in a later

review by Almedom and Glandon (2008). All these mental health reviews considered the cross-sectional design of the studies to be a crucial limitation, making it impossible to determine the direction of the association between mental illness and social capital. Additionally, Whitley and McKenzie (2005) summarised the evidence from 7 studies published in 2000-2005 (two of them not included in the aforementioned systematic reviews) connecting social capital with several mental health outcomes, namely depression, anxiety and psychosis. They concluded that the existing studies did not provide strong evidence for the association between social capital and mental health. They pointed out two major developmental needs in social capital studies: the use of validated instruments measuring social capital and prospective designs.

Based on previous evidence, it is hypothesized that a literature review of prospective studies would yield at least some evidence of an inverse relationship between social capital and health (i.e. the lower the social capital the higher the adverse outcomes such as incident disease rates or mortality rates) at least in relation to some adverse outcomes. Nevertheless, the broad picture would not be different from cross-sectional evidence as the definitional and measurement ambiguity would remain. Thus, a systematic review was undertaken to evaluate the relevant published quantitative studies that have assessed the relationship between social capital and health longitudinally. To decrease bias from confounding and reversed causality in the observed associations of social capital with health outcomes, the literature review focused exclusively on longitudinal studies.

2.2.3. An updated systematic review

The specific question to be answered in the review was: In working-aged populations, is low social capital a risk factor for poor health? The study question, study selection criteria, quality appraisal process and data extraction were pre-determined (Jackson, the Cochrane Collaboration). A systematic search for relevant studies was undertaken in five electronic databases on 24 February 2009. Keywords, titles and abstracts were searched in Medline (PubMed, from 1966), EMBASE (from 1947), PsychINFO (from 1987), Web of Science (from 1986) and Scopus (from 1960) to the date of search. Only longitudinal studies that evaluated the effect of social capital on a health outcome were included. The search was limited to English-language articles published in peer-reviewed journals that used at least one aspect of social capital in the analysis.

The wide search strategy was defined entirely in terms of the explanatory variable (social capital) and the study design (longitudinal). In Medline, studies were searched using a combined text word and Medical Subject Heading (MeSH) search strategy. To identify all potentially relevant studies, in addition to “social capital”, a wide range of terms for searching for social capital were selected including “social cohesion”, “social participation” and “social trust”, #trust, “neighbourhood cohesion”, “neighborhood cohesion” and “collective efficacy”. Search terms in quotes were searched for as exact text phrases. The selected search terms for social capital were entered together with the description of the study design using the Boolean operator “AND” with #cohort studies

or “longitudinal OR prospective OR follow-up”. The # sign stands for the inclusion of the MeSH terms found below the searched MeSH term in the MeSH hierarchy, i.e. exploding the term. As regards “cohort studies” this meant that the search also encompassed the following terms: “longitudinal studies”, “follow-up studies”, “prospective studies” and “incidence studies”. However, the use of “longitudinal OR prospective OR follow-up” identified additional studies. The search with #trust was restricted to Major Topic headings. No combination with any subheading was made.

Additional searches were undertaken in four electronic databases (EMBASE, PsychINFO, Web of Science and Scopus) using combined text words as exact text phrases for the search: (“social capital” OR “social cohesion” OR “social participation” OR “social trust” OR “neighbourhood cohesion” OR “neighborhood cohesion”) AND (longitudinal OR prospective OR “cohort studies” OR follow-up). In Scopus, the search was restricted to the subject areas of Health and Social Sciences. Bibliographies of the abovementioned reviews and reference lists of the potentially relevant papers identified in the initial search were additionally searched.

Criteria for the inclusion and exclusion of the studies. The criteria for inclusion were: (1) the aim of the study was to investigate the relationship between social capital and health, (2) a meaningful indicator of social capital was used as an explanatory variable, (3) the study was a prospective cohort study, (4) the study targeted working-aged population and (5) the health outcome was assessed using a relevant measure of health status. Studies were included if they contained any key aspect of the current understanding of the definition of social capital even though they did not call it social capital. Studies were not excluded if they additionally measured social capital by non-orthodox indicators. Despite the problematic overlapping of social cohesion and social capital, studies investigating social cohesion were included if they measured key aspects and indicators of social capital. In the case of duplicate reports, the one with a more valid assessment of exposure or outcome was chosen. And if there was no difference in this respect, the paper first published was included. Preferably the study populations were initially free of the measured adverse health outcome or adjusted for baseline health status. Studies that did not present original data (i.e. reviews), were qualitative rather quantitative or investigated social support or social networks rather than social capital were excluded. Studies that were not genuine longitudinal prospective studies and studies that only reported health-related behaviours as outcome were also excluded. Studies were not excluded on grounds of methodological quality.

Data abstraction. All the relevant studies that met the preliminary inclusion criteria were identified. Data were abstracted on publication details, population details, the measurement of social capital, outcomes and findings. For each qualifying study, the following information was tabulated: publication year and study author(s); sample size, population and setting; age range and sex division of the participants; social capital measure, the level(s) of assessment (individual or/and contextual level); health outcome measure; the completeness of follow-up (% of participants with follow-up data) and

the duration of follow-up; potential confounders considered in the analyses; and key findings. Effect estimates were extracted separately for each health outcome. For each estimate, the most complete model including all potential confounders was selected. If effect estimates were reported for the working-aged and other age groups separately, only the former was extracted. Following the data extraction, a critical appraisal of the quality of each study was made.

Assessment of the quality of the studies. It is recommended to include an assessment of the quality of the primary studies and the possibility of bias such as publication bias in a review of prospective epidemiological studies (Altman 2001, Stroup et al. 2000). The fact that epidemiological studies are prone to publication bias and studies showing a strong association are more likely to be published may also apply to studies on social capital. There are no widely agreed criteria for reviews for assessing the quality of and susceptibility to bias in observational longitudinal prospective studies in epidemiology (Altman 2001, Sanderson et al. 2007). In fact, systematic reviews have used a wide variety of tools comprising checklists, summary judgement checklists and scales, in many cases without describing their development or validity and reliability. The use of a transparent checklist that concentrates on a few, principal, potential sources of bias has been recommended rather than summary scores that involve weighting of component items (Sanderson et al. 2007). Among the preferable domains to be appraised is the appropriate selection of participants, the appropriate measurement of variables and the appropriate control for confounding (Altman 2001, Sanderson et al. 2007). As concerns prospective studies of etiological risk factors, the study features relating to follow-up also need to be evaluated, i.e. the length of follow-up and the loss to follow-up (Altman 2001). Following these recommendations, this review concentrated on only a few domains and evaluated the studies and the possible threats to internal validity using the following checklist:

1. Selection of participants (representativeness of the target population, participation rate)
2. Completeness and duration of follow-up (loss to follow-up, sufficient follow-up time)
3. Measurement of social capital (key aspects covered)
4. Measurement of outcome (validity of measure of health)
5. Control for important confounding

Selection of studies. The searches identified altogether 1,287 citations: 199 in Medline, 126 in EMBASE, 217 in PsychINFO, 410 in Web of Science, and 335 in Scopus. The titles and abstracts were screened to exclude obviously irrelevant publications reducing the number of potentially relevant studies to 39. Additional 12 papers that had not been retrieved by the systematic literature search were identified by cross-referencing the bibliographies of previous reviews and the identified studies. Full copies of the 51

articles that appeared to be relevant were obtained and considered for suitability. Finally, 15 publications were considered to meet the inclusion criteria (Figure 2).

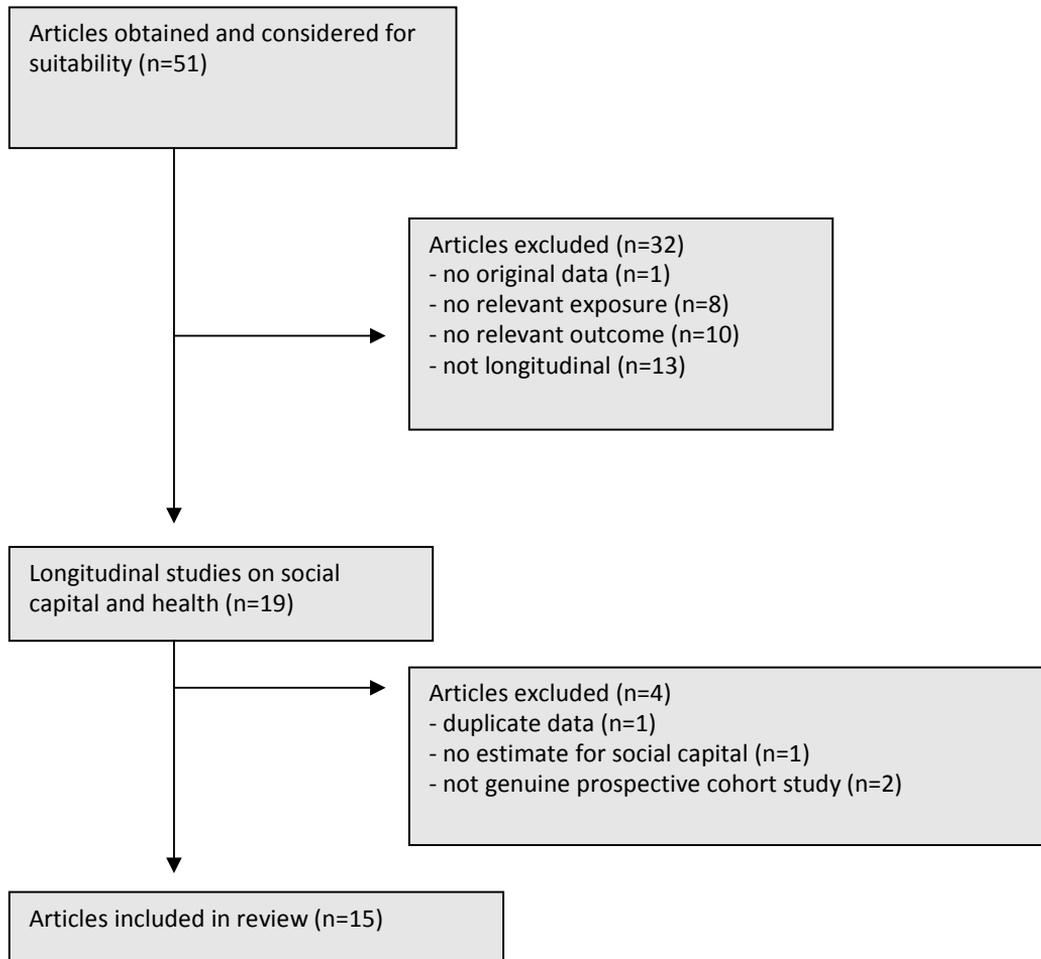


Figure 2. Selection of studies.

Description of studies. Of 15 studies that met the inclusion criteria, 7 studies evaluated the effect of social capital on all-cause mortality and/or cause-specific mortality, 7 investigated social capital and cardiovascular disease and 4 studies measured social capital and mental health, yielding altogether 53, 17 and 11 effect estimates, respectively. One study additionally estimated the effect of social capital on self-rated health and the result is tabulated in combination with the results on mental health. The characteristics of the included studies are displayed by outcome in Tables 1-3. The included studies comprised a total population of approximately 2.7 million adults for the study of the relationship between social capital and mortality, 4.3 million for the investigation of cardiovascular morbidity and mortality and 4.5 million for studying the association between social capital and mental health. Of the combined populations, more than half were men. All the studies included the working-aged although most studies also included

the elderly. Most of the studies (12) were published during the last five years. The studies were carried out in a limited set of countries: eleven studies in Europe (7 in Sweden, 2 in Finland, 1 in the UK and 1 in Norway), 3 in the USA and 1 in New Zealand. Of the 13 studies that derived data on the health outcome from health registers, the majority came from the Scandinavian countries. None of the studies came from developing countries.

There was wide variation as to how social capital was operationalised and measured. The vast majority of the studies used multiple indicators of social capital or a combined index of items to measure social, leisure or political participation, volunteering, trust and voting turnout. Assessment of social participation included questions ranging from attending cultural and sports events, religious participation, singing in a choir to associational memberships and attendance at meetings. One study used a previously validated scale, i.e. Petris Social Capital Index (Scheffler et al. 2008), and three studies had conducted factor analyses (Hyypä et al. 2007, Blakely et al. 2006, Sundquist et al. 2004). The oldest study included in the review (Bygren et al. 1996) reported carrying out secondary analyses of survey questions not originally designed to measure social capital. Seven studies measured individual level social capital, seven area-level social capital and one measured both. Of the eight area-level studies, seven studies carried out multilevel analyses. The area-level unit of analysis for social capital varied from neighbourhood, electoral ward, municipality, and functional region to county. None assessed social capital at state level.

The indicators of individual social capital were obtained from surveys. At area level the assessment of social capital included objective measures such as voting turnout in elections derived from official records and subjective measures obtained from surveys, such as volunteering, social and political activity and neighbourhood activities aggregated to area-level. Some studies additionally used non-common indicators of social capital, such as reading books or periodicals, family cohesion, residential stability and blood donorship rate. Two recently published (2006, 2007) Swedish studies measured linking social capital in neighbourhoods. It is to be noted that they measured linking social capital by voting turnout which was used as an indicator of social capital in several other studies without naming the variable as linking social capital. A meaningful meta-analysis was impaired by the heterogeneity of its operationalisation and measurement of social capital. The findings are summarised in words and the numbers of effect estimates showing inverse/null/positive association are shown by outcome.

2.2.3.1. Social capital and mortality

Altogether seven studies met the inclusion criteria for social capital and mortality (Table 1). Five studies employed data from representative samples of adults who were interviewed and two gathered population census data. Information about mortality was obtained from comprehensive population level death registers. The follow-up times varied from 3 to 24 years. Three studies investigated individual-level social capital, three community-level social capital and one measured social capital at both levels. Three of

the community-level studies were multilevel studies. The majority of the studies assessed social capital by means of multiple indicators. Of the four individual-level studies, two measured aspects of social participation (Bygren et al. 1996, Dalgaard and Lund Håheim 1998), one measured social participation, trust and residential stability, (Hyypä et al. 2007), and one study measured perceptions of belonging to community, reliable friends and loneliness (Mohan et al. 2005). The multilevel studies aggregated survey responses to area-level (Blakely et al. 2006, Mohan et al. 2005) or obtained area-level social capital from other sources, such as official records on voting turnout (Blomgren et al. 2004, Islam et al. 2008). One study additionally measured community social capital by average crime rate (Islam et al. 2008).

In three individual-level studies a suitable control was carried out for several individual-level factors, including demographic characteristics (e.g. age, sex), socioeconomic status (education and/or income), health-related behaviours (e.g. smoking, body mass index) and baseline health using adjustment in statistical models or stratification (Bygren et al. 1996, Dalgaard and Håheim 1998, Hyypä et al. 2007). One individual-level study did not take into account any indicator of baseline health (Mohan et al. 2005). Only the study conducted in New Zealand controlled for ethnicity. Adjustment for potential confounders in the studies of area-level social capital was variable. All the studies controlled for a limited set of individual-level characteristics but the control at area-level was confined to area-level socioeconomic deprivation (Blakely et al. 2006), income inequality (Islam et al. 2008), or was or totally absent (Mohan et al. 2005). Blomgren et al. (2004) also controlled for regional unemployment level, level of urbanisation, and proportions of manual workers and Swedish-speakers.

Table 1. Longitudinal studies on social capital and mortality.

Year and author(s)	Sample size, population/setting	Age, sex	Social capital measure; Level of assessment	Health outcome measure	Follow-up: % and years	Potential confounders considered	Findings RR/OR/HR (95% CI)	Validity
1996, Bygren et al.	Random sample of 12,675 individuals in Sweden, Swedish annual survey of living conditions in 1982-83	16-74 years, 50% males	Individual level: Social participation: - attending at cultural and sports events (index of 7 items) - making music or singing in a choir - reading books or periodicals	All-cause mortality	100%, 8-9 years	Individual level: Age, sex, educational level, income, long term disease prevalence, social network, smoking, physical exercise	Rarely attending cultural events RR 1.57 (1.18-2.09) (very often as reference) Making music/singing in a choir sometimes (rarely as reference) RR 0.89 (0.72-1.10) Reading books rarely (occasionally as reference) RR 1.05 (0.88-1.25)	3
1998, Dalgaard and Lund Håheim	Random sample of 1,010 individuals in Oslo, Norway, in 1974-76	>20 years, 44% males	Individual level: Social participation index (1-3) - associational membership, attendance of meetings, assessment of importance of associations, possibility to influence decisions in associations	All-cause mortality, cause-specific mortality due to cardiovascular diseases, cancer, stratified by sex	99%, 17 years	Individual level: Age, household income, somatic illness ever, hospitalisation last year, smoking, increased blood pressure, angina, MI, sport, outdoor exercise, locus of control, close relationships, mental health, self-rated health	Social participation (one unit increase): Men: total mortality HR 0.69 (0.54-0.89) cardiovascular disease HR 0.74 (0.49-1.10) cancer HR 0.39 (0.23-0.66) other causes HR 1.09 (0.65-1.82) Women: total mortality HR 0.77 (0.61-0.96) cardiovascular disease HR 0.81 (0.60-1.08) cancer HR 0.91 (0.56-1.46) other causes HR 0.59 (0.36-0.99)	3

Year and author(s)	Sample size, population/setting	Age, sex	Social capital measure; Level of assessment	Health outcome measure	Follow-up: % and years	Potential confounders considered	Findings RR/OR/HR (95% CI)	Validity
2007, Hyyppä et al.	Random sample 7,217 individuals in Finland, Mini- Finland Health Survey in 1978-80	30-99 years; 45% males	Individual level; Leisure participation - engagement in voluntary associations, attendance in cultural and sports events, congregational, outdoor and hobby activity, studying and reading books or listening to music; Interpersonal trust - number of and trust in close friends; Residential stability - one year or longer in the current home municipality	All-cause mortality, cardiovascular mortality; first 5 years excluded from the analyses	100 % 24 years	Individual level: Age, household income, BMI, physical activity, smoking status, alcohol consumption, glucose, total cholesterol, HDL-cholesterol, triglycerides, creatinine, blood pressure, self-rated health, diagnosed chronic disease, mental health status	RR All-cause mortality: Leisure participation HR 0.95 (0.89-1.01) for men HR 0.96 (0.91-1.01) for women Interpersonal trust: HR 0.94 (0.89-0.99) for men HR 0.96 (0.92-1.01) for women Residential stability*: HR 0.98 (0.93-1.04) for men HR 0.96 (0.91-1.02) for women Cardiovascular mortality: Leisure participation HR 0.99 (0.90-1.09) for men HR 1.01 (0.92-1.10) for women Interpersonal trust HR 0.94 (0.86-1.02) for men HR 0.93 (0.86-1.01) for women Residential stability* HR 0.99 (0.90-1.08) for men HR 0.97 (0.88-1.06) for women	3

Year and author(s)	Sample size, population/setting	Age, sex	Social capital measure; Level of assessment	Health outcome measure	Follow-up: % and years	Potential confounders considered	Findings RR/OR/HR (95% CI)	Validity
2005, Mohan et al.	Sample of 7,578 individuals in 396 electoral wards in England, UK, interviewed in 1984/1985, the English Health and Lifestyle Survey	18 years and over, % males ns.**	<p>Individual level:</p> <ul style="list-style-type: none"> - Belonging to community - Reliable friends - Loneliness <p>Ward level:</p> <ul style="list-style-type: none"> - Volunteering - Social activity - Political activity - Voter turnout - Altruistic activity - Important friends - Belonging to neighbourhood - Want to improve neighbourhood - Talk to neighbours - Meet locals - Standardised blood donorship ratio 	All-cause mortality	97%, 16 years	<p>Individual level:</p> <p>Age, sex, tenure, social class, smoking, alcohol consumption, exercise, diet</p>	<p>Individual level social capital: Lowest levels of: Perceived belonging to community: OR 1.11 (0.93-1.32) Reliable friends: OR 1.05 (0.63-1.78) Frequency of feeling lonely OR 1.30 (0.98-1.72)</p> <p>Ward level social capital: Lowest levels of: Any volunteering: OR 1.35 (1.06-1.71) Core volunteering OR 1.31 (1.03-1.67) Social activity: OR 1.36 (1.07-1.73) Political activity: OR 1.27 (1.01-1.60) Altruistic activity: OR 1.27 (1.00-1.57) Importance of local friends OR 1.20 (0.96-1.51) Belonging to neighbourhood OR 0.93 (0.73-1.18) Willingness to work to improve neighbourhood OR 1.09 (0.86-1.38) Talking to neighbours OR 1.04 (0.83-1.30) Frequently meet local people OR 0.80 (0.63-1.02) Feels that local area is friendly OR 0.84 (0.67-1.06) Blood donorship ratio OR 1.05 (0.83-1.32) Electoral participation (=voting turnout): OR 1.03 (0.81-1.29)</p>	5

Year and author(s)	Sample size, population/setting	Age, sex	Social capital measure; Level of assessment	Health outcome measure	Follow-up: % and years	Potential confounders considered	Findings RR/OR/HR (95% CI)	Validity
2004, Blomgren et al.	1.1 million men in 84 functional regions in Finland, Helsinki metropolitan area excluded; 1990 census	25-64 years; 100% males	Regional level: - Voting turnout; - Family cohesion (proportion of persons living alone, divorced or married and of one-parent families)	Alcohol-related mortality	>99%, 6 years	Individual level: Age, education, socioeconomic status, marital status, mother tongue Regional level: proportion of manual workers, unemployment level, median income of households, Gini coefficient, level of urbanisation, proportion of Swedish-speakers	Voting turnout (lowest quartile vs. highest): RR 1.23 (1.09-1.38) Low family cohesion (lowest quartile vs. highest) RR 1.21 (1.03-1.42)	3, 5
2006, Blakely et al.	Approx. 1.6 million people in 1683 census area units in New Zealand, 1996 census	25-74 years; 49% males	Neighbourhood level: Volunteering (aggregated from survey responses)	All-cause mortality, cause-specific mortality: cardiovascular disease, cancer, injury, suicide stratified by sex	79%, 3 years	Individual level: Age, education, marital status, ethnicity, income, smoking, car access, employment status, rurality Neighbourhood level: neighbourhood deprivation	Low volunteerism: (lowest quintile vs. highest) highest Men: all-cause mortality RR 0.95 (0.89-1.02) cancer RR 0.98 (0.88-1.10) cardiovascular disease RR 1.00 (0.90-1.12) unintentional injury RR 0.60 (0.44-0.82) suicide RR 0.89 (0.64-1.22) Women: all-cause mortality RR 0.96 (0.88-1.04) cancer RR 1.00 (0.89-1.12) cardiovascular diseases RR 0.87 (0.75-1.02) unintentional injury RR 0.85 (0.51-1.44) suicide RR 0.57 (0.31-1.05)	3, 5

Year and author(s)	Sample size, population/setting	Age, sex	Social capital measure; Level of assessment	Health outcome measure	Follow-up: % and years	Potential confounders considered	Findings RR/OR/HR (95% CI)	Validity
2008, Islam et al.	Random sample of 95,026 individuals in 272-275 municipalities in Sweden, Pooled data from interviews in 1980-97, Survey of Living Conditions	20-84 years; 100% males	Municipal level; -Voting turnout: -Crime rate (average number of crimes/1000 for all municipalities)	All-cause mortality	4-21 years 100%	Individual level: Age, education, annual income, cohabitation status, number of children, initial health status (HRQoL score) Municipal level: income inequality	Male participants 20-64 years: Election participation rate (one unit change): HR 1.00 (p=0.57) Crime rate HR 1.00 (p=0.49) Estimates for women not reported.	3, 5

* crude, not adjusted for confounders

** ns, not specified

The results of the studies are presented in Table 1. Six of the seven studies reported significant or nonsignificant inverse associations between social capital and mortality. Four studies also reported nonsignificant positive associations (Bygren et al. 1996, Dalgaard and Lund Håheim 1998, Hyyppä et al. 2007, Mohan et al. 2005). One study that used pooled data over two decades reported null findings (Islam et al. 2008). Table 2 shows that there was weak evidence of an inverse association between individual- and area-level social capital and mortality, with 6 of 26 (individual-level) and 7 of 27 (area-level) effect estimates reporting higher levels of social capital to be associated with lower risk of mortality among the working aged after multiple adjustment for potential confounders. Of cause-specific associations, 5 effect estimates showed a significant inverse association between social capital and alcohol-related mortality, and death due to cancer or unintentional injury in men, and other than cancer or cardiovascular death in women.

Table 2. Summary of longitudinal studies on social capital and mortality.

	Number of effect estimates	Number of effect estimates		
		Inverse association*	No association*	Positive association*
Individual level social capital	26	6	20	0
Total mortality	14	4	10	0
Cardiovascular mortality	8	0	8	0
Cancer mortality	2	1	1	0
Mortality, other causes	2	1	1	0
Area-level social capital	27	7	20	0
Total mortality	16	4	13	0
Cardiovascular mortality	2	0	2	0
Cancer mortality	2	0	2	0
Alcohol-related mortality	2	2	0	0
Mortality, other causes	4	1	3	0
Total	53	13	40	0

* statistically significant at 5% level

2.2.3.2. Social capital and cardiovascular disease

Seven studies of social capital and cardiovascular disease (incidence or mortality) met the inclusion criteria, overlapping with studies that looked at the relation between social capital and mortality (Table 3). The data were derived from random samples or total populations. The study of Scheffler et al. (2008) included only people with previous history of coronary heart disease. In all studies, only severe manifestations of cardiovascular disease were taken into account, i.e. hospitalisation due to an acute event or death, and thus the misclassification of cases was unlikely. The outcome data were derived from reliable hospital records and death registers. The studies that included both fatal and non-fatal outcomes did not present separate estimates for those who survived. The follow-up times varied from an average of 19 months to 24 years. A wide range of indicators of social capital were used. Four individual level studies measured social participation and two of them additionally trust, whereas one also measured residential

stability. All three area-level studies were multilevel with the highest levels ranging from neighbourhood to county. Voting participation and volunteering were used as indicators of area-level social capital. Two studies reported of using a valid scale (Ali et al. 2006, Scheffler et al. 2008).

Adjustment for potential confounders was variable. Only one study (Hyypä et al. 2007) controlled for a suitable set of confounders including demographic factors (e.g. age, sex, socioeconomic status), life style issues related to cardiovascular disease risk (e.g. smoking, obesity) and other known risk factors for cardiovascular disease (e.g. hypertension, cholesterol, comorbid conditions), while others adjusted for a limited set of confounders, and one study (Scheffler et al. 2008) did not control for individual socioeconomic status. Two multilevel studies controlled for area-level deprivation or income inequality, whereas one study (Sundquist et al. 2006) included no area-level variables other than social capital. Three studies (Sundquist, Lindström et al. 2004, Ali et al. 2006, Sundquist et al. 2006) excluded participants that were not healthy in relation to outcome.

Table 3. Longitudinal studies on social capital and cardiovascular diseases

Year and author(s)	Sample size, population/setting	Age, sex	Social capital measure; Level of assessment	Health outcome measure	Follow-up: % and years	Potential confounders considered	Findings HR/HRR/OR (95% CI)	Validity
1998, Dalgard and Lund Håheim	Random sample of 1,010 individuals in Oslo, Norway, interviewed in 1974-76	>20 years, 44% males	Individual level: Social participation index (1-3) - associational membership, attendance of meetings, assessment of importance of associations, possibility to influence decisions in associations	Cause-specific mortality due to cardiovascular diseases	99%, 17 years	Individual level: Age, household income, somatic illness ever, hospitalisation last year, high blood pressure, angina, myocardial infarction, sport, outdoor exercise, locus of control, close relationships, mental health, self-rated health	Social participation (one unit increase): HR 0.74 (0.49-1.10) for men HR 0.81 (CI 0.60-1.08) for women	3, 5
2004, Sundquist, Lindström et al.	6,861 healthy individuals in Sweden, interviewed in 1990-91, the Swedish Annual Level-of-Living Survey	35-74 years, 49% males	Individual level: Social participation index (18 items): - level of social capital in the residential neighbourhood, social, cultural and religious participation, political empowerment	First hospitalisation for a fatal or non-fatal coronary heart disease event	100%, 9-10 years	Individual level: Age, sex, educational status, housing tenure, smoking	Low social participation (lowest tertile vs. highest) HR 1.69 (1.21-2.37)	3, 5
2006, Ali et al.	13,322 healthy individuals in Scania, Sweden, The public health survey in 1999-2000	18-80 years, 45% males	Individual level: Social participation index (13 items): - involved in study circle/course, union or other organisations' meeting, cultural, religious or sports event attendance, letter to editor, demonstration, night club/entertainment, gathering of relatives, private party Trust; Social capital= a combination of similar ratings of social participation and trust (high and low and low and low)	First myocardial infarct; fatal or non-fatal	100%, 3 years	Individual level: Age, sex, education, economic stress, daily smoking, low leisure time physical activity, BMI, self-reported health	Low social participation (vs. high) HRR 1.3 (95% CI 0.9-2.0) Low trust (vs. high) HRR 0.8 (95% CI 0.5-1.2) Low social capital (low social participation and low trust) (vs. high) HRR 1.0 (95% CI 0.6-1.7)	1, 5

Year and author(s)	Sample size, population/setting	Age, sex	Social capital measure; Level of assessment	Health outcome measure	Follow-up: % and years	Potential confounders considered	Findings HR/HRR/OR (95% CI)	Validity
2007, Hyyppä et al.	Random sample 7,217 individuals in Finland, Mini-Finland Health Survey in 1978-80	30-99 years, 45% males	Individual level; Leisure participation - engagement in voluntary associations, attendance in cultural and sports events, congregational, outdoor and hobby activity, studying and reading books or listening to music; Interpersonal trust - number of and trust in close friends; Residential stability - one year or longer in the current home municipality	Cardiovascular mortality, first 5 years excluded from the analyses	100%, 24 years	Individual level: Age, household income, BMI, physical activity, smoking status, alcohol consumption, glucose, total cholesterol, HDL-cholesterol, triglycerides, creatine, blood pressure, self-rated health, diagnosed chronic disease, mental health status	Leisure participation HR 0.99 (0.90-1.09) for men HR 1.01 (0.92-1.10) for women Interpersonal trust HR 0.94 (0.86-1.02) for men HR 0.93 (0.86-1.01) for women Residential stability* HR 0.99 (0.90-1.08) for men HR 0.97 (0.88-1.06) for women	3
2006, Sundquist et al.	All healthy residents (approx. 2.7 million) of 45-74 years of age in 9,667 small administrative areas in Sweden, in 1997	45-74 years, % males ns.*	Neighbourhood level: Voting participation in local government elections in 1998 (indicator of linking social capital)	First hospitalisation for a fatal or non-fatal CHD event	99%, 2 years	Individual level: Age, sex, education, marital status, housing tenure, country of birth	Low linking social capital (lowest tertile vs. highest) OR 1.19 (1.14-1.24) for men OR 1.29 (1.21-1.38) for women	3, 5
2006, Blakely et al.	Approx. 1.6 million people in 1683 census area units in New Zealand, 1996 census	25-74 years, 49% males	Neighbourhood level: Volunteering; (aggregated from survey responses)	Mortality due to cardiovascular disease, stratified by sex	79%, 3 years	Individual level: Age, sex, education, marital status, ethnicity, income, smoking, car access, employment status, rurality Neighbourhood level: neighbourhood deprivation	Low volunteerism (lowest quintile vs. highest) RR 1.00 (0.90-1.12) for men RR 0.87 (0.75-1.02) for women	3, 5
2008, Scheffler et al.	34,572 acute coronary syndrome survivors in 35 counties and 6621 census block groups in Northern California, USA between 1998-2002	30-85 years, 66% males	County level: Petris Social Capital Index (number of individuals employed in voluntary organisations)	Recurrence of acute coronary syndrome; fatal or non-fatal	100%, 19 months (median)	Individual level: Age, sex, race/ ethnicity, median household income at block-group level, prior coronary heart disease history, comorbid conditions, medication use, medical procedures Block-group level: median household income County-level: health maintenance organisation penetration, income inequality, racial concentration	Social Capital (per one SD) HR 0.92 (0.88-0.97)	1, 3, 5

*ns, not specified

The results are displayed in Table 3 and summarised in Table 4. Lower social capital was not consistently associated with a higher risk of a subsequent cardiovascular event. All studies reported a significant or non-significant inverse association between at least one indicator of social capital and cardiovascular disease and three studies also reported non-significant positive associations. Two multilevel studies reported significant inverse associations of area-level social capital and incident CHD events (Sundquist et al. 2006, Scheffler et al. 2008). Although the studies did not control for all potential individual- and area-level confounders they only included participants without previous coronary heart disease. The largest effect size was reported in an individual-level analysis, as Sundquist, Lindström et al (2004) found that low social participation increased the risk of fatal or non-fatal CHD event by 70%. However the results may be subject to confounding by unmeasured variables because they controlled for a limited set of known risk factors for cardiovascular disease.

Table 4. Summary of longitudinal studies on social capital and cardiovascular disease.

	Number of effect estimates	Number of effect estimates		
		Inverse association*	No association*	Positive association*
Individual level social capital	12	1	11	0
Area-level social capital	5	3	2	0
Total	17	4	13	0

* statistically significant at 5% level

2.2.3.3. Social capital and mental health

Four studies of social capital and mental health were included in the review (Table 5). One multilevel study measured neighbourhood-level electoral participation in local government elections (Lofors and Sundquist 2007) and another one county-level voting participation rates combined with the indicators of social participation derived from surveys aggregated to county-level (Rosenheck et al. 2001). One individual-level study incorporated a large number of items to be combined into a single indicator of social participation through factor analysis (Sundquist et al 2004), and the other to be employed as single items or combined indexes with a description of the internal reliability of the scales (Fujiwara and Kawachi 2008). The response rate in the study of Fujiwara and Kawachi (2008) was 60.8%. One study was confined to homeless persons with mental illness (Rosenheck et al. 2001). The measure of the mental health outcome varied from hospitalisation due to any psychiatric illness or psychosis or depression to interviewer ratings of major depression or self-reported psychiatric problems. The follow-up times were shorter than in the studies on mortality and cardiovascular disease, ranging from 1 to 8 years. Control for potential confounders was variable. Two multilevel studies adjusted for multiple individual-level characteristics but only one controlled for an area-level variable (neighbourhood deprivation) (Lofors and Sundquist 2007). The individual level studies controlled for several known risk factors, such as previous psychiatric morbidity.

The nationally representative samples of adults between 25 and 74 years reported significant inverse associations between individual level social capital and severe psychiatric illness (Sundquist et al 2004) and major depression (Fujiwara and Kawachi 2008), although the latter reported also positive associations as high mutual aid and frequent volunteer work were associated with an increased risk of adverse mental health. The study of the whole Swedish population observed a significant inverse association of neighbourhood level voting turnout and first admission to hospital due to psychosis but not due to depression (Lofors and Sundquist 2007). Social capital was not associated with subsequent psychiatric problems among homeless people with previously diagnosed mental illnesses. The only study that had self-rated health as outcome reported null findings. The summary of the effect estimates is shown in Table 5 and all the results are compiled in Table 6.

Table 5. Summary of studies on the association between social capital and mental health.

	Number of effect estimates	Number of effect estimates		
		Inverse association*	No association*	Positive association*
Individual level social capital	6	2	4	0
Area-level social capital	5	2	3	0
Total	11	4	7	0

* statistically significant at 5% level

Table 6. Longitudinal studies on social capital and mental health and self-rated health.

Year and author(s)	Sample size, population/setting	Age, sex	Social capital measure; Level of assessment	Health outcome measure	Follow-up: % and years	Potential confounders considered	Findings OR/ HR (95% CI)	Validity
2004, Sundquist, Johansson et al.	National random sample of 9,170 individuals in Sweden, interviewed 1990-91, the Swedish Annual Level of Living Survey	25-74 years, 49% males	Individual level: Social participation index (17 items): - level of social capital in the residential neighbourhood, social, cultural and religious participation, political empowerment	First hospital admission due to psychiatric illness	100%, 7-8 years	Individual level: Age, sex, educational status, housing tenure, self-reported long-term psychiatric illness, physical environment index	Low social participation (lowest tertile vs. highest) HR 1.69 (1.07-2.66)	3, 5
2008, Fujiwara and Kawachi	Nationally representative sample of 724 individuals, at baseline in National Survey of Midlife Development in the United States in 1995-96, follow-up PEFUS survey 1998	25-74 years, 44% males	Individual level: Cognitive social capital: - social trust - sense of belonging - mutual aid Structural social capital: - volunteer work - community participation	Major depression (CIDI-SF interview)	82%, 2-3 years	Individual level: Age, sex, education, race, working status, marital status, self-rated health, baseline depression (CIDI-SF), extroversion	High social trust (vs. low) OR 0.43 (0.23-0.93) High sense of belonging (vs. low) OR 0.51 (0.25-1.04) High mutual aid (vs. low) OR 1.09 (0.52-2.25) Frequent volunteer work (vs. none) OR 1.64 (0.83-3.24) Frequent community participation (vs. none) OR 0.77 (0.35-1.71)	1
2001, Rosenheck et al.	3,293 homeless persons with mental illness in USA, interviewed at 18 sites between 1994-96	mean age 38.5 years, 64% males	County level: Social capital - attendance at club meetings, number of community projects worked on, participation in volunteer work, belief that people are honest (from surveys in 1975-1997), voting participation (official records 1994, 1996)	Psychiatric problems (Addiction Severity Index, range 0-1); General health (self-assessed, range 1 excellent - 5 poor)	83%, 1 year	Individual level: Age, gender, race, income, social support, duration of homelessness, housing status, service use, self-reported symptoms of depression, psychosis and substance abuse, psychiatric behaviour	Social capital Psychiatric problems B 0.015 (p=0.63) Poor general health B 0.025 (p=0.33)	1, 3, 4, 5
2007, Lofors and Sundquist	The whole Swedish population of 25-64 years of age in 8,482 neighbourhoods (approx. 4.5 million people); combined register data in 1997	25-64 years, 51% males	Neighbourhood level: Voting participation in local government elections in 1998 (indicator of linking social capital)	First hospital admission due to depression or psychosis; stratified by sex	100%, 3 years	Individual level: Age, socioeconomic status employment, marital status, country of birth Neighbourhood level: neighbourhood deprivation	Low voting participation Depression: OR 1.05 (0.98-1.13) for men OR 0.97 (0.92-1.03) for women Psychosis: OR 1.09 (1.02-1.18) for men OR 1.14 (1.06-1.23) for women	3, 5

2.2.3.4. Summary of findings

This review evaluated the existing literature comprising of longitudinal studies on social capital and health among the working-aged and found that the association of social capital and mortality and subsequent morbidity was not consistent. There was modest evidence of an inverse association of individual level social capital and mortality, cardiovascular morbidity and adverse mental health. The finding was supported by multilevel studies which reported significant inverse associations of area-level social capital and mortality, subsequent cardiovascular event and psychosis. Most of the studies also reported non-significant and some positive associations. Area-level social capital was assessed across a variety of spatial scales ranging from neighbourhoods in New Zealand to counties in the USA which may have contributed to the inconsistency of the findings. The population-based studies showed smaller effect sizes than the studies of random samples: on average lower social capital increased the probability of adverse health outcomes by 20-40% in population level studies.

As regards the assessment of the quality of the studies, most of the studies included random samples or were carried out at whole-population level, had reasonable follow-up times, could follow virtually all the participants and used documented outcomes from health registers. The validity of the many of the studies was reduced by the fact that they predominately did not cover all aspects of social capital and controlled for a limited set of potential confounders. The vast majority of the studies assessed social capital with key indicators, i.e. social participation, volunteering, trust and voting turnout, whereas non-common indicators were also used. Five studies investigated the effect of voting turnout, an indicator of linking social capital, but the findings were inconsistent. No indicator of social capital was superior to others in explaining variations in mortality or morbidity, however all studies assessed social capital at one point in time only.

The fact that only one fourth of the published estimates showed a significant association might be indirect evidence of a reduced likelihood of publication bias. Noteworthy is the selective reporting of results in the study of Islam et al. (2008) as that study did not report effect estimates for women because they were non-significant.

2.3. Gaps in the evidence

Taking into account that many previous studies have provided promising evidence about social capital as a determinant of population health, the data to back up this claim is not robust, as was pertinently argued in the above-mentioned reviews. The diversity in conceptualisation, operationalisation and measurement of social capital across studies is wide. Furthermore, a major limitation of the evidence lies in the cross-sectional designs that do not allow for the evaluation of the causal questions as they provide no direct evidence of the sequence of events. In addition, the results of cross-sectional studies are subject to potential bias arising from the fact that perceptions of social capital are contaminated by poor health and vice versa. Longitudinal well-defined studies are

needed because they could overcome some of these limitations. In lack of RCT:s and intervention studies on social capital and health, they are the best available substitutes to establish the incidence of diseases and conditions.

To date, the mainstream of social capital studies has focused on social capital in residential or geographical areas like states, communities and neighbourhoods. It has been suggested that the social capital research should be extended to workplaces (Kawachi 1999). For working populations, sources of variation in social capital are likely to be found in settings where these people spend plenty of time, i.e. in workplaces. Besides, it may be that larger geographic units, such as states, do not capture the important social interactions and social networks that are the core of social capital (Sundquist and Yang 2007). However, research on social capital in work settings is still sparse. As the existing measures of social capital in residential areas may not be applicable in the work context a measurement tool that captures the true contextual, multi-dimensional elements of social capital in workplaces could prove important to studies of the potential of social capital accrued at work.

Recently, many researchers in the field have called for studies that distinguish between the different dimensions of social capital and investigate whether the health effects of social capital vary by dimension (Kawachi et al. 2004, Strezer and Woolcock 2004, Ferlander 2007). Furthermore, there is an urgent need to develop more theory-based measures of social capital and the assessment of different forms and dimensions of social capital have been warranted (Kawachi et al. 2004, De Silva et al. 2005). For example, theoretically the vertical and horizontal components are different features of the same phenomenon and may be differentially associated with health. In relation to health the vertical dimension has been studied much less than the horizontal dimension and few standardised instruments for assessing vertical/linking social capital are available. The potential relevance of distinguishing between the vertical and horizontal component of social capital in work setting is unknown, let alone whether their effects on health or mental health are different. Taking into account the current concern about the loss of productivity and work days due to mental disorders, and depression in particular, there is emerging longitudinal evidence of the association of social capital and mental disorders among the working aged population. There is no reason why the beneficial returns of social capital in residential areas would not be attained by social capital accrued in work settings. Still, no study has specifically targeted workplace social capital and depression.

Previous prospective analyses of social capital and depression have assessed severe depression as indicated by hospital admission, major depression or psychiatric problems diagnosed in psychiatric interview. In large-scale epidemiological studies self-reports from repeated surveys are frequently used to ascertain the incidence of diseases, including depression. In such a case, the accuracy of self-reported information on incident diseases is actually a sum of the accuracy of self-report at two stages: baseline and follow-up. The assessment of incident disease with self-reports is more open to measurement error

than the self-report assessment of prevalent disease, primarily because the measurement requires both an accurate determination of the disease-free population at baseline and an accurate detection of new-onset disease at follow-up, leading to potential accumulation of errors at the two stages. However, the accuracy of such a measurement remains unclear, as major evidence from the validity of self-report relies on prevalent rather than incident disease.

The current attention in social capital research has also been drawn to the advancement of the analysing techniques (Szreter and Woolcock 2004, Yen and Syme 1999). Increasingly, multilevel approaches are seen as relevant to epidemiological research and research on social capital, in particular (Yen and Syme 1999, Krieger 2001, Strezer and Woolcock 2004). These techniques provide researchers with an analytical approach that is appropriate for the analysis of data with nested sources of variability - that is, involving units at a lower level (for example individuals) nested within units at a higher level (for example neighbourhoods or communities). Despite the importance of multilevel modelling, only few researchers have studied social capital in an explicit multilevel setting.

3. AIMS OF THE STUDY

Existing evidence links residential and geographical social capital with variations in population health. Accordingly, it was hypothesised that workplace could represent a meaningful source of social capital for employees and that variations in workplace social capital could explain differences in employee health. The specific objectives for the study were (including referral to the corresponding articles):

1. To develop and test a questionnaire measure to assess social capital at work (I)
2. To study whether workplace social capital and changes in social capital predict subsequent self-rated health (II)
3. To study whether the associations of social capital with depression vary by level of assessment of social capital (individual vs. work unit level) and by assessment of incident depression (self-reported vs. register based) (III)
4. To study whether the vertical and horizontal components of workplace social capital equally important in predicting depression (IV)
5. To study whether self-reported incidence figures are valid (V)

4. MATERIAL AND METHODS

4.1. Participants

The participants came from the Finnish Public Sector Study (FPSS), which is an ongoing prospective cohort study of work and health of local government employees in the service of 10 towns and 6 hospital districts around Finland. FPSS consists of two parallel studies: The 10-Town Study and the Work and Health in Finnish Hospital Personnel Study. Both studies are carried out by the Finnish Institute of Occupational Health. The studies cover almost 20% of the full-time public sector employees working in municipalities in Finland. The target organisations are (1) the towns of Turku, Espoo, Vantaa, Tampere, Oulu, (2) five smaller nearby towns of Raisio, Naantali, Valkeakoski, Virrat and Nokia, and (3) the federations of municipalities including central and regional hospitals in the hospital districts of Varsinais-Suomi, Kanta-Häme, Vaasa, Pirkanmaa, Pohjois-Pohjanmaa and Helsinki-Uusimaa district. The towns provide municipal services to one million and the hospitals specialised health care services to 1.9 million inhabitants around Finland.

Data collection for FPSS has been in progress from the end of the 90's. The employers' records were used to identify the eligible populations for surveys and to link the respondents to their work units. There were at least four hierarchical levels in the target organisations. The work units were the lowest administrative units, for example a hospital ward or a kindergarten. The registers included data on all job contracts and workplace characteristics, updated annually. At regular intervals, all employees of the participating organisations who had a permanent or long-term temporary job contract were sent identifiable survey questionnaires. The surveys consisted of repeated measurements of aspects of social capital, psychosocial work environment, health, well-being and health-related behaviours. The respondents were given research-IDs to be used in the data analyses. The first survey was conducted in a sub-cohort of the towns in 1997 and of the hospitals in 1998. The first large-scale surveys were carried out in the towns in 2000–01 and in the hospitals in 2000–02. In 2000–02 the eligible population comprised altogether 71,705 municipal and hospital employees in 3,678 work units. This baseline survey yielded 32,299 responses (response rate 67%) from the towns and 16,299 responses (69%) from the hospitals. In 2004, the survey targeted 72,437 municipal and hospital employees and 48,076 responded (response rate 66%). Of the 48,598 baseline respondents, 46,414 identifiable employees were targeted for the follow-up in 2004 or 2005. A total of 29,180 responses were received in 2004 from those who were still in the service of the towns and hospital and 6,901 responses in 2005 from those who were not anymore employed by the target organisations. Thus the cohort included 35,914 identifiable employees (77% of the eligible population). The Ethics Committee of the Finnish Institute of Occupational Health has approved the study.

4.2. Study designs

The studies employed data from the FPSS surveys collected in 2000–02 (baseline) and 2004–05 (follow-up). Study I was cross-sectional and used the baseline survey data only. Study II was limited to data from the 10-Town study. This was because in order to study the impact of change in workplace social capital only employees who had not changed their work unit between baseline and follow-up could have been included. Accurate comparison of the work units in two time points was possible only in the towns. Studies II-V used longitudinal data from repeated surveys.

With the use of personal identification numbers (a unique number containing birth date and code for sex assigned to all citizens in Finland) all participants of FPSS were linked to comprehensive national health registers: the Drug Reimbursement Register, the Drug Prescription Register and the National Hospital Discharge Register. The validity of these health registers has been found to be high, i.e. few missing data (Gissler et al. 2004, Pajunen et al. 2005, Klaukka 2001), reasonably accurate and highly reliable for the purposes of epidemiological studies (Rapola et al. 1997, Mähönen et al. 1997).

The Drug Prescription Register of the Social Insurance Institute includes all out-patient data of filled prescriptions classified according to the anatomical therapeutic chemical (ATC) classification code of the World Health Organization (WHO 2004). The Register does not include diagnoses for prescriptions, but the data contain the exact dates of all purchases of these prescribed drugs and the corresponding number of defined daily doses (DDDs). A DDD is defined as the assumed average maintenance dose per day for a drug used for its main indication in adults (WHO 2004).

The Drug Reimbursement Register of the Social Insurance Institute contains information about persons entitled to special reimbursement of the costs for medication (currently 72% to 100%) for many chronic and severe diseases. Patients who apply for the special reimbursement need to attach a detailed medical certificate in which the treating physician provides data to confirm the diagnosis. The entitlement is further subject to the approval of a physician at the Institute who reviews each case history. The diagnostic criteria for qualifying for special reimbursement are stricter than the current care guidelines for many diseases.

The Hospital Discharge Register of the National Research and Development Centre for Welfare and Health includes countrywide data on all patients who have been admitted to hospital. The treating physicians have assigned the diagnoses for the admission according to ICD-9 (up to 1986) or ICD-10 (from 1987 onwards).

The studies II-V included only the healthy in relation to outcome with no missing data on the dependent variable. To study the risk of health impairment among healthy employees, participants who had rated their health as very good or good were included (II). In the same way, to study the onset of new depression among non-depressed participants, employees who had no history or pre-existing physician-diagnosed depression were

included (III-IV). The descriptive characteristics of the samples and the data used in each study are shown in Tables 7 and 8.

Table 7. Descriptive characteristics for the samples by study.

	I	II	III	IV	V
Study design	cross-sectional	longitudinal	longitudinal	longitudinal	longitudinal
Data source	FPSS*	10-Town study	FPSS*	FPSS*	FPSS*
Baseline survey (response rate)	2000-02 (68%)	2000-01 (67%)	2000-02 (68%)	2000-02 (68%)	2000-02 (68%)
Follow-up survey (response rate)	-	2004 (79%)	2004-05 (77%)	2004-05 (77%)	2004-05 (77%)
Study sample					
N of participants	48,592	9,524	25,928	25,763	34,616
Mean age at baseline (years)	44.3	44.2	44.4	44.4	48.8 (at follow-up)
Women (%)	80	79	82	82	82
Manual employees (%)	16	14	16	16	17
Baseline status	all inclusive	healthy	non-depressed	non-depressed	healthy
Outcome of interest	development of measure of social capital at work	impairment in self-rated health	incident depression by self-report	incident depression by self-report and new antidepressant treatment	accuracy of self-report in detecting incident disease

* Finnish Public Sector Study

Table 8. The Finnish Public Sector Study, survey and register data used in each study.

Year	1994-1995	1996-1999	2000-2002	2003	2004-05
Surveys			I-V		II-V
Register data					
- Prescription Register	V	III-V	III-V	III-V	III-V
- Drug Reimbursement Register	V	V	V	V	V
- Hospital Discharge Register	V	V	V	V	V
Employers' records					
- Job characteristics			I-V		
- Identification of work units			I-IV		II
- Work unit characteristics			II		

4.3. Measures of workplace social capital

4.3.1. Development of a short measure of social capital at work

In study I, a short measure was developed to assess social capital specifically in work context. Eight items to describe social capital at work were selected from survey questionnaires by an expert in the field. Theoretically, the selection of items was based on the inequality perspective of the efficacy of social capital (Wilkinson 2005). The inequality thesis posits that socioeconomic inequality results in the disruption of the social fabric and the withering of social capital. The eight items in the scale indicate

whether people feel that they are respected, valued and treated as equals at work, rather than feeling that it is all a matter of seniority in their hierarchy. The definition of workplace social capital is in agreement with the current notions of the concept, such as the widely used definition offered by Kawachi and colleagues (1997): “those features of social structures, such as levels of interpersonal trust and norms of reciprocity and mutual aid, which act as resources for individuals and facilitate collective action”.

The items were as follows:

1. “People keep each other informed about work-related issues in the work unit”
2. “We have a ‘we are together’ attitude”
3. “People feel understood and accepted by each other”
4. ”People in the work unit cooperate in order to help develop and apply new ideas”
5. “Do members of the work unit build on each other’s ideas in order to achieve the best possible outcome?”
6. “Our supervisor treats us with kindness and consideration”
7. “Our supervisor shows concern for our rights as an employee”
8. “We can trust our supervisor”

As considered important by many researchers in the field (Harpham et al. 2002, Baum and Ziersch 2003, Kawachi et al. 2004, Shortt 2004) the measure captures the latest theoretical developments in the field: it measures both the cognitive and structural forms of social capital, and taps the bonding, bridging and linking dimensions of social capital. The cognitive component of social capital represents the shared values, attitudes and norms of trust and reciprocity in the work unit (items 2,3 and 8) while the structural component includes aspects related to the practices of collective action in the different associations and networks in the workplace (items 1, 4, 5, 6, 7). The measure also covers some aspects of bonding social capital with questions asking about horizontal tight knit ties and relationships to co-workers who are trusted and share similar values of reciprocity and mutual aid in daily interactions needed to “getting by” at work (items 1, 2 and 3), bridging social capital with questions about co-operative relationships to co-workers in all occupations needed to “getting ahead” (items 4 and 5), and linking social capital with questions about relationships between people who are interacting across authority gradients at work (items 6, 7 and 8).

The responses were given in a 5-point rating scale. The response options ranged from 1=totally disagree to 5=totally agree apart from the fifth item where the categories were: 1=“very little”, 5=“very much”. A summary score of the ratings of the items was constructed for those who responded to at least half of the items. The reliability and validity of the measure was evaluated.

4.3.2. Individual-level and work unit level social capital at work

The work unit of each respondent was identified. As it is generally accepted that social capital is accumulated only by virtue of a membership in a group or a social structure (Bourdieu 1986, Coleman 1988, Putnam 1993a, Putnam 2000), a group was a priori defined to consist of three persons at minimum, and individuals in work units with less than three were excluded. High scores indicated high individual-level social capital

Work unit level scores were constructed by aggregating the mean of all the individual responses from the same work unit (I). In studies II-IV, the work unit level scores were calculated from co-workers' assessments. This meant that the work unit level scores were independent of the self-assessment, i.e. the mean of the scores of the co-workers in the work unit were assigned to each worker. For the analyses, the scores were divided into quartiles and the lowest quartile was used as the reference category. In the study II, the study sample was divided into four groups according to the baseline and follow-up levels of social capital (median split), i.e. having low and low, high and low, low and high, or high and high levels of social capital at the baseline and follow-up stages, respectively. In this way, there were four categories of exposure to social capital (baseline-follow-up): high-high (which was used as the reference group), high-low, low-high and low-low. These four categories were considered to represent exposure to different levels of social capital (Kawachi and Subramanian, 2006).

4.3.3. Vertical and horizontal components of workplace social capital

Recent theoretical developments suggest that the concept of social capital comprises at least two dimensions: the linking (vertical) dimension of social capital which refers to vertical connections that span differences of power and the horizontal dimension of social capital which includes relationships between individuals at the same level of hierarchy (Baum and Ziersh 2003, Szreter and Woolcock 2004), and that they could be distinguished for example in the work context (Lindström 2008a, Ferlander 2007). In the developed short measure of workplace social capital, some items assess vertical social capital between superior and employee (items 6, 7, 8) and others horizontal social capital among peers. In study IV, summary scores based on responders' ratings on a 1–5 scale of vertical and horizontal forms of social capital were constructed and divided into quartiles. A higher score indicated higher social capital. To verify that the measure distinguished between vertical and horizontal components of social capital, a principal components factor analysis was conducted.

4.4. Health outcomes

Responses to survey questionnaires and individual records in national health registers were used to assess the health outcomes. All of the register data covered the period between 1 January 1994 and 31 December 2005.

4.4.1. Self-rated health

Self-rated health is shown to be an independent predictor of mortality even after controlling for several medical diagnoses (Idler and Benyamini 1997, Marmot et al. 1998). It is also shown to be a simple and valid tool to assess health, and sex differences are minor (Idler and Benyamini 1997, Singh-Manoux et al. 2006). Self-rated health was measured with a question of individual's perception of his or her own health. The answers to the question "How would you estimate your current state of health" were dichotomised. Ratings of good and rather good were combined as "good", and average, fairly poor or poor were combined as "poor". The probability of poor self-rated health at follow-up was used as an outcome in study II.

4.4.2. Depression

Studies III and IV used incident depression as an outcome. Prevalent and incident depression cases were identified from self-reports and individual pharmacy records. In the survey questionnaires, participants were asked to indicate a pre-existing or current disease with a response to a question of "Has a doctor ever told you to have or have had..." followed by a checklist of 18 chronic conditions and diseases. An affirmative response to the respective question of depression was considered as self-reported depression at baseline. Among those who did not report being diagnosed with depression by a physician at baseline, an affirmative response to the question of depression at follow-up was considered as self-report of incident depression. Additionally, individual records of filled prescriptions of antidepressants (ATC-coded class N06A drugs) were retrieved from the Drug Prescription Register. Any purchase of antidepressants within a 4-year period before baseline was considered as a case of baseline depression. An annual amount of purchased antidepressants lasting at least one month in any subsequent year after baseline was considered as an indicator of incident depression among those with no previous purchase of antidepressants.

4.5. Covariates

All covariates were measured at baseline. Information on *sex*, *age* and socioeconomic status, *type of employment contract* (permanent or fixed-term) and *place of work* (town/hospital) were obtained from the employers' registers. The *socioeconomic status* was based on the existing occupational classification of Statistics Finland, the International Standard Classification of Occupations (ISCO) (Statistics Finland 2001). The occupational titles were categorised into four classes for study II. Classes 1 and 2 were combined as "managers and professionals", the third class served as it is as "associate professionals", and classes 4 and 5 were again combined to form "clerks and service workers". Manual workers' group referred to ISCO-classes 6-9. In the studies III-V, the socioeconomic status/position was based on the division of occupations into three categories: upper-grade white-collar workers (e.g. physicians, teachers), lower-grade white-collar workers (e.g. technicians, registered nurses), and blue collar workers (e.g. cleaners, maintenance

workers). *Marital status* was obtained from survey responses: married or cohabiting/single, divorced or widowed.

The health-related behaviours assessed were smoking, alcohol use and physical exercise, combined with information on body mass index. Based on responses to current and previous *smoking* status, the respondents were classified as never, former or current smokers. In study II the first two categories were combined to include both ex- and never smokers. The weekly *consumption of alcohol* was measured in grams and dichotomised into slight or moderate use and heavy drinking using a cut point of 210 g/wk (Rimm et al. 1999). To assess the amount of regular *physical activity*, the reported time spent in physical activity every week was multiplied by its typical energy expenditure and expressed as Metabolic Equivalent Task (MET) hours. Physical activity of less than two MET-hours per day was considered to represent sedentary lifestyle (Kujala et al. 2002). The *Body Mass Index* (BMI) was calculated as weight (kilograms) divided by height (meters) squared, obtained from self-reports. Responses were divided into three groups: normal body weight, overweight (25-<30 kg/m²) and obesity (≥30 kg/m²) (WHO 2000). Psychological distress was measured by a 12-item version of General Health Questionnaire (Goldberg 1988). Participants scoring 4 or more were considered to have psychological distress.

In the study II, the following work unit characteristics were obtained for each participant from the employers' records using the work unit identification codes: the work unit size, the proportion of male, manual and temporary workers, and the division of age during the survey year. The *work unit size* (the size of personnel) was calculated from person-years allocated into the unit. For example, three persons working for four months each made up one person-year for that work unit and were not counted as three persons. The age of each employee was linked to his/her work unit to calculate the *mean age of the personnel* in the unit. The *proportions of men, temporary and manual workers* were calculated from the respective proportions of person-years done by the male, temporary and manual employees to the unit. All second level variables were treated as continuous variables in the analyses.

4.6. Self-report as an indicator of incident diseases

In relation to self-report of incident depression as an outcome in studies III-IV, the question whether self-report was accurate in detecting incident depression was raised. To test the accuracy of self-report as an indicator of incident disease, self-reports are to be compared with the gold standard. As regards depression, medical records are not accurate enough to serve as the reference criterion (Mitchell et al. 2009). Psychiatric interviews would be considered as a robust outcome standard but their use is restricted to smaller scale studies. Thus, there were no data available to represent the gold standard in relation to depression in the current cohort. However, related to some common diseases such register data that could serve as the reference were available. Thus, instead of depression, five common chronic diseases of public health importance were selected to

investigate the issue, namely hypertension, diabetes, asthma, coronary heart disease and rheumatoid arthritis (study V). The self-reported cases were identified from the surveys in a similar way as the depression cases in studies III and IV.

The combination of individual records in comprehensive health registers was used as the gold standard and self-reports of the diseases in repeated surveys were linked to the records. To identify the cases in the registers, the dates of the participants' purchases of disease-specific medication for hypertension (ATC-coded as C02, C03, C07, C08 or C09), diabetes (A10), asthma (R03) and rheumatoid arthritis (M01C) were derived from the Prescription Register. Also, the entitlement records in the Special Reimbursement Register and main diagnoses for hospitalisation in the Hospital Discharge Register due to hypertension (diagnoses in ICD-9 and ICD-10 401–405 and I10–I15, respectively), diabetes (250 and E10–E15), asthma (493 and J45), coronary heart disease (410–414 and I20–I25) and rheumatoid arthritis (714 and M05, M06 and M08) were reviewed. The retrieved documentations were combined to form the validity criterion.

4.7. Statistical methods

Multilevel logistic regression analyses were applied in the studies I-IV. This analytic approach acknowledges the nested nature of data; such as employees nested within work units. Multilevel models allow for the simultaneous examination of the effects of individual level (1st level) and group level (2nd level) variables on individual level outcome while controlling for the non-independence of observations within groups (Goldstein 1995). Multilevel models recognise the existence of data hierarchies by allowing for residual components at each level of hierarchy and assume that there is independence between individual and work unit residuals. In multilevel logistic regression analysis it is assumed that both individuals and work units are randomly sampled. A two-level modelling technique was used for data analysis, i.e. individuals at 1st level and work units at 2nd level. The results of the logistic regression analyses were expressed as odds ratios (OR) and their 95% confidence intervals (CI).

Prior to the aggregation of work unit members' perceptions of social capital to form a derived variable, the uniformity in the unit was evaluated through examining the patterns of within-group agreement. It was done with two approaches: a consistency based approach of inter-rater reliability by computation of intra class correlation (ICC) and a consensus based approach of inter-rater agreement by estimating r_{wg} . The assessment is a pre-requisite for arguing that a higher level construct can be operationalised (Klein and Kozlowski 2000). R_{wg} (within-group agreement index) is a widely used index of inter-rater agreement on Likert-type scales and it is calculated by comparing an observed group variance with an expected random variance (James et al. 1984). It defines the extent to which the different judges tend to make exactly the same judgments about the rated subject. An r_{wg} rate ≥ 0.7 denotes acceptable within-group agreement and supports the aggregation of unit members' perceptions of a phenomenon to form an aggregated variable.

When studying individuals nested within areas, the intra class correlation (ICC) is used as a measure of the degree of similarity among the outcomes of members of the area (Bryk and Raudenbush 1992). In this study, the ICC was used to estimate the degree of resemblance of individual perceptions of social capital (explanatory variable) between individuals belonging to the same work unit. Technically, the multilevel ICC is a variance partition coefficient that indicates the proportion of the total variance that is accounted for by the 2nd level variance (Diez Roux 2002). The ICC was calculated by estimating an empty random intercept model including the individual perceptions of workplace social capital at baseline as a continuous variable. These tests justified the aggregation of individual responses to group level (work unit level) and supported the implementation of social capital as a contextual phenomenon and the use of multilevel models.

These tests also constituted part of the evaluation of the validity and reliability of the developed measure of social capital at work. Ideally, the validation would involve comparison with a gold standard. However, such measures have proved elusive. Thus, a wide range of psychometric methods were used to evaluate its validity and reliability. Validity (accuracy) describes the degree to which the measure actually measures what it was intended to measure. The evaluation of validity included the assessment of construct validity by calculating the intra class correlation (ICC), and the convergent and divergent validity in the form of an examination of the associations of social capital with theoretically related (procedural justice, effort-reward imbalance, job control) and unrelated constructs (trait anxiety, the magnitude of changes at work). Additionally, criterion-related validity was assessed with the associations of the measure and self-rated health. Reliability describes the extent to which repeated measurements of a phenomenon by different people at different times and places get similar results (Fletcher and Fletcher 2005). Reliability was estimated with internal consistency reliability (Cronbach's alpha), item-item and item-total correlations (Pearson correlations between the items) and within-unit (inter-rater) agreement index (r_{wg}). In order to examine whether the items of workplace social capital scale distinguished between vertical and horizontal components, a principal component factor analysis was conducted. A varimax rotation was made to help the interpretation of the findings. Factors were retained based on eigenvalues greater than 1 and variable loadings of >0.4

The associations of workplace social capital with the characteristics of participants were studied with analysis of variance. In study II, repeated measures analysis of variance was carried out to examine the differences in trends between mean levels of social capital at baseline and follow-up. Multilevel logistic regression analyses were used to model the effects of individual level and work unit level social capital on health outcomes in a hierarchical context controlling for potential confounders and mediators (studies II-IV). In studies II-III, multilevel logistic regression analysis was applied to study the associations between individual level and work unit level workplace social capital and impairment in self-rated health or onset of depression controlling for socio-demographics and health-related behaviour. The study II additionally adjusted for work unit characteristics. In study IV, the analyses were conducted in a similar vein

to study the associations of individual vertical and horizontal workplace social capital with incident depression. The analyses were stratified by sex and mutually adjusted for both components. In study III, the adjustment was additionally made for psychological distress and the analyses repeated to study the effect of work unit level social capital. The potential interactions between sex and the social capital and components of social capital on incident depression were tested with the corresponding interaction terms in models including the main effect.

For significant associations between categorical workplace social capital variables and new-onset depression, an estimated population-attributable fraction (PAF) for the social capital indicator in question was calculated using the following formula (Fletcher and Fletcher 2005):

$$\frac{(\text{Incidence of exposed} - \text{Incidence of unexposed}) \times \text{Prevalence of exposure to risk factor}}{\text{Total incidence in the study population.}}$$

Furthermore, due to the finding of a significant role of the socioeconomic structure of the work unit in the association between work unit social capital and health impairment, the work units were divided into three groups based on their proportion of manual workers (divided into quartiles and the second and third quartile combined)(study II). In addition to the main effects, the statistical significance of interactions between individual social capital and sex and between individual social capital and occupational status were tested by including interaction terms in the models. Also, cross-level interaction between individual level and work unit level was tested. The work unit level variance in the outcome (the change of health) was counted and the random effects were estimated through their variance components (Singer 1998, Datta et al. 2006).

The study V evaluated the accuracy of self-report as an indicator of incident disease. First, the accuracy of the baseline situation (the prevalence of the disease) was estimated by comparing self-reported diseases with the dates of the entry of the disease in the registers by the survey. Second, the accuracy of the follow-up situation was evaluated by comparing the responses to the follow-up survey with the recorded data after the baseline and up to the time of the follow-up. The true negative self-report at baseline combined with true positive self-report at follow-up was considered as the accurate self-report of incident disease (true positive). To assess the accuracy of self-report sensitivity, specificity and kappa were calculated from the following equations:

$\text{Kappa} = (P_o - P_e) / (1 - P_e)$; $\text{Sensitivity} = a / (a + c)$ and ; $\text{Specificity} = d / (b + d)$ where P_o = observed agreement and P_e = expected agreement, a = survey and register positive, b = survey positive and register negative, c = survey negative and register positive, and d = survey and register negative.

All statistical analyses were performed with SAS® 9.1.3 statistical package (SAS Institute, Inc., Cary, North Carolina).

4.8. Non-response analyses

Non-response analyses were carried out based on the identification of the eligible population from the employers' registers. At baseline, the eligible population comprised 71,705 employees of whom 48,598 responded to the survey. Studies II-IV were confined to survey respondents who were healthy in relation to outcome at baseline, i.e. neither reported poor self-rated health (II) nor had a history of depression (III-IV). To evaluate the generalisability of the findings to the public sector employees, baseline characteristics of the participants were compared with those of the eligible population. The results showed statistically significant but relatively small differences in terms of mean age, sex and socioeconomic status.

5. RESULTS

The occupational cohort in the study was comprised of the 48,592 respondents of the baseline survey working in 3,575 work units. A total of 67% of them were in the service of the local municipalities, i.e. in the ten towns around Finland. The rest were employed by 21 hospitals in 6 hospital districts. The most common occupations included teachers, nurses and practical nurses, and only a minority of the employees (19%) were in manual occupations. The respondents were mainly females (81%).

5.1. Workplace social capital

5.1.1. Psychometric properties of the short measure of workplace social capital

The reliability of the measure was evaluated with several indicators. The internal consistency of the scale was good: Cronbach's alpha was 0.88. An alpha-value greater than 0.7 indicates a satisfactory internal consistency for a scale (Bland and Altman 1997). The r_{wg} index was 0.88, which indicates a significant within-unit agreement. The item-item correlations were in the range of 0.28 to 0.80 and the item-total correlations varied between 0.58 and 0.69 (all $p < 0.001$). Several measures were used to assess the validity of the scale. Face validity appeared credible because the measure encompassed the multidimensional nature of the concept and did not measure the outcome of social capital. The ICC was 21% which indicated that a substantial proportion of the variance of individual social capital was between work units. The social capital scale was positively associated with conceptually close constructs of procedural justice ($\beta = 0.53$ for women and $\beta = 0.65$ for men) and job control ($\beta = 0.28$ and $\beta = 0.29$) and negatively associated with effort-reward imbalance ($\beta = -0.23$ and $\beta = -0.25$). The associations with conceptually more distant concepts (trait anxiety, the magnitude of changes at work) were weaker (β ranged from -0.02 to -0.14). As an indicator of criterion-related validity, the scale was inversely associated with self-rated health. In women, age adjusted ORs (95% CI) for poor health for the lowest quartile of individual social capital were 2.42 (2.24-2.61) and for the lowest quartile of work unit level social capital 1.19 (1.10-1.30). In men, the ORs were 2.99 (2.56-3.50) and 1.79 (1.51-2.11), respectively.

Factor analysis identified two factors with a cumulative variance proportion of 73.0% confirming the existence of the vertical and horizontal components of workplace social capital. The first factor, labelled *the horizontal component of social capital*, accounted for 53.8% of the total variance and the second factor, *the vertical component of social capital*, 19.2% of the total variance. Summary scores of the vertical (Cronbach's alpha 0.90) and horizontal (Cronbach's alpha 0.87) components of social capital were constructed with a higher score indicating higher social capital (range 1-5). The mean (SD) score was 3.86 (0.97) for vertical and 3.50 (0.78) for horizontal workplace social capital. The Pearson correlation coefficient between the two components was 0.46 ($P < 0.0001$).

5.1.2. Individual level workplace social capital

In 2000-02, workplace social capital was determined for all survey respondents and their work units. The individual level workplace social capital score at baseline was calculated for 45,989 participants who were working in units with at least three respondents and who had responded to the items assessing workplace social capital (Cronbach's alpha for the social capital scale 0.88).

At baseline, the mean (SD) of individual level social capital was 3.59 (0.76). Table 9 shows the associations of social capital by individual characteristics. Women and the married (or cohabiting) had higher perceptions of workplace social capital than men or the single ($p < 0.0001$). The difference in the level of social capital between occupational groups was statistically significant ($p < 0.0001$). Employees whose occupation was graded as upper-grade non-manual (29% of all the participants) had higher social capital than their counterparts with lower occupational status. By contrast, the participants who were between 40 and 50 years of age, high alcohol consumers, current smokers, obese and those more likely to have sedentary lifestyle had lower levels of workplace social capital.

Table 9. Associations of individual level workplace social capital by individual characteristics at baseline.

Individual characteristic	N	Social capital at baseline	
		Mean (SD)*	P for difference
All	45,989	3.59 (0.76)	
Sex			<0.0001
Women	37,195	3.61 (0.76)	
Men	8,794	3.50 (0.78)	
Age class			<0.0001
≤ 40	15,007	3.61 (0.74)	
41-50	16,239	3.55 (0.77)	
> 50	14,743	3.60 (0.77)	
Occupational status			<0.0001
Upper-grade non manual	13,408	3.67 (0.73)	
Lower-grade non manual	23,728	3.57 (0.76)	
Manual	8,379	3.50 (0.81)	
Marital status			<0.0001
Married or cohabiting	34,534	3.60 (0.75)	
Other	10,956	3.55 (0.78)	
Current smoking			0.0005
No (previously or never)	36,703	3.59 (0.75)	
Yes	7,950	3.56 (0.80)	
Heavy alcohol use			<0.0001
No (< 210g/wk)	41,977	3.60 (0.76)	
Yes (≥210g/wk)	3,775	3.47 (0.79)	
Physical activity (MET-hours/day)			<0.0001
≥ 2	34,199	3.60 (0.75)	
< 2	11,319	3.54 (0.78)	
Body Mass Index			<0.0001
Normal (< 25)	25,521	3.60 (0.75)	
Overweight (25-29)	14,339	3.57 (0.77)	
Obese (≥30)	5,144	3.54 (0.79)	

*unadjusted mean scores (standard deviations) from analysis of variance

5.1.3. Work unit level workplace social capital

During the year of the baseline survey, a total of 3,136 work units with at least three respondents were identified. The median work unit size was 19 employees (interquartile range 12-33, total range 3-397). Of the respondents, 19% worked in units with female employees only. The description of the available work unit characteristics is displayed in Table 10. The work units were divided into categories using median split or other sensible cut point based on the distribution of the characteristic.

Two test measures were counted to investigate the justification to treat social capital as a contextual variable. R_{wg} (0.88) indicated significant homogeneity in the perceptions of social capital among co-workers and ICC (21%) significant variance between work units.

Table 10. Associations between work unit level social capital and work unit characteristics during the baseline survey year

Work unit characteristic	Median (interquartile range)	Work unit level social capital at baseline	P for difference
		Mean (SD)*	
Work unit size (person-years)	13.8 (7.3-23.0)		<0.0001
Small (< 7.3)		3.68 (0.52)	
Medium (7.3-23)		3.62 (0.45)	
Large (> 23)		3.54 (0.37)	
Mean age of personnel (years)**	43.9 (40.9-46.4)		<0.0001
Low		3.66 (0.45)	
High		3.57 (0.46)	
Proportion of male workers (%) **	11.0 (0-31.0)		<0.0001
Low		3.68 (0.44)	
High		3.55 (0.46)	
Proportion of temporary workers (%) **	24.0 (13.0-36.0)		<0.0001
Low		3.57 (0.48)	
High		3.66 (0.43)	
Manual workers (%)**	0 (0-19.0)		0.81
None		3.61 (0.46)	
One or more		3.62 (0.45)	

*unadjusted mean scores (standard deviations) from analysis of variance

** median split

Table 10 also shows the associations between work unit characteristics and the aggregated work unit level social capital derived from the means of the individual responses in the respective work unit. The results show that units with a majority of female or temporary workers were more likely to have higher social capital, whereas the proportion of manual workers did not influence the level of workplace social capital. Smaller work units scored higher. An increase in the mean age of the personnel was associated with declining social capital.

5.2. Workplace social capital and self-rated health

The study II included those participants of the 10-Town study who responded to the baseline and follow-up surveys (n=19,077). Of them, 73% had rated their health as very good or good at baseline. After the exclusion of those with missing data and those who had changed their work unit between baseline and follow-up and who rated their health as poor at baseline, the final cohort comprised of 9,524 municipal employees working in 1,522 work units.

5.2.1. The association between workplace social capital and health by level of assessment

Individual-level social capital. Persistent low levels of workplace social capital increased the likelihood of poor health at follow-up. The crude odds for health impairment were 1.8 times higher for participants with persistent low (low to low) levels of individual workplace social capital compared to those with constantly high perceptions of social capital at work. The decline (from high to low) in the individual level workplace social capital also increased the likelihood of poor health at follow-up, whereas an improvement in social capital (from low to high) was associated with sustained good health. Individual characteristics (sex, age, marital status, occupational status) did not explain the associations (Table 11). Additional adjustment for health related behaviours (smoking, heavy alcohol use, overweight and low physical activity) did not attenuate the associations.

Multilevel models revealed that work unit variance attenuated from 0.019 (p=0.0008) to 0.010 (p=0.07) when the individual variables were added in the model indicating that individual factors (i.e. compositional differences) explained much of the work unit level variation in self-rated health at follow-up.

Table 11. The risk of health impairment by exposure to social capital at baseline and at follow-up

Social capital at baseline and at follow-up	N (%)	OR (95% CI)*
Individual level		
Low-low	3,557 (38)	1.77 (1.55-2.02)
High-low	1,423 (15)	1.62 (1.37-1.92)
Low-high	1,389 (15)	1.08 (0.89-1.29)
High-high	3,155 (33)	1.00 (reference)
Work unit level		
Low-low	3,441 (36)	1.18 (1.02-1.35)
High-low	1,323 (14)	1.01 (0.84-1.21)
Low-high	1,321 (14)	1.10 (0.92-1.31)
High-high	3,439 (36)	1.00 (reference)

* from multilevel logistic regression model adjusted for sociodemographics (sex, age, marital status, occupational status)

Work unit level social capital. Work unit level social capital at work (co-workers' assessment, self-assessment excluded) also had a contextual effect on the risk of health impairment. The crude odds for adverse change in health were 1.3 times higher for participants working in units with low social capital compared to their counterparts in

units with high social capital. Controlling for individual factors did not remove the associations. Counting the variance components showed that the work unit variance decreased to non-significant after the inclusion of work unit characteristics in the models (variance 0.010, $p=0.074$). This indicated that contextual characteristics of the work units explained the variation of the effects of work unit level social capital on individual health. No interactions between sex and social capital or occupational status and social capital were found at either level of assessment of social capital.

5.2.2. The role of work unit characteristics in the association between workplace social capital and health

Working in work units where the co-workers constantly reported low levels of workplace social capital predicted an adverse change in employee health only before the work unit properties were taken into account. When work unit level variables were included in the empty model, the risk of health impairment in work units with constant low levels of contextual social capital attenuated by 40%, the reduced OR was 1.14 (95% CI 0.99-1.32). Additional analyses showed that the attenuation was attributable to the inclusion of the proportion of manual workers in the model. The results from the models adjusted for each work unit characteristics are shown in Table 12.

To gain further understanding about the role of the socioeconomic structure in the association between workplace social capital and health, the work units were divided into three groups based on the proportion of manual workers using Q1 and Q3 as cut points, i.e. no, 1-23% and 24-100% of the personnel were manual employees. Altogether 3,492 participants worked in units with no manual workers and 2,361 in the units with the highest amount of manual workers. Constant low levels of individual social capital were associated with higher odds for health impairment irrespective of the proportion of manual workers in the unit: OR (95% CI) was 1.56 (1.25-1.95) for workers in the units with no manual employees, 1.75 (1.42-2.16) for the medium group, and 2.21 (1.71-2.87) for employees in units with the highest proportion of manual employees, adjusted for age and sex. By contrast, constant low levels of work unit level social capital increased the risk of poor health only in the units characterised with high share of manual workers, the corresponding adjusted OR was 1.52 (1.13-2.05). This contextual effect was not accounted for by individual occupational status.

5.3. Workplace social capital and depression

Studies III and IV investigated the risk of incident depression in respondents to baseline and follow-up surveys who were initially healthy in relation to the outcome, i.e. no history of depression at study entry (no pre-existing or current depression diagnosed by a physician or purchases of antidepressants within a 4-year period prior to baseline). Incident depression was assessed by the self-report of a new physician-diagnosed depression at follow-up and a new onset of antidepressant treatment after baseline from national pharmacy records. Of 25,928 initially non-depressed participants in study III, 1,238 (4.7%) reported new depression at follow-up and 1,153 (4.5%) were prescribed antidepressant medication during the follow-up. The incidence rates were equal in study IV with 25,763 participants.

5.3.1. The associations of workplace social capital and new-onset depression by level of assessment

Individual-level social capital. In study III, the individual level workplace social capital at baseline was associated with the onset of new depression. The lowest level (the lowest quartile vs. the highest quartile) of individual social capital was associated with 1.3 higher odds for new antidepressant treatment and 1.5 higher likelihood of self-report of new depression. Controlling the individual sociodemographic characteristics did not remove the associations (Table 13). The association was not accounted for by health-related behaviours. After further adjustment for psychosocial distress at baseline the association of social capital and self-report of new-onset depression remained significant whereas the association between social capital and new antidepressant treatment attenuated to non-significant, OR 1.09 (95% CI 0.91- 1.31).

Work unit level social capital. Co-workers' assessment of social capital at work was not associated with a new onset of depression. Working in units with low baseline level of social capital (derived from co-workers' perceptions) was not predictive of subsequent depression, and controlling for individual sociodemographics did not change the situation (Table 13).

Table 13. The association between workplace social capital and new-onset depression by the level of assessment.

Workplace social capital at baseline	Self-reported depression			Antidepressant treatment	
	N (%)	N of cases	OR (95% CI)*	N of cases	OR (95% CI)*
<i>Individual level</i>					
1 low	6,530 (25)	384	1.53 (1.30-1.81)	328	1.34 (1.12-1.59)
2	6,107 (24)	280	1.16 (0.97-1.38)	284	1.23 (1.03-1.47)
3	7,119 (27)	315	1.10 (0.92-1.30)	302	1.12 (0.94-1.33)
4 high	6,172 (24)	259	1.00	239	1.00
<i>Work unit level</i>					
1 low	6,323 (25)	296	1.02 (0.86-1.22)	278	0.98 (0.82-1.18)
2	6,696 (25)	303	0.98 (0.83-1.17)	300	0.98 (0.82-1.17)
3	6,459 (25)	312	0.98 (0.82-1.16)	268	0.92 (0.77-1.10)
4 high	6,540 (25)	327	1.00	307	1.00

*from multilevel regression model adjusted for sociodemographics (sex, age, marital status, socioeconomic position and place of work (town/hospital))

5.3.2. *The associations of vertical and horizontal component of workplace social capital and new-onset depression*

Study IV included 25,763 non-depressed participants of the baseline survey to study the association of the vertical and horizontal components of workplace social capital and onset of new depression. During the follow-up, 1,235 previously non-depressed respondents were diagnosed with depression (4.1% of male and 4.9% of female participants) and 1,150 started a new antidepressant treatment (3.0% of men and 3.8% of women). The participants with either low perceptions of vertical or horizontal social capital at work were 30–40% more likely to be diagnosed with depression or start antidepressant treatment than their counterparts with high workplace social capital. Adjusted for sociodemographics, the odds for new antidepressant treatment were 42% higher for employees with low vertical social capital and 47% higher for those with low horizontal social capital at work than for those reporting high social capital. Likewise, low levels of vertical or horizontal social capital at work increased the risk of new-onset of self-reported depression by 30–40% (Table 14). In mutually adjusted models, the vertical and horizontal social capital remained independent predictors of depression. Since the overall measure of workplace social capital at work unit level was not associated with depression in study III, only the associations between individual-level social capital and depression were investigated in study IV.

Table 14. The associations of the vertical and horizontal components of workplace social capital and new-onset depression

Workplace social capital at baseline	Self-reported depression			Antidepressant treatment	
	N	N of cases	OR (95% CI)	N of cases	OR (95% CI)
Vertical component of social capital					
1 low	5,837	349	1.42 (1.20-1.69)	307	1.39 (1.16-1.66)
2	4,779	220	1.06 (0.88-1.28)	212	1.17 (0.96-1.42)
3	9,517	416	1.00 (0.85-1.18)	415	1.17 (0.99-1.38)
4 high	5,630	250	1.00	216	1.00
Horizontal component of social capital					
1 low	7,196	418	1.47 (1.25-1.74)	358	1.32 (1.11-1.58)
2	4,540	207	1.14 (0.94-1.38)	212	1.22 (1.00-1.48)
3	8,525	370	1.04 (0.88-1.23)	364	1.11 (0.94-1.32)
4 high	5,502	240	1.00	216	1.00

*from multilevel regression model adjusted for sociodemographics (sex, age, marital status, socioeconomic position and place of work (town/hospital))

The estimated population-attributable fraction (PAF) for new self-reported depression for low individual social capital ranged between 7.5% and 7.9% depending on the measure of social capital (total score, the horizontal component, the vertical component). For new-onset antidepressant treatment, the corresponding PAF ranged between 4.0% and 5.6.

5.4. The accuracy of self-report as an indicator of incident disease

The accuracy of self-report was worse for incident diseases than for prevalent diseases. The specificity of self-reports (true negative cases) was equally high for the prevalent and incident diseases (range 93%–99%), but the sensitivity of self-reports (true positive cases) was considerably lower for incident than for prevalent diseases: hypertension (55% vs. 86%), diabetes (62% vs. 96%), asthma (63% vs. 91%), coronary heart disease (62% vs. 78%), and rheumatoid arthritis (63% vs. 83%). The kappa for the agreement between self-reports and health register data did not substantially differ between the incident (range 51%–69%) and prevalent (range 47%–75%) diseases.

When the combination of individual records in comprehensive health registers was used as the validity criterion, a considerable degree of misclassification was found for self-reports as a measure of incident disease in relation to all the selected diseases. Only 55% to 63% of the incident cases in registers (true cases) were also self-reported as incident disease (true positive) (Table 15). The incorrect self-reports of disease incidence (false negative) were the result of no entry of the disease in the records during the study period or of a recorded disease already at baseline.

Table 15. The status of self-report of incident disease by caseness in registers

Self-report of incident disease	True incident cases in registers			True non-incident cases in registers	
	All	True positive	False negative	True negative	False positive
	N	N (%)*	N (%)*	N (%)†	N (%)†
Hypertension	34211	949 (55)	789 (45)	31230 (96)	1243 (4)
Diabetes	34120	179 (62)	111 (38)	33519 (99)	311 (1)
Asthma	34269	189 (63)	110 (37)	33498 (96)	472 (4)
Coronary heart disease	34400	116 (62)	70 (38)	33988 (99)	226 (1)
Rheumatoid arthritis	34145	67 (63)	39 (37)	33798 (98)	241 (2)

6. DISCUSSION

The overarching aim of this study was to examine social capital in occupational settings. A questionnaire measure to assess social capital at work settings was developed and tested. This measure was then used to assess workplace social capital in a large cohort of public sector employees. The major focus was to longitudinally study the association of workplace social capital and self-rated health and depression and to examine whether these associations vary depending on whether social capital is determined based on individual's own perceptions or those made by his or her co-workers. A further objective was to study whether the vertical and horizontal components of workplace social capital are equally important in predicting new-onset depression. Additional attention was given to judging the use of self-report as a sole source of information of incident diseases. The principal findings, the strengths and weaknesses of the study and the possible explanations for the findings followed by methodological considerations about the accuracy of the measure of social capital and the accuracy of self-report as an indicator of incident disease are discussed in the following sections.

6.1. Principal findings

The main findings were four-fold. First, workplace was found to be a relevant context of social capital. Workplace social capital was accrued from the employees' perceptions of trustworthiness of the leaders, the norms of mutual respect, trust and reciprocity which facilitate action for mutual benefit. Additionally, it was found important to distinguish between the vertical and horizontal aspects of workplace social capital.

Second, persistent low levels of workplace social capital predicted poor self-rated health in employees who initially rated their health as good in a 4-year follow-up, irrespective of individual characteristics and lifestyle. The fact that adverse change in social capital at work was associated with an increased likelihood of impaired self-rated health added to the plausibility of the finding. Additionally, an improvement in social capital at work was associated with sustained good self-rated health.

Third, low levels of workplace social capital were associated with an increased risk of new self-reported physician-diagnosed depression and recorded antidepressant treatment. Both low vertical social capital (i.e. the shortage of respectful and trusting relationships between superior and employee) and low horizontal social capital (i.e. low trust and reciprocity between co-workers) were associated with an increased likelihood of new-onset depression, independently of each other.

Fourth, an additional contextual effect of workplace social capital was observed on self-rated health but not on depression. That is, the probability of impaired self-rated health was higher for employees whose co-workers assessed social capital as low compared to

those whose co-workers assessed workplace social capital as high, irrespective of their own perception of social capital.

6.2. Strengths and weaknesses of the study

This study has several strengths. Data were obtained from a large occupational cohort that was followed up for several years. The large number of participants with a relatively high response rate increased the possibility that the observed effects were beyond chance. The design included repeated measures of social capital and health, linkage to national health registers and detailed recorded data on the characteristics of the job contracts and work units. A major strength was the explicit management of the work context. The work unit of each participant was identified from the employers' registers and in the analyses the participant was linked to the respective work unit. Moreover, the work unit characteristics were obtained from the employers' registers.

This study also benefits from the multilevel modelling, i.e. control for the hierarchical data structure with employees at the first level and their work units at the second level. In the predictive analyses, only employees who were healthy in relation to outcome at baseline were included. Depression was also measured from prescription records which helped to reduce bias due to reverse causation, to avoid the possibility of common method bias and the possible accumulation of errors in reporting the disease at baseline and follow-up.

To avoid subjectivity bias in the assessment of workplace social capital, this study additionally used inferred measures in the assessment of the work unit level social capital by exploiting data on co-workers' perceptions in the work unit and excluding self-assessment. That is, the assessments of workplace social capital by the co-workers in the respective work unit were taken into account. Residual confounding due to unmeasured factors can never be totally ruled out in observational studies, but a wide range of potential individual and contextual characteristics which might confound the association of social capital and health were controlled for. Thus, major confounding is an unlikely explanation for the results.

This study also has some limitations emphasising the need to interpret the results cautiously. A major weakness of the study is its observational nature, and as such, the results from the associations of workplace social capital and employee health are only suggestive and do not permit to draw definite conclusions about the causality. However, given that intervention studies and randomised controlled trials in this field of research are largely lacking, longitudinal prospective studies provide the best available framework to demonstrate the associations with the incidence of diseases and to overcome several limitations inherent in cross-sectional studies.

Further potential weaknesses are related to the assessment of social capital. First, the survey responses of individual perceptions of social capital at work rather than objective

measures were used to assess the contextual social capital. Second, the definition of the context in the assessment of workplace social capital was in some cases imprecise as it was defined by administrative units. The work units were obtained from the employers' records collected for administrative rather than research purposes. Thus, it is possible that the context in which the social capital was measured does not represent individuals' perceptions of their real work groups, important networks or functional units where social capital is accrued. This might be the case at least in the largest work units including dozens of employees. Third, survey responses were used to assess the social capital at work and the level of social capital was used as the explanatory variable, thus social capital accrued outside work was not measured. Fourth, exposure misclassification may be caused by the fact that in studies III and IV social capital was only measured at one point in time. However, in study II, repeated assessments of social capital were made and an exposure variable indicating the persistence of workplace social capital over two time points was used in the analyses.

Although the response rates to the baseline and follow-up surveys were high (approximately 70%), the possibility of non-response bias cannot be excluded. However, according to the non-participation analyses differences in mean age, sex and socioeconomic status between the participants of the baseline survey and the eligible population were small and the analyses were adjusted for these characteristics. The possibility of healthy worker effect needs to be taken into consideration because those who remain employed tend to be healthier than those who leave employment (McMichael 1976). However, studies III and IV included also those who had left the organisations and the register data on new antidepressant treatments covered virtually all the baseline respondents. As these analyses provided findings that were consistent with other analyses, major confounding by the healthy worker effect seems an unlikely explanation for the findings. All participants were local government employees, the sample was predominantly female and 19% of the participants worked in units with female employees only which might reduce the generalisability of the findings to general working populations.

6.3. Strengths and weaknesses in relation to previous studies on social capital and health

In this chapter, the strengths and weaknesses of this study are discussed in relation to the 15 previous longitudinal studies on social capital and health in working-aged populations (see tables 1, 3 and 6).

6.3.1. Sample selection and completeness of follow-up

Compared to several earlier studies, selection bias is less likely to be a problem in this study because the baseline survey was sent to all full-time employees, irrespective of their job contract as permanent or temporary. The baseline response rate (68%) was satisfactory, although not high, and the sociodemographic differences between the eligible population and the respondents were small and unlikely to introduce a major

selection bias. In previous longitudinal studies which have employed survey data, the response rate has varied from around 60% (Ali et al. 2006, Fujiwara and Kawachi 2008) to 85 %.

The study sample is large and provides occupational diversity from manual workers in the harbour to city mayors. However, it included only public sector employees whereas there are several previous papers based on random population samples and thus with better generalisability (Bygren et al. 1996, Dalgaard and Lund Håheim 1998, Hyypä et al. 2007, Islam et al. 2008, Sundquist et al. 2004, Fujiwara and Kawachi 2008).

In prospective studies, a selective loss to follow-up could bias the results. As in the present study, 12 previous longitudinal studies were able to follow up virtually all the participants from their records in national health registers such as hospital discharge data. Some of the outcomes were assessed with a questionnaire. The response rate to the follow-up survey was 77%. This is broadly in agreement with the 82-83% response rate in two previous studies based on survey follow-ups (Fujiwara and Kawachi 2008; Rosenheck et al. 2001).

In case of selective sample retention, the associations could be biased in either direction, i.e. be an over- or underestimation of the true effects. However, the differences between the eligible population and the present study sample in terms of age, sex and socioeconomic status were small and the analyses were adjusted for these sociodemographic characteristics. Furthermore, in the studies (III and IV) on the association of workplace social capital and new-onset depression, all participants included in the study were free from depression at the baseline. Thus, variation in baseline depression is not a likely source of loss to follow-up. To study this possibility of selective loss, all the non-depressed baseline respondents (no previous antidepressant treatment or physician-diagnosed depression) were looked at. Of those who also responded to the follow-up study, 4.5% started a new antidepressant treatment during the follow-up. The corresponding proportion was 5.9% of those who did not respond to the follow-up survey. If anything, the selective loss might have contributed to an underestimation of the association of workplace social capital and new-onset depression.

In the present study, the follow-up period was 3 to 4 years compared to 1 to 24 years in the previous longitudinal studies. Very long follow-up times may be disadvantageous due to increased possibility of confounding by unmeasured or time-varying covariates (health-related behaviour) and by changes in exposure. The same possible methodological limitation is related to all studies with long follow-up time and no interims or examinations after baseline (e.g. Hyypä et al. (2007).

The inclusion of only initially healthy participants helped to reduce the possibility of reverse causality which may arise if baseline health influences the ratings of social capital. Few previous studies have been able to run similar analyses (Sundquist, Lindström et al. 2004, Sundquist et al. 2006, Ali et al. 2006)

6.3.2. Assessment of social capital

This study was the only one to measure workplace social capital with a scale that was specifically designed to measure social capital at work. The measure assessed values, attitudes and the norms of trust and reciprocity as well as the practices of collective action in the different associations and networks in the work unit. In previous studies, there has been a striking heterogeneity in the indicators used to assess social capital making comparisons of results between studies difficult. The assessment of social capital varied from single and multiple items to created indexes and scales predominantly covering the aspects of social participation and trust. Some studies measured social capital with uncommon indicators, such as reading books (Bygren et al. 1996), residential stability (Hyypä et al. 2007) and family cohesion (Blomgren et al. 2004). One study (Islam et al. 2008) additionally measured social capital by crime rate which may be in the causal pathway between social capital and health. In the study of Bygren et al. (1996) the association between rare attendance in cultural and sports events and mortality may be influenced by the fact that the reference group included people who reported of a very frequent attendance of at least 80 times/year. In addition, the social participation index used in the Finnish study of Hyypä et al. (2007) included items of outdoor activity, attendance of sports events and voluntary activities which may all be associated with health.

Several psychometric tests were conducted to estimate the validity and reliability of the developed short measure of social capital at work. The results revealed the measure of social capital to be a valid tool to assess social capital in the workplace. Of the fifteen previous studies, eight used any psychometric validation such as factor analysis to assess internal validity (Sundquist et al. 2004, Blakely et al. 2006, Sundquist, Johansson et al. 2004, Hyypä et al. 2007) or calculated Cronbach's alpha to assess internal consistency (Fujiwara and Kawachi 2008) or reported of previous validation of the measure used (Scheffler et al. 2008, Mohan et al. 2005, Ali et al. 2005).

This study appears to be the first longitudinal study to employ data from repeated measures of social capital. Previous studies have predominantly assessed social capital at one point in time only. In such case, the findings may be attributable to the misclassification bias of life-course social capital. Blakely et al. (2006) tested this possibility by excluding people who had not lived at the same residence for at least five years and no association between neighbourhood social capital and mortality remained.

6.3.3. Assessment of the health outcome

The validity of the outcome measurement was generally good in the previous studies as the majority targeted mortality, coronary heart disease events and mental health, obtained from the health registers. The few exceptions that used surveys include the studies of Fujiwara and Kawachi (2008) who linked data from interviews that assessed the possibility of major depression with CIDI-questionnaire and Rosenheck et al. (2001) who inquired the mentally ill patients in the study about their assessment of psychiatric

problems at follow-up using Addiction Severity Index. As the completeness and coverage of the documentations in relation to survival and hospital admission is likely to be high, the self-reported incidence of diseases from surveys may be less reliable. To overcome this limitation, this study used in addition to survey data on self-rated health and self-reports of diagnosed depression antidepressant treatment identified from national pharmacy registers covering virtually all the participants to detect new-onset depression cases. However, depression cases that have not been recalled or reported, or that were not treated with antidepressants may have been missed. This is likely to contribute imprecision to the estimates of the true associations.

6.3.4. Multilevel modelling

This study is among the ones to use multilevel modelling techniques with employees at first level and their real work context (operationalised as work units) at second level to study the health effects of workplace social capital. Measures of variation are important in public health in understanding the distribution of health in the population and the significance of specific contexts for different health outcomes (Merlo et al. 2005). It has been suggested that the research on the social environment, in particular, should include the consideration of multilevel models (Yen and Syme 1999). Increasingly, multilevel approaches have been used in social capital research as this analytic approach acknowledges the nested nature of the data, such as individuals within census tracts or neighbourhoods. Although this approach is widely accepted it is not always used in social capital research despite the hierarchical data structure (see e.g. Islam et al. 2008). Recently, it has been suggested that there is a need to more specifically define the social environment so that it is meaningful for public health practice and that research should be expanded into health effects of the well-defined contexts (e.g. schools, workplaces) which include modifiable features likely to be related to health (Diez Roux 2008).

6.3.5. Causality and confounding

When weighting the evidence for and against a causal effect, the research designs and the quality of the studies are considered (Fletcher and Fletcher 2005). As regards the association of social capital and health, no randomized controlled trials and consequently no meta-analyses of randomized controlled trials have been done. Thus, any causal inferences are premature. To date, the strongest evidence to date comes from the systematic reviews of observational studies in the field. Previous systematic reviews have not summarized the evidence in single or multiple estimates but they have reported that the heterogeneity in the study designs, indicators of social capital and their applications has prevented a meta-analysis (De Silva et al. 2005). This study contributes to the existing longitudinal evidence on the relation of social capital and health among the working aged by providing evidence from a well-designed prospective cohort study with repeated measures of social capital at two time points.

In observational studies confounding due to unmeasured factors is an important source of bias. In the studies of social capital and health, several individual and contextual factors need to be controlled for. These include the predictors of health such as age, sex and socioeconomic status and health-related behaviours. The validity of almost all of the previous longitudinal studies was mainly reduced by the limited range of control for confounding in terms of individual characteristics or contextual factors. In this study, a wide set of confounders was controlled for, including sociodemographic factors, health-related behaviours and additionally work unit characteristics. However, the possibility of unmeasured third factors as an explanation to the findings can never be totally excluded in observational studies.

6.4. Workplace as a potential source of social capital

The mainstream of social capital studies to date has focused on social capital in geographically defined contexts such as states, counties, electoral wards and neighbourhoods. However, by definition, social capital is not restricted to any particular social entity or social networks of one size or another (Stone and Huges 2002). People constitute parts of social contexts defined in dimensions other than residential entities (Lindström 2008a). Thus, a workplace entity could also constitute an important social context in this respect. From the theoretical point of view, the workplace seems to be an important place for the creation of social capital as it may encourage regular collaborative contacts among peers, and be a setting where people feel a sense of community among co-workers and enjoy mutual help and reciprocity in the job (Putnam 2000). Indeed, the workplace could be an important source of social capital because employees spend significant time at work and are exposed to a reasonable amount of social relations and day-to-day interactions there (Kawachi 1999). Accordingly, it seems plausible that social capital can arise from the shared experiences, norms and values at workplace as well as in local networks.

The findings of this study suggest that workplace is a relevant setting for studies on social capital and health. Levels of individual and work unit level social capital were found to vary by individual and work unit characteristics. For example, women and those in highest occupational positions had higher levels of social capital, as reported in a community context (Nieminen et al. 2008, Engström et al. 2008). However, the single-level analyses capture social capital at the individual and at the work unit level. Further examination of the multilevel structure conveyed information on variability both within and between work units. Calculating the within group agreement index, r_{wg} , revealed that there was a significant homogeneity within the work units ($r_{wg}=0.88$): the observed group variance in the individual perceptions of social capital was significantly smaller than the expected variance, the variance of the uniform distribution.

The intraclass correlation (ICC) informed of an appreciable clustering of individual social capital within the workplaces by showing that 21% of the total individual differences in social capital occurred at the work unit level. The between work unit differences might be

attributable to contextual or compositional factors, this means that work unit differences in social capital can arise because there is something inherently different about the units themselves. Alternatively, this clustering of social capital might be attributable to the different composition of work units. Individuals working in the same work unit may be more similar to each other than those working in different work units.

Previously reported ICCs in non-work contexts have been substantially lower. For example, Sampson et al. (1997) studied the relationship of neighbourhood level collective efficacy and violent crime in Chicago. The authors reported the variance components of collective efficacy within and between neighbourhoods with an estimated ICC of 7.5%. The higher the ICC the more support is given to the contextual nature of the variable in question, here social capital. It is likely that larger geographic units, such as census tracts, capture less of the important social interactions and social networks that are the core of social capital (Sundquist and Yang 2006) and that regions and areas at which the social capital is measured, may not represent the residents' view of their neighbourhood or community.

In the present study, the smallest work units scored higher than the large units which could indicate that the creation of social capital at work is more likely in units with a limited number of employees. It is assumed that social capital is gained at the workplace by participating and acting for mutual benefit (Putnam 2000). This may be easier in well-defined contexts and networks of tangible size. All these findings lend support to the set hypotheses that workplace could represent a meaningful source of social capital for employees.

6.5. Workplace social capital as a predictor of employee self-rated health

Numerous studies have examined the relation between social capital and self-rated health. The reason for the wide interest may be two-fold. First, self-rated health has been shown to be an independent predictor of mortality even after controlling for several medical diagnoses (Idler and Benyamini 1997, Marmot et al. 1998). Second, self-rated health is a simple and valid tool to measure health status as such one of the most widely used measures of health status in surveys (Idler and Benyamini 1997, Krause and Jay 1994).

Individual social capital. To date, the strongest evidence of the association of social capital and self-rated health comes from the systematic reviews of observational studies in the field. In a review of 32 studies, Kim et al. (2008) found fairly consistent associations between individual level social capital and self-rated health. Several indicators were used to measure social capital. The evidence for trust was stronger for self-rated health than for other physical health outcomes, the odds ratios varied between 0.5 and 0.8 for the association of trust and poor health. Also, associational membership was consistently associated with better self-rated health, the odds ratios were between 0.3 and 1.0 for associational membership and poor health. However, results from studies that used

associational membership as an indicator of social capital could be biased by reverse causality because volunteering and membership in associations can be a precursor or a consequence of social capital (Kim et al. 2008). In another review of 42 studies, Islam et al. (2006) classified the studies by the degree of egalitarianism of the country and found that the association between social capital and health was more consistent in more egalitarian countries, irrespective of the level of assessment of social capital. The authors concluded that the association between individual level social capital and self-rated health was robust with respect to the degree of egalitarianism within a country. However, the vast majority of the evidence came from cross-sectional studies, which has frequently been noted as a major limitation (Kawachi et al. 2004, De Silva et al. 2005, Almedom 2005).

This prospective cohort study with the repeated measurements of social capital provides further evidence of the effects of changes in social capital on employee self-rated health which were not attributable to individuals' socio-demographic characteristics or lifestyle. Although no definite conclusions about the causality of the associations can be drawn, using repeated measurements and analysing the effect of change in social capital gave further support to suggest that persistent low levels of and decline in individual social capital can have deleterious effects on employee health. The effect sizes varied from OR 1.6 to 1.8, which were in line with previous evidence.

The only previous longitudinal study on self-rated health that was identified (Rosenheck et al. 2001) was confined to mentally ill homeless people and reported no association of county level social capital and poor self-rated health at follow-up. The differences in the sample and design limit comparisons between that study and the present investigation.

Contextual social capital. To date, the best evidence of the association linking contextual social capital with self-rated health comes from three reviews of which two were conducted as systematic reviews. Kim et al. (2008) concluded that the evidence was inconsistent. Islam et al. (2008) similarly reported that the results were mixed. Kawachi et al. (2004) summarised the findings by concluding that with a few exceptions, the ecological studies had consistently found an association between social capital and health outcomes such as self-rated health.

In the present study, a contextual effect was observed for self-rated health. The association was not accounted for by individual sociodemographic factors or lifestyle. Instead, the contextual effect was largely explained by contextual rather than compositional factors. Especially the proportion of manual workers in the work units appeared to explain the variation of the effects of work unit social capital on health.

Direct comparison between the present study and previous work is problematic because of the differences in the study context. Area-level social capital has been assessed across a variety of spatial scales ranging from neighbourhoods to counties and nation states. Studies on the contextual social capital may be subject to ecological fallacy, in particular when social capital is measured at state-level. The ecological fallacy arises because

associations between two variables at the group level (or ecological level) may differ from associations between analogous variables measured at the individual level. (Diez Roux 2002). In the present study, the possibility of ecological fallacy is less likely a problem because of the identification of the real work unit at the lowest administrative levels from employers' records. Observed differences between areas could also be confounded by the characteristics of residents that constitute neighbourhoods because the controlling for potential confounders is varying (Subramanian et al. 2003). The differences in the approaches used to measure social capital may also contribute to the variations in the observed relationships between social capital and health across studies.

Social capital in residential areas and work units might have different meanings (Macinko and Starfield 2001) and further studies are needed to examine the contextual health effects across various settings. In addition, different settings might also need different measures to assess social capital. Nevertheless, the obtained results are consistent with the set hypothesis that workplace social capital may explain variation in employee health.

6.6. Workplace social capital as a predictor of new-onset depression

Despite the many studies of the association between social capital and physical health outcomes, relatively little attention has been paid to the studies of the association between social capital and mental health. To date, the strongest evidence of the association of social capital and mental health comes from the systematic review of 25 observational studies undertaken by De Silva et al. (2005). Among the individual social capital studies, strong evidence was found for an inverse association between cognitive social capital and common mental disorders but not for structural social capital. The authors found that the diversity in methodology, populations and mental health outcomes in the ecological studies in the review made it impossible to summarise the effects. The majority of the studies included in the review were cross-sectional making the direction of the association between social capital and mental illness impossible to determine. Furthermore, the authors of the review highlighted the need for the measurement of all dimensions of social capital, the use of validated social capital measures, longitudinal designs and multilevel modelling.

This prospective cohort study, using a psychometrically tested measure of social capital at work and employing multilevel techniques provides partially inconsistent evidence of the effect of workplace social capital on new-onset depression. Low levels of workplace social capital predicted the new-onset depression measured by new self-reports of doctor-diagnosed depression and new recorded antidepressant treatment, irrespective of sociodemographics or lifestyle. When baseline psychological distress, as a proxy measure of undiagnosed depression, was entered in the models the association between social capital and self-reported new-onset depression remained significant. However, this finding could not be replicated in relation to recorded antidepressant treatment as an indicator of depression.

The results of this study are in keeping with the two previous longitudinal studies that have suggested a link between individual level social capital and mental health. In the USA, Fujiwara and Kawachi (2008) found that the perceptions of high cognitive social capital (operationalised as trust of neighbours) were associated with a reduced risk of major depression at follow-up, whereas structural social capital (community participation and volunteering) was not. In Sweden, Sundquist, Johansson et al. (2004) found a gradient between the social participation index and the first admission to hospital due to a psychiatric illness. The observed association between the individual perceptions of social capital and mental health may be attributable to reverse causation if the baseline health had influenced the rate of social capital, i.e. poor mental health had lead to lower social capital. This was noted as a limitation in the study of Fujiwara and Kawachi (2008). They checked the robustness of the observed associations by repeating the analyses after excluding those who reported major depression at baseline and observed an attenuation of the results to non-significant. By contrast, the association was robust to adjustment of baseline psychiatric illness in the Swedish study (Sundquist, Johansson et al. 2004). In the present study only non-depressed participants were included and the new-onset depression was also measured from prescription records which helped to reduce the possibility of reverse causality and to avoid common method bias.

This study failed to confirm the observed association of individual workplace social capital and new-onset depression at contextual level, i.e. by co-workers' assessments of social capital. The finding is in agreement with the results of the only previous study that has longitudinally examined the relation of contextual social capital and depression (Lofors and Sundquist 2007). That study employed data from the whole Swedish population aged 25-64 years. The authors analysed the association of neighbourhood level social capital (inferred from mean voting participation within neighbourhood) and first hospital admission due to depression adjusting for socio-demographic characteristics and neighbourhood deprivation. They reported a weak inverse association of contextual social capital and depression for men and women but after adjusting for neighbourhood deprivation the results attenuated to null. This might indicate that neighbourhood deprivation needs to be taken into account in studies of the association between social capital and mental disorders (Lofors and Sunquist 2007). Moreover, the results could be subject to ecological fallacy. Thus, an important task remains for empirical studies to demonstrate the contextual effect of social capital on mental health using prospective designs.

By contrast, the results of this study suggest that in relation to depression individual factors are more important determinants of future risk of depression than the social environment. The lack of an observed association between work unit level social capital and subsequent depression may also be due to the imprecise measure of depression, that is the accumulation of error in the measurement of new-onset depression by self-reports or inability to detect non-treated cases of depression from prescription records.

All in all, more studies are needed to understand how social capital is related to mental health and depression in particular, in communities and workplaces alike.

6.7. Potential pathways linking social capital and health

Although it is claimed that social capital is causally associated with population health, little is known what the etiological pathways might be. Social capital is multi-faceted and its relationship with health is complex (Ziersch et al. 2005). Thus, it is also possible that different dimensions of social capital are differently associated with health (Lindström 2008a). At least five plausible pathways by which social capital might influence health have been suggested (Kawachi et al. 1999b, Drukker et al. 2003). They include a promotion of a more rapid diffusion of health information, increased likelihood that healthy norms or behaviour are adopted, increased social control over deviant health-related behaviour, increased access to local services and amenities, and psychosocial processes such as affective support, self-esteem and mutual respect. The mechanisms linking workplace social capital with health might not be different.

In workplaces as well as in communities, social capital can help to disseminate health information and knowledge more quickly across communities (Kawachi and Berkman, 2000). According to the theory of the diffusion of innovations the innovative behaviours (e.g. use of preventive services) can diffuse much more rapidly in communities that have higher levels of social capital. This is supported by criminology studies (Sampson et al. 1997) suggesting that a higher the degree of “collective efficacy” leads to a higher degree of social control over deviant behaviour. The second plausible pathway is that high social capital increases the likelihood (a) that healthy norms or behaviour are adopted (like physical activity) and (b) the social control over deviant health-related behaviour (such as smoking) is taken. Third, higher social capital can lead to better access to local services and amenities. Support to this mechanism comes from studies that have found that socially cohesive communities have better access to local services and amenities because they are more likely to be successful at fighting potential cuts in services (Sampson et al. 1997, Kawachi et al. 1999). Fourth, social capital could influence health of individuals via psychosocial processes by providing effective support and acting as the source of self-esteem and mutual respect (Wilkinson 1996). Fifth, social capital could provide a buffer against the adverse effects of stress (Wilkinson, 1996).

Previously, Poortinga (2006) has found limited support for the hypothesis that health-related behaviours mediate the relationship between social capital and health. As regards the association of workplace social capital and depression, health-related behaviours could act as mediators. There is some empirical support for the hypothesis. Social capital has been found to be associated with various health-related behaviours, such as smoking, physical activity and obesity (Kouvonen et al. 2008, Weitzman et al. 2005, Lindström et al. 2001, Kim et al. 2006) and health-related behaviours with depression (Pasco et al. 2008, Paschall et al. 2005, Strawbridge et al. 2002, Dixon et al. 2003, Atlantis et al. 2008). Although the examination of the mechanisms linking social capital with health was beyond the scope of this study, it should be noted that controlling for health-related behaviours did not notably change the associations. This finding suggests that the association between social capital and depression is not accounted for by health-related behaviours.

6.8. The importance of the vertical and horizontal components of workplace social capital in relation to depression

Recent studies have emphasized the multidimensional nature of the social capital concept (Szreter and Woolcock 2004, Kawachi et al. 2004). However, the measurements of social capital have not matched up to the theory as none of the studies included in the review of social capital and mental health by De Silva et al. (2005) had measured any aspect of bridging or linking social capital. This study adds to previous evidence by showing that the horizontal and vertical components are conceptually distinct aspects of social capital and that it is relevant to distinguish between these components in work settings to understand their effects on mental health. This study found that both the vertical and horizontal components predicted the new-onset of depression, independently of each other. Public sector employees with either low individual level vertical or low horizontal social capital were approximately 30-50% more likely to be diagnosed with depression or start antidepressant treatment than their counterparts with high social capital.

Previous longitudinal studies that have explicitly reported the effects of horizontal social capital are lacking. The findings of the present study are therefore compared with the few existing studies that have focused on the vertical dimension of social capital. The findings are partially in keeping with the previous results suggesting that vertical social capital is associated with health. However, the previous studies assessed area-level vertical (or linking) social capital. Two large-scale studies examined the association of vertical social capital, as indicated by voting turnout, and hospitalization for coronary heart event (Sundquist et al. 2006), depression or psychosis (Lofors and Sundquist 2007). The studies found significant contextual effects of low vertical social capital for a new coronary heart disease event and hospital admission due to psychosis but not for depression after controlling for potential individual and contextual confounders. Other studies examined the contextual effect of low voting turnout at area-level on total mortality and alcohol-related mortality, but reported inconsistent findings (Mohan et al. 2005, Blomgren et al. 2004, Islam et al. 2008).

There are several reasons for the inconsistency in the findings. First, a dimension of social capital in one context may not correspond with a different dimension of social capital in another context, or with outcomes that can be measured differently (Stone and Hedges 2002). In work context, the vertical component of social capital refers to the respectful and trusting relationships across power differentials at work. By contrast, the indicator of the vertical social capital at area-level was voter turnout which described the rate of participation in elections. The turnout in local elections can be highly variable, depending on local circumstances (Mohan et al. 2005). Second, the context-specificity of vertical social capital may, in particular, apply to studies of individual social capital and depression. The vertical dimension refers to the norms of respect and networks of trusting relations which are interacting across explicit, formal or institutionalized power or authority gradients in society (Szreter and Woolcock 2004). In the work context the vertical component includes the trusting relations between the employee

and the superior, whereas in the community context it involves networks and ties with individuals, groups or corporate actors represented in public agencies, schools, business interests, legal institutions and religious/political groups (Cote and Healy 2001). Finally, the differences in the results may be attributable to the exposure time, i.e. the length of time that the individuals had actually lived in the area or worked under supervision of the same supervisor. In the present study, the vertical and horizontal components of workplace social capital were assessed only once, and the misclassification of exposure might bias the associations. Similarly, in the study of Blomgren et al. (2004) the first elections were held two years before the census which was the source of the individual data and selective migration could bias the associations.

The mechanisms by which the vertical and horizontal dimension of social capital at work operates may be quite similar in residential areas and at workplaces. The novel approach of vertical (linking) social capital has the merit of incorporating linkages across power differentials in society (Kawachi et al. 2004). Like bridging connections, these vertical ties enable people to access resources outside their own network. Furthermore, vertical ties between citizens and the institutions of power might make us feel we can do something about arising issues, be part of civil society and might increase our chances of securing health promotion resources in our neighbourhoods (Blakely and Ivory 2006). In the work context, it is plausible that respectful and trusting relationships across power differentials enable employees to access resources, support, and information outside their own network (Ferlander 2007, Whitley and McKenzie 2005, Sundquist and Yang 2007). Furthermore, high vertical social capital at work might encourage employees to comply with preventive measures, to heed advice on healthy behaviour from the supervisor, and to follow healthy norms set by the leaders (Lindström and Janzon 2007, Fujiwara and Kawachi 2008).

The horizontal aspect of social capital, in turn, captures the intra- and intergroup relations at workplace. Thus, high horizontal workplace social capital could be associated with various interpersonal factors that reduce the risk of mental problems and improve prognosis, including high emotional, instrumental and informational support from the fellow workers (Ferlander 2007, Kavanagh et al. 2006). In any case, more research is needed to elucidate the pathways linking workplace social capital and different health outcomes and data from more than two time points are needed in order to investigate the pathways appropriately.

6.9. Methodological considerations

6.9.1. Accuracy of the short measure of social capital at work

Given the interest in social capital, it is surprising how few measures have assessed their validity and/or reliability. One reason maybe that there is no gold standard for measuring social capital with which the measure of social capital could be compared. Thus, a broader approach to validation is necessary. De Silva et al. (2006) reviewed

eleven studies that had reported of successive validation of their social capital tool. The majority of the studies had used psychometric validation such as factor analysis. Using a checklist to assess the traditional sub-categories of validity, Harpham et al. (2002) reported on several aspects of validity and reliability of A-SCAT (Adapted Social Capital Assessment Tool). De Silva et al. (2006) used a range of different psychometric tests to evaluate the short version of the A-SCAT known as SASCAT and showed the measure to be a valid tool reflecting known constructs and displaying postulated links with other variable.

Similarly, this study used a wide range of psychometric tools and tested the relationship of the developed measure with other variables and assessing how well these relationships conform to theoretical expectations. Several measures supported the validity and reliability of the scale in the present cohort. Face validity (intuitive appeal) appeared credible; the construct validity was good as indicated by associations with but redundancy of conceptually close concepts; and expected associations with self-rated health revealed appropriate criterion-related validity. The ICC and r_{wg} were high indicating significant between-unit variance and within-unit agreement.

This measure took into account the latest theoretical developments in the field of social capital and identified the multidimensional nature of the concept, as previously recommended (Harpham et al. 2002). It measured both the cognitive and the structural component of social capital. The measurement tool also covered the aspects of bonding, bridging and linking social capital with questions asking about bonding relationships to close co-workers and those with a similar social identity at work, bridging relationships to co-workers of a different occupational or organisational background, and linking relationships through formal power structures at work. It was also possible to distinguish between the vertical and the horizontal component of workplace social capital. The findings of this study support the notion that workplace social capital is a meaningful construct. It displays credible validity and reliability, although the shortness of the tool may limit the aspects of social capital that were measured comprehensively. As it is important to validate a generic tool in each cultural setting in which it is to be applied, more research in other contexts and countries is needed to further validate the short measure of social capital at work.

6.9.2. Accuracy of self-report as an indicator of incident disease

Validation studies across several decades have supported the accuracy of self-reports as a measure of several prevalent chronic diseases, for example diabetes and coronary heart disease (Colditz et al. 1986, Midthjell et al. 1992, Haapanen et al. 1997, Bergmann et al. 2004). By contrast, accuracy is reported being at best moderate for some diseases such as rheumatoid arthritis (Kriegsman et al. 1996, Beckett et al. 2000). However, less is known about the accuracy of self-reports in ascertaining incident disease despite their frequent use in epidemiological studies.

Study V examined the accuracy of self-report as an indicator of incident disease by comparing individual records in comprehensive health registers with the self-reports of five diseases (hypertension, diabetes, asthma, coronary heart disease, rheumatoid arthritis) in repeated surveys. This study showed that there was a considerable degree of misclassification for self-reports as a measure of new occurrences of diseases. Errors seem to accumulate in self-report measures of incident diseases compared to self-reports of prevalent diseases as the accuracy of self-report was worse for incident diseases than for prevalent diseases. Only 55% to 63% of the true incident cases were reported correctly as incident, i.e. as true positives. The low sensitivity suggested that self-report is not accurate in detecting those who actually have an incident disease. By contrast, the number of true negative cases was high for incident diseases, ranging from 96% to 99%. This indicated high specificity and supported the accuracy of self-report in correctly detecting the ones who are actually healthy, i.e. self-reports of incident disease rarely give false positives.

As a conclusion, the accumulation of errors in reporting the disease at baseline and follow-up may lead to inaccurate estimates particularly, when self-report is used as a sole source of information to ascertain new occurrences of diseases. Results from studies that use self-reports in detecting incident disease should be interpreted with caution.

7. CONCLUSIONS AND IMPLICATIONS FOR FUTURE RESEARCH

The enthusiasm for social capital is running high and many new researchers are entering the field. In spite of this, there is still no consensus of application of social capital in different contexts and researchers have adopted a variety of different approaches to assess social capital. Longitudinal studies on social capital and health are limited. Furthermore, recent research has begun to emphasise the importance of distinguishing between the dimensions and components of social capital.

This study contributes to existing evidence by showing that social capital in the forms of social connectivity, shared values and norms of reciprocity and trust can be found inside the workplace, and not only outside. This notion follows the highly plausible idea that social capital is accrued at places where people spend significant time, such as in workplaces. In prospective analyses, persistent low levels of workplace social capital were associated with impaired self-rated health at follow-up. The results from the repeated measurements of social capital further showed that change in social capital was associated with subsequent self-rated health which could support causality in the association, however, the results are suggestive and no definite conclusion about the causality can be drawn. There was additionally a contextual effect of workplace social capital on self-rated health and the effect was largely attributable to work unit characteristics.

Low workplace social capital was found to be associated with an increased risk of new onset depression when indicated by self-reports of diagnosed depression. As this study also highlighted the fact that if self-report is used as a sole source of information in a cohort study errors in reporting the disease at baseline and follow-up may accumulate, incident depression cases were additionally obtained from individual pharmacy records. However, the association of workplace social capital and incident depression was not robust in relation to recorded antidepressant treatment. Moreover, this study failed to confirm the observed association of individual workplace social capital and new-onset depression by co-workers' assessments of social capital. It may be that individual factors play a key role in relation to development of depression or that the assessment of social capital by co-workers' perceptions was less accurate than self-reports. This study contributed to previous evidence also by distinguishing the vertical and horizontal components of workplace social capital. Both the vertical and horizontal components were found to be independent predictors of new-onset depression. Given the inconsistent findings the global burden of depression calls for further research of the determinants of depression. Much hope is put to the investigation of the social environment, and social capital in particular (De Silva et al. 2005). To date, the strength of evidence from observational studies is not sufficient to consider social capital as an important feature of mental health promotions. More studies are needed in this field.

Estimating the effect of social capital on work performance or productivity was beyond the scope of this study. Previous studies have shown that high social capital could result in career success (Burt 1992), better opportunities to find new jobs (Granovetter 1973), resolution of problems and achievement of common goals more easily (Putnam 2000), or more efficient institutional performance (Woolcock 1998). The meager stocks of social capital can make it more difficult for ideas, information, and resources to circulate between groups, in communities and workplaces as well (Woolcock 2001). According to the estimated population-attributable fraction, the proportion of new-onset depression cases attributable to low levels of individual workplace social capital or either of the components of workplace social capital was between 4.0% and 7.9% in the study population. If the observed associations between workplace social capital and depression were causal, this result may be interpreted so that up to 8% of new-onset depression cases in the study population might be avoided if exposure to low social capital was eliminated. As depression is one of the most costly mental disorders in terms of direct and indirect costs in the labour force (Kessler et al 1999, Wang et al 2003), the findings of this study may have indirect economic implications in the target organisations. For example, depressed workers have been found to have more short-term sickness absence days than other workers, with a salary-equivalent productivity loss averaging between \$182 and \$395 per depressed worker (Kessler et al 1999). Thus, workplace social capital might be related to work performance and productivity but the results of this study do not allow for drawing any direct inferences in this regard and further studies are needed to examine this issue.

All in all, the results of this study proved support for the hypothesis that high workplace social capital may be beneficial for employee health. If the observed associations were causal, it could indicate that the social relations and daily interactions at work combined with the perceptions of shared values and norms in the workplace are more than just individual perceptions of the social environment at work but rather play a role in shaping employee health. Thus, it would be important to facilitate horizontal workplace social capital among equals and enhance vertical workplace social capital across power differentials. It has been suggested that without vertical social capital connecting communities to local government or groups with resources, social networks, norms and trust may not be able to actually improve any aspect of well-being of a community (Harpham et al. 2002). Equally, without horizontal links to other groups or communities, important information channels, support channels or other benefits of solidarity will be lost. Ideally, this restoration of both vertical and horizontal social capital will support bonds, build bridges, and link vertical and horizontal relations thus strengthen the overall cohesiveness of society, and workplace alike (Colletta and Cullen 2000).

From the organisational point of view there is a need to identify organisational practices for building and strengthening social capital. At an operational level, the horizontal workplace social capital involves social contacts and trust in relation to co-workers and the vertical dimension of workplace social capital refers to employees' relations with employers and supervisors. However, the results of this study do not provide evidence of

how to enhance the development of social capital at work. Possibly, qualitative research could provide insights into the factors determining the development of social capital at work and in deepening the understanding about the factors shaping its implementation. One of obvious next steps for research would be to undertake intervention studies to examine whether social capital at workplace can be increased via well-defined procedures and whether the increased social capital then leads to better employee health. This is challenging as the modern work life is characterised by on-going changes in the work organisation and the organisation of work, such as the regular restructuring of organisations, changing the number of personnel by downsizing or outsourcing, or expanding by mergers, rather than stable situations over months and years. In this context, it is hard to imagine any successful intervention to take place. Indeed, it would be a very difficult task to distinguish between the effects of the intervention and the parallel changes at work. Thus, large prospective cohort studies with repeated measurements of social capital and health are the ones to currently give the best available information about the trends of social capital across time and about the potential that social capital has to explain the variation in employee health.

In conclusion, this study extends the existing literature on the associations of psychosocial factors at work and employee health by showing that workplace social capital is a potentially important factor in affecting the health of the individuals in the labour force. Further studies are needed to corroborate the findings of this study in diverse populations and with different outcomes.

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