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The impact of social networks and social support on mental disorders and mortality

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If one member suffers, all suffer together; if one member is honored, all rejoice together

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General abstract

Abstract in English

Introduction: There is conflicting evidence regarding the role of social support networks in health and wellbeing and more research is needed to address the lack of information. The objective of this project is to categorize key indicators of social support and social networks, and further to determine the impact of such indicators on mental disorder and mortality.

Methods: This project will include three research articles: paper I is a review of the literature which involves an investigation into the evidence on associations between social support networks and depression in the general population (systematic literature review). Paper II is an original research paper that involves an examination of how social network integration predicts all-cause mortality among older adults in six Latin-American countries, India, and China (prospective analysis). Finally, paper III is an original research paper involving an investigation into relationship quality (positive and negative aspects of social support) and social networks with depression, anxiety and suicidal ideation in a nationally representative sample of older Irish adults in intimate relationships (cross-sectional analysis).

Results: I) A number of key indicators of social support and social networks were identified to be associated with depression. Generally, studies have found protective effects of perceived social support and large, diverse social networks against depression in the general population. II) For older adults in developing countries, survival time is significantly reduced in individuals embedded in restricted social networks. III) For older Irish adults in intimate relationships, we found that worse relationship quality with the spouse is positively associated with depression, anxiety, and suicidal ideation, and that restricted social network integration is positively associated with depression.

Conclusion: A number of recommendations have been made for future research in order to make a more comprehensive assessment of the role of social support networks in relation to mental health outcomes. Further, being embedded in good social support networks is negatively associated with mortality and also a number of outcomes on mental disorder among older adults in the general population. Social care and public mental health interventions may be enhanced by tailoring interventions to improve the quantity and quality of social support networks in order to promote population mental health and health status. Implications for health research, policy and future directions are discussed.

Abstract in Spanish (Español)

Introducción: Hay pruebas contradictorias sobre el rol de las relaciones sociales en la salud y el bienestar y más investigación es necesaria para hacer frente a la falta de información. El objetivo de este proyecto es categorizar los indicadores clave identificados en relación con la salud y el bienestar, y determinar el impacto de este tipo de indicadores en la salud mental y mortalidad.

Métodos: Este proyecto incluirá tres artículos de investigación: El artículo I es una revisión de la literatura que investiga la evidencia sobre asociaciones entre las relaciones sociales y la depresión en la población general. El artículo II es un trabajo de investigación original con el objetivo de examinar cómo el tipo de red social identificada al inicio del estudio predice la mortalidad entre los adultos mayores en los países en desarrollo. El artículo III es un trabajo de investigación original que consiste en la investigación de las asociaciones de las interacciones sociales positivas y negativas y las redes sociales con la depresión, la ansiedad y la ideación suicida entre los adultos mayores irlandeses con una relación sentimental.

Resultados: I) Se identificaron asociaciones entre la depresión y un número de indicadores claves de apoyo social y redes sociales. En general, los estudios encontraron que el apoyo social percibido y tener redes sociales grandes y diversas tenían efectos protectores sobre la depresión en la población general. II) Para adultos mayores procedentes de países en vías desarrollo, el tiempo de supervivencia se reduce significativamente en individuos con redes sociales limitadas. III) En una muestra irlandesa de adultos mayores con una relación sentimental, encontramos que una peor calidad de la relación con la pareja se relacionaba positivamente con depresión, ansiedad e ideación suicida, y que redes sociales limitadas se asociaban positivamente con depresión.

Conclusión: Se hacen una serie de recomendaciones para hacer una evaluación más completa sobre el papel de las redes sociales de apoyo en relación con la salud mental en el futuro. Además, estar incluido en relaciones sociales de apoyo de calidad se asocia negativamente con mortalidad y con trastornos mentales entre los adultos mayores en la población general. La asistencia social y las intervenciones de salud mental pública podrían ser mejoradas mediante la adaptación de las intervenciones para aumentar la cantidad y calidad de las redes de apoyo social con el fin de promover la salud mental y el estado de salud general de la población. Se discuten las implicaciones para la investigación en salud, las políticas sanitarias y sociales, y direcciones futuras.

Outline of this thesis

In chapter 1, I provide a brief review of why it is important to investigate the role of social support networks in the context of mental health and survival. In Chapter 2, I introduce the specific objectives and hypotheses of the doctorate project. Chapter 3 is divided into three sections that present the three papers that constitute the thesis methods and results. Paper I includes a literature review to assess the association between social relationships and depression in the general population. Paper II covers a survival analysis to assess social network typologies and their associated risk of mortality in China, India, and six Latin American countries. Paper III presents a cross-sectional study to assess associations between relationship quality and social networks with depression, anxiety, and suicidal ideation in a nationally-representative sample of the Irish population. Chapter 4 includes a general discussion, where the findings of each paper are considered from a broader perspective. Implications of social network science as a tool in public health interventions are discussed, as well as future directions for social support networks in health research. Finally, chapter 5 presents a conclusion for the entire project.

Chapter 1: Introduction

The role of social influence in human psychology, behavior, and health

A large body of literature continues to document how the real or imagined influence of other people in a person's social environment can affect mental and physical health outcomes. For centuries, philosophers, scholars and scientists have debated whether nature or nurture is more important in predicting human psychology, behavior, and health. Recently, a meta-analysis across 2,748 studies and 14.5 million pairs of twins revealed that the effect of genetic versus the environment is around 50/50 in terms of predicting a range of outcomes, such as personality, intelligence, propensity for mental disorder, and physical health (Polderman et al., 2015). In other words, social and environmental influences are estimated to account for at least 50% of the variation in health and psychological outcomes, implying that it is essential to consider the social dimensions of human health.

There are several reasons why health may be affected by social conditions. One important and fundamental reason to consider is that humans are social creatures who learn to live and survive based on verbal and non-verbal information that is transmitted to them socially. This occurs even at a very basic level, where humans act or react by instinct or from unconscious processes as a result of social influence. For example, it is well known that yawning can be contagious, that is, watching another person yawn can trigger an unconscious and instinctual urge to yawn (Platek, 2010; Schurmann et al., 2005). Other forms of basic behaviors can be very much influenced by social stimuli, such as laughing. Research has shown that people are 30% more likely to laugh in a group than when alone (Provine & Fischer, 1989), and further that humans derive important information about their relationships with other people based on the type of laughter they express (Bryant et al., 2016; Scott, Lavan, Chen, & McGettigan, 2014). Finally, a well-known phenomenon in the field of behavioral psychology is that of vicarious conditioning, which is when fear or anxiety responses are transmitted from one person to another through social observation, even without the personal experience of the aversive event that originally elicited the response (Olsson, Nearing, & Phelps, 2007; Olsson & Phelps, 2007).

From the moment people are born, they learn about life through their social environment. Outcomes, such as those relating to health, are heavily determined by what people learn from their social connections. Consider the children's game telephone, where a message is passed along a line by each child whispering into another child's ear. The final message reported contains the error introduced by the previous child, along with all those introduced by prior children to whom the child is not directly connected. Information flows through social networks, and the information one person receives through his or her social networks can be entirely opposite from the information another person will receive through a different social network. The information that is transmitted and learned through the social environment can have great implications for health and behavior. Not only do people learn and receive important information from their social surroundings, but they can be strongly influenced by the information transmitted from social connections, even when the information transmitted by those social connections appears to be inaccurate. Several decades ago, Solomon Asch (1956) conducted his famous line study, demonstrating that people will conform to the erroneous perceptions of their social connections even in clearly unambiguous situations.

How social connections can affect thought, feeling, and action

Importantly, social influence can affect health in important ways, sometimes to the extent where it becomes virtually unexplainable from a medical standpoint. For example, in 1998, an outbreak of headache, nausea, dizziness, and shortness of breath took place at a Tennessee high school after a teacher had reported a "gasoline-like" smell in her classroom (Jones et al., 2000). Soon after, the school was evacuated, 80 students and 19 teachers went to the emergency room, 38 persons were hospitalized overnight. Several government agencies were called in to perform an extensive investigation, but were unable to find any medical or environmental explanation for the outbreak of symptoms. After five days of intense investigation and still no discovery of any environmental health hazards, the school reopened. That same day, the outbreak started again, and another 71 people went to the emergency with similar symptoms. All in all, more than 170 people had gone to the hospital with symptoms for which no organic cause could be found. It was determined that Mass Psychogenic Illness was the cause, which is a phenomenon where symptoms of illness rapidly spread through a group, although the physical complaints exhibited have no

corresponding organic etiology (Bartholomew & Wessely, 2002). In other words, the spread of disease can occur with no other cause than the power of social influence itself.

To give an example of how psychological factors can be influenced by social relationships, one might consider an interesting Norwegian study that showed how the number of social ties (here siblings) can affect a person (Kristensen & Bjerkedal, 2007). It has been known for some time that first-born children tend to score slightly higher on tests of intelligence quotient (IQ) than second-born children, who in turn score higher than third-born children. An outstanding question has been whether these differences could be attributed to biological or social factors. The Norwegian study was able to demonstrate that simple social network features were responsible for these differences in intelligence. They found that if a first-born child died during the first few years of a second-born child's life, the IQ of the second-born would come to resemble the IQ of a first-born child. If a first-born *or* second-born child died during the first few years of a third-born child's life, the IQ of the third-born child would come to resemble the IQ of a second-born child. If both of the earlier-born children died, the IQ of the third-born child would come to resemble the IQ of a first-born child. This means that IQ appears to have much more to do with social rank than genetic or biological predisposition. Importantly, lower intelligence has been found to have important implications for survival (Whalley & Deary, 2001) and also a range of mental disorders (Mortensen, Sorensen, Jensen, Reinisch, & Mednick, 2005). Thus, a person's position in a social network can influence cognitive abilities and ultimately mental health and longevity.

A last example can be given to show how social influence can have an impact on psychological outcomes. Over the past few decades, China experienced dramatic economic growth, while rates of happiness and life-satisfaction did not seem to rise along with this growth. One would assume that general happiness would increase with rising income. However, a number of studies have shown that this was not exactly the case (Knight & Gunatilaka, 2011; Wu & Li, 2013). Although personal income did affect life satisfaction positively on an individual level, overall happiness did not rise due to dramatic shifts in relative income. The remarkable growth that took place in the Chinese economy also increased levels of income inequality, and such discrepancies in people's income relative to others tend to have a negative effect on life satisfaction. One reason for this is that income inequality triggers social comparison. In other

words, a higher individual income appears to only be a predictor of happiness when income levels grow evenly. However, when income levels grow unevenly, relative income gaps become larger, and as one person makes a little more money, another person makes a lot more money. The implication is that personal success is not an individual characteristic, but is defined relative to the success of others (Rutledge, de Berker, Espenhahn, Dayan, & Dolan, 2016). Thus, it is important to understand how the social environment may affect health and wellbeing, and how it may be possible to improve or promote population health by utilizing or targeting social relationship factors.

A focus on social networks and social support

Social relationships can affect a person's overall health, as they can be a source of financial, practical and emotional resources. The importance of social relationships for health and wellbeing has been extensively demonstrated in high-income countries. In a meta-analysis of 20 population-based cohort studies, relationships as a source of social capital had a significant inverse association to mortality (Nyqvist, Pape, Pellfolk, Forsman, & Wahlbeck, 2014). According to evidence from another meta-analytic review, good social relationships can prolong survival by 50% (Holt-Lunstad, Smith, & Layton, 2010). Further, having poor social relationships was reported to be more harmful than excessive drinking and smoking, obesity, and lack of exercise in terms of associated risk. A seven-decade longitudinal study discovered that social relationships are better predictors of health than a range of biological and economic factors (Vaillant, 2008). In the case of older adults specifically, a number of studies have reported that maintaining social contacts in late life is associated with a reduced risk of psychological distress (Golden et al., 2009), dementia (Fratiglioni, Wang, Ericsson, Maytan, & Winblad, 2000), functional decline (Stuck et al., 1999), disability (Avlund, Lund, Holstein, & Due, 2004), institutionalization and mortality (Steinbach, 1992).

Structural and functional properties of social relationships have important implications for both mental health and survival across the life-course (Christakis & Fowler, 2011; Smith & Christakis, 2008). According to Thoits (2011), the link between social relationships and mental health can be attributed to a number of psycho-social pathways that operate both directly and as stress buffers. Ultimately, good social relationships generally tend to be beneficial for mental

health due to emotional sustenance and active coping assistance provided by a person's social ties. While one can perhaps intuitively understand how social relationships can affect mental health, the link between social relationships and physical health or survival is less obvious. According to Uchino (2006, 2009), social relationships are associated with health and mortality in a number of ways, including physiological, behavioral, and psychological pathways. Physiological pathways may involve metabolic function (Yang, Li, & Ji, 2013), or cardiovascular, neuroendocrine, and immune function (Uchino, 2006). Behavioral pathways may involve for example diet and obesity (Christakis & Fowler, 2007), sexual behaviors (Liljeros, Edling, Amaral, Stanley, & Aberg, 2001), or even suicide (Bearman & Moody, 2004; Hedström, Ka-Yuet, & Nordvik, 2008; Tsai, Lucas, Sania, Kim, & Kawachi, 2014). Finally, psychological pathways may for example involve depression, which is particularly important in the context of social isolation or loneliness (Luo, Hawkey, Waite, & Cacioppo, 2012).

Social networks (not to be confused with *online* social networks) are the structural components of people's *in-person* social relationships, such as network size (the amount of social ties one has), type of network tie (e.g. spouse, child, friend), contact frequency (how often), network position (central versus peripheral), density (the degree of connection in a network), reciprocity (uni or bi-directionality between social ties), transitivity (the extent to which a person's connections are connected to each other), or network type (e.g. family dependent, private, locally integrated). Two distinct approaches exist for assessing social networks: egocentric and sociocentric approaches. Egocentric models include data from individuals about members in their network, whereas socio-centric models utilize not only the network information from each individual, but also information from the network members themselves. As a consequence, socio-centric models often yield more novel insights, but also make much greater demands of data (Smith & Christakis, 2008). Although the original studies conducted in this thesis project do not include socio-centric data analysis, it is nevertheless an important area that will be addressed in the general discussion. An example of a socio-centric social network is illustrated in figure 1.

The functional properties of people's social relationships, i.e. social support, also play important roles in mental health and well-being (Schuster, Kessler, & Aseltine, 1990; Uchino, 2006). Social support can be emotional (relating to sympathy, trust, and confidence) or instrumental (relating to practical aid). Further, support can be provided or received, and this can

occur via different sources (e.g. to/from spouse, child, friend). Finally, the literature generally tends to separate social support into perceived support (relating to one's subjective evaluation) or enacted support (relating to a person's specific recollection of supportive behaviors). Generally, information about social networks and social support is collected through self-report data (although social network analysis can also involve other types of data, such as connections between political parties, import/export patterns between countries or industries, ball passing patterns among college soccer players, or mating patterns among Amazon rainforest frogs). In the context of the current project, below are some examples of typical social support or social network items or variables used in population surveys:

Social support

- How much does [person A] really understand the way you feel about things? (perceived emotional support)
- How much can you rely on [person A] to help out with practical matters? (perceived instrumental support)
- When was the last time [person A] gave you advice during a difficult time? (enacted emotional support)
- When was the last time [person A] helped you with practical matters? (enacted instrumental support)
- When was the last time you gave [person B] advice during a difficult time? (provided emotional support)
- When was the last time you helped [person B] with practical matters? (provided instrumental support)

Social networks (ego-centric)

- Marital/partnership status
- Number and frequency of contact with children, relatives, or close friends
- Membership in religious or community organizations

Social networks (socio-centric)

- How many friends do [person A] have?
(network size)
- Is [person A] located centrally or peripherally in the social network?
(network centrality)
- Does [person A] designate [person B] as a friend? (uni/bi-directionality)
- Does [person B] designate [person A] as a friend? (uni/bi-directionality)
- Are [friend B] and [friend C] also friends with one another? (transitivity)

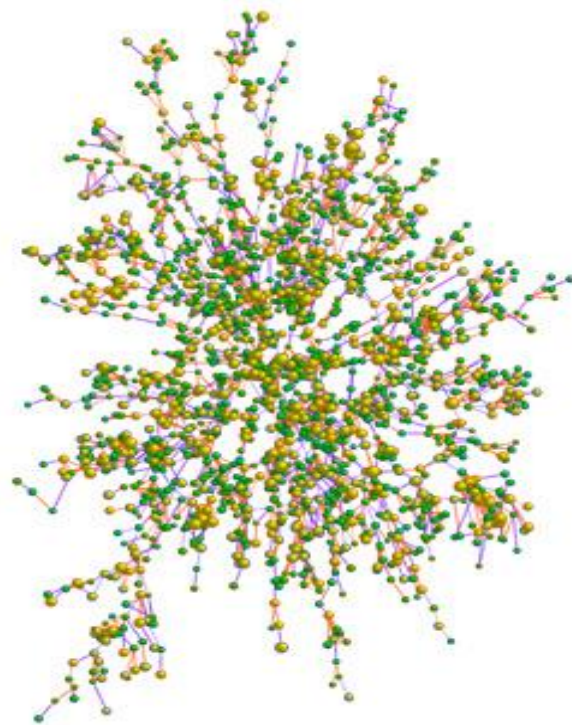


Figure 1. A network of 2,200 people from the Framingham Heart Study in the year 2000. Node borders indicate gender (red for female, blue for male); node colors indicate obesity (yellow for body mass index [BMI] of 30 or more, green for BMI less than 30); node sizes are proportional to BMI; tie colors indicate the type of relationship (purple for friend or spouse, orange for family). Picture and caption taken from Christakis and Fowler (2011).

Research narrative

Assessing associations between social support networks and health can be approached in many ways. Qualitative studies are often very beneficial for exploration of the topic and generation of hypotheses, while quantitative studies tend to provide more tangible insights into associations and mechanisms that are relevant to the research question. Naturally, both qualitative and quantitative studies can be conducted in the context of clinical settings (e.g. psychiatric patients), specified sub-populations (e.g. marginalized groups), or wider epidemiological settings (e.g. with data representative of a nation). From a public health standpoint, it is essential to advance wider epidemiological research in regards to the link between social support networks and health, which may ultimately provide some valuable information to health policy makers. This doctorate dissertation aims to do exactly that, that is, to investigate epidemiologically the role of social

support and social networks in relation to mental health and mortality in the general population. It does this by a) exploring and assessing the literature systematically regarding the link between social support networks and depression, b) investigating how fundamental social network integration is in terms of survival, and c) assessing associations between social support networks and a range of mental health outcomes. Finally, the findings of each paper are considered in a broader context, and implications for population health, public health interventions, and health / medical research are discussed. Some considerations are made for future directions. General conclusions are made based on the findings and the discussions presented.

Chapter 2: Hypotheses and objectives

Objectives

The main objective of this thesis dissertation is to provide an insight into the role and impact of social support and social networks on mental disorders and mortality in the general population.

The specific objectives are:

1. To review the evidence on associations between social support networks and depression.
2. To examine the extent to which social network integration predicts mortality among older adults.
3. To assess associations between relationship quality (positive and negative aspects of social support) and social network integration with mental disorders among older adults in intimate relationships.

Hypotheses

In the context of mental health and survival, some issues remain unclear with regard to the implications of social support networks in the aging population. It is essential to add to the existing body of epidemiological literature in order to assess the role of social support networks in terms of their specific association with mental disorders and mortality in the general population. The specific hypotheses and the corresponding research papers in this thesis dissertation are:

1. Systematic literature review – no hypothesis generated.
2. Poor social network integration constitutes an independent risk factor for reduced survival among older adults in developing countries.
3. Higher levels of relationship quality (in terms of positive and negative aspects of social support) and better social network integration are negatively associated with outcomes relating to depression, anxiety, and suicidal ideation among older Irish adults.

Ethics

Ethical approval for this doctorate project has been obtained from the ethics committee of Parc Sanitari Sant Joan de Déu. The two original research papers in this dissertation involve secondary data analyses with no human subject issues. Ethical approval for the 10/66 Dementia Research Group's population-based prevalence surveys and The Irish Longitudinal Study on Ageing (TILDA) was obtained from local ethical committees in the countries involved as well as the King's College London Research Ethics Committee, and the ethics committee of Trinity College Dublin respectively.

Chapter 3: Methods and results

**The association between social relationships and depression: A
systematic review**

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Review

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ABSTRACT

Background: Depression is one of the most prevalent mental disorders globally and has implications for various aspects of everyday-life. To date, studies assessing the association between social relationships and depression have provided conflicting results. The aim of this paper was to review the evidence on associations between social relationships and depression in the general population.

Methods: Studies investigating the association of social support, social networks, or social connectedness with depression were retrieved and summarized (searches using Pubmed, ScienceDirect, PsycNet were conducted in May 2014).

Results: Fifty-one studies were included in this review. The strongest and most consistent findings were significant protective effects of perceived emotional support, perceived instrumental support, and large, diverse social networks. Little evidence was found on whether social connectedness is related to depression, as was also the case for negative interactions.

Limitations: Due to the strict inclusion criteria relating to study quality and the availability of papers in the domain of interest, the review did not capture 'gray literature' and qualitative studies.

Conclusion: Future research is warranted to account for potential bias introduced by the use of subjective measures as compared to objective measures of received support and actual networks. Due to the heterogeneity between available studies on the measure of social relationships, the inclusion of comparable measures across studies would allow for more valid comparisons. In addition, well-designed prospective studies will provide more insight into causality. Future research should address how social support and networks interact and together affect risks for depression. Social connectedness and negative interactions appear to be underutilized as measures in population-based studies.

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1. Introduction

Depression is arguably one of the most prevalent and prominent mental disorders of our time, touching the lives of people across nations, ages, and social and cultural groups. The Global Burden of Disease Study 2010 has identified depressive disorders as the second leading cause of years lived with disability, designating it as a major public-health priority (Ferrari et al., 2013). Besides depression being a serious and debilitating disorder in and of itself, it has various negative consequences for physical health (Prince et al., 2007). At worst, depression can lead to suicide (Ferrari et al., 2013), and 15% of those who are clinically depressed die by suicide (Verster et al., 2008). Further, the economic consequences of depression are substantial. The costs of mood disorders in Europe for the year 2010 has been estimated to be € PPP 113.4 billion (Gustavsson et al., 2011). Almost half of these costs is the result of productivity loss, implying the vast negative impact of depression on populations' economy and sustainability. Depression has been found to be associated with a wide range of factors such as female gender, somatic illness, and cognitive and functional impairments. Additionally, loss of close social contacts has been found to be an important predictor of depression, along with various other variables relating to social relationships (Djernes, 2006).

Social relationships have important implications for both physical and mental health. The state of one's social relationships can affect that person's overall health. Specifically, according to evidence from a recent review, good social relationships can prolong survival by 50% (Holt-Lundstad et al., 2010). A seven-decade follow-up study discovered that social relationships are better predictors of health than a range of biological and economic factors (Vaillant, 2008). Similarly, Holt-Lundstad et al. (2010) reported that having poor social relationships is potentially more harmful than excessive drinking and smoking, obesity, and lack of exercise.

Studies investigating social relationships generally pertain to three major domains: social support, social networks, and social connectedness (Ashida and Heaney, 2008; Barratt et al., 2006; Noone and Stephens, 2014; Ottmann et al., 2006; Stone, 2003). Social support has long been known to exert considerable influence on mental health and wellbeing (Thoits, 2011). The literature distinguishes between perceived and received (or enacted) social support. Perceived support is the subjective feeling of being supported by one's relationships, while received support refers to the actual support provided. The literature on social support further distinguishes between emotional support (e.g. someone being available to listen or offer sympathy during times of crisis or hardship, or someone available to give advice) and instrumental support (e.g. someone available to offer help with issues that require physical effort or financial aid). All these different forms of social support appear to have different implications for mental health (Nurullah, 2012). Support may also be provided to or received from different sources, such as spouse, children, relatives,

friends, and co-workers. It has been demonstrated that the role and effect of social support on health and psychological well-being varies depending on the source of support (Li et al., 2014; Walen and Lachman, 2000). Finally, as an opposite measure of supportive behaviors, some studies also include negative interactions (strain), such as tension, criticism, or placing too strong demands on others (Schuster et al. 1990).

Social relationships can be more clearly distinguished in terms of their network structure (i.e. social networks) and network function (i.e. social support) (House, 1987). Thus, while the term social support relates to the functional content in social relationships, social networks is a concept that relates to the formal structure of social relationships, such as size, composition, contact frequency, boundedness, etc. (Prince et al., 1997). Studies on social networks have been characterized by investigating the web of social connections that surrounds an individual and this has been shown to have important associations with both physical and mental health (Smith and Christakis, 2008). Two distinct approaches exist for assessing social networks: egocentric and sociocentric approaches. Egocentric models include data from individuals about members in their network, whereas sociocentric models utilize not only the network information from each individual, but also information from the network members themselves. As a consequence, sociometric models often yield more novel insights, but also make much greater demands of data (Smith and Christakis, 2008). Another insightful way to examine social networks is to categorize them into network types, such as network composition (e.g. the level of diversity of family members, friends, and coworkers in a network) and other measures, such as social engagement. Network types thus tend to encompass a more comprehensive assessment of network properties and can be particularly informative (e.g. Litwin and Landau, 2000).

Finally, social connectedness refers to the degree to which a person experiences belongingness, attachment, relatedness, togetherness, or entrenchment in one's social relationships. Thus, it refers more to subjective feelings and attitudes towards oneself in relation to the social context, rather than specific social relationships (Townsend and McWhirter, 2005; Williams and Galliher, 2006). The literature also makes use of the term 'social disconnectedness' to refer to conditions of social isolation, such as living alone, physical separation from others, widowhood, etc. (Cornwell and Waite, 2009a, 2009b; Zavaleta et al., 2014).

A number of recent reviews have been published that address the influence of social relationships on populations' health status (Holt-Lundstad et al., 2010; Smith and Christakis, 2008; Tajvar et al., 2013; Uchino, 2006). However, the evidence in the literature concerning the influence of social relationships on mental illness, particularly for depression, is often conflicting or sparse (Nurullah, 2012). Moreover, many studies on social relationships employ non-probability or convenience sampling, which considerably

limits the degree to which one can extrapolate findings and draw conclusions about the influence of global network and support properties in the general population (Smith and Christakis, 2008). Thus, this work focuses on population-based studies that investigate the association between social relationships (social support, social networks, and social connectedness) and depression.

2. Methods

2.1. Search strategy

The electronic databases of PsycInfo/PsycNet, PubMed/MedLine, and ScienceDirect were searched for studies measuring the association between social networks, social support, or social connectedness, and depression. Search words were customized for each database, and each search involved combining key word searches for a list of social relationships variables ('social support', 'peer support', 'emotional support', 'social networks', 'social relationship', 'social connectedness', 'belongingness') and specific terms relating to outcomes of depression ('depression', 'depressive symptoms'). Medical Subject Headings (MeSH) (i.e. "social support", "depression", "adult") were used whenever possible. MeSH is the National Library of Medicine's controlled vocabulary for the purpose of indexing journal articles in a hierarchical structure, which makes it possible to conduct a more comprehensive search. This terminology is commonly used in review articles to identify relevant studies. Databases were searched for studies published in English, Spanish, French, Scandinavian (Danish, Swedish, Norwegian), or Ex-Yugoslavian (Croatian, Bosnian, Serbian) languages. These languages were selected based on the availability of people who understand these languages in the research group.

The search was limited to studies published between 2004 and 2014 in order to obtain the most recent scientific articles. Studies were

included if: (a) they published empirical quantitative research examining the association between social support, social networks, and/or social connectedness, and depression or depressive symptoms; (b) social support, social networks, and/or social connectedness were the predictor/independent variable or one of the main predictors/independent variables of the study; and (c) depression or depressive symptoms was the outcome/dependent variable of the study. Due to the bias introduced when designating particular target groups as participants, only studies involving community samples were included (Tsuang et al., 2011). Thus, studies not employing random sampling were excluded, and included studies had to have been carried out according to conventional standards relating to appropriate sampling procedures to reflect the general population (Bonita et al., 2006). Due to the focus on adults, published studies exclusively on infants, children, and adolescents were also excluded.

Two authors independently reviewed potential articles to be included based on the inclusion criteria. The level of agreement was assessed with kappa statistics (kappa 0.82; SE 0.05), and disagreements were resolved subsequently by consensus. The initial search yielded 1737 articles with duplicates removed. Inspection of abstracts and titles found that 1675 articles did not fulfill the inclusion criteria. Sixty-two articles were identified as potentially relevant, but 11 of those were later excluded as closer examination revealed that they did not match the inclusion criteria. An overview of the search process is illustrated in Tables 1 and 2 and Fig. 1.

2.2. Data extraction

The search strategy resulted in a total of 51 papers being included in the review. All the information from each article that was relevant to the research question and in line with the inclusion criteria was extracted and tabulated. Extracted data comprised publication data, country, language, setting and aims

Table 1

List of sources searched and search terms used for systematic review.

| |
|---|
| Electronic databases |
| Pubmed/Medline |
| PsycNet/PsycInfo |
| ScienceDirect |
| Search terms |
| Social support [MeSH] OR peer support [keyword] OR emotional support [keyword] OR social networks [keyword] OR social relationship [keyword] OR social connectedness [keyword] OR belongingness [keyword] |
| AND |
| Depression [MeSH] OR depressive symptoms [keyword] |
| AND |
| Adult [MeSH] |
| AND |
| Year: 2004 TO 2014 |

Table 2

Overview of the search terms used in each search database.

| Pubmed | | ScienceDirect | | PsycNet | |
|--------------------------------|-------------------|--------------------------------|-------------------|--------------------------------|-------------------|
| Search terms | Boolean operators | Search terms | Boolean operators | Search terms | Boolean operators |
| Social support [MeSH] | OR | Social support [keyword] | OR | Social support [keyword] | OR |
| Peer support [keyword] | OR | Peer support [keyword] | OR | Peer support [keyword] | OR |
| Emotional support [keyword] | OR | Emotional support [keyword] | OR | Emotional support [keyword] | OR |
| Social networks [keyword] | OR | Social networks [keyword] | OR | Social networks [keyword] | OR |
| Social relationship [keyword] | OR | Social relationship [keyword] | OR | Social relationship [keyword] | OR |
| Social connectedness [keyword] | OR | Social connectedness [keyword] | OR | Social connectedness [keyword] | OR |
| Belongingness [keyword] | AND | Belongingness [keyword] | AND | Belongingness [keyword] | AND |
| Depression [MeSH] | OR | Depression [keyword] | OR | Depression [keyword] | OR |
| Depressive symptoms [keyword] | AND | Depressive symptoms [keyword] | AND | Depressive symptoms [keyword] | AND |
| Adult [MeSH] | | | | Adulthood (18yrs & older) | AND |
| | | | | Year: 2004 TO 2014 | |
| Hits: | 1550 | Hits: | 167 | Hits: | 58 |

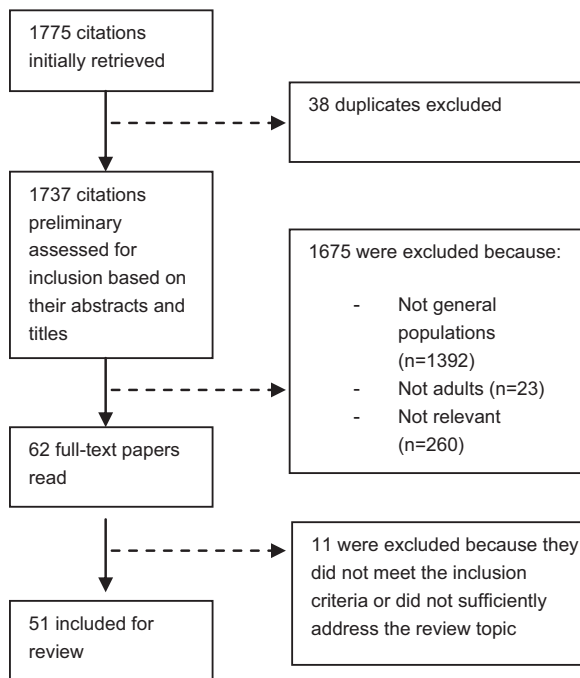


Fig. 1. Selection of studies for systematic review.

of the study, study design, sample characteristics, data collection methods, key measures, theoretical framework, and main findings. Extracted data also comprised quality assessment of each study following the guidelines of the Effective Public Health Practice Project (Armijo-Olivo et al., 2012; Thomas et al., 2004). An overview and description of included studies including quality assessment can be found in Tables 3 and 4. The quality assessment comprised of six components: (1) selection bias; (2) study design; (3) confounders; (4) blinding; (5) data-collection method; and (6) withdrawals and drop-outs. Each component was rated as weak, moderate, or strong, and a final rating was made of each study. A study was rated as 'low quality' if it had received two or more weak ratings; 'moderate quality' if it had received one weak rating; and 'high quality' if it had not received any weak ratings. Any discrepancies in terms of rating were resolved between the two reviewers. The complete details of the quality assessment procedure can be found on the Effective Public Health Practice Project website: <http://www.ehphp.ca/tools.html>.

2.3. Synthesis

Due to the broad nature of the search and the different studies included in the review, a narrative synthesis was conducted to synthesize the information (see Table 1 and Fig. 1). The synthesis was guided by the methods described by Popay et al. (2006). This guide provides some basic steps to the process of conducting a narrative synthesis which is more systematic and transparent, and also minimizes bias in both the assessment of studies and decision made by reviewers. The guide includes topics on developing a theoretical model and a preliminary synthesis for a narrative review, exploring the relationships in the data, and assessing the robustness of the synthesis product. As a component to this approach, different studies in this review were grouped into overarching conceptually or thematically related categories.

3. Results

The review included 28 cross-sectional and 23 prospective studies. According to quality criteria set forth by the Effective Public Health Practice Project (Armijo-Olivo et al., 2012; Thomas et al., 2004), nine studies were rated as 'low quality' (9/51 = 17.6%), 30 studies were rated as 'moderate quality' (30/51 = 58.8%), and 12 studies were rated as 'high quality' (12/51 = 23.6%). Of those rated as 'low', seven were cross-sectional, and two were prospective studies. Of those rated as 'moderate', 21 were cross-sectional, and nine were prospective studies. Finally, the 12 studies rated as 'high' were all prospective studies.

3.1. Social support

Perceived emotional support was the most frequently utilized social support variable, being used in 35 of the studies. This variable was significantly associated with depressive symptoms in 32 of the 35 five studies (32/35 = 91.4%). In all these studies, higher levels of perceived emotional support were protective against depression, and lower levels were associated with the presence, onset or development of depression [15.6% (5/32) of the studies were cross-sectional with low quality (Chen et al., 2005; Harvey et al., 2010; Ostberg and Lennartsson, 2007; Virtanen et al., 2008; Zhang and Li, 2011); 40.6% (12/32) were cross-sectional with moderate quality (Alexandrino-Silva et al., 2011; Chazelle et al., 2011; Choi and Ha, 2011; Fiori et al., 2006; Fiori and Denckla, 2012; Glaesmer et al., 2011; Grav et al., 2012; Leung et al., 2007; Li and Liang, 2007; Mair et al., 2010; Millan-Calenti et al., 2013; Sicotte et al., 2008); 6.3% (2/32) were prospective with low quality (Heponiemi et al., 2006; Tiikkainen and Heikkinen, 2005); 21.9% (7/32) were prospective with moderate quality (Bierman and Statland, 2010; Jokela et al., 2007; Koizumi et al., 2005; Pettit et al., 2011; Plaisier et al., 2007; Rugulies et al., 2006; Stoetzer et al., 2009); and finally 15.6% (5/32) were prospective with high quality (Fauth et al., 2012; Huang et al., 2011; Taylor and Lynch, 2004; Teo et al., 2013; Yang, 2006)]. The remaining three studies (3/35 = 8.6%) did not find perceived emotional support to be a significant correlate of depression [33.3% (1/3) cross-sectional moderate (Litwin, 2011); 66.7% (2/3) prospective moderate (Smith and Bielecky, 2012; Tsai et al., 2005)].

The findings from the five studies which measured both perceived emotional support and perceived negative interactions were mixed. One study found that neither were significantly associated with depression [20% (1/5) cross-sectional moderate (Litwin, 2011)]. Two studies found that emotional support was negatively associated with depression, and that negative interactions were positively associated with depression with similar magnitudes in opposite directions [20% (1/5) cross-sectional moderate (Li and Liang, 2007); 20% (1/5) cross-sectional moderate (Fiori et al., 2006)]. One study found that only negative interactions were significantly and positively associated with depression [20% (1/5) cross-sectional low (Ford et al., 2011)], while another study found that both emotional support and negative interactions were associated with depression in opposite directions (i.e. emotional support being protective, and negative interactions being a risk factor), but with the effect of negative interactions being modestly stronger [20% (1/5) prospective high (Teo et al., 2013)].

Findings for received emotional support were similar to findings regarding perceived emotional support. Low levels of received emotional support were significantly associated with depression in eight out of 12 studies (8/12 = 66.7%) [37.5% (3/8) cross-sectional moderate (Fiori and Denckla, 2012; Leggett et al., 2012; Mair et al., 2010); 25% (2/8) prospective moderate (Rugulies et al., 2006; Stoetzer et al., 2009), and 37.5% (3/8) prospective high (Chao, 2011; Garcia-Pena et al., 2013; Sonnenberg et al., 2013)]. One study out of the twelve (1/12 = 8.3%) reported that receiving emotional

Table 3
Overview of the 28 cross-sectional studies included in the review.

| Reference | Location of study | Number of participants and age group | Design and study length | Social relationships measure | Depression outcome measure | Methodological quality |
|---------------------------------|-------------------|--------------------------------------|-------------------------|--|--|------------------------|
| Fiori and Denckla (2012) | USA | N=6767 All adults (18+ years) | Cross-sectional | Support (perceived; received; provided; instrumental, emotional) | The Center for Epidemiologic Studies-Depression scale (CES-D) short form | Moderate |
| Glaesmer et al. (2011) | Germany | N=5033 60–85 years old | Cross-sectional | Support (perceived emotional) | The Depression Module of the Patient Health Questionnaire (PHQ-9) | Moderate |
| Grav et al. (2012) | Norway | N=40659 20–89 years old | Cross-sectional | Support (perceived emotional) | The Hospital Anxiety and Depression scale for depression (HADS-D) | Moderate |
| Harvey et al. (2010) | Norway | N=40401 20–89 years old | Cross-sectional | Support (perceived emotional) | The Hospital Anxiety and Depression scale for depression (HADS-D) | Low |
| Leggett et al. (2012) | Vietnam | N=600 55 years old and above | Cross-sectional | Support (received emotional) | The Center for Epidemiologic Studies-Depression scale (CES-D) | Moderate |
| Li and Liang (2007) | China | N=2943 60–94 years old | Cross-sectional | Support (perceived instrumental and emotional) and negative interactions | The Center for Epidemiologic Studies-Depression scale (CES-D) | Moderate |
| Ostberg and Lennartsson (2007) | Sweden | N=5053 18–75 years old | Cross-sectional | Support (perceived instrumental and emotional) | Self-reporting of the occurrence of depression | Low |
| Zhang and Li (2011) | China | N=1428 55 years old and above | Cross-sectional | Support (perceived emotional) | The Center for Epidemiologic Studies-Depression scale (CES-D) | Low |
| Choi and Ha (2011) | USA | N=2924 57–85 years old | Cross-sectional | Support (perceived emotional) | The Center for Epidemiologic Studies-Depression scale (CES-D) | Moderate |
| Litwin (2010) | Europe | N=9054 60 years old and above | Cross-sectional | Network (contact frequency, size, structure) and social engagement | The EURO-D depression Scale | Moderate |
| Litwin (2012) | USA | N=1349 65 years old and above | Cross-sectional | Network (contact frequency; size) and network type | The Center for Epidemiologic Studies-Depression scale (CES-D) | Moderate |
| Mair et al. (2010) | USA | N=3105 All adults (18+ years) | Cross-sectional | Combined network (ties) and support (perceived emotional and reciprocal emotional and instrumental) | The Center for Epidemiologic Studies-Depression scale (CES-D) | Moderate |
| Millan-Calenti et al. (2013) | Spain | N=579 65 years old and above | Cross-sectional | Combined network (contact frequency) and support (perceived emotional and instrumental) | The Geriatric Depression Scale (GDS) short form | Moderate |
| Tsai et al. (2005) | Taiwan | N=1200 65 years old and above | Cross-sectional | Combined network (size) and support (perceived emotional) | The Geriatric Depression Scale (GDS) short form | Moderate |
| Fiori et al. (2006) | USA | N=1669 60 years old and above | Cross-sectional | Support (perceived emotional) and negative interactions. Network types | The Center for Epidemiologic Studies-Depression scale (CES-D) short form | Moderate |
| Litwin (2011) | USA | N=1350 65–85 years old | Cross-sectional | Combined network (social ties) and support (perceived emotional). Negative interactions and network types | The Center for Epidemiologic Studies-Depression scale (CES-D) | Moderate |
| Sicotte et al. (2008) | Cuba | N=1905 60 years old and above | Cross-sectional | Combined network (social ties) and support (perceived and received; network type emotional and instrumental) | The Geriatric Depression Scale (GDS) | Moderate |
| Wilby (2011) | USA | N=91 65 years old and above | Cross-sectional | Combined network (social ties; contact frequency) and support (received emotional) | The Center for Epidemiologic Studies-Depression scale (CES-D) | Low |
| Tiedt (2010) | Japan | N=3807 65 years old and above | Cross-sectional | Combined network (size; contact frequency) and support (perceived and received emotional and instrumental) | The Center for Epidemiologic Studies-Depression scale (CES-D) | Moderate |
| Chan et al. (2011) | Singapore | N=4489 60 years old and above | Cross-sectional | Combined network (size; contact frequency) and support (perceived emotional) | The Center for Epidemiologic Studies-Depression scale (CES-D) | Moderate |
| Chen et al. (2005) | China | N=1600 60 years old and above | Cross-sectional | Combined network (contact frequency) and support (perceived emotional) | The Geriatric Mental State (GMS) and the Automated Geriatric Examination for Computer Assisted Taxonomy (AGECAT) | Low |
| Alexandrino-Silva et al. (2011) | Brazil | N=367 60 years old and above | Cross-sectional | Support (perceived emotional) | The Composite International Diagnostic Interview version 1.1 (CIDI 1.1) | Moderate |
| Ford et al. (2011) | UK | N=9377 45 years old | Cross-sectional | Combined network (size; social ties; contact frequency) and support (perceived and received emotional and instrumental). Negative interactions | The abbreviated revised Clinical Interview Schedule (CIS-R) | Low |
| Leung et al. (2007) | China | N=507 65 years old and above | Cross-sectional | Support (perceived instrumental and emotional) | The Symptom Checklist-90 revised (SCL-90-R) | Moderate |

Table 3 (continued)

| Reference | Location of study | Number of participants and age group | Design and study length | Social relationships measure | Depression outcome measure | Methodological quality |
|---------------------------|-------------------|--------------------------------------|-------------------------|--|---|------------------------|
| Chazelle et al. (2011) | Ireland | N=9978 All adults (18+ years) | Cross-sectional | Combined network (composition) and support (perceived emotional) | The short form of the Composite International Diagnostic Interview (CIDI-SF) | Moderate |
| Virtanen et al. (2008) | Finland | N=3374 30–64 years old | Cross-sectional | Support (perceived emotional) | The WHO Composite International Diagnostic Interview (M-CIDI) for depressive disorder | Low |
| Waldenstrom et al. (2008) | Sweden | N=672 20–64 years old | Cross-sectional | Support (perceived instrumental) | DSM-IV depressive syndromes assessed via SCAN interviews | Moderate |
| Russell and Taylor (2009) | USA | N=947 All adults (18+ years) | Cross-sectional | Support (perceived emotional) | The Center for Epidemiologic Studies-Depression scale (CES-D) | Moderate |

Methodological quality was rated in terms of six components: (1) selection bias; (2) study design; (3) confounders; (4) blinding; (5) data-collection method; (6) withdrawals and drop-outs. Each component was rated as weak, moderate or strong, and a final rating was made of each study. A study was rated as 'low quality' if it had received two or more weak ratings; 'moderate quality' if it had received one weak rating, and 'high quality' if it had not received any weak ratings. Any discrepancies in terms of rating were resolved between the two reviewers.

support was a predictor of depression [prospective high (Bisschop et al., 2004)], while the remaining studies (3/12=25%) did not reach statistical significance [33.3% (1/3) cross-sectional low (Ford et al., 2011); 33.3% (1/3) prospective moderate (Smith and Bielecky, 2012), 33.3% (1/3) prospective high (Taylor and Lynch, 2004)].

Low levels of perceived instrumental support also emerged as an important predictor of depression in eleven out of twelve studies (11/12=91.6%) [27.3% (3/11) cross-sectional low (Harvey et al., 2010; Ostberg and Lennartsson, 2007; Virtanen et al., 2008); 45.4% (5/11) cross-sectional moderate (Fiori and Denckla, 2012; Grav et al., 2012; Leung et al., 2007; Li and Liang, 2007; Scotte et al., 2008); 9.1% (1/11) prospective low (Tiikkainen and Heikkinen, 2005); 9.1% (1/11) prospective moderate (Koizumi et al., 2005); 9.1% (1/11) prospective high (Huang et al., 2011)], while only one study (1/12=8.4%) examining perceived instrumental support did not find it to be a significant correlate [cross-sectional moderate (Millan-Calenti et al., 2013)]. Three studies included both perceived and received support, and all of these found that perceived support was a more important predictor of depression than received support, which was found to have either a less strong or non-significant association [33.3% (1/3) cross-sectional moderate (Fiori and Denckla, 2012), 66.7% (2/3) prospective high (Taylor and Lynch, 2004; Yang, 2006)].

Findings were more mixed for received instrumental support. Only two out of ten studies (2/10=20%) reported protective effects of instrumental support receipt [50% (1/2) cross-sectional moderate (Waldenstrom et al., 2008); 50% (1/2) prospective high (Muramatsu et al., 2010)]. Three studies (3/10=30%) found receipt of instrumental support to be a significant risk factor for depression [33.3% (1/3) cross-sectional low (Ford et al., 2011); 33.3% (1/3) cross-sectional moderate (Tiedt, 2010); 33.3% (1/3) prospective high (Bisschop et al., 2004)], while four studies (4/10=40%) did not reach significance [50% (2/4) cross-sectional moderate (Fiori and Denckla, 2012; Tsai et al., 2005); 50% (2/4) prospective high (Taylor and Lynch, 2004; Yang, 2006)]. The remaining study [prospective high (Garcia-Pena et al., 2013)] reported that low levels of both received emotional and instrumental support predicted deterioration of depressive symptoms for people with depression at baseline, but neither was a significant predictor of depressive symptoms for people without depression at baseline.

Eight studies utilized variables on both emotional and instrumental support. Five of those (5/8=62.5%) found emotional support to be more strongly related to depression than instrumental support [60% (3/5) cross-sectional moderate (Fiori et al., 2006; Leung et al., 2007;

Millan-Calenti et al., 2013), 40% (2/5) prospective high (Chao, 2011; Yang, 2006)], while the remaining three studies (3/8=37.5%) concluded the opposite [66.6% (2/3) cross-sectional low (Ford et al., 2011, Ostberg and Lennartsson, 2007); 33.3% (1/3) prospective moderate (Koizumi et al., 2005)].

In terms of the source of social support, five studies out of seven studies (5/7=71.4%) concluded that social support from friends was equally important in terms of predicting depression as family support [20% (1/5) cross-sectional low (Zhang and Li, 2011); 60% (3/5) cross-sectional moderate (Choi and Ha, 2011; Leggett et al., 2012; Russell and Taylor, 2009), 20% (1/5) prospective high (Muramatsu et al., 2010)], while two studies (2/7=28.6%) reported that only family support exerted a significant influence on depression [50% (1/2) prospective moderate (Pettit et al., 2011), 50% (1/2) prospective high (Teo et al., 2013)].

In terms of studies focusing on the role of support in work-settings, four studies provided evidence that emotional and instrumental support in the workplace was protective against depression [25% (1/4) cross-sectional moderate (Waldenstrom et al., 2008); 75% (3/4) prospective moderate (Plaisier et al., 2007; Rugulies et al., 2006; Stoetzer et al., 2009)]. Stoetzer et al. (2009) [prospective moderate] found that work-related social support had a protective effect, however, when stratified by gender, this relationship was only found to be protective for men. Rugulies et al. (2006) [prospective moderate] reported that low levels of support from workplace supervisors significantly predicted depression, but only for women. Low coworker support was not found to be significant for either gender. One study did not find evidence that work-related social support predicted depression (Smith and Bielecky, 2012) [prospective moderate]. Two of the studies reported that negative working conditions were strong predictors of depression, and that social support was not effective enough to buffer against the effect of this association [100% (2/2) prospective moderate (Plaisier et al., 2007; Smith and Bielecky, 2012)].

3.2. Social networks

Nine studies (9/13=69.2%) reported that a larger social network was an important protective factor against depression [11.1% (1/9) cross-sectional low (Ford et al., 2011); 33.3% (3/9) cross-sectional moderate (Chan et al., 2011; Scotte et al., 2008; Tsai et al., 2005); 55.5% (5/9) prospective high (Chao, 2011; Garcia-Pena et al., 2013; Kuchibhatla et al., 2012; Rosenquist et al., 2011; Sonnenberg et al., 2013)] while the remaining four studies (4/13=30.8%) did not find a significant association between social network size and depression [25% (1/4) cross-sectional low (Wilby, 2011); 25% (1/4) cross-sectional

Table 4
Overview of the 23 prospective studies included in the review.

| Reference | Location of study | Number of participants and age group | Design and study length | Social relationships measure | Depression outcome measure | Methodological quality |
|---------------------------------|-------------------|--------------------------------------|---|--|---|------------------------|
| Garcia-Pena et al. (2013) | Mexico | N=7449 60 years old and above | Prospective; 3 time points over 3 years | Combined network (size) and support (received emotional and instrumental) | The Geriatric Depression Scale (GDS) | High |
| Huang et al. (2011) | Taiwan | N=1017 65 years old and above | Prospective; 4 time points over 10 years | Support (perceived instrumental and emotional) | The Center for Epidemiologic Studies-Depression scale (CES-D) | High |
| Koizumi et al. (2005) | Japan | N=1178 70 years old and above | Prospective; 2 time points over 1 year | Support (perceived instrumental and emotional) | The Geriatric Depression Scale (GDS) | Moderate |
| Pettit et al. (2011) | USA | N=816 21–30 years old | Prospective; 4 time points over 14 years | Support (perceived emotional) | The Center for Epidemiologic Studies-Depression scale (CES-D) | Moderate |
| Teo et al. (2013) | USA | N=4642 25–75 years old | Prospective; 2 time points over 10 years | Support (perceived emotional) and negative interactions | The short form of the Composite International Diagnostic Interview (CIDI-SF) | High |
| Kuchibhatla et al. (2012) | USA | N=4162 65 years old and above | Prospective; 4 time points over 10 years | Network (contact frequency; size) | The Center for Epidemiologic Studies-Depression scale (CES-D) | High |
| Rosenquist et al. (2011) | USA | N=12067 30 years old and above | Prospective; 3 time points over 18 years | Network (social ties) | The Center for Epidemiologic Studies-Depression scale (CES-D) | High |
| Tiikkainen and Heikkinen (2005) | Finland | N=133 80 years old | Prospective; 2 time points over 5 years | Social connectedness (perceived togetherness) | The Center for Epidemiologic Studies-Depression scale (CES-D) | Low |
| Chao et al. (2011) | Taiwan | N=4049 60 years and above | Prospective; 5 time points over 14 years | Combined network (social ties; composition; contact frequency) and support (received emotional and instrumental) | The Center for Epidemiologic Studies-Depression scale (CES-D) | High |
| Sonnenberg et al. (2013) | The Netherlands | N=2823 55–85 years and above | Prospective; 5 time points over 14 years | Combined network (size) and support (received emotional) | The Center for Epidemiologic Studies-Depression scale (CES-D) | High |
| Heponiemi et al. (2006) | Finland | N=3596 15–30 years old | Prospective; 2 time points over 5 years | Support (perceived emotional) | Beck's Depression Inventory (BDI-modified) | Low |
| Jokela et al. (2007) | Finland | N=341 All adults (18+ years) | Prospective; 2 time points over 4 years | Support (perceived emotional) | Beck's Depression Inventory (BDI-modified) | Moderate |
| Bierman and Statland (2010) | USA | N=1167 65 years and older | Prospective; 2 time points over 2 years | Support (perceived emotional) | Four items from the Hopkins Symptoms Checklist | Moderate |
| Bisschop et al. (2004) | The Netherlands | N=2288 55–85 years old | Prospective; 3 time points over 6 years | Combined network (size; contact frequency) and support (received instrumental and emotional) | The Center for Epidemiologic Studies-Depression scale (CES-D) | High |
| Fauth et al. (2012) | Sweden | N=779 70 years old and above | Prospective; 3 time points over 12 years | Support (perceived emotional) | The Center for Epidemiologic Studies-Depression scale (CES-D) | High |
| Taylor and Lynch (2004) | USA | N=3876 65 years and older | Prospective; 4 time points over 12 years | Support (perceived emotional; received emotional and instrumental) | The Center for Epidemiologic Studies-Depression scale (CES-D) | High |
| Yang (2006) | USA | N=1149 65 years old and above | Prospective; 2 time points over 6 years | Combined network (size; contact frequency) and support (perceived emotional; received instrumental) | The Center for Epidemiologic Studies-Depression scale (CES-D) | High |
| Muramatsu et al. (2010) | USA | N=6535 70 years old and above | Prospective; 5 time points over 10 years | Support (perceived and received instrumental) | The Center for Epidemiologic Studies-Depression scale (CES-D) short form | High |
| Plaisier et al. (2007) | The Netherlands | N=7076 18–64 years old | Prospective; 3 time points over 4 years | Support (perceived emotional) | The CIDI interview | Moderate |
| Rugulies et al. (2006) | Denmark | N=4470 All adults (18+ years) | Prospective; 2 time points over 5 years | Support (perceived emotional and instrumental) | The five-item Mental Health Inventory (MHI-5) of the Short-Form Health Survey | Moderate |
| Smith and Bielecky (2012) | Canada | N=3753 15–74 years old | Prospective; 3 time points over 5 years | Support (perceived emotional and instrumental) | The short form of the Composite International Diagnostic Interview (CIDI-SF) | Moderate |
| Stoetzer et al. (2009) | Sweden | N=4040 20–64 years old | Prospective; 2 times points over 3 years | Support (perceived emotional) | The Major Depression Inventory (MDI) | Moderate |
| Cacioppo et al. (2010) | USA | N=229 50–68 years old | Prospective; 5 time points over 5 years | Support (perceived emotional) | The Center for Epidemiologic Studies-Depression scale (CES-D) | Moderate |

Methodological quality was rated in terms of six components: (1) selection bias; (2) study design; (3) confounders; (4) blinding; (5) data-collection method; (6) withdrawals and drop-outs. Each component was rated as weak, moderate or strong, and a final rating was made of each study. A study was rated as 'low quality' if it had received two or more weak ratings; 'moderate quality' if it had received one weak rating, and 'high quality' if it had not received any weak ratings. Any discrepancies in terms of rating were resolved between the two reviewers.

moderate (Millan-Calenti et al., 2013); 50% (2/4) prospective high (Bisschop et al., 2004; Yang, 2006)]. The findings on the role of frequency of social contact on depression were less consistent. Two studies out of four (2/4=50%) reported that lower frequency of social contact predicted depression [50% (1/2) cross-sectional moderate (Chan et al., 2011); 50% (1/2) prospective high (Chao, 2011)], while two other studies (2/4=50%) did not find any significant associations between frequency of contact and depression [50% (1/2) cross-sectional moderate (Millan-Calenti et al., 2013), 50% (1/2) prospective high (Teo et al., 2013)].

In terms of studies utilizing more comprehensive measures of network properties, four studies analyzed the effect of the type of social network on depression, and these studies consistently found that diverse social networks were protective against depression as opposed to more restricted network types, i.e., networks including family, relatives, and several networks of friends had favorable effects on depression outcomes [100% (4/4) cross-sectional moderate (Fiori et al., 2006; Litwin, 2011, 2012; Sicotte et al., 2008)]. Chao (2011) [prospective high] concluded that a network consisting of 25–50% family and 50–75% friends was the most beneficial in terms of protecting against depression. Rosenquist et al. (2011) [prospective high] analyzed the distribution of depression across social ties over time and discovered that depression levels in one person were positively correlated with depression levels in friends and neighbors, and that these correlations remained significant up to three degrees of separation. In the events of financial strain, Sicotte et al. (2008) [cross-sectional moderate] reported that social networks served as a buffer against depression. Living with others and having a great diversity of social ties were important deterrents of depression under conditions of insufficient income.

In terms of living arrangements, two studies reported that multigenerational co-residence was a protective factor against depression, i.e. people who live with their relatives or children benefit from the social networks of their living arrangements [50% (1/2) cross-sectional moderate (Sicotte et al., 2008); 50% (1/2) prospective high (Chao, 2011)]. While maintaining relationships to one's family and relatives is important, Fiori et al. (2006) [cross-sectional moderate] concluded that having only a family network with few or no friends was more detrimental and posed a greater risk of depression than having a network with friends but no family.

3.3. Social connectedness

In relation to social connectedness, Tiikkainen and Heikkinen (2005) [prospective low] assessed the impact of perceived togetherness on the association between loneliness and depression over time and concluded that people who feel mutual proximity and security in their social environment suffer significantly less often from depression.

In terms of social isolation, three studies out of twelve (3/12=25%) did not find significant associations between living alone or without a partner and depression [33.3% (1/3) cross-sectional low (Wilby, 2011); 66.6% (2/3) prospective high (Garcia-Pena et al., 2013; Teo et al., 2013)]. However, nine studies (9/12=75%) reported that living alone or without a partner were significant predictors of depression [11.1% (1/9) cross-sectional low (Chen et al., 2005); 44.4% (4/9) cross-sectional moderate (Chan et al., 2011; Fiori et al., 2006; Russell and Taylor, 2009; Sicotte et al., 2008); 11.1% (1/9) prospective low (Tiikkainen and Heikkinen, 2005); 11.1% (1/9) prospective moderate (Cacioppo et al., 2010); 22.2% (2/9) prospective high (Bisschop et al., 2004; Sonnenberg et al., 2013)]. Four studies were consistent in reporting that living alone or without a partner was a greater risk factor of depression for men [75% (3/4) cross-sectional moderate (Chan et al., 2011; Fiori et al., 2006; Sicotte et al., 2008); 25% (1/4) prospective high (Sonnenberg et al., 2013)], while three studies

suggested that women were more at risk from the loss of close friends [100% (3/3) cross-sectional moderate (Alexandrino-Silva et al., 2011; Choi and Ha, 2011; Fiori et al., 2006)]. Zhang and Li (2011) [cross-sectional moderate] reported that widows either had or perceived themselves as having less emotional support from the family than the married elderly, and this lower level of support predicted higher levels of depression. Russell and Taylor (2009) [cross-sectional moderate] similarly concluded that people who live alone seem to benefit less from social support than people who live with a partner.

3.4. Other salient findings

As a result of sorting all included papers into overarching thematically or conceptually related categories, several distinct topics emerged on how various factors play a role in the association between social relationships and depression. These factors were gender (13 studies), intrapersonal characteristics (5 studies), and chronic physical illness and disability (8 studies).

3.5. Gender

In terms of associations by sex, eight studies out of 13 (8/13=61.5%) reported that lack of social support was a significant predictor of depression for women, while this was not the case for men [12.5% (1/8) cross-sectional low (Virtanen et al., 2008); 50% (4/8) cross-sectional moderate (Fiori and Denckla, 2012; Mair et al., 2010; Sicotte et al., 2008; Tiedt, 2010); 25% (2/8) prospective moderate (Koizumi et al., 2005; Rugulies et al., 2006); 12.5% (1/8) prospective high (Huang et al., 2011)]. Four studies (4/13=30.8%) discovered that this same pattern was significant for men, but not for women [50% (2/4) cross-sectional moderate (Alexandrino-Silva et al., 2011; Choi and Ha, 2011); 50% (2/4) prospective moderate (Plaisier et al., 2007; Stoetzer et al., 2009)]. One study (1/13=7.7%) reported that lack of emotional support was a significant predictor only in women, while lack of instrumental support was a significant predictor only in men [cross-sectional moderate (Grav et al., 2012)].

Only two studies included measures on support provision. Fiori and Denckla (2012) [cross-sectional moderate] reported that provision of emotional support was protective against depression for both men and women, while women especially seemed to benefit from having a network in need of emotional support. Sicotte et al. (2008) [cross-sectional moderate] concluded that women seem to benefit from reciprocity of social support, i.e. balanced exchanges of social support play a protective role against depression only for women.

3.6. Intrapersonal characteristics

Yang (2006) [prospective high] reported that a favorable effect of perceived support in the association between disabilities and depression could be explained by psychological mechanisms, in the sense that perceived emotional support bolstered an individual's sense of control. Two studies showed results that implied the opposite effect, but with instrumental support. In these studies, receipt of instrumental support exacerbated symptoms of depression, suggesting that such support may undermine feelings of control [50% (1/2) cross-sectional moderate (Tiedt, 2010); 50% (1/2) prospective high (Bisschop et al., 2004)]. Heponiemi et al. (2006) [prospective low] investigated the influence of perceived emotional support on progression to depression, while taking into account childhood anger and later hostility. They reported an overall protective effect of support - an effect that was associated with decreases in depressive symptoms over time. Although hostility itself was a risk factor for depression, its presence often caused interpersonal conflicts, and this in turn, effectively reduced an individual's opportunities for receiving support. Sonnenberg et al. (2013) [prospective high] investigated the influence

of individuals' need for social affiliation – the need to actively seek out support from social connections – in the relation between received emotional support and late-life depression. Across both genders, a high need for social affiliation seemed to worsen outcomes under low levels of emotional support.

Finally, [Jokela et al. \(2007\)](#) [prospective moderate] assessed the influence of a particular genetic factor on the association between perceived social support and depression. Over a four year period, low social support predicted an increase in depressive symptoms only in individuals carrying both dominant alleles of the Tryptophan hydroxylase 1 gene, implying a greater risk for individuals with this particular genetic feature under conditions of low social support.

3.7. Chronic physical illness and disability

Eight studies reported that perceived social support played a significant protective role in the association between disability or chronic illness and depression [12.5% (1/8) cross-sectional moderate ([Leung et al., 2007](#)), 12.5% (1/8) prospective moderate ([Bierman and Statland, 2010](#)), 75% (6/8) prospective high ([Chao, 2011](#); [Fauth et al., 2012](#); [Huang et al., 2011](#); [Muramatsu et al., 2010](#); [Taylor and Lynch, 2004](#); [Yang, 2006](#))]. In a similar fashion, [Huang et al. \(2011\)](#) [prospective high], [Yang \(2006\)](#) [prospective high] and [Bierman and Statland \(2010\)](#) [prospective moderate] found that adults with high levels of perceived social support experienced less distress from disability and limitations in activities of daily living. [Leung et al. \(2007\)](#) [cross-sectional moderate] also reported a similar protective effect of perceived emotional support in the association between chronic illnesses and depression. [Fauth et al. \(2012\)](#) [prospective high] found that greater levels of perceived social support predicted fewer depressive symptoms at disability onset, and a more pronounced decline in depressive symptoms at later time points, thus implying a protective effect. Both [Taylor and Lynch \(2004\)](#) [prospective high] and [Muramatsu et al. \(2010\)](#) [prospective high] reported that changes in trajectories of perceived emotional support over time mediated the relationships between worsening disability and depressive symptoms, and can act as a buffer against the detrimental effects of disability on depression. Finally, [Chao \(2011\)](#) [prospective high] concluded that provision of instrumental support was protective when it was received on a short-term basis, which can be indicative of a less severe illness, while the opposite was the case when it was received on a long-term (permanent) basis, as can be expected with more severe illnesses.

4. Discussion

4.1. Social support

There was a general consensus that perceived support is more important than received support, and there was also overwhelming evidence that the perceived emotional variant consistently played a protective role against depression across general populations. A considerable amount of good quality studies demonstrated a causal direction from perceived social support to depression through prospective analyses. Also, there was some indication that negative interactions are important risk factors for depression. However, only few studies utilized measures relating to negative interactions.

The evidence was mixed for receipt of instrumental support, and it was difficult to pinpoint exactly how this influences depression. The evidence was conflicting across studies that were different in terms of both quality and design. Other reviews note that the effect of received social support on mental health is generally inconclusive ([Haber et al., 2007](#)), which seems to also be the case for received

instrumental support in this review. A number of the included studies suggested that receipt of instrumental support has negative implications for depression. Previous research has also noted associations between receipt of instrumental support and adverse mental health outcomes ([Deelstra et al., 2003](#); [Kawachi and Berkman, 2001](#); [Nurullah, 2012](#)).

Across included studies, there was some evidence that work-related social support was an important determinant of depression, but the evidence was limited and sometimes conflicting. Similarly, several studies found more important determinants relating to negative working conditions. Previous research reports that the effect of work-related social support seems to be sensitive to other factors, and that several psychosocial work characteristics must be taken into account to predict physical health ([Hoogendoorn et al. 2000](#); [Michie and Williams, 2003](#)).

4.2. Social networks

The protective effect of larger social networks against depression has been confirmed in the literature ([Smith and Christakis, 2008](#)). In this review, over half of the studies arriving at this same conclusion were of the highest quality and had a prospective design. Notably, the diverse types of social networks were consistently found to be associated with favorable depression outcomes. It seems that having close family relationships combined with a number of different peer networks from different contexts is particularly beneficial. Finally, depression can spread through social networks. The contagious properties of depression have been corroborated by other independent studies and meta-analyses ([Haefel and Hames, 2014](#); [Joiner and Katz, 1999](#)). Although this may seem disconcerting, [Smith and Christakis \(2008\)](#) note that positive and beneficial emotional states, such as happiness and optimism, also seem to spread through social networks.

4.3. Social connectedness

Summarizing the limited evidence for social connectedness, it seems that people in a social environment with relationships in which they feel mutual proximity and belongingness are less likely to be at risk of depression. [Ashida and Heaney \(2008\)](#) found that social connectedness may be more important for the health status of older adults, possibly because higher levels of feeling socially connected offer more proximity to social networks, and greater likelihood of feeling comfortable while relying on networks for support. Thus, social connectedness may play a protective role against depression by mediating the positive effects of social relationships on mental health ([Williams and Galliher, 2006](#)). Previous reviews and independent studies have confirmed the protective effect of social connectedness against various mental health outcomes ([Townsend and McWhirter, 2005](#); [Lee et al., 2001](#); [Lee and Robbins, 1998](#); [Resnick et al., 1997](#)). However, this review highlights the current situation of social connectedness being underutilized in studies assessing social determinants of depression.

There was good evidence in terms of both prospective designs and quality to support that social isolation is particularly detrimental in terms of predicting depression. Multi-generational living arrangements was a general protective factor against depression. This finding may be considered in the light of research demonstrating that transitions to institutional settings predict depressive symptoms ([Pot et al., 2005](#)). There may be several reasons for this, but it could be attributed to feelings of proximity and social inclusion. Living alone or without a partner were generally found to be strong predictors of depression, and bereavement in particular played an important role. The importance of psychological factors of social isolation and bereavement in the association with depression in community-dwelling elderly has been emphasized in previous reviews ([Cole and Dendukuri, 2003](#); [Kawachi and Berkman, 2001](#)).

Reviews have confirmed that bereavement can be more damaging to the physical and mental health of men, while women are strongly affected by the loss of close friends (Smith and Christakis, 2008; Kawachi and Berkman, 2001). This may be explained by the consistent finding that men tend to rely on spouses for support, while women seem to rely more on friends as confidants (Glynn et al., 1999; Reevy, 2007; Schultz and Schwarzer, 2004; van Daalen et al., 2005).

4.4. Gender

The literature supports significant associations between social support and depression particularly and sometimes exclusively for women (Kawachi and Berkman, 2001), and also that reciprocity of support seems to be an important protective factor for women (Belle, 1987).

4.5. Intrapersonal characteristics

A variety of psychological characteristics play important roles in the relationship between social support and depression. In terms of feelings of control, previous research confirms that different types of social support may either promote self-efficacy or have detrimental effects on self-esteem by reinforcing dependence (Kawachi and Berkman, 2001). Only three studies in this review included measures of feelings of control. More research is warranted to explore sense of control and self-efficacy as a possible mechanism in the link between social relationships and outcomes on mental disorders. A high need for social affiliation also seems to be important, especially under conditions of low levels of social support. Similar conclusions have been drawn in studies utilizing the variables of social neediness in relation to depression (Rude and Burham, 1995). Another intrapersonal characteristic, hostility, was a risk factor for depression, which often resulted in interpersonal conflicts and reduced opportunities for receiving support. Thus, psychological factors and levels of social support seem to have a reciprocal effect on each other in these instances, which ultimately have important consequences for depression outcomes. A moderating role of psychological characteristics on physical health outcomes has been noted in a previous review and may be equally relevant for mental health (Uchino, 2006). Uchino further provides evidence for the influence of social support on the relationship between various biological characteristics and disease. In this review, we identified one particular genetic composition which seems to have a role to play in the support-depression relationship.

4.6. Chronic physical illness and disability

Perceived social support seems to offer a sense of security and reliance on social networks for people that are physically disadvantaged or people that are experiencing disease. This was a robust finding across a range of different included studies, with three quarters being prospective high quality studies. Previous research has found similar favorable associations between perceived social support and outcomes relating to depression, levels of functional impairment, and ability to cope with physical disabilities (Evers et al., 1998; Greenglass et al., 2006; Holahan et al., 1997, 1995, 1996).

The included studies were less informative in terms of the influence of received support, particularly instrumental support. The reason for this may be that long-term received instrumental support is often referred to under the term 'informal care', which was beyond the scope of this review. However, it should be noted that an abundance of studies demonstrate that long-term instrumental support for various reasons is associated with adverse mental health outcomes (Blazer, 2003; Kwak et al., 2014; Martire et al., 2002; Newsom and Schultz, 1998; Roe et al., 2001; Beach

et al., 2005; Christie et al., 2009; Jang et al., 2002; Krause and Rook, 2003; Wallsten et al., 1999; Wolff and Agree, 2004).

4.7. Limitations

A number of limitations should be born in mind when interpreting the results. First, reporting bias may exist for perceived social support. For example, lack of perceived support may appear to be a risk factor for depression, but this may be due to the tendency of individuals with depression to form rather cynical and pessimistic perceptions of the reality of their social surroundings, and this may not necessarily mean that support is actually lacking. This could explain the discrepancies observed for the associations between perceived or received support and depression. In addition, reverse causality may exist between depression and social relationships, where people with depression may be less likely to engage in social activities or seek social support. This is a limitation of particular importance for cross-sectional studies, as prospective studies are less likely to be affected by this type of bias. Further, due to the large number of studies available in the domain of interest, only studies from peer-reviewed journals were included. Publication bias and the fact that 'gray literature' (i.e. papers published in databases that are not controlled by academic publishers) were not included in our review may have limited our findings. One should also note that our emphasis on studies assessing the influence of social relationships in populations-based samples did not allow for the inclusion of qualitative studies. Although qualitative studies are less able to address how one variable influences another, they can be useful in terms of offering explanations of psychosocial phenomena that are often not accessible through quantitative research. Finally, given that this review included studies from a wide range of cultural and national contexts, cultural differences may exist and have implications for how findings should be interpreted. A growing body of literature has examined how social relationships vary across culture, such as social support seeking in individualistic as opposed to collectivistic cultures (Kim et al., 2008). However, the articles included in this review generally focused on the population in question, and we did not come across any studies drawing particularly insightful conclusions regarding culture differences. This is an area that should be further explored.

5. Conclusion

This review provides some confirmation that perceived social support and larger, diverse social networks, in particular, play important protective roles against depression in the general population, including those with chronic somatic illness or disability. However, some challenges persist and must be addressed. First, studies are needed to address how people's *perceptions* of social support and networks, as compared to objective measures, affect the association between social relationships and depression. Second, it was difficult to compare studies due to the utilization of different support and network variables that are distinct and not necessarily comparable even when pertaining to social support or social networks. Thus, the best comparisons were derived from studies that utilized several social support variables (e.g. perceived and received support) or social network variables (e.g. size and contact frequency). Studies on social support and social networks could benefit from more coherence in terms of incorporating several relevant measures, and research should aim to include a broad range of social relationships variables, rather than just one or two single measures. This would pave the way for a more robust research base for social support and social networks, and ultimately strengthen the comparability across studies. Third, measures on negative interactions (as opposed to emotional support) were largely underutilized, which made it difficult to make conc-

lusions about how supportive relationships and negative interactions may interact and impact on health. Thus, studies on social support are more informative when also including measures on negative interactions in social relationships. Forth, although the included studies on social support and social networks were vast and comprehensive, many of the studies did not include variables on both social networks and social support, and often when they did, they still did not include all the necessary and relevant variables. On the contrary, most studies focused either on social support or social networks, and were not able to evaluate how these two constructs relate to each other. The most informative studies were those that did not focus exclusively on social support or social networks, but those that considered these two in their analyses as being two distinct aspects of basically the same construct. As emphasized previously, social networks and social support have sometimes been referred to as 'network structure' and 'network function', respectively. This may be a particularly useful way to engage in research with these variables, as this approach seems to take both elements into account. There is a strong call for future research to determine how social networks and social support interact and ultimately affect risks for depression. Finally, social connectedness is underutilized as a social relationships measure in studies assessing depression outcomes in the general population. Future research has yet to assess the degree to which this variable constitutes a vital social determinant of depression in population-based samples.

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Conflict of interest

None of the authors have any interests to declare in relation to this submission.

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**Social network typologies and mortality risk among older people in
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Social network typologies and mortality risk among older people in China, India, and Latin America: A 10/66 Dementia Research Group population-based cohort study



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ABSTRACT

Background: Restricted social networks have been associated with higher mortality in several developed countries but there are no studies on this topic from developing countries. This gap exists despite potentially greater dependence on social networks for support and survival due to various barriers to health care and social protection schemes in this setting. Thus, this study aims to examine how social network type at baseline predicts all-cause mortality among older adults in six Latin American countries, China, and India.

Methods: Population-based surveys were conducted of all individuals aged 65+ years in eight countries (Cuba, Dominican Republic, Peru, Venezuela, Mexico, Puerto Rico, China, and India). Data on mortality were obtained at follow-up (mean 3.8 years after cohort inception). Follow-up data for 13,891 individuals were analysed. Social network types were assessed using Wenger's Practitioner Assessment of Network Type (PANT). Cox proportional hazard models were constructed to estimate the impact of social network type on mortality risk in each country, adjusting for socio-demographics, receipt of pension, disability, medical conditions, and depression. Meta-analysis was performed to obtain pooled estimates.

Results: The prevalence of private network type was 64.4% in urban China and 1.6% in rural China, while the prevalence of locally integrated type was 6.6% in urban China and 86.8% in rural China. The adjusted pooled estimates across (a) all countries and (b) Latin America showed that, compared to the locally integrated social network type, the locally self-contained [(b) HR = 1.24, 95%CI 1.01–1.51], family dependent [(a) HR = 1.13, 95%CI 1.01–1.26; (b) HR = 1.13, 95%CI 1.001–1.28], and private [(a) HR = 1.36, 95%CI 1.06–1.73; (b) HR = 1.45, 95%CI 1.20–1.75] social network types were significantly associated with higher mortality risk.

Conclusion: Survival time is significantly reduced in individuals embedded in restricted social networks (i.e. locally self-contained, family dependent, and private network types). Social care interventions may be enhanced by addressing the needs of those most at risk of neglect and deteriorating health. Health policy makers in developing countries may use this information to plan efficient use of limited resources by targeting those embedded in restricted social networks.

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1. Introduction

Worldwide, the number of people aged 65 years and above will outnumber children under age five by 2016, implying a radical increase in the proportion of old to young (WHO, 2011). Demographic ageing is associated with an increase in the burden of morbidity, disability, and dependency, which in turn will increase the demand on health care services and social costs. This increase in demand may be particularly significant in developing countries, where population ageing is occurring at a faster pace than in developed countries. For example, in 2010, the global population of people aged 60 years and above residing in developing countries was 65%, and this figure is projected to increase to 80% by 2050 (Kinsella and Wan, 2009). Many developing countries do not have the industrial and socio-economic resources to support the increasing health and social care demands associated with an ageing population, and are typically characterised by significant infrastructural barriers to accessing existing social protection schemes (WHO, 2011).

The lack of social protection for older people in developing countries is increasingly becoming recognised as a significant but yet under-prioritised problem in health and human development agendas (Cho et al., 2012; Prince et al., 2008; UN, 2002; UNAIDS, 2010). This is in spite of evidence showing the importance of various socioeconomic factors and vulnerabilities in predicting mortality among older people in developing countries (Ferri et al., 2012). Social networks can be a source of financial, practical and emotional support, and hence represent a key component to social protection. The importance of social networks for health and wellbeing has been extensively demonstrated in high-income countries. In a recent meta-analysis of 20 population-based cohort studies, social network integration, was inversely associated with mortality [HR = 0.91, 95%CI (0.86; 0.97)] (Nyqvist et al., 2014). Another meta-analysis also involving studies mainly in high-income countries found that the effect size for the association of poor social relationships with mortality was comparable to that for excessive drinking, and smoking, and greater than that for obesity, and lack of exercise (Holt-Lunstad et al., 2010). In the case of older people specifically, studies conducted in high-income countries have reported that maintaining social contacts in late life is associated with a reduced risk of psychological distress (Golden et al., 2009; Reich and Zautra, 1991), cognitive decline (Bassuk et al., 1999; Fratiglioni et al., 2000), functional decline (Stuck et al., 1999), disability (Avlund et al., 2004; Escobar-Bravo et al., 2012), institutionalization, and mortality (Steinbach, 1992). For the developing countries involved in the current study, being embedded in restricted social networks has been reported to be positively correlated with loneliness, depression, less happiness, poor health, disability, and need for care (Thiyagarajan et al., 2014). As yet, however, there are no studies specifically on social networks and its effect on mortality in developing country settings.

Using a large multi-country population-based sample, the aim of this study is to assess the association of social network type with all-cause mortality among older people living in India, China, and six Latin American countries. The countries participating in the 10/66 Dementia Research Group's population-based research program were not purposively selected, but rather represent those that chose to join the group in the late 1990s to conduct research into a topic of growing social and public health significance. These were all, at that time, or shortly to become, middle income countries, and are all undergoing particularly rapid population ageing and economic development, with attendant social change. Nevertheless, the countries and sites comprise considerable diversity in culture, sociodemographic and health characteristics. Correlations between social networks and health have been reported previously, at the baseline of these cohorts (Thiyagarajan et al., 2014). For these reasons, all countries with mortality outcomes recorded at follow-

up were retained for this analysis. Based on the literature discussed, we hypothesise that more restricted network types will be associated with higher mortality. Harnessing information about how restricted social network types predict increased mortality risk is particularly important in the economic context of low and middle income countries, where resources are limited and people are more likely to depend on their social networks for support and survival. Understanding the association between social network structures and mortality may be relevant in regards to allocating limited resources or establishing public health interventions to improve population health and well-being in developing countries.

2. Methods

2.1. Study design, settings and sample

The baseline for this cohort study is defined by the 10/66 population-based prevalence surveys conducted of residents aged 65 years and above in geographically defined catchment area sites in the subset of eight countries (Cuba, Dominican Republic, Peru, Venezuela, Mexico, Puerto Rico, China, and India) where follow-up assessments of vital status were subsequently carried out. All of these eight countries are still classified as middle-income countries, except for Puerto Rico, which changed its status to high-income between the two surveys.

Details of study methodology and protocols have been described elsewhere (Ferri et al., 2012; Prince et al., 2007). In brief, baseline assessments were carried out between 2003 and 2006 with the exception of Puerto Rico (2007–2009). The 10/66 study questionnaires were translated from the original English into Spanish, Tamil, and Mandarin. The study sites consisted of urban and rural areas. Urban sites which represented the typical predominately lower income or mixed neighbourhoods were purposively selected and consisted of the following sites: Cuba (Havana and Matanzas), Dominican Republic (Santo Domingo), Venezuela (Caracas), Peru (Lima), Mexico (Mexico City), Puerto Rico (Bayamon), China (Xicheng, Beijing) and India (Chennai). Rural sites referred to areas remote from major population centres with agriculture and related trade as the main local industry and included the following: Peru (Cañete Province), Mexico (Morelos State) and China (Daxing, Beijing Province).

The original target sample size for each country was between 2000 and 3000 (see Table 1). The boundaries of each catchment area were precisely defined, and households mapped. Each household was then systematically door-knocked to identify all household members aged 65 years and over who were eligible to participate in the survey. A full assessment (lasting 2–3 h) was conducted for all eligible individuals if they or their kin agreed to participate in the survey. The assessment comprised a background sociodemographic, health and risk factor interview, a structured clinical mental state assessment, and a physical examination. For those with marked communication difficulties arising from dementia, severe mental illness, deafness or mutism, the background interview, which included the social network assessment, was administered to a key informant (Prince et al., 2007).

Each centre had a coordinator who supervised the interviewers. There were between four and ten interviewers for each site, usually non-specialist graduates (apart from Cuba and China where medical doctors were used) extensively trained for the interviews and the main diagnostic assessment. Previous experience was also gained during the dementia diagnostic pilot study. Several meetings for the principal investigators were also conducted before the start of fieldwork, and at regular intervals of six months during the project. A standardised operating procedure manual covering all aspects of the interviews and procedures was also available to all interviewers, who were supervised during the fieldwork until the quality of the

Table 1
Baseline characteristics by country among older adults in eight developing countries.

| | Cuba | Dominican Republic | Peru | Venezuela | Mexico | Puerto Rico | China | India |
|---------------------------------------|--------|--------------------|------|-----------|--------|-------------|-------|-------|
| Baseline response rate (%) | 94.0 | 95.0 | 82.3 | 80.0 | 85.0 | 93.0 | 84.2 | 98.0 |
| Cohort at baseline | 2806 | 2009 | 1929 | 1931 | 2003 | 2002 | 2162 | 1004 |
| Vital status ascertained at follow-up | 2628 | 1704 | 1748 | 1667 | 1844 | 1562 | 1991 | 747 |
| Mean time of follow-up in years | 4.12 | 4.36 | 3.06 | 4.16 | 2.91 | 4.13 | 4.62 | 2.93 |
| Person years | 10,814 | 7437 | 5343 | 6942 | 5367 | 6447 | 9194 | 2206 |
| Deaths (%) | 605 | 23.0 | 467 | 27.4 | 152 | 8.7 | 186 | 11.2 |
| Age (years) | | | | | | | | |
| 65–74 | 1387 | 52.9 | 878 | 51.4 | 939 | 54.3 | 1147 | 67.8 |
| 75–84 | 942 | 35.9 | 596 | 34.9 | 594 | 34.2 | 438 | 25.9 |
| 85+ | 295 | 11.2 | 234 | 13.7 | 202 | 11.8 | 108 | 6.4 |
| Gender | | | | | | | | |
| Female | 1695 | 64.5 | 1134 | 66.5 | 1057 | 60.8 | 1073 | 63.3 |
| Male | 932 | 35.5 | 572 | 33.5 | 681 | 39.2 | 622 | 36.7 |
| Marital status | | | | | | | | |
| Not married | 1461 | 55.7 | 1182 | 69.7 | 734 | 42.4 | 826 | 49.9 |
| Married/cohabiting | 1162 | 44.3 | 514 | 30.3 | 996 | 57.6 | 831 | 50.2 |
| Education | | | | | | | | |
| None | 95 | 3.62 | 326 | 19.3 | 139 | 8.07 | 135 | 8.1 |
| Incomplete primary | 606 | 23.1 | 871 | 51.5 | 243 | 14.1 | 364 | 21.9 |
| Completed primary | 864 | 32.9 | 313 | 18.5 | 623 | 36.2 | 846 | 50.9 |
| Completed secondary | 635 | 24.2 | 114 | 6.8 | 453 | 26.3 | 233 | 14.0 |
| Completed tertiary | 423 | 16.1 | 66 | 3.9 | 265 | 15.4 | 83 | 5 |
| Assets [Mean (SD)] ^a | 5.6 | (1.0) | 5.0 | (1.4) | 5.7 | (1.1) | 6.2 | (1.0) |
| Any pension | | | | | | | | |
| No | 512 | 19.5 | 1172 | 68.6 | 628 | 36.1 | 699 | 41.2 |
| Yes | 2119 | 80.5 | 536 | 31.4 | 1110 | 63.9 | 996 | 58.8 |

Data are N and % unless otherwise stated.

^a Number of assets ranged from 0 to 7 and corresponded to the total number of assets owned.

interview was deemed satisfactory. Random checks were also carried out during the project. Data were collected onto paper and then extracted, cleaned and processed in SPSS (version 15.0; SPSS, Inc., USA), or directly onto laptops (in Cuba) using computerised questionnaires driven by EpiData (version 2.0; EpiData Software, Denmark). Data were finally checked a number of times (three to four) in London after completion of the interviews (Prince et al., 2007).

Vital status was assessed in the second, incidence wave of the 10/66 survey, in which we sought to trace and re-interview all participants three to four years after the original baseline survey (see Table 1 for mean follow-up time at each site). We first called on their residence at baseline, revisiting on up to four occasions. If the participant had moved away, we sought information regarding their vital status and/or current residence through non-co-resident friends or family members for whom information on names and addresses were recorded at baseline. Where a participant had died, we recorded the date of death in the course of a verbal autopsy interview with a suitable key informant.

Response and follow-up rates for all sites are presented in Table 1. In total, 15,901 older persons were interviewed at baseline, of whom 13,891 had vital status ascertained at follow-up. Ethical approval was obtained from local ethical committees and the King's College London Research Ethics Committee. A signed informed consent, or witnessed oral consent in case of illiteracy, or next of kin written agreement in case of incapacity, was obtained from all participants.

2.2. Baseline measures

2.2.1. Social network type

Various ways to measure social networks exist, such as size, density, or contact frequency (Smith and Christakis, 2008). However, a more informative assessment using social network typologies can help to identify separate categories of social network composition, thereby making it possible to capture distinct social environments that may be harmful or beneficial to health. In this study, we used the Practitioner Assessment of Network Type (PANT)

to identify five distinct social network types described by Wenger (1991, 1996, 1997); Wenger et al. (2007). The construct validity of Wenger's typology has been supported by the findings of an ecological study in New Zealand (Stephens et al., 2011), and more recently in the countries included in the 10/66 survey (Thiyagarajan et al., 2014). The algorithm used in this study to identify Wenger's (1989, 1991, 1996) five network types was based on the participants' responses to eight questions pertaining to the following:

- 1) Distance to nearest relative (not spouse). Possible responses were 0 (no relatives); 1 (within 1 mile); 2 (1–5 miles); 3 (6–15 miles); 4 (16–50 miles); 5 (50 + miles).
- 2) Distance to nearest child. Possible responses were 0 (no children); 1 (within 1 mile); 2 (1–5 miles); 3 (6–15 miles); 4 (16–50 miles); 5 (50 + miles).
- 3) Distance to nearest sibling. Possible responses were 0 (no sisters or brothers); 1 (within 1 mile); 2 (1–5 miles); 3 (6–15 miles); 4 (16–50 miles); 5 (50 + miles).
- 4) Contact frequency with children or other relatives. Possible responses were 0 (never/no children or relatives); 1 (daily); 2 (2–3 times per week); 3 (at least weekly); 4 (at least monthly); 5 (less often).
- 5) Contact frequency with friends in the community/neighbourhood. Possible responses were 0 (never/no friends); 1 (daily); 2 (2–3 times per week); 3 (at least weekly); 4 (at least monthly); 5 (less often).
- 6) Contact frequency with neighbours. Possible responses were 0 (no contact with neighbours); 1 (daily); 2 (2–3 times per week); 3 (at least weekly); 4 (at least monthly); 5 (less often).
- 7) Religious involvement. Possible responses were 0 (none); 1 (regularly); 2 (occasionally).
- 8) Involvement in community or social groups. Possible responses were 0 (none); 1 (regularly); 2 (occasionally).

The exact algorithm used to construct the variable has been described in detail in Wenger (1991). Wenger's network typology is

described as follows:

1. The locally integrated network type includes close involvement with local family members, friends, neighbours, and the community. This type of network is typically larger than other types and provides the optimal level of social support.
2. The locally self-contained network type involves a household-focused lifestyle with arm's-length relationships with kin, and little community activity, though the person may rely considerably on neighbours for support. Community involvement, if any, tends to be very low.
3. The wider community-focused network type refers to a lack of local family members, but involves extensive contact with friends and neighbours, and with relatives such as adult children who live some distance away. Participants with this type of network are generally involved in community voluntary organizations.
4. The family dependent network type is characterised by active involvement with close local family members, but few peripheral friends and little contact with neighbours. This network is often based on a shared household with adult children or siblings, or very near separate households.
5. The private network type can be described as an absence of local family and kin, few nearby local friends and low levels of community contact or involvement.

The analysis utilised social network type as a categorical variable, where the locally integrated type was contrasted to each other network type (1 = locally integrated, 2 = locally self-contained, 3 = wider community focused, 4 = family dependent, 5 = private).

2.2.2. Socio-demographic characteristics

Socio-demographic characteristics included age, sex, marital status, education, wealth (number of assets), and pension. Education was classified as none, incomplete primary, completed primary, completed secondary, and completed tertiary. A variable for household assets was generated by summing up the number of household assets owned (i.e. car, television, refrigerator, telephone, mains electricity, mains water, plumbed toilet). This ranged from 0 to 7. Receipt of any occupational or government pension was a dichotomous variable.

2.2.3. Physical health status, disability, dementia, and depression

Physical health status was assessed through self-report of a list of 11 commonly occurring physical impairments, and was grouped into none, one to two, and three or more. Disability was measured using the psychometrically validated 12-item World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0) (WHO, 2001). Higher scores (on a 0–100 scale) indicate greater disability. Dementia was assessed using the 10/66 Dementia Research Group criteria (Prince et al., 2003). Depression was assessed with the cross-culturally validated EURO-D scale, derived from the Geriatric Mental State examination (Castro-Costa et al., 2007; Guerra et al., 2015; Guerra et al., 2009; Prince et al., 1999). The total score ranges from 0 to 12, with a score of either four and above or five and above (depending on the country) representing the presence of probable depression. This has been identified the optimal cut-point for the EURO-D against the reference criterion of ICD-10 depressive episode specifically regarding the countries included in the 10/66 study (Guerra et al., 2015). Physical health, disability, dementia, and depression were considered as potential confounders as they may lead to higher mortality among older adults (Dewey and Saz, 2001; Fried et al., 1998; Schulz et al., 2000), and because they are also known to be related to social relationships (Avlund et al., 2004; Escobar-Bravo et al., 2012; Kuiper et al., 2015; Santini et al., 2015;

Uchino, 2006, 2009). We sought to control for these factors by entering them into the models as covariates. Alcohol consumption was also considered a potential confounder but was later omitted because it did not affect the estimates and did not improve the model fit.

2.3. Statistical analysis

All analyses were conducted using STATA 13.1. For each country, univariate and multivariate Cox proportional hazard models were constructed to estimate the mortality risk as a function of social network types. The start of the risk period was the time of the first survey. Participants were censored either at the date of death, or the date of follow up for those who were traced successfully. There were 1961 participants for whom vital status could not be determined at follow-up. Participants for whom vital status could not be determined at follow-up were not included in the survival analysis. The number (%) of those not traced at follow-up by social network type were: family dependent, 410 (11.6%); locally integrated 906 (10.5%); locally self-contained 215 (18.6%); wider community focused, 164 (19.0%), private 264 (16.3%). The models employed Wenger's 5-level social network type variable (i.e. each type contrasted to locally integrated type) as the main exposure variable of interest.

The multivariate analyses adjusted for age, gender, marital status, education, number of assets, receipt of pension, disability, number of physical impairments, and depression. All covariates were entered as categorical variables, apart from household assets and education, which were entered as categorical variables. Information on the covariates used for adjustment was obtained from the baseline survey. All regression analyses were based on the sample with no missing data. Only <2% of the data were missing for the covariates in the model. For all Cox proportional hazard models, the proportional hazards assumption was tested using the Schoenfeld residuals. A pooled estimate of the effects of network type on mortality was calculated by taking the estimates of each country and combining them into a fixed-effect meta-analysis. The analysis included one pooled analysis across all countries, and one pooled analysis of Latin American countries. The Cochrane Q heterogeneity and Higgin's I^2 were calculated to estimate the degree of heterogeneity. A heterogeneity level of less than 40% was considered to be negligible and 40–60% was considered to indicate moderate heterogeneity (Higgins and Thompson, 2002). Kaplan–Meier cumulative mortality curves were drawn to display the non-adjusted failure probability as a function of social network type using the pooled sample. Hazard ratios (HR) and their 95% confidence intervals (CIs) are reported.

3. Results

Table 1 presents the baseline characteristics of the sample in each country, and Fig. 1 shows the prevalence of the five different social network types across all sites. Participants were generally younger in Venezuela, China and India, while high proportions of the oldest age group were observed in Cuba, Dominican Republic, Peru, and Puerto Rico. Across all sites, urban China had the far lowest prevalence of locally integrated network type (6.6%), while rural China had the highest across all sites (86.8%). The prevalence of this network type was slightly less prevalent in Mexico and India as compared to the remaining sites. Overall, the locally integrated network type was generally the most prevalent and represented around 50% of network types across all sites apart from urban China. The prevalence of private network type was generally lower than the prevalence of other types, except in the case of urban China where this network type was about two thirds (64.4%).

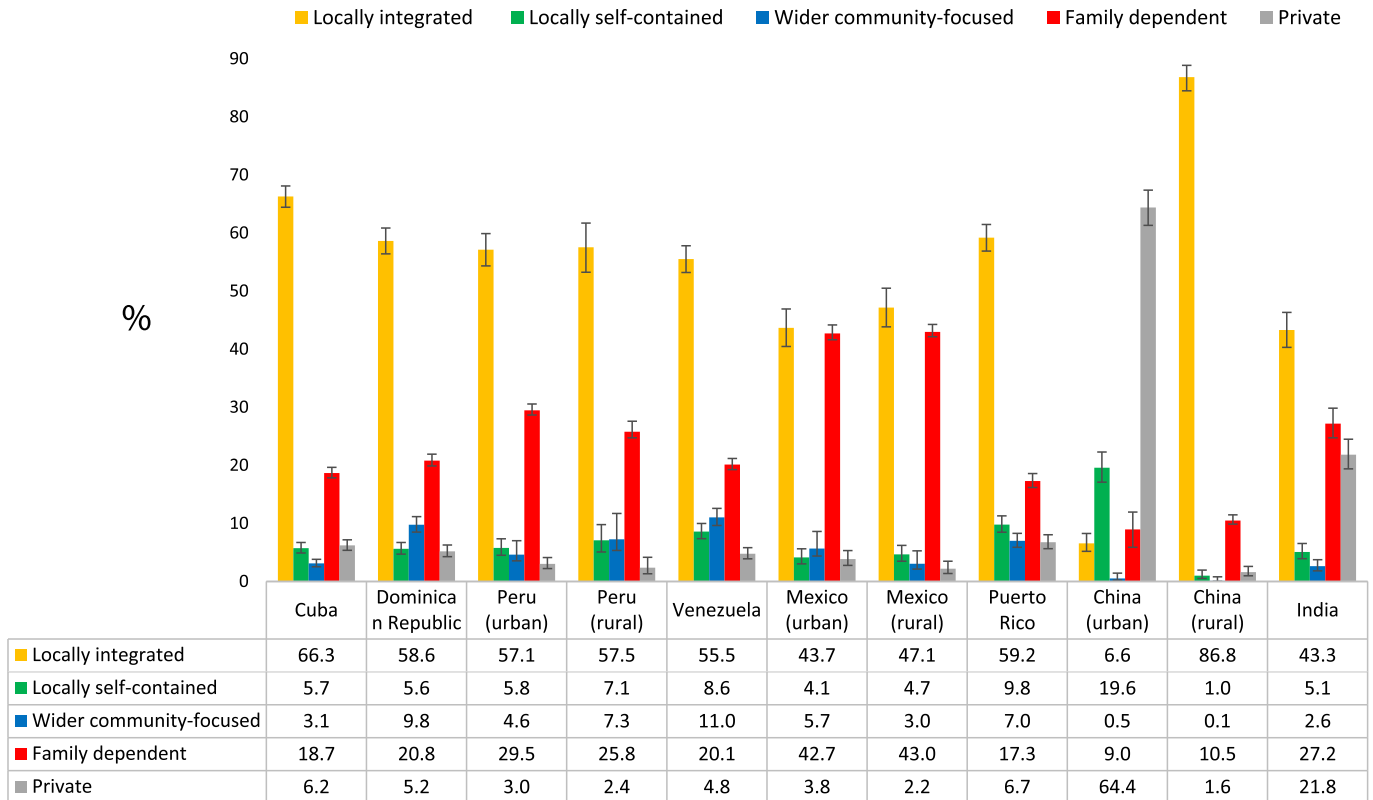


Fig. 1. Crude prevalence of social network type in eight developing countries. Bars denote 95% confidence intervals. The locally integrated support network includes close relationships with local family, friends and neighbours. The family dependent support network is focused on close family ties, few neighbours and peripheral friends. The locally self-contained support network typically has arms-length relationships or infrequent contact with at least one relative but the primary reliance is on neighbours. The wider community-focused support network is typified by an absence of nearby relatives but active relationships with distant relatives, usually children, and a high salience of friends. The private restricted support network is associated with an absence of local kin, few nearby friends and low levels of community contacts or involvement.

Locally self-contained type was lowest in rural China and highest in urban China. The wider community-focused network type was more prevalent in Latin American countries as compared to the Asian sites. The family dependent network type had the lowest prevalence in both Chinese sites, while the highest were observed in Mexico. Overall, the family dependent type was the second most common network type in almost all sites.

Overall, vital status was ascertained for 13,891 individuals (87.7% of the cohort at baseline). Deaths were recorded for 2584 participants (18.6% of those for whom vital status was ascertained) during the 53,750 person years of follow-up. Fig. 2 presents the crude Kaplan–Meier failure curve by baseline social network type. The family dependent and the private social network types had the highest probability of mortality. Table 2 presents the association between social network type and mortality. In terms of the country-wise adjusted analyses, the locally self-contained social network type was significantly associated with mortality in Venezuela (HR = 1.69, 95%CI 1.07–2.68), while the private social network type significantly predicted mortality in Cuba (HR = 1.56, 95%CI 1.18–2.07), Peru (HR = 2.91, 95%CI 1.21–6.97), and Mexico (HR = 2.08, 95%CI 1.10–3.93). In the adjusted analysis across all countries, family dependent, and private social network types were significantly associated with 1.13 (95%CI [1.01–1.26], $I^2 = 0.0\%$) and 1.36 (95%CI [1.06–1.73], $I^2 = 55.3\%$) times higher mortality risks respectively. In the adjusted pooled analysis for Latin America only, the corresponding figures for each network type were: locally self-contained (HR = 1.24, 95%CI 1.01–1.51, $I^2 = 15.4\%$), family dependent (HR = 1.13, 95%CI 1.001–1.28, $I^2 = 0.0\%$), and private (HR = 1.45, 95%CI 1.20–1.75, $I^2 = 44.5\%$). Because of the great difference in social networks between urban and rural China (Fig. 1),

we carried out a sensitivity analysis by re-running the Cox models across the two different centres. The direction of associations between social networks in urban China was different compared to

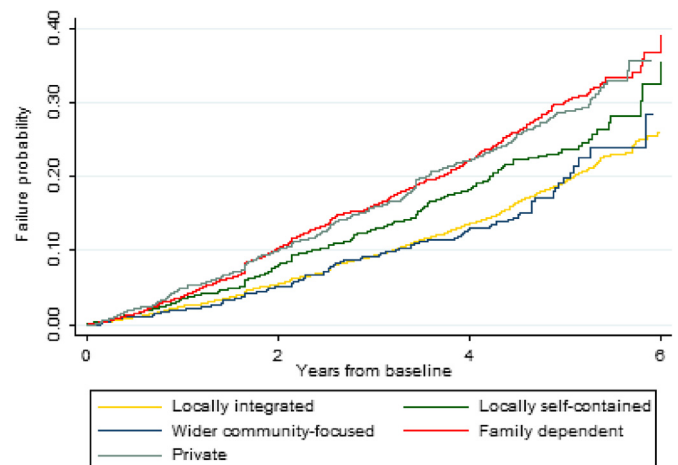


Fig. 2. Crude mortality risk by social network type across eight developing countries. The locally integrated support network includes close relationships with local family, friends and neighbours. The family dependent support network is focused on close family ties, few neighbours and peripheral friends. The locally self-contained support network typically has arms-length relationships or infrequent contact with at least one relative but the primary reliance is on neighbours. The wider community-focused support network is typified by an absence of nearby relatives but active relationships with distant relatives, usually children, and a high salience of friends. The private restricted support network is associated with an absence of local kin, few nearby friends and low levels of community contacts or involvement.

Table 2

Country-wise unadjusted and adjusted hazard ratios and pooled estimates of the effect of social network type (contrasted to the locally integrated type) on all-cause-mortality among older adults in eight developing countries.^a

| Country | Locally self-contained | | Wider community-focused | | Family dependent | | Private | | | | | |
|--|------------------------|-----------|-------------------------|-----------------|------------------|----------------|-------------|------------|----------------|-------------|-----------|----------------|
| | HR | 95%CI | HR | 95%CI | HR | 95%CI | HR | 95%CI | | | | |
| Unadjusted model | | | | | | | | | | | | |
| Cuba | 1.45 | 1.06–1.98 | 0.63 | 0.34–1.17 | 1.85 | 1.53–2.25 | 2.24 | 1.69–2.97 | | | | |
| Dominican Republic | 1.29 | 0.86–1.95 | 1.42 | 1.06–1.91 | 1.21 | 0.96–1.53 | 1.99 | 1.40–2.81 | | | | |
| Peru | 2.65 | 1.55–4.53 | 0.59 | 0.21–1.61 | 2.07 | 1.48–2.89 | 4.57 | 2.49–8.38 | | | | |
| Venezuela | 2.22 | 1.42–3.47 | 1.03 | 0.60–1.76 | 1.83 | 1.27–2.62 | 2.69 | 1.62–4.46 | | | | |
| Mexico | 1.57 | 0.80–3.07 | 1.30 | 0.62–2.72 | 1.85 | 1.37–2.48 | 3.05 | 1.61–5.80 | | | | |
| Puerto Rico | 1.70 | 1.13–2.56 | 1.19 | 0.75–1.89 | 2.51 | 1.90–3.30 | 2.43 | 1.63–3.64 | | | | |
| China | 0.78 | 0.55–1.11 | NA ^c | NA ^c | 1.76 | 1.37–2.27 | 0.93 | 0.75–1.15 | | | | |
| India | 0.98 | 0.42–2.26 | 0.85 | 0.27–2.67 | 1.79 | 1.25–2.56 | 1.49 | 0.98–2.27 | | | | |
| Pooled estimate (all countries) ^b | 1.42 | 1.22–1.65 | $I^2 = 68.2\%$ | 1.15 | 0.94–1.40 | $I^2 = 23.3\%$ | 1.79 | 1.62–1.96 | $I^2 = 60.0\%$ | 1.67 | 1.48–1.90 | $I^2 = 87.3\%$ |
| Pooled estimate (Latin-America only) | 1.67 | 1.40–1.99 | $I^2 = 26.1\%$ | 1.16 | 0.95–1.42 | $I^2 = 33.7\%$ | 1.79 | 1.61–1.99 | $I^2 = 71.4\%$ | 2.43 | 2.06–2.87 | $I^2 = 21.7\%$ |
| Adjusted model^d | | | | | | | | | | | | |
| Cuba | 1.12 | 0.82–1.52 | 0.68 | 0.36–1.26 | 1.00 | 0.79–1.26 | 1.56 | 1.18–2.07 | | | | |
| Dominican Republic | 0.87 | 0.57–1.30 | 1.30 | 0.96–1.75 | 1.06 | 0.82–1.36 | 1.04 | 0.68–1.60 | | | | |
| Peru | 1.44 | 0.79–2.64 | 0.63 | 0.23–1.71 | 1.23 | 0.84–1.81 | 2.91 | 1.21–6.97 | | | | |
| Venezuela | 1.69 | 1.07–2.68 | 0.67 | 0.37–1.21 | 1.24 | 0.84–1.85 | 1.82 | 0.99–3.32 | | | | |
| Mexico | 1.64 | 0.83–3.26 | 1.19 | 0.57–2.70 | 1.31 | 0.95–1.80 | 2.08 | 1.10–3.93 | | | | |
| Puerto Rico | 1.31 | 0.82–2.09 | 1.12 | 0.70–1.78 | 1.19 | 0.84–1.70 | 0.98 | 0.59–1.65 | | | | |
| China | 0.85 | 0.55–1.33 | NA ^c | NA ^c | 0.96 | 0.69–1.32 | 0.91 | 0.67–1.24 | | | | |
| India | 1.07 | 0.47–2.45 | 0.82 | 0.25–2.67 | 1.44 | 0.96–2.14 | 1.42 | 0.92–2.21 | | | | |
| Pooled estimate (all countries) ^b | 1.16 | 0.98–1.36 | $I^2 = 14.4\%$ | 1.03 | 0.85–1.26 | $I^2 = 21.4\%$ | 1.13 | 1.01–1.26 | $I^2 = 0.0\%$ | 1.36 | 1.06–1.73 | $I^2 = 55.3\%$ |
| Pooled estimate (Latin-America only) | 1.24 | 1.01–1.51 | $I^2 = 15.4\%$ | 1.04 | 0.85–1.28 | $I^2 = 33.2\%$ | 1.13 | 1.001–1.28 | $I^2 = 0.0\%$ | 1.45 | 1.20–1.75 | $I^2 = 44.5\%$ |

Results in bold are statistically significant ($p < 0.05$). Heterogeneity tests were performed with Higgin's I^2 .

^a Each network type is contrasted to the locally integrated type. The locally integrated support network includes close relationships with local family, friends and neighbours. The locally self-contained support network typically has arms-length relationships or infrequent contact with at least one relative but the primary reliance is on neighbours. The wider community-focused support network is typified by an absence of nearby relatives but active relationships with distant relatives, usually children, and a high salience of friends. The family dependent support network is focused on close family ties, few neighbours and peripheral friends. The private restricted support network is associated with an absence of local kin, few nearby friends and low levels of community contacts or involvement.

^b Pooled estimates were obtained by meta-analysis with fixed effects.

^c Estimates could not be obtained because there were no deaths in this category for China.

^d The multivariate analysis adjusted for age, gender, marital status, education, number of assets, receipt of pension, disability, number of physical impairments, depression, dementia.

the other centres, but this was not significant, and the meta-analyses pooled estimates remained unaffected. The Schoenfeld residuals confirmed that there were no appreciable violations in the proportional hazard assumption for any of the Cox proportional hazard models.

4. Discussion

In this study, we investigated the association of baseline social network type with all-cause mortality among older adults in urban and rural catchment areas in Latin America, China and India. Overall, our findings demonstrate that having a social network with few friends or community contacts is associated with higher mortality, as compared to those embedded in a more integrated social network. In the pooled analyses, the locally self-contained, family dependent, and private social network types were associated with significantly increased risk of mortality. After adjusting for socio-demographic variables and health status, the associations were considerably attenuated but those for family dependent and private networks remained statistically significant. When the analysis was restricted to Latin America, the effects were mostly stronger and less heterogeneous, given the generally null associations in China. Thus, lack of integration in one's social networks may be detrimental to health, particularly when the network is restricted to family, but not to friends and neighbours.

4.1. Strength and limitations

The strengths of this study include the use of a large,

population-based sample with over 50,000 person-years of follow-up. Further, to our knowledge, this is the first multi-country study using standardized questionnaires to assess the direct impact of social networks on mortality risk across a wide range of cultures in developing countries. However, some limitations deserve mentioning. First, our findings may not be generalized beyond the particular catchment areas sites where the study was carried out, and should not be taken to refer to the respective countries as a whole, or urban or rural settings in general within them. Second, social networks were assessed at baseline in late life, with no information regarding either exposures earlier in the life course, or subsequent changes in social networks. These may have been affected by the onset of disability or care dependence, which may have limited access to friends outside of the household, and increased dependence upon family. Moreover, we acknowledge a potential risk of overadjustment, since impaired health, disability, and needs for care are likely to be determinants of 'family dependent' network types, and may mediate the association between other restricted network types and mortality. There were some differences in the distributions of social network types at baseline between those who were and were not part of the second survey. Thus, some level of bias may have been introduced due to these differences. Furthermore, there were some potential confounders such as personality type (Bogg and Roberts, 2004; Weiss and Costa, 2005) that we could not adjust for due to lack of data. Next, area-level contextual variables such as social capital, or neighbourhood crime and violence (as indicators of social disintegration) may be important determinants of mortality risk independent of individual social network exposures (Wilkinson et al., 1998), but our

catchment area study design precluded the examination of these effects due to restricted area-level variance. Finally, the Wenger's social network construct and accompanying assessment tool, originally developed as having meaning, relevance and predictive validity for older people living in North Wales (Wenger, 1991), has not been formally validated in our study setting, although there is evidence at least to support its construct validity (Thiyagarajan et al., 2014). Other studies have highlighted some points of divergence between network typologies described in high income countries (Doubova Dubova et al., 2010).

4.2. Contextualization of findings

We did not find the wider-community focused network type to be associated with increased risk of mortality. This is consistent with a body of research that attests to the salience of friendships and community relationships, rather than family relations, to mental health and wellbeing (Adams and Blieszner, 1995; Chao, 2011), self-reported health (DuPertuis et al., 2001) and survival (Fiori et al., 2006). On the other hand, the family dependent network type carried significant risk. This seems to be in accordance with previous research, and additional factors may exacerbate the risk for this network type. Relationships in which family members are obliged to provide care for an older person can result in caregiver strain, poor relationship quality and patterns of caregiving behaviours that are directly harmful to the health and wellbeing of the older person receiving care (Beach et al., 2005; Christie et al., 2009; Krause and Rook, 2003).

Older people with a private social network type, characterised by having a very restricted network and being socially isolated, were at considerably high risk of mortality. To a lesser degree, this was also the case for the locally self-contained social network type characterised by a focus on household and immediate neighbours with little wider community engagement. Although people with the family dependent network type are at higher risk of mortality, it appears that having a family network is still better than having a very small network or no network at all (consistent with previous research; Fiori et al., 2008). One reason for this finding could be that family support still may serve to promote certain fundamental and preventive behaviours (better diet, health screening, physical activity, etc.). Other research has documented the negative impact of social isolation on morbidity and mortality (Cacioppo and Cacioppo, 2014; Cerhan and Wallace, 1997; Luo et al., 2012; Luo and Waite, 2014; Steptoe et al., 2013). Social isolation means that people will effectively be restricted in terms of fostering relationships with peers, participating in religious services, and being actively involved in the community. According to the broader social networks and social support literature, it is the lack of social integration that negatively influences health (Berkman and Syme, 1979; Krause et al., 1990).

As discussed previously, people in countries with less well-developed social welfare systems may be more reliant than those in high-income countries on informal social networks for social protection, and this may have implications for mortality. Comparing our results with those conducted in high income countries, we find that the risk of mortality associated with the most restricted network type (as compared to the most integrated type) is relatively stronger in our sample (HR = 1.45 for Latin America and HR = 1.36 across all countries) as compared to those results obtained among older adults in the USA (HR = 1.19) (Fiori et al., 2008), (HR = 1.20) (Keller et al., 2003) and among older adults in Israel (HR = 1.32) (Litwin and Shiovitz-Ezra, 2006) (for purposes of comparison, we reversed the hazard ratios reported in these papers because their focus was on protective effects rather than risk). The aforementioned studies did not use the exact same

social network typology and did not include as many covariates as our study, with some studies omitting important confounders such as level of disability or number of medical conditions. Therefore, it is possible that the differences observed may not be directly comparable. However, it does serve to at least indicate that social networks may be of particular importance to the health and longevity of older adults in settings where their social protection is not assured.

4.3. Mechanisms, and implications for policy and practices

Social networks have been linked to health and mortality in various ways, including physiological, behavioural, and psychological pathways (Smith and Christakis, 2008; Uchino, 2006, 2009). Physiological pathways may involve metabolic function (Yang et al., 2013) or cardiovascular, neuroendocrine, and immune function (Uchino, 2006). Behavioural pathways to mortality may include suicide (Tsai et al., 2014). Finally, psychological pathways to mortality may involve mental disorders such as depression, which is particularly relevant in the context of perceived social isolation or loneliness (Luo et al., 2012). In order to assess the influence of depression on the association between social networks and mortality, we compared the pooled estimates obtained from the model with and without depression but an appreciable change in the estimates for social networks was not observed, suggesting that depression may not be a significant mediator of this association at least in our study setting.

The relationship between social networks and mortality is probably best understood from a life course perspective, acknowledging that social networks both influence and are influenced by life transitions and changes in health status (Melchior et al., 2003). First, there is evidence that social networks increase in size in early life and then decrease over time as individuals focus selectively on a core of positive long-term relationships (English and Carstensen, 2014). There is likely to be some continuity over time in the ability and propensity of an individual to form and maintain positive relationships. Marriage (Kalmijn, 2003; Mildardo, 1987; Parks et al., 1983), reproduction (Bost et al., 2002) and retirement (van Tilburg, 1992, 2003) are key life course events with the potential transiently to impact upon social networks and relationships. For those that survive into older age, there is, naturally, a loss of some of these long-term core relationships through bereavement (Ha, 2008; Utz et al., 2002). Being embedded in more integrated and diverse network types thus appear to be beneficial for health in various ways such as through psychological and material resources, instrumental and informational support, and social identification with or belongingness to resourceful community groups or social class (Cohen, 2004; Smith and Christakis, 2008).

While there is evidence that social networks and relationships influence mortality across the life course, the critical period or periods for intervention have not been clearly established. Social isolation has been shown to be a predictor of mortality similar to that of well-documented clinical risk factors in terms of associated risk (Pantell et al., 2013). However, although most other factors are generally non-modifiable, this is not the case for social integration. It thus becomes all the more relevant to consider it as an important non-pharmacological approach for public health planning and gerontological interventions to promote the health and wellbeing of the elderly population. Further, the trend of a decline in the size of social networks as people age means that social network integration may be assessed before the transition into old adulthood. Hence, individuals embedded in restricted networks could be identified before serious consequences for health take place.

Many different forms of social networks interventions exist, and are typically designed to 1) enhance existing network linkages

(Heaney, 1991; Sandler et al., 1992; Wing and Jeffery, 1999), 2) develop new network linkages (Helgeson and Gottlieb, 2000), 3) enhance networks through the use of indigenous natural helpers and community health workers (Earp et al., 1997; Kegler and Malcoe, 2004; Krieger et al., 2005), or 4) enhance networks through community capacity building and problem solving (Boutilier et al., 2000; Minkler, 2001). For a detailed review, see Heaney and Israel (2008). In terms of preventing loneliness and promoting social integration among older adults, a literature review assessing social network interventions identified educational and social activity group interventions to be effective, whereas the effectiveness of home visiting and befriending schemes remained unclear (Cattan et al., 2005). In terms of possibilities for clinical practice interventions, Wenger's social network typology has been used as a practical tool in England and Wales as an integral part of gerontological social work practice, reflecting differing risk profiles for mental disorder and differing implications for health care utilization and transition to institutional care. This has also resulted in greater confidence among practitioners, increased understanding of the situations and needs of older people, and more appropriate tailoring of interventions (Wenger and Tucker, 2002).

Our results demonstrate that family dependent and private social network types were associated with mortality risk. The intervention required among older adults embedded in these types of networks would thus be to diversify the network member structure, particularly by incorporating friends and facilitating contact with neighbours and the community. Health and social care practitioners and community organisations can reinforce such networks by promoting social activity group interventions, or a broader community level programme designed specifically to facilitate social interaction. Another intervention perhaps relevant particularly to people embedded in the family dependent network type would be supporting the family caregivers to prevent possible stress or strain that could undermine the quality of the informal care provided and further potentially facilitate harmful caregiver behaviours (Cutrona and Cole, 2000). Enhancing and diversifying networks would not only add new social ties and interpersonal contact to the elderly client, but would also serve to provide respite for the family caregivers.

Future studies may make a more informative assessment of mortality risk by social network type if they also include measures of relationship quality (i.e. positive and negative interactions) (Schuster et al., 1990) or, in the case of informal care relationships, measures of potentially harmful caregiving behaviours (Williamson and Shaffer, 2001) and exemplary care (Dooley et al., 2007). Including such measures could provide more insight into the dynamics involved in the link between social network types and mortality. Finally, a thorough assessment of differences in the impact of social network types on mortality between developed and developing country settings is needed.

5. Conclusion

Our findings present evidence that more restricted networks are related to higher mortality. Specifically, the locally self-contained, the family dependent and the private social network types are associated with considerable risk among older adults in developing countries. Individuals embedded in such restricted social network types in a resource-limited context may suffer serious consequences. This study has demonstrated that Wenger's social network typology may be used as an effective tool to identify older adults who lack the social protection necessary to meet future needs of care. This could inform the development or enhancement of social care interventions in order to address the needs of those most at risk of neglect and deteriorating health. Health policy

makers may use this information to plan more efficient use of limited care resources to improve health outcomes by targeting those embedded in restricted social networks. Initiatives could include for example educational and social activity group interventions for such individuals, preferably applied before the transition into older adulthood. Geriatric practitioners may also benefit from addressing older adults' level of social network integration in their assessment of patients.

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The association of relationship quality and social networks with depression, anxiety, and suicidal ideation among older married adults: Findings from a cross-sectional analysis of the Irish Longitudinal Study on Ageing (TILDA)

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The association of relationship quality and social networks with depression, anxiety, and suicidal ideation among older married adults: Findings from a cross-sectional analysis of the Irish Longitudinal Study on Ageing (TILDA)



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ABSTRACT

Background: Important associations have been found between social relationships and various mental health outcomes. However, limited data exists for these associations among older adults especially in terms of relationship quality in partnerships. This study aimed to examine the associations of positive and negative partner interactions and social networks with depression, anxiety and suicidal ideation.

Methods: Nationally-representative, cross-sectional data of the Irish Longitudinal Study on Ageing (TILDA) was analyzed. The analytical sample consisted of 4988 community dwelling adults aged ≥ 50 years in spouse/partner relationships. Information on sociodemographics and social relationships were assessed using standard questions. Validated scales for depression and anxiety, and a single-item question for suicidal ideation were used to assess mental health outcomes. Multivariable logistic regression was used to assess the association between social relationships and depression, anxiety, and suicidal ideation.

Results: After adjusting for confounders, negative partner interactions were significantly associated with increased likelihood of depression, anxiety, and suicidal ideation, while positive partner interactions were significantly and inversely related to anxiety and suicidal ideation. Higher levels of social integration were significantly associated with lower odds for depression.

Limitations: Given the cross-sectional nature of the research, no firm conclusions can be made in terms of directions of causality.

Conclusion: By assessing the available social network of older adults, as well as the areas in their social relationships that need to be addressed, it may be possible for practitioners and policy makers to maximize the benefits of network integration and minimize the potentially harmful aspects of social relationships, thereby improving overall mental health and emotional well-being.

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1. Introduction

Europe is currently facing aging of the populations at an unprecedented speed, making efforts to prevent or treat mental disorders among people transitioning into old age a top priority (Rechel et al., 2009). Mental disorders in late-life is a major public health issue, with mood and anxiety disorders being some of the most common mental disorders among the elderly (Byers et al., 2010). Late-life depression is clearly different from depression occurring earlier in life due to its increased risk of suicide, impairment of physical, cognitive, and social functioning, and greater self-neglect which in turn may lead to

increased mortality (Fiske et al., 2009). Anxiety is even more common than depression among the elderly, and the course of anxiety disorders is generally less favorable than that of depressive disorders. Anxiety disorders are frequently comorbid with other medical and psychiatric conditions, and are associated with an increased risk of cognitive decline (Blay and Marinho, 2012). Furthermore, older adults have been identified as a high-risk group for death by suicide, with suicide completion rates being highest in persons aged 70 years or over in almost all regions of the world (Weaver and Koenig, 1996; WHO, 2014). Considering that the proportion of older adults in the population will increase considerably worldwide in the coming decades, the absolute number of deaths by suicide is expected to rise accordingly (Christensen et al., 2009; Lapiere et al., 2011).

In Ireland, the prevalence of major depressive disorder and generalized anxiety disorder among adults 45 years old and above

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have been reported to be 10% and 5% respectively (Barry et al., 2009). Ireland has seen a steady increase in death by suicide over the past half century, with a four-fold increase in suicide mortality in men from 6.4 to 25.3 per 100,000 population between 1980 and 2000 (Lucey et al., 2005). This rising trend in Ireland is in sharp contrast with decreasing male suicide rates in most other European Union countries (Chishti et al., 2003). Men in particular are at risk for suicide, comprising 83% of the total number of completed suicides in Ireland in 2011. Within age groups, male suicide rates were highest in the age group 45–65 years old, while women's were highest in the age group 25–44 years old (CSO, 2014). Furthermore, suicidality in Ireland has been strongly linked to the financial crisis and unemployment, and the current rapid increase in unemployment suggests that Irish rates of suicide will rise again as they did in previous recessions (Corcoran and Arensman, 2011; Thekiso et al., 2013). In 2012, the suicide rate was 12% higher than in 2007, the year before the latest economic recession (NOSP, 2012).

In terms of the factors that influence mental health, the importance of people's social relationships has increasingly become recognized in recent years (Smith and Christakis, 2008; Uchino, 2009). In particular, positive (supportive) interactions have been reported to be of considerable importance (Schuster et al., 1990). Positive interactions refer to the degree a person feels that his or her partner/child/friend/relative can be trusted, relied on, or is perceived to be supportive (Schuster et al., 1990). While measures of positive interactions (often referred to as emotional social support) have been well utilized in studies, a more informative assessment can also be made by incorporating negative interactions, which relates to the extent that a person feels criticized, let down, or demanded too much from (Schuster et al., 1990). Rook (1984, 1990) introduced the term "negativity effect" to explain findings where negative interactions exerted stronger effects than positive interactions on well-being outcomes.

While mental health status is generally influenced by the quality of many different social relationships, several studies have concluded that the quality of spousal/partner relationships are particularly important (Dehle et al., 2001; Okabayashi et al., 2004; Okun and Lockwood, 2003; Pettit et al., 2011; Teo et al., 2013). Spousal relationship quality among older adults has been found to be an important determinant of both physical health as well as mental disorders, with negative social interactions and harmful behaviors being associated with depression and poorer health and wellbeing, whereas supportive interactions have been found to predict higher life-satisfaction and exert a protective effect against depression (Antonucci et al., 2001; Bookwala, 2005; Haley et al., 2003; Williamson and Shaffer, 2001).

Being integrated in social networks also has implications for health and wellbeing. Social networks are the structural components of a person's social relationships, such as the amount and type of social relations, frequency of contact, and social participation (Smith and Christakis, 2008). Studies assessing the social determinants of mental disorders particularly among older adults have consistently found that greater levels of social integration are protective against various outcomes on mental disorders. (Chan et al., 2011; Chao, 2011; Fiori et al., 2006; Garcia-Pena et al., 2013; Kuchibhatla et al., 2012; Sciotte et al., 2008; Tsai et al., 2005).

The aim of the study was to assess the association between social relationships and mental health among the older population. Research has established that poor social relationships and social isolation can pose a greater risk for mortality than excessive drinking and smoking, obesity, and lack of exercise (Holt-Lunstad et al., 2010). However, the literature is scarce in terms of studies examining the role of social networks and both positive and negative aspects of relationship quality specifically in regards to outcomes on depression, anxiety, and suicidal ideation in the older population. Further, the bulk of published studies on relationship quality and social networks have restricted their analyses to either of these constructs, rather than including both. This

study included both of these constructs in order to make a more comprehensive assessment of their roles. In addition, given that the vast majority of the literature on social support includes only positive interactions or supportive behaviors, this study took into account the role of both positive and negative aspects of relationship quality. Interventions targeted at intimate or family relationships have been suggested to be a particularly efficient approach for improving health and well-being among the elderly, as opposed to interventions that aim to address individuals wholly detached from a social context, which may be vague in scope. (IOM, 2001; Priebe et al., 2013). It is thus relevant to investigate the role of relationship quality in spousal/partner relationships, in order to inform effective intervention strategies that could benefit a broader social context than individuals seen in isolation from close social ties.

Using a large-scale, Irish nationally representative sample, we examined the associations between positive and negative interactions with spouse/partner (from here on 'partner interactions') and social networks in relation to anxiety, depression and suicidal ideation among older population over 50 years old living with a partner/spouse.

2. Methods

2.1. Study design and sample

Data for this study came from the first wave of the Irish Longitudinal Study on Ageing (TILDA) conducted between 2009 and 2010 by Trinity College in Dublin (Accessed via the Irish Social Science Data Archive – www.ucd.ie/issda). TILDA is an Irish nationally-representative, longitudinal study of the economic, health, and social status of 8175 people aged 50 years and above, along with an additional 329 spouses or partners younger than 50 years. The baseline survey excluded participants who reported a doctor's diagnosis of dementia. All participants were required to provide written informed consent, and those not able to consent personally because of severe cognitive impairment (judged at the interviewer's discretion) were not included. Full details of the survey and its sampling procedure have been described elsewhere (Cronin, O'Regan et al., 2013; Kearney et al., 2011; Whelan and Savva, 2013). Briefly, wave 1 of the TILDA study included face-to-face interviews conducted by trained professionals using Computer Assisted Personal Interviewing (CAPI). The study also included a self-completion questionnaire, which was returned after the visit. Ethical approval was obtained from the ethics committee of Trinity College Dublin. Informed consent was obtained from all participants. The overall response rate of the study was 62% and the response rate of the self-completion questionnaire was 84% (Kearney et al., 2011; Whelan and Savva, 2013). For the analysis, participants under the age of 50 years were excluded. Also, since the domain of interest was people with spouse/partner, only those living with a partner or spouse at the time of the interview were included in the analysis. The sample size after restriction to these individuals was 4988.

2.2. Measures

2.2.1. Mental disorders and suicidal ideation

Depression was measured with the 20-item Center for Epidemiologic Studies Depression (CES-D) (Radloff, 1977), which assesses symptoms experienced over the last week. Each of the 20 items was scored on scales from 0 (rarely or none of the time, less than one day in the week) to 3 (most or all of the time, five-seven days in the week). These scores were summed to create a scale that ranged from 0 to 60 (Cronbach's alpha = 0–88). Depression was defined as a score of ≥ 16 . A cut-off point of ≥ 16 has been associated with 100% sensitivity and 88% specificity for major depression in community dwelling older adults (Beekman et al., 1997).

Anxiety was measured with the anxiety subscale of the Hospital Anxiety and Depression Scale (HADS-A). The measure consists of 7 items rated on a four-point scale from 0 (not at all) to 3 (very often indeed) with 5 items reverse coded. Reverse coded items were recoded so that all items were based on the same scale. The scores of the 7 items were summed to create a scale that ranged from 0 to 21 (Cronbach's $\alpha=0.84$). Anxiety was defined as a score of ≥ 8 . This cut-off point has been associated with 89% sensitivity and 75% specificity for generalized anxiety disorder (Bjelland et al., 2002; Olsson et al., 2005).

Suicidal ideation was assessed with a question from the EURO-D scale (Prince et al., 1999). This component was included in the survey because the CES-D did not include suicidal ideation (Whelan and Savva, 2013). Thus, the measure for suicidal ideation included a single item scale, similar to that used in other studies on suicidal ideation and suicidality (Giletta et al., 2014; Kang et al., 2015; Mackelprang et al., 2014; Murphy, 2014; Sareen et al., 2005a; Sareen et al., 2005b; Triñanes et al., 2014). Participants were asked the following: "In the last month, have you felt that you would rather be dead?" The variable was coded 1 for "yes" and 0 for "no".

2.2.2. Relationship quality and social networks

Relationship quality in terms of participants' experiences of positive and negative partner interactions was assessed with items described by Schuster et al. (1990). Positive partner interactions were measured with three items relating to support: "How much does he/she really understand the way you feel about things?"; "How much can you rely on him/her if you have a serious problem?"; and "How much can you open up to him/her if you need to talk about your worries?" Negative partner interactions were measured with four items relating to social strain including: "How much does he/she make too many demands on you?"; "How much does he/she criticize you?"; "How much does he/she let you down when you are counting on him/her?" and "How much does he/she get on your nerves?" Responses for positive and negative partner interactions were coded in the following way: 1 (not at all); 2 (a little); 3 (some); and 4 (a lot). The scores for positive and negative partner interactions were summed separately to create a scale ranging from 3–12 and 4–16 respectively. Cronbach's α for positive and negative partner interactions were 0.86 and 0.78 respectively. Finally, for the sake of comparability, both were converted into scales of 0–10, with 10 referring to the highest possible score for positive/negative partner interactions.

Social networks were assessed utilizing the Berkman–Syme Social Network Index (SNI). The SNI is a validated self-report questionnaire (Berkman and Syme, 1979) that assesses a person's degree of social integration by marital/partnership status (married/with partner versus not), sociability (number and frequency of contact with children, close relatives, and close friends), and church group membership or membership in community organizations. The composite score ranged from 0 to 4 and was categorized as 0–1 (most isolated), 2 (moderately isolated), 3 (moderately integrated), and 4 (most integrated). Because the sample was based on participants in marital/partner relationships, all individuals in the study had a score of at least 1. Further information about psychometric properties and evidence for the predictive validity of the SNI is available in Berkman and Breslow (1983).

2.2.3. Stressful life events (SLE)

SLEs were measured with a 12-item self-reported measure to assess exposure to traumatic events and other major stressful events over the life course. This measure was a modification of a previously utilized measure of traumatic life events (Krause et al., 2004). Stressful life events included experience of: being in a fire or natural disaster; drug addiction of family member; victim of serious assault;

life-threatening illness or accident; family member having life-threatening illness or accident; death of child; repetition of school year in childhood; parental addiction in childhood; physical abuse in childhood by parent; physical abuse by other; sexual abuse in childhood by parent; and sexual abuse in childhood by other. Responses to each SLE were coded as 0 (had not experienced that event) or 1 (had experienced that event). Responses were added up to create a scale ranging from 0 to 12.

2.2.4. Sociodemographic characteristics, chronic medical conditions, and harmful drinking

Sociodemographic characteristics included age, gender, education, financial circumstances, and place of residence. Age was categorized as 50–59, 60–69, 70–79, and ≥ 80 years. Education was classified as: primary (some primary/not complete; primary or equivalent); secondary (intermediate/junior/group certificate or equivalent; leaving certificate or equivalent); and tertiary (diploma/certificate; primary degree; postgraduate/higher degree). As a measure of wealth, since more than 50% of the values on income was missing, a proxy measure (financial strain) was utilized instead. Answers to the statement "shortage of money stops me from doing the things I want to do" were coded as follows: 1 (never); 2 (rarely); 3 (sometimes); and 4 (often). Place of residence was dichotomized into urban (Dublin city or county/another town or city) and rural.

The number of chronic medical conditions was assessed by the question "Has a doctor ever told you that you have any of the conditions on this card?" Responses included 11 conditions: high blood pressure or hypertension; angina; heart attack (including myocardial or coronary thrombosis); congestive heart failure; diabetes or high blood sugar; stroke (cerebral vascular disease); ministroke or transient ischemic attack; high cholesterol; heart murmur; abnormal heart rhythm; and any other heart trouble. The total number of chronic medical conditions was calculated and was categorized as 0 (none), 1, 2–4 and ≥ 5 .

Harmful drinking was measured with the validated and reliable CAGE screening test for the clinical assessment of harmful drinking (Chan et al., 1994; Mayfield et al., 1974; Steinbauer et al., 1998). This instrument is designed as an instrument that can be used to alert the interviewer regarding the possible presence of alcoholism. The CAGE instrument assesses four aspects of drinking with the following questions: Have you ever felt you should cut down on your drinking?; Have people annoyed you by criticizing your drinking?; Have you ever felt bad or guilty about your drinking?; and Have you ever had a drink first thing in the morning to steady your nerves or to get rid of a hangover? Individual item responses were scored 0 (no) or 1 (yes). These scores were added to create a composite score ranging from 0 to 4 and problem drinkers were defined as those with a score of ≥ 2 on the CAGE scale (Mayfield et al., 1974).

2.3. Statistical analysis

The selection of control variables was based on the past literature (Djernes, 2006; Kessler et al., 1999; Nock et al., 2008; Vink et al., 2008). Continuous variables were presented as mean \pm standard deviation (SD) and categorical variables as proportions. Comparisons of continuous and categorical variables between groups were performed using *t*-tests and Chi-square tests respectively. Multivariable logistic regression analyses were performed to assess the association between relationship quality, social networks, or other variables and the three mental health outcomes (depression, anxiety, and suicidal ideation) independently. Continuous variables included in the models were those pertaining to relationship quality and stressful life events. Since some previous studies have suggested that the effect of relationship quality or social support on mental health outcomes may differ by gender (Fiori et al., 2013; Tiedt, 2010), we tested for

effect modification by gender in the association between relationship quality or social networks and the three mental health outcomes by including interaction terms in the model (i.e. positive partner interactions X gender, negative partner interactions X gender, or SNI X gender). However, since no significant interactions were observed, we did not stratify the analyses by gender. The sample weighting and the complex study design were taken into account in all analyses to generate nationally-representative estimates. Results are expressed as odds ratios and their 95% confidence intervals. A *P*-value < 0.05 was considered to be statistically significant. We analyzed data with Stata version 13 (Stata Corp LP, College Station, Texas).

3. Results

The mean (SD) age of the sample was 62.0 (8.5) years and 52.1% were males. The prevalence of depression, anxiety, and suicidal ideation were 22.7%, 25.2%, and 2.9% respectively. The baseline characteristics of the study sample including their association with depression, anxiety, and suicidal ideation are illustrated in Table 1. Age, female gender, urban residence, lower educational level, higher levels of financial strain, social isolation, or negative partner interactions, greater numbers of chronic medical conditions, or stressful life events, and less positive partner interactions were significantly associated with higher likelihoods for the three mental health outcomes with the exception of the associations between education and anxiety, and age or gender and suicidal ideation.

The association between positive and negative partner interactions, social networks, or other covariates and depression, anxiety, and suicidal ideation are shown in Table 2. Experiencing more positive partner interactions was significantly associated with lower odds for anxiety or suicidal ideation but not depression. Experiencing more negative partner interactions was associated with significantly higher odds for depression, anxiety, and suicidal ideation. Higher levels of social network integration was significantly and inversely related to depression.

4. Discussion

The current study investigated the associations of relationship quality and social networks, with three mental health outcomes (depression, anxiety, and suicidal ideation) among participants aged 50 and above in spousal/partner relationships in Ireland. Negative partner interactions were positively related to all outcomes, while positive partner interactions were negatively related to anxiety and suicidal ideation. Social integration was inversely related to depression. The strengths of the study include the use of data from a large nationally-representative sample of the Irish population, and a range of validated scales to assess the determinants of mental disorders. Furthermore, to the best of our knowledge, this is the first study examining the associations of social networks and both positive and negative aspects of relationship quality with mental health outcomes specifically among older adults in Ireland, and one of the few conducted with European population-based samples. In addition,

Table 1
Baseline characteristics of older adults in marital/partner relationships.

| | Overall | Depression | | <i>P</i> -value | Anxiety | | <i>P</i> -value | Suicidal ideation | | <i>P</i> -value |
|--|-------------|-------------|-------------|-----------------|-------------|-------------|-----------------|-------------------|-------------|-----------------|
| | | No | Yes | | No | Yes | | No | Yes | |
| Unweighted <i>N</i> | 4988 | 3841 | 1085 | | 3655 | 1181 | | 4847 | 132 | |
| Age (years) | | | | 0.009 | | | < 0.001 | | | 0.591 |
| 50–59 | 2211 (46.2) | 1659 (50.0) | 532 (50.4) | | 1524 (43.9) | 653 (56.2) | | 2137 (50.0) | 69 (52.3) | |
| 60–69 | 1706 (33.7) | 1356 (34.9) | 327 (29.2) | | 1297 (35.0) | 361 (30.1) | | 1665 (33.9) | 38 (28.5) | |
| 70–79 | 888 (16.0) | 688 (15.9) | 184 (15.7) | | 696 (17.0) | 141 (11.0) | | 866 (16.0) | 21 (14.6) | |
| 80+ | 183 (4.13) | 138 (3.9) | 42 (4.7) | | 138 (4.1) | 26 (2.7) | | 179 (4.1) | 4 (4.6) | |
| Male | 2455 (52.1) | 2014 (55.6) | 409 (40.3) | < 0.001 | 1912 (55.1) | 471 (43.9) | < 0.001 | 2397 (52.4) | 56 (43.9) | 0.054 |
| Urban residence | 2518 (49.1) | 1889 (47.6) | 596 (53.4) | 0.003 | 1809 (47.8) | 634 (53.2) | 0.007 | 2426 (48.6) | 86 (65.7) | < 0.001 |
| Education | | | | 0.005 | | | 0.103 | | | 0.003 |
| Primary | 1259 (33.2) | 927 (30.0) | 306 (37.2) | | 870 (31.6) | 313 (34.3) | | 1210 (30.0) | 49 (47.5) | |
| Secondary | 2127 (46.8) | 1661 (47.7) | 449 (44.7) | | 1563 (47.3) | 507 (47.1) | | 2076 (47.0) | 45 (36.2) | |
| Tertiary | 1595 (20.0) | 1252 (20.6) | 324 (18.1) | | 1220 (21.2) | 357 (18.6) | | 1556 (20.1) | 36 (16.3) | |
| Financial strain | | | | < 0.001 | | | < 0.001 | | | < 0.001 |
| Never | 1103 (21.7) | 929 (20.0) | 161 (14.9) | | 917 (24.6) | 145 (11.9) | | 1078 (20.0) | 23 (16.7) | |
| Rarely | 1127 (21.4) | 928 (23.4) | 188 (14.8) | | 893 (23.4) | 212 (16.3) | | 1110 (21.7) | 17 (11.9) | |
| Sometimes | 1856 (38.4) | 1411 (38.1) | 423 (39.9) | | 1356 (38.5) | 467 (39.9) | | 1810 (38.6) | 43 (31.9) | |
| Often | 812 (18.4) | 507 (14.8) | 291 (30.4) | | 439 (13.6) | 342 (31.9) | | 762 (17.8) | 46 (39.6) | |
| Number of chronic medical conditions | | | | < 0.001 | | | 0.039 | | | 0.001 |
| None | 1836 (36.9) | 1486 (39.0) | 333 (30.3) | | 1367 (37.7) | 428 (36.0) | | 1793 (37.2) | 40 (29.6) | |
| 1 | 1692 (33.7) | 1315 (34.1) | 356 (32.3) | | 1265 (34.5) | 378 (31.8) | | 1654 (33.9) | 35 (27.0) | |
| 2–4 | 1374 (27.6) | 989 (25.5) | 363 (34.4) | | 967 (26.2) | 348 (30.0) | | 1322 (27.3) | 50 (39.1) | |
| 5+ | 86 (1.7) | 51 (1.3) | 33 (3.0) | | 56 (1.5) | 27 (2.3) | | 78 (1.6) | 7 (4.3) | |
| Problem drinking | 608 (12.3) | 427 (11.2) | 173 (16.3) | < 0.001 | 374 (10.2) | 221 (18.8) | < 0.001 | 569 (11.8) | 38 (28.9) | < 0.001 |
| Social Network Index | | | | < 0.001 | | | < 0.001 | | | < 0.001 |
| Most isolated | 59 (1.5) | 27 (0.9) | 28 (2.9) | | 37 (1.3) | 17 (1.6) | | 54 (1.4) | 5 (3.8) | |
| Moderately isolated | 1012 (21.6) | 711 (19.6) | 285 (27.9) | | 681 (19.7) | 291 (25.9) | | 964 (21.1) | 44 (35.7) | |
| Moderately integrated | 2170 (44.6) | 1689 (45.1) | 457 (43.0) | | 1590 (44.8) | 513 (44.1) | | 2110 (44.7) | 57 (43) | |
| Most integrated | 1747 (32.4) | 1414 (34.4) | 315 (26.2) | | 1347 (34.2) | 360 (28.4) | | 1719 (32.9) | 26 (17.4) | |
| Stressful life events ^a (mean ± SD) | 0.93 ± 1.19 | 0.85 ± 1.12 | 1.19 ± 1.34 | < 0.001 | 0.85 ± 1.13 | 1.20 ± 1.36 | < 0.001 | 0.92 ± 1.17 | 1.35 ± 1.53 | 0.020 |
| Positive partner interactions ^b (mean ± SD) | 8.55 ± 2.26 | 8.76 ± 2.06 | 7.9 ± 2.66 | < 0.001 | 8.86 ± 1.98 | 7.75 ± 2.61 | < 0.001 | 8.6 ± 2.21 | 7.08 ± 3.08 | < 0.001 |
| Negative partner interactions ^b (mean ± SD) | 2.37 ± 2.15 | 2.17 ± 2.01 | 3.04 ± 2.41 | < 0.001 | 2.03 ± 1.91 | 3.35 ± 2.42 | < 0.001 | 2.33 ± 2.11 | 3.71 ± 2.62 | < 0.001 |

Data are unweighted *n* (%) in the overall sample, or among those with or without that mental health condition, unless otherwise specified. Sampling weights were used for the calculation of proportions and means (SD). *P*-values based on chi-square tests for categorical variables and *t*-tests for continuous variables.

^a The scale for stressful life events ranged from 0 to 12 and corresponded to the total number of stressful life events experienced.

^b The scales for positive and negative partner interactions ranged from 0 to 10, with higher scores corresponding to higher levels of positive or negative partner interactions (refer to text for details).

Table 2
Association of positive and negative partner interactions and social network (independent variables) with depression, anxiety, or suicidal ideation (dependent variables) among older adults in marital/partner relationships estimated by multivariable logistic regression.

| | Depression | | | Anxiety | | | Suicidal ideation | | |
|--|------------|-----------|---------|---------|-----------|---------|-------------------|------------|---------|
| | OR | 95% CI | P-value | OR | 95% CI | P-value | OR | 95% CI | P-value |
| Positive partner interactions ^a | 0.98 | 0.94–1.01 | 0.213 | 0.95 | 0.91–0.99 | 0.011 | 0.91 | 0.83–0.997 | 0.044 |
| Negative partner interactions ^a | 1.14 | 1.09–1.19 | < 0.001 | 1.23 | 1.18–1.29 | < 0.001 | 1.14 | 1.02–1.28 | 0.021 |
| Social Network Index | | | | | | | | | |
| Most isolated | 1 | | | 1 | | | 1 | | |
| Moderately isolated | 0.45 | 0.20–1.01 | 0.053 | 1.25 | 0.61–2.56 | 0.545 | 1.08 | 0.21–5.41 | 0.929 |
| Moderately integrated | 0.39 | 0.18–0.86 | 0.019 | 1.40 | 0.67–2.91 | 0.367 | 1.02 | 0.20–5.09 | 0.985 |
| Most integrated | 0.34 | 0.15–0.75 | 0.008 | 1.41 | 0.67–2.96 | 0.360 | 0.78 | 0.15–4.06 | 0.766 |
| Stressful life events ^b | 1.15 | 1.07–1.23 | < 0.001 | 1.16 | 1.09–1.23 | < 0.001 | 1.04 | 0.85–1.28 | 0.685 |
| Problem drinking | 1.43 | 1.13–1.82 | 0.003 | 1.65 | 1.3–2.1 | < 0.001 | 2.77 | 1.61–4.78 | < 0.001 |
| Age (years) | | | | | | | | | |
| 50–59 | 1 | | | 1 | | | 1 | | |
| 60–69 | 0.77 | 0.63–0.95 | 0.016 | 0.67 | 0.56–0.82 | < 0.001 | 0.58 | 0.33–1.03 | 0.063 |
| 70–79 | 1.02 | 0.77–1.36 | 0.891 | 0.54 | 0.41–0.73 | < 0.001 | 0.56 | 0.27–1.18 | 0.126 |
| 80+ | 1.17 | 0.71–1.91 | 0.536 | 0.52 | 0.29–0.94 | 0.029 | 0.21 | 0.03–1.58 | 0.128 |
| Gender (male vs. female) | 0.44 | 0.37–0.52 | < 0.001 | 0.61 | 0.51–0.73 | < 0.001 | 0.68 | 0.42–1.08 | 0.104 |
| Education | | | | | | | | | |
| Primary | 1 | | | 1 | | | 1 | | |
| Secondary | 0.89 | 0.72–1.09 | 0.262 | 0.80 | 0.65–0.99 | 0.043 | 0.60 | 0.35–1.05 | 0.074 |
| Tertiary | 0.83 | 0.66–1.04 | 0.101 | 0.70 | 0.56–0.88 | 0.003 | 0.59 | 0.33–1.05 | 0.073 |
| Financial strain | | | | | | | | | |
| Never | 1 | | | 1 | | | 1 | | |
| Rarely | 1.02 | 0.77–1.34 | 0.887 | 1.33 | 1.00–1.76 | 0.049 | 0.64 | 0.30–1.33 | 0.231 |
| Sometimes | 1.63 | 1.28–2.08 | < 0.001 | 1.83 | 1.44–2.32 | < 0.001 | 0.95 | 0.49–1.87 | 0.889 |
| Often | 2.52 | 1.88–3.37 | < 0.001 | 3.12 | 2.35–4.14 | < 0.001 | 1.38 | 0.69–2.77 | 0.364 |
| Residence (urban vs. rural) | 1.24 | 1.03–1.49 | 0.020 | 1.15 | 0.97–1.37 | 0.105 | 1.54 | 0.99–2.38 | 0.054 |
| Number of chronic medical conditions | | | | | | | | | |
| None | 1 | | | 1 | | | 1 | | |
| 1 | 1.41 | 1.14–1.75 | 0.001 | 1.02 | 0.83–1.25 | 0.877 | 1.12 | 0.64–1.94 | 0.698 |
| 2–4 | 1.78 | 1.44–2.19 | < 0.000 | 1.28 | 1.04–1.58 | 0.019 | 2.08 | 1.25–3.46 | 0.005 |
| 5+ | 2.81 | 1.55–5.08 | 0.001 | 1.73 | 0.93–3.2 | 0.083 | 2.95 | 0.79–10.95 | 0.107 |

OR: odds ratio; CI: confidence interval. All models were mutually adjusted for all variables in the table.

^a The scales for positive and negative partner interactions ranged from 0 to 10, with higher scores corresponding to higher levels of positive or negative partner interactions, respectively. Odds ratio represents the change for each additional point.

^b The scale for stressful life events ranged from 0 to 12 corresponding to the number of stressful life events experienced.

this study is the first of its kind to assess associations between positive and negative partner interactions and suicidal ideation.

Several limitations deserve mention before discussing the results. First, these findings were based on cross-sectional data, which precludes the possibility to make firm conclusions about directions of causality. For example, poorer relationship quality may be the result of depression and not the cause of depression (Steger and Kashdan, 2009). Future studies are needed to establish causal relationships between these variables using prospective data. Second, since the data were based on self-report, reporting bias may exist. For example, some may have been reluctant to disclose harmful alcohol use due to social non-acceptance. Recall bias may also have affected reports of things such as the occurrence of stressful life events. Further, residual confounding may exist due to potential confounders that we could not adjust for due to lack of data. For example, information regarding possible confounders such as personality type (Krueger et al., 2001; Lopes et al., 2003) or intimate partner violence (Coker et al., 2002) were not included in the survey and therefore could not be adjusted for. Finally, due to age related factors, conventional limits for alcohol intake may not apply to older people (O'Connell et al., 2003) to detect problem drinking. Although the CAGE questionnaire used in our study to detect problem drinking has good validity and reliability among older people, some authors have recommended the use of supplementary questions to improve sensitivity (Berks and McCormick, 2008; Hinkin et al., 2001; O'Connell et al., 2003). Unfortunately, these supplementary questions were not available in the TILDA, and thus there might have been some level of under-detection especially in the older group of our study population.

Positive partner interactions were inversely related to anxiety and suicidal ideation. However, negative partner interactions were more significantly associated to all outcomes of mental disorders, and confirmed previous findings of negative partner interactions having stronger implications for mental health (Leung et al., 2007). Given that most previous research has focused solely on positive interactions/support, these results underline the importance of examining both types of social exchanges when considering outcomes on mental disorder. Overall, the associations between negative partner interactions and all outcomes were stronger than those for positive partner interactions. These findings are in line with previous research (Bertera, 2005; Ford et al., 2011; Ha, 2010; Leung et al., 2007; Rook, 1984; Teo et al., 2013), and provides further support to the negativity effect, implying that the deleterious effects of negative partner interactions are greater than the protective effect of positive partner interactions. It has been suggested that positive interactions may be protective specifically in times of crisis or acute need of support, while negative interactions universally contribute to feelings of strain and psychological distress, regardless of a person's living situation or experience of traumatic events (Rook, 1984). Our results underline the need to address dysfunctional relationships among people living with a spouse/partner as a non-pharmacological approach to improve mental health outcomes.

Higher levels of social integration were protective only against depression. Interestingly, this was not the case for the other outcomes, i.e. socially isolated participants were not more likely to have anxiety or suicidal ideation. The literature is sparse concerning associations between social networks and anxiety/suicidal ideation, and the

absence of significant relationships for these two outcomes suggests that they are less sensitive to levels of social integration. In terms of depression, previous longitudinal studies have established causal protective effects of larger and more diverse social networks against depression (Chao, 2011; Rosenquist et al., 2011; Sonnenberg et al., 2013). Research indicates that being socially integrated is related to mental health via a number of biological, psychological, and social pathways, and that social isolation affects both physical and psychological functionings through feelings and perceptions of emptiness, worthlessness, lack of control, and personal threat (Cacioppo et al., 2010; Rosenquist et al., 2011; Uchino, 2009). The association between social isolation and depression may also be underpinned by feelings or perceptions of loneliness which have been reported to be associated with both social isolation and depression in older adults (Meltzer et al., 2013). Future research is needed to examine possible mediating or moderating effects of loneliness between these variables. Alternatively, other possible explanations include: the tendency of depressed individuals to isolate themselves, which may facilitate or further exacerbate feelings of loneliness; or the tendency of individuals with depression to form rather cynical and pessimistic perceptions of the reality of their social surroundings, thereby causing them to feel less integrated in social networks than they actually are (Steger and Kashdan, 2009).

Financial strain, chronic medical conditions, and harmful drinking were also strongly associated with adverse mental health outcomes. Since these factors are also known to influence intimate relationships (Beach et al., 2005; Hardie and Lucas, 2010; Homish and Leonard, 2007; Robles et al., 2014), addressing these issues as well may have the added benefit of ameliorating relationship quality in addition to improving mental health outcomes. In particular, future research is warranted to assess how supportive behaviors and network integration interact with these variables and together affect mental and emotional well-being.

From a public health standpoint, this study may have important implications for the prevention and treatment of mental disorders in the aging population. Focusing interventions on intimate partner relationships, rather than individual family members, can be particularly fruitful in terms of improving health outcomes, because they address a broader social context. For example, research on family interventions for management of chronic diseases in adults and the elderly suggests that recognizing and attending to the family relationship adds considerably to improving the health and well-being of both patients and family members (IOM, 2001; Priebe et al., 2013). Accordingly, a recent systematic review on suicide among the elderly emphasized the effectiveness of social intervention programs that promote healthy social interactions and community participation. Such programs have been found to increase levels of wellbeing, social and physical activity, and improve quality of life while also reducing depressive symptoms (Alves et al., 2014).

5. Conclusion

Our findings demonstrate that the quality of individuals' relationships with their spouse/partner is associated with depression, anxiety, and suicidal ideation among older adults. It is possible that public health interventions could benefit considerably from focusing on marital/spousal relationship quality and especially relationship dysfunction in order to prevent a range of mental health problems. Our results indicate that while interventions for spouse/partner interactions may have an effect on all three mental health outcomes, social network integration may only have an effect on depression. If our findings are confirmed by longitudinal studies, strategies to improve relationship quality may have a positive impact on the mental wellbeing of the older population.

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Nothing declared.

Conflict of interest

None of the authors have any interests to declare in relation to this submission.

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Chapter 4: General discussion

Strengths and limitations

Before moving on to a general discussion of each paper and their broader implications, the most important strengths and limitations of the studies will be discussed briefly here. For the more in-depth discussions, please refer to the respective journal article included in the ‘methods and results’ section.

Paper I: Systematic literature review

To our knowledge, our systematic review is the first to assess the literature documenting associations between social support networks and depression in the general population. Although our review provides some important insights into findings from a decade of research, a number of limitations should be born in mind.

First, as all included studies were based on survey databases, reporting bias may exist. This could mean that individuals may not accurately recollect information, or they may purposefully provide inaccurate information due to stigma, personal boundaries or the like. Also, perceptions of support could appear to be a risk factor for depression, but this could also be attributed to the tendency of individuals with depression to form rather cynical and pessimistic perceptions of the reality of their social surroundings, and thus, support may not actually be lacking. Second, reverse causality may exist between depression and social support networks, where people with depression may be less likely to engage in social activities or seek social support. This is a limitation of particular importance in the context of cross-sectional studies, as prospective studies are less likely to be affected by this type of bias.

Third, due to the large number of studies available in the domain of interest, only studies from peer-reviewed journals were included. Publication bias and the fact that ‘gray literature’ (i.e. papers published in databases that are not controlled by academic publishers) were not included in our review may have limited our findings. One should also note that our emphasis on studies assessing the influence of social relationships in populations-based samples did not allow for the inclusion of qualitative studies. Although qualitative studies are less able to address how one variable influences another, they can be useful in terms of offering explanations of psychosocial phenomena that are often not accessible through quantitative research. Finally, given that our review included studies from a wide range of cultural and national contexts, cultural differences

may exist and have implications for how findings should be interpreted (e.g. differences in social support seeking in individualistic as opposed to collectivistic cultures). However, the articles included in our review generally focused on one particular population, and we did not come across any studies drawing particularly insightful conclusions regarding culture differences.

Paper II: Prospective study

The strengths of our study on social network types and mortality include the use of a large, population-based sample with over 50,000 person-years of follow-up. To our knowledge, this is the first multi-country study using standardized questionnaires to assess the direct impact of social networks on survival across a wide range of cultures in developing countries. However, some limitations deserve mentioning.

First, our findings may not be generalized beyond the particular catchment areas sites where the study was carried out, and should not be taken to refer to the respective countries as a whole, or urban or rural settings in general within them. Second, social networks were assessed at baseline in late life, with no information regarding either exposures earlier in the life course, or subsequent changes in social networks. These may have been affected by the onset of disability or care dependence, which may have limited access to friends outside of the household, and increased dependence upon family. Third, there were some differences in the distributions of social network types at baseline between those who were and were not part of the second survey. Thus, some level of bias may have been introduced due to these differences. Furthermore, there were some potential confounders, such as personality type, that we could not adjust for due to lack of data.

Fourth, area-level contextual variables such as social capital, or neighborhood crime and violence (as indicators of social disintegration) may be important determinants of mortality risk independent of individual social network exposures, but our catchment area study design precluded the examination of these effects due to restricted area-level variance. Fifth, as the survey was based on self-report data, report-bias is an issue that could affect the reliability of some variables and ultimately the results. Finally, the Wenger's social network construct and accompanying assessment tool, originally developed as having meaning, relevance and predictive validity for older people living in North Wales, has not been formally validated in our study setting.

Paper III: Cross-sectional study

The strengths of our cross-sectional study include the use of data from a large nationally-representative sample of the Irish population, and a range of validated scales to assess mental disorders. Furthermore, to the best of our knowledge, this is the first study examining the associations of social network integration and both positive and negative aspects of relationship quality with mental disorder specifically among older adults in Ireland, and one of the few conducted with European population-based samples. In addition, the study is the first of its kind to assess associations between positive and negative partner interactions and suicidal ideation. Nevertheless, a number of limitations should be considered.

First, these findings were based on cross-sectional data, which precludes the possibility to make firm conclusions about directions of causality. For example, poorer relationship quality could be the result of depression and not the cause of depression. Second, since the data were based on self-report, reporting bias may exist. For example, some may have been reluctant to disclose harmful alcohol use due to social non-acceptance. Recall bias may also have affected reports of things such as the occurrence of stressful life events. Of particular importance to this study is the issue of ‘common methods variance’, where self-report data pertaining to both predictor and outcome variables can result in an inflation of associations to some extent. Cross-sectional studies are particularly vulnerable to this type of bias. Last, residual confounding may exist due to potential confounders that we could not adjust for due to lack of data. For example, some relevant information regarding possible confounders such as personality type or intimate partner violence were not included in the survey.

Social relationships in the context of psychiatric epidemiology

Methodological issues in social support and network research

Our literature review indicated that several methodological issues could be raised in terms of research in the context of the broader social network and social support literature. First, many studies have tended to utilize only a limited set of measures relating to social support or networks. However, as we have demonstrated, many different measures of social support networks exist, such as perceived and received social support (emotional and instrumental), social network integration (size, frequency, source, centrality, transitivity, type), and social isolation (objective and perceived). Therefore, utilizing only a limited number of measures in an isolated manner runs the risk of other similarly important measures not being taken into account, thereby generating results that are not sufficiently comprehensive. Naturally, this can sometimes be attributed to a limited capacity in large epidemiological surveys, that require some prioritization of the content of questionnaires due to time-constraints and other resource-limitations. Nevertheless, the quantity of social networks can be very different from the quality of social networks, and perceptions of support can be different from enacted support. By extension, the utility of these measures due to such differences can sometimes produce inconsistent or conflicting results pertaining to mental health outcomes. There is a need to construct measures for population-based data that comprehensively include the various aspects of social support networks. Such measures could be constructed as a scale, which could then also be separated into sub-dimensions, thereby making it possible to explore each factor separately from the others. Alternatively, structural equation modeling techniques offer possibilities for taking various factors into account at the same time, although this naturally also requires that the necessary information exists in the dataset in the first place.

Second, it is common that studies in the social network and support literature only take into account positive aspects of social support, while the negative aspects are not represented. However, only positive aspects of support within social ties do not paint a complete picture of the quality of relationships. For example, frequent supportive behaviors from a person is not the same as few negative interactions exerted by that same individual. Similarly, a relationship may be characterized by inconsistent interpersonal behaviors from the same person, fluctuating between high levels of support to high levels of strain.

Third, the social support literature is scarce in terms of utilizing measures relating to the provision of social support rather than only focusing on the receipt of the same. This trend exists despite important differences reported in the dynamics between support provision and support receipt (Abbey, Andrews, & Halman, 1995; Fiori & Denckla, 2012; Mickelson, Helgeson, & Weiner, 1995). It is perhaps intuitive to assume that being on the receiving end of social support is the key player that affects health. However, it is also likely that *providing* social support has an equally important role to play in health, as indicated by a number of prospective studies reporting protective properties of support provision or helping behaviors against mortality (Brown, Nesse, Vinokur, & Smith, 2003; Lum & Lightfoot, 2005; Okun, Yeung, & Brown, 2013; Poulin, Brown, Dillard, & Smith, 2013). One prospective study demonstrated that altruistic and supportive behaviors towards others were associated with 38% less time spent in hospitals (Kim & Konrath, 2016). Other studies have reported significant associations between engaging in pro-social behavior and positive affect or reduced anxiety-symptoms (Dunn, Aknin, & Norton, 2008; Gallup, 2016; Lum & Lightfoot, 2005; Nelson, Layous, Cole, & Lyubomirsky, 2016; Trew & Alden, 2015). Thus, there appears to be a need for increased prioritization of specifically support provision in the area of social support networks and their implications for health and wellbeing.

Fourth, we have explored the different types of data available for investigations into social support networks. The vast majority of epidemiological studies are based on ego-centric network data, which does not include information about who is connected to whom in the dataset. The only exception (to our knowledge) is the Framingham Heart Study, which has been used for socio-centric data purposes. Socio-centric network data offers a wealth of opportunities for understanding network dynamics and their implications for health that cannot be discovered with ego-centric network data (Christakis & Fowler, 2011; Smith & Christakis, 2008). Unfortunately, socio-centric network data is rare, particularly in the field of large-scale epidemiological research, as well as researchers who have the skills and expertise to work with such data. There is a need for more socio-centric data in epidemiological surveys, and more attention given to social network analysis in higher learning, particularly the health sciences.

Social support networks and implications for mental health

In terms of associations between social support networks and depression, our primary conclusions were that perceived social support and larger, diverse social networks were protective against depression in the general population. These associations were reported in a number of high-quality cross-sectional as well as prospective studies. Other studies included in our review found that being socially isolated was particularly detrimental in terms of outcomes on depression. Similar findings have been reported in previous reviews and research articles relating to objective as well as perceived social isolation (i.e. loneliness) and their associated elevated risk for depression (Cacioppo, Hawkey, & Thisted, 2010), cognitive decline (Kuiper et al., 2016; Shankar, Hamer, McMunn, & Steptoe, 2013), and dementia (Kuiper et al., 2015). Thus, being objectively or subjectively socially isolated emerge as important risk factors for mental and neurological disorders. At the opposite end of the spectrum, a few words may also be said about outcomes relating to positive psychology. Research has reported that greater social integration and social participation predicts trust towards others (Glanville, Andersson, & Paxton, 2013), happiness and life-satisfaction (Lei, Shen, Smith, & Zhou, 2015; Litwin & Shiovitz-Ezra, 2011; Olsson, McGee, Nada-Raja, & Williams, 2013). Thus, a growing body of research suggests that being well integrated into social support networks is protective against a number of outcomes pertaining to mental disorders or neurological decline, and also appears to promote better mental health in terms of psychological and social well-being.

Social support networks and implications for gender

Our literature review suggested that some gender differences exist in the association between social support networks and depression. Particularly (but not exclusively) women appear to be sensitive to levels of social support, and may experience more detrimental consequences to mental health when support is lacking. However, this does not mean that men do not need support. Rather, the social support literature indicates that specifically spousal relationships appear to be more central to the emotional well-being of men than women (Dykstra & de Jong Gierveld, 2004). A number of studies have reported that whereas women tend to seek support from an often wider circle of friends (Antonucci & Akiyama, 1987; Haines & Hurlbert, 1992), men are less likely to have a close confiding relationship with someone other than an intimate partner (Umberson,

Wortman, & Kessler, 1992; van Grootheest, Beekman, Broese van Groenou, & Deeg, 1999), and therefore tend to draw more heavily on their spouses or partners for emotional support (Gurung, Taylor, & Seeman, 2003; Schwarzer & Gutiérrez-Doña, 2005).

A number of research findings have demonstrated dyadic relationships can have very significant implications for health and behavior. The literature suggests that this is the case especially for men in intimate relationships, and appear to give at least some credence to the expression that *behind every successful man is a woman*. For example, recent research relating to spousal relationships and marital satisfaction indicates that specifically men's life satisfaction is contingent on the marital appraisal of his spouse (but not vice versa), suggesting somehow that her happiness appears to be a prerequisite for his happiness (Carr, Freedman, Cornman, & Schwarz, 2014). Similarly, other research has found that husbands' blood pressure is particularly sensitive to the level of stress experienced by wives, while the effect in the opposite direction is much less pronounced (Birditt, Newton, Cranford, & Ryan, 2015). The findings seem to imply that women who are stressed or dissatisfied with the relationship may, as a result, be less likely to offer support, which in turn affects the emotional and physical wellbeing of their male counterparts.

The influence of women on their spouses may even spill over to the work settings, as one study demonstrated that the occupational success of men is influenced by the behavioral and supportive traits of their wife (Solomon & Jackson, 2014). Finally, there is evidence to suggest that although dependence on wives for emotional support is important for husband's psychological wellbeing, other forms of dependence appear to be associated with rather unfavorable outcomes. For example, studies have shown that women who are more dominant in terms of control over economic or social resources may exert some kind of masculinity threat, which in turn affects the health or behavior in men, such as increased risk of engaging in infidelity (Munsch, 2015) or experiencing erectile dysfunction (Cornwell & Laumann, 2011). These studies all highlight the importance of examining social relationships, and how one person can influence the health, attitudes, behavior, and wellbeing of someone the person is closely connected to.

Social network types and mortality

Social network integration as a need for survival

Our study on social networks and mortality demonstrated that survival time is significantly reduced in individuals embedded in restricted social networks as compared to those in the most integrated and diverse social network types. These results remained significant after controlling for socio-demographics, health indicators, disability, depression, and dementia. Our findings are in line with other previous research documenting the detrimental effects of restricted social networks and social isolation in terms of survival time (Holt-Lunstad et al., 2010; Nyqvist et al., 2014; Steptoe, Shankar, Demakakos, & Wardle, 2013), physical health (Luanaigh & Lawlor, 2008; Luo et al., 2012; Valtorta, Kanaan, Gilbody, Ronzi, & Hanratty, 2016), pain tolerance (Johnson & Dunbar, 2016), health-risk behaviors (Shankar, McMunn, Banks, & Steptoe, 2011; Shiovitz-Ezra & Litwin, 2012), adherence to medical treatment (DiMatteo, 2004), living conditions (York Cornwell & Cagney, 2014), and a number of biological health indicators (Shankar et al., 2011). More recently, Holt-Lunstad, Smith, Baker, Harris, and Stephenson (2015) performed yet another meta-analytic review which reported that social isolation, loneliness, and living alone were associated with a corresponding 29%, 26%, and 32% increased likelihood of mortality, respectively. They conclude that both subjective and objective social isolation is comparable to established risk factors for mortality. Other studies have arrived at similar conclusions regarding the comparability of social isolation to other well-documented risk factors for reduced survival time (Pantell et al., 2013).

These findings together demonstrate that social interaction and embeddedness in social support networks are fundamentally important as a means for health and survival. However, human social connectedness has not historically been given the attention it deserves from the medical profession. Several decades ago, high mortality rates were observed among infants in orphanages, even when controlling for clinical conditions and medical treatment. Some researchers discovered that the defining factor predicting death among those infants was the lack of social interaction and physical contact. The medical profession was shocked to learn that without social interaction, infants would die (Bowlby, 1951; Provence & Lipton, 1962; Spitz, 1945). This finding is a prime example of a historical tendency in medicine to under-estimate the power of social influence due to an assumption that genetic or biological factors are more essential to consider for health

outcomes. This is not to say that a biological approach is not important or necessary. In fact, some important considerations regarding the role of genetics will be introduced briefly later in the discussion. Nevertheless, the point here is that evidence continues to accumulate and suggest that social context factors deserve a lot more attention from the medical profession and public health disciplines than it has conventionally received. Importantly, a key research study recently demonstrated that the dominant disease-centered medical model used to predict mortality/incapacity actively ignores many relevant domains (McClintock, Dale, Laumann, & Waite, 2016). The authors show that a more comprehensive model of health is warranted, where specifically loneliness should be included as one of the main indicators to be taken into account when defining vulnerable health classes.

Our results have added to the literature and complemented findings from high-income countries that have shown that restricted social network types are significant predictors of reduced survival in older adults (Fiori, Antonucci, & Akiyama, 2008; Giles, Glonek, Luszcz, & Andrews, 2005; Keller, Magnuson, Cernin, Stoner, & Potter, 2003; Litwin & Shiovitz-Ezra, 2006). Further, there is evidence to suggest that social network typology assessment can be used as a practical tool to benefit gerontological social work and health care services (Wenger & Tucker, 2002). Thus, there is a large and growing evidence-base pointing to the notion that structural and functional properties of social relationships deserve more consideration in public health agendas, and that implementing methods to identify vulnerability based on social network integration could enhance gerontological practice and social care.

Social networks in the developing country context

In our survival analysis, we were also able to compare our findings to those conducted in different socio-economic settings. That is, comparing our results to those from high-income countries, the associated risk of reduced survival time among those embedded in restricted networks was relatively stronger. This is important because it suggests that individuals in country-settings with less developed social welfare systems may rely even more on their social networks for support, and consequently experience a more pronounced associated risk of reduced survival when social networks are restricted. Conversely, being embedded in good and diverse social support networks can have a more pronounced meaning in the context of limited social and health

infra-structures that do not have the sufficient resources to fully meet the demands for formal care (Fuhr et al., 2014). This means that for vulnerable individuals in limited resource-settings, it may be possible to harness information about social support networks and thereby promote health using a less resource-demanding approach than conventional public health strategies and interventions would otherwise require.

This concept becomes increasingly relevant as information technology and online social media use becomes more and more commonplace globally. For example, in spite of economic constraints, internet and mobile technology have increasingly become part everyday life in the world's emerging and developing economies (PRC, 2014). China is still a middle-income country, yet they have the highest population of smartphone users across all economies. India ranks lower than China in terms of the economic condition, yet it occupies the third rank in smartphone usage across the globe (eMarketer, 2014). It has been projected that the global number of smartphone users will increase from 2.6 billion today to 6.1 billion by 2020. Further, this increase will primarily be led by a huge growth in developing economies (Ericsson, 2016). Importantly, once people gain access to the internet via smartphones, they quickly begin to integrate it into their lives and engage in online social networking (PRC, 2014). Thus, communication technologies and online social network platforms may be used as tools in public health strategies to derive social and behavioral information for clinical use (Onnela & Rauch, 2016; Torous, Staples, & Onnela, 2015), and to facilitate social connectedness in order to reduce mental disorder and unhealthy behaviors in a population (Laranjo et al., 2015; Maher et al., 2014; Rice et al., 2014). This could potentially be an effective and low-cost approach to promoting health and wellbeing among otherwise socially vulnerable individuals in limited resource settings. Such an approach is essential to consider especially given that a third of the global burden of disability attributable to mental, neurological, and substance use disorders are found in China and India, a number greater than all developed countries combined (Charlson, Baxter, Cheng, Shidhaye, & Whiteford, 2016). Critically, only about 10 percent or less of people in China and India with a mental disorder receive effective psychiatric treatment for their condition (Patel et al., 2016; Thirthalli et al., 2016). Thus, if mobile technology and online social networks can be taken advantage of to address these imminent health issues, it is very much worth considering.

Social support networks and their association with mental disorders

Mental health in dyadic intimate relationships

In our cross-sectional study, we assessed associations between social support networks and three mental health outcomes among older married couples in Ireland. For this paper, we chose to focus specifically on spouses because marriage is the central relationship for most adults (Robles & Kiecolt-Glaser, 2003), and we were interested in investigating the association between social support networks and mental disorders within dyadic intimate relationships. A common finding in the broader social network and support literature is that marriage is good for health in general and plays a fundamental role in terms of longevity and even physiological function (Christakis & Fowler, 2011). For example, it has been demonstrated that on average, being married adds approximately seven years to a man's life and two years to a woman's life (Waite, 1995). Investigations into the links between marriage, bereavement, and death have shown that entering into marriage is associated with a sharp and substantial decrease in the risk of death (considerably more pronounced for men than for women), and subsequently a sharp increase in mortality risk mainly during the first 6-12 months after a spouse's death (also a much more pronounced association for men) (Young, Benjamin, & Wallis, 1963).

Interesting phenomena also occur in the time between couples enter into marriage and the point of bereavement. A large body of research has consistently linked marriage and positive health outcomes, and identified a typical trend where couples often have similar or concordant health statuses (Hoppmann & Gerstorf, 2014; Meyler, Stimpson, & Peek, 2007). Recent research has shown that as people age in relationships, they continuously become more and more like their partners, with their health becoming linked to each other over time. One 14.5 years long prospective study following the health trajectories of older long-term married couples found that levels and changes of both functional limitations and depressive symptoms are closely interrelated between spouses, implying that couples' health appears to change, for better or for worse, in sync (Hoppmann, Gerstorf, & Hibbert, 2011). Other studies have found similar interrelations between intimate partners in terms of happiness (Hoppmann, Gerstorf, Willis, & Schaie, 2011), cognitive functioning (Gerstorf, Hoppmann, Anstey, & Luszcz, 2009), memory and depression (Gerstorf, Hoppmann, Kadlec, & McArdle, 2009).

Hoppmann, Gerstorf, and Hibbert (2011) further found that the between-person associations crossed over from the mental to the physical, which indicates that a person's psychological health has an impact on the spouse's physical functioning, and vice versa. Similarly, another prospective study found that having a more optimistic spouse predicted better self-rated health, physical functioning, and fewer chronic illnesses (Kim, Chopik, & Smith, 2014). Most recently, Mejía, Gonzalez, and Smith (2015) investigated married couples who were together for several decades in order to examine partner similarity in a set of key predictors of mortality. They found striking patterns of concordance between spouses in terms of biomarkers and functional health indicators, specifically kidney function, total cholesterol level, and grip strength. According to the authors, long-term couples “co-create” their health over time as they spend their lives together, which ultimately promotes biological similarities and leads both individuals toward a parallel-like health trajectory. These studies demonstrate the unique role of intimate partners in predicting health, and that both the physical and mental health of older adults in intimate relationships are related to their spouses in a bi-directional manner.

In terms of being separated from an intimate partner, research investigating neurological responses to the breakup of long-term intimate relationships have found that the human brain appears to process relationship breakups similarly to sensations of physical pain (Eisenberger, 2015; Kross, Berman, Mischel, Smith, & Wager, 2011). Other research has reported that intimate and romantic relationships involve brain activity patterns of motivation, reward, and euphoria similar to those seen in drug addiction (Acevedo, Aron, Fisher, & Brown, 2012; Aron et al., 2005). For this reason, being separated from an intimate partner (such as in the case of a break-up or bereavement) can result in identifiable “withdrawal symptoms” for the lost partner in the form of intense distress and psychological as well as physiological discomfort (Fisher, Brown, Aron, Strong, & Mashek, 2010; Mearns, 1991). All these results appear to give scientific credence to the notions of ‘*getting the heart broken*’ and ‘*dying from a broken heart*’ as phenomena that actually do take place at some form of neurological and physiological level.

In our study, we found that better relationship quality was positively associated with depression, anxiety, and suicidal ideation, while greater social network integration was inversely related to depression. Our results confirm documented benefits of supportive relationships for mental health in general (Thoits, 2011), and complement other recent findings demonstrating that

social support is positively associated with considerable increased likelihood of attaining complete remission from depression (Fuller-Thomson, Agbeyaka, LaFond, & Bern-Klug, 2016). Contrary to our expectation, social network integration did not predict anxiety symptoms and suicidal ideation in our sample. Other studies have found limited evidence for associations between social networks and anxiety, and seem to suggest that anxiety and phobic disorders, along with their somatic symptoms, appear to be somewhat less sensitive to structural social network factors (Beekman et al., 1998; Lindsay, 1991). Rather, they may be more related to certain vulnerability factors, such as family history or traumatic events, which also may be the case for suicidal ideation (Panagioti, Gooding, & Tarrier, 2009).

It may be that social networks are more likely to exert indirect effects in associations between vulnerability factors and anxiety or suicidal ideation. For example, stressful life events, such as rejection from peers, may facilitate social isolation and withdrawal, which in turn may result in social phobia or exacerbate symptoms of anxiety (Ollendick & Hirshfeld-Becker, 2002). Further, recent research has reported surprisingly high heritability of the long-term risk of developing social anxiety symptoms, implying that genes may play a particularly significant role in anxiety disorders (Torvik et al., 2016). Further, the lack of a significant association between social network integration and suicidal ideation may be a result of assessing associations independent from depression, as co-morbid depression has important implications for suicide and suicidal ideation (Panagioti et al., 2009). However, our results confirmed our expectation that relationship quality would be associated with anxiety and suicidal ideation. This suggests that the quality of interpersonal relationships within intimate social ties plays an important role in terms of various aspects of mental health, and may be more essential in regards to anxiety than structural aspects of social networks.

Social negativity and mental health

We found some indication that negative interactions (social strain) have a stronger effect on mental health outcomes than was the case for positive interactions (emotional support). The term ‘negativity effect’ has been used to explain findings where negative interactions tend to exert stronger effects than positive interactions on mental and physical health outcomes (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Rook, 1984). It has been suggested that positive

interactions may be protective specifically in times of crisis or acute need of support, while negative interactions universally contribute to feelings of strain and psychological distress, regardless of a person's living situation or experience of traumatic events (Rook, 1984). Previous research appears to confirm that while supportive behaviors generally are associated with favorable psychological outcomes, negative social interactions with social ties are particularly detrimental to mental health (Bertera, 2005; Ford, Clark, & Stansfeld, 2011; Ha, 2010; Leung, Chen, Lue, & Hsu, 2007; Stafford, McMunn, Zaninotto, & Nazroo, 2011; Teo, Choi, & Valenstein, 2013), social wellbeing (Stokes, 2016), physical health (Birditt et al., 2015; Kiecolt-Glaser et al., 2015; Kiecolt-Glaser et al., 2005; Liu & Waite, 2014; Robles & Kiecolt-Glaser, 2003), as well as being strongly linked to mistreatment and harmful behaviors (Luo & Waite, 2011). Further, a number of studies have demonstrated that specifically marital strain accelerates the normal decline in health as people age, and that its adverse effect is greater at older ages (Liu & Waite, 2014; Umberson, Williams, Powers, Liu, & Needham, 2006). This may partly be due to the effect of negative interactions as a stressor to the cardiovascular and immune systems, which become especially critical in the transition to older adulthood.

Social negativity and social strain are detrimental environmental conditions at all ages, and more intense forms have been shown to have serious deleterious effects on mental health when occurring throughout the developmental stages of childhood and adolescence. These effects can persist well into adulthood and tend to accumulate over time. For example, a number of studies have demonstrated that both frequent and occasional bullying from social ties during childhood are strongly associated with depression, anxiety, psychological distress, suicidal thoughts, and psychosis later in life (Lereya, Copeland, Costello, & Wolke, 2015; Takizawa, Maughan, & Arseneault, 2014; Varese et al., 2012). The results of these studies further reveal that the magnitude of these effects are similar to that of being placed in public care, experiencing childhood maltreatment, or experiencing multiple childhood adversities. Another study has reported even more pronounced effects of bullying from specifically kin relationships (siblings) on outcomes of depression, anxiety, and self-harm in late adolescence (Bowes, Wolke, Joinson, Lereya, & Lewis, 2014).

Bullying and other forms of social negativity can be considered types of social-psychological strain, which has only recently been shown to be associated with considerable

adverse mental health outcomes similar to other well-established social risk factors. For example, recent studies have shown that childhood psychological abuse (such as emotional neglect or verbal aggression) is significantly associated with a range of psychiatric outcomes later in life, also including psychosis (Spinazzola et al., 2014; Teicher, Samson, Polcari, & McGreenery, 2006; Varese et al., 2012), and dissociative identity disorder (Vissia et al., 2016). Alarming, these studies have shown that the magnitude of the effects of psychological abuse is similar or even stronger than the effects of experiencing physical abuse, sexual abuse, or witnessing domestic violence. These results underline the importance of considering the quality of people's psychosocial environment and interpersonal relationships. Our study confirms previous similar findings indicating that basic forms of social strain between intimate partners are significantly associated with adverse mental health outcomes. Therefore, we conclude that especially social strain should be prioritized in public mental health strategies.

Implications for public health research and interventions

Social network and support interventions

There are many different ways to intervene in social support networks, for example by improving social skills, enhancing social support, increasing opportunities for social contact, or addressing maladaptive social cognition (e.g. therapeutic interventions aimed at altering thought processes related to social interaction) (Heaney & Israel, 2008; Masi, Chen, Hawkey, & Cacioppo, 2011). A meta-analysis covering 30 social network interventions designed to reduce social isolation and loneliness among older adults found that educational and social activity group interventions were effective, whereas the effectiveness of home visiting and befriending schemes remained unclear (Cattan, White, Bond, & Learmouth, 2005). In terms of reducing loneliness specifically, Masi et al. (2011) conducted a meta-analysis across 50 intervention studies and found a larger effect size for interventions that addressed maladaptive social cognition than for interventions designed to improve social skills, enhance support, or increase opportunities for social interaction. This finding underscores that being objectively socially isolated can be distinct from perceiving to be social isolated (i.e. feeling lonely), and interventions may therefore be designed differently depending on whether they intend to enhance social network structure and function, or to reduce perceptions of social isolation. In terms of mental health outcomes, systematic reviews have provided some evidence that interventions to facilitate psychosocial supports, as compared to standard mental health care or controls, have beneficial effects on psychiatric outcomes, such as depression (Forsman, Schierenbeck, & Wahlbeck, 2011), anxiety (Tol et al., 2011), or severe mental illness (Fuhr et al., 2014). Thus, the literature does provide some documentation as to how it is possible to intervene effectively in social support networks, and also how this may be done as a means to promote mental health. There are several reasons why intervening in social support networks is worthwhile to consider as a sustainable strategy to public mental health. These are discussed below.

Problems associated with pharmacological or psychotherapeutic approaches to health

Social support and network interventions have several important implications for public health planning and intervention strategies. First and foremost, social network interventions constitute a non-pharmacological approach to public health. This is important because a growing

body of research continues to document the vast and diverse negative health outcomes associated with particularly psychiatric drugs. One survey investigating the adverse effects of antidepressants revealed that these effects appear to be much more frequent than previously thought, and that the association between antidepressant use and adverse effects exists independent of the level of depression before the initiation of pharmacological treatment. Between 40-60% of recipients of antidepressants report sexual difficulties, emotional numbness, reduction in positive feelings, caring less about others, suicidality, drug withdrawal effects, and not feeling like oneself (Read, Cartwright, & Gibson, 2014).

Studies have reported significant associations between use of antidepressants and long-term weight gain (Arterburn et al., 2016), risk for subsequent bipolar and manic disorders (Patel et al., 2015), and that antidepressants used in combination with common painkillers increases the risk of intracranial hemorrhage (Shin et al., 2015). Some recent studies have shown that antidepressant use (specifically in children and teenagers) is largely ineffective as a treatment option (Cipriani et al., 2016; Ma, Zhang, Zhang, & Li, 2014), and considerably increases the risk of aggression, self-harm or suicide (Le Noury et al., 2015; Sharma, Guski, Freund, & Gotzsche, 2016). Similarly, other research has demonstrated the effectiveness of antidepressants in adults to be rather limited, with only a modest significant effect for those suffering from severe depression, while the magnitude of benefit in those with mild or moderate depression was minimal or non-existent (Fournier et al., 2010).

There is also evidence to suggest that common psychiatric drugs prescribed for anxiety disorders or sleep problems are associated with considerable increased risks for developing dementia (Billioti de Gage et al., 2012; Billioti de Gage et al., 2014; Lagnaoui et al., 2002) and overdose mortality (Bachhuber, Hennessy, Cunningham, & Starrels, 2016). Further, a systematic review recently found considerable increased risk of heart attack associated with anti-psychotic drug use (Yu et al., 2016). Thus, seeking to address mental disorders with a pharmacological approach may not always be an effective solution, while at the same time running the risk of exposing vulnerable individuals to various side-effects and adverse health outcomes.

Finally, psychotherapy is widely accepted as the ideal alternative to pharmacotherapy for mental disorders. However, it is important to consider that although psychotherapeutic approaches can be effective (Cuijpers, Donker, Weissman, Ravitz, & Cristea, 2016; Woelbert, 2015), they

tend to be expensive (whether funded publically or privately), characterized by limited availability (e.g. limited to one session per week), often not easily accessed (e.g. may be subject to a waiting list), and can also sometimes result in adverse outcomes and worsening of symptoms (Crawford et al., 2016).

Potential advantages of social network interventions

Social support and network interventions certainly constitute a non-pharmacological approach to mental health and wellbeing. The evidence shows that having a large social network with supportive relationships is predictive of a range of favorable physical and mental health outcomes. However, not all people are equally fortunate when it comes to having social support networks, and this has implications for health. As mentioned previously, social isolation has been reported to be a predictor of mortality similar to other well-documented clinical risk factors in terms of associated risk (e.g. being obese or an alcoholic) (Holt-Lunstad et al., 2010; Pantell et al., 2013). However, while other common risk factors are irreversible or at least not easily reversed (such as in the case of obesity or substance use disorders), it is in fact very tangible to intervene in people's social networks and to reverse for example social isolation. Further, the literature shows that people's social networks generally increase in size early in life, and subsequently tend to decrease in size as people begin to focus selectively on a core set of long-term relationships (English & Carstensen, 2014; Marsden, 1987). This means that people's embeddedness in social support networks can be assessed in early adulthood, well before the transition into older ages where many adverse health conditions begin to develop.

It is also worthwhile to consider that a person's social support networks can be a readily available resource in the absence of formal mental health and social care services. This is especially relevant as health systems in most economic settings are faced with significant financial constraints, with about 35-50% of people in developed countries and more than 75% of people in the developing world receiving no treatment for mental disorders (Demyttenaere et al., 2004). Contrary to formal mental health and social services that may not be available or affordable, people generally provide support to their social ties free of charge and may do so rather frequently. Once a close relationship between two people is established, these two people may benefit from receiving each other's support as long as the relationship persists. Further, the more close social

ties a person has, the more the person can benefit from the social support these connections offer (naturally, there is also an upper limit to the amount of close social ties a person can have). Although public health interventions designed to improve social support networks would require some monetary investment, the fact remains that if lasting supportive relationships can be facilitated between individuals, there should be virtually no costs related to maintaining the relationship. This is not the case for formal health and social services, which often require sustained financial resources over a long-term period.

Another thing to consider is that both having good social support networks and providing support or engaging in pro-social behavior are associated with beneficial physical and mental health outcomes (Kim & Konrath, 2016; Lum & Lightfoot, 2005; Smith & Christakis, 2008; Thoits, 2011; Trew & Alden, 2015). Thus, effective interventions to improve social support networks could very well have the double impact, in the sense that two parties may benefit: the support recipient and the support provider. Conventional health interventions generally target a particular population of vulnerable individuals. Interventions to improve social support networks would technically target socially isolated individuals or those having poor social relationships. However, given that such interventions would involve the expansion of social support networks or the facilitation of supportive behaviors from social ties, they would automatically come to affect those connections as well. In other words, every time an individual is subject to improved social support, there must also be at least one other individual who provides the social support, and this may benefit both the recipient and providers at the same time. Similar to the way a vaccine not only affects a vaccinated individual, but also the individuals that were not infected as a result (this phenomenon is referred to as a ‘positive externality’ in health economics), social support interventions have the potential to affect not only individuals that are socially vulnerable, but also those social connections who, as a result of the intervention, will provide support. Thus, social support networks involve an essentially free resource that, with the right intervention, may have spillover effects and benefit more people than just the individual exposed to unfavorable social conditions.

However, the point is not that social support and network interventions should replace formal mental health care services, whether they involve pharmacological or psychotherapeutic treatment. Rather, the point is that it may be possible to benefit from interventions into social

support networks as a means to complement or enhance existing formal social and health care services, to possibly prevent, limit or reduce adverse effects resulting from pharmacological treatment, or to address a need where sufficient formal services cannot be delivered due to various financial or structural barriers.

The importance of socio-centric approaches to analysis and intervention

Some words should be said about the implications of socio-centric network data in health research. One article included in our systematic review identified a pattern of contagion through social networks, that is, depression spreads through social networks on average up to three degrees of separation (e.g. from one person to the friend of a friend of a friend) (Rosenquist, Fowler, & Christakis, 2011). The contagious properties of depressive symptoms through social networks have been confirmed in a previous meta-analysis (Joiner Jr. & Katz, 1999) and subsequently in experimental settings (Barsade, 2002) as well as prospective cohort studies (Haefffel & Hames, 2013). It is not merely that emotional states cluster together among similar individuals in a population, but that particular emotional states, attitudes, or even lifestyle factors can be identified to spread across social networks through time. Network contagion have also been identified to occur with loneliness (Cacioppo, Fowler, & Christakis, 2009), anxiety (Eley et al., 2015), happiness (Fowler & Christakis, 2008), laughter (Provine & Fischer, 1989; Scott et al., 2014), altruistic behavior (Fowler & Christakis, 2010), rudeness (Fouk, Woolum, & Erez, 2016), concentration (Desender, Beurms, & Van den Bussche, 2016), workplace productivity (Bandiera, Barankay, & Rasul, 2010; De Grip & Sauermann, 2012; Falk & Ichino, 2006; Mas & Moretti, 2009), smoking cessation (Christakis & Fowler, 2008), risky behavior (Suzuki, Jensen, Bossaerts, & O'Doherty, 2016), body temperature (Cooper et al., 2014), obesity (Christakis & Fowler, 2007), divorce (McDermott, Fowler, & Christakis, 2013), childbearing and contraceptive use (Bloom, Canning, Günther, & Linnemayr, 2008; Kuziemko, 2006).

Suicide contagion is perhaps the most devastating example to illustrate the power of network influence, operating similarly through the transmission of ideas, behaviors, and norms across social relationships. A large epidemiological study among American adolescents showed that having a friend who took his or her own life increased the likelihood of suicidal ideation about three-fold, and suicide attempt two-fold. The association was further exacerbated by other

structural social network risk factors, such as having fewer friends (more restricted networks), and having a network structure where one's friends are not friends with one another (lower network transitivity) (Bearman & Moody, 2004). Another Swedish population-based study found that men (but not women) were 8.3 times more likely to take their own life if a family member had died by suicide, and 3.5 times more likely if a co-worker had taken his or her life (Hedström et al., 2008). It should be noted that emotional states, thought patterns, or lifestyle factors do not spread evenly across an entire social network, but also depends on factors such as network centrality vs periphery, transitivity, physical proximity, and type of social ties (Christakis & Fowler, 2011), which further underlines the importance of socio-centric network analysis in health research.

This has implications for public health planning and interventions, as it demonstrates that interpersonal health phenomena operate on a larger and more complex scale than conventional strategies, and it offers some novel approaches to health and medical care. For example, a social network perspective demands a rethinking of how interventions are designed given that social contagion depends on how and where someone is located in a network. This point is perhaps best illustrated in the context of sexually transmitted diseases. Sexual networks serve as a particularly good example because having sex with someone is clearly a very deliberate and detectable type of social tie. While for example asking people about their friendships can depend on one's subjective values regarding what constitutes a friendship, a sexual relationship can be said to be a much more tangible measure of a previous or ongoing social interaction. One might say that a sexual relationship is the equivalent to what death is in medicine: an unambiguous end-point. One study used socio-centric network data to investigate the spread of sexually transmitted diseases by reporting and mapping the number of individuals' sexual partners (Liljeros et al., 2001). Importantly, this study showed that the social network had highly active cores, and that safe-sex campaigns would be most effective if aimed at high-activity members rather than just targeted equally across all members of a population.

Contrary to a conventional public health perspective, social network research reveals that structural and functional network factors can sometimes determine risk more so than individual attributes, i.e. sometimes having more to do with who people know than who people are. In short, the spread of disease depends on the larger patterns of contact and connectedness in the overall network. Without information about individuals' interconnectedness in a population, high or low

risk of contagion cannot be determined. For example, in the case of sexually infectious diseases, simple enumeration of numbers of sexual partners per individual cannot yield such insights without actually mapping the networks. Since it has been established that mental states and behaviors have contagious properties through social networks, a similar approach can be used in the area of public health and prevention strategies. Thus, the effectiveness of interventions may be increased by gathering information about how people are socially connected in a population, thereby targeting those most central and likely to exert the most influence and facilitate contagion in a network.

Finally, a social network perspective gives rise to new ways of assessing the effectiveness of interventions. For example, conventional health interventions are mainly focused on the effect of an intervention specifically among those individuals exposed to the intervention. However, since it has been shown that psychological states, emotions, and behaviors can spread through social networks, a network approach to health interventions would emphasize as well the effect of the intervention among those not exposed to the intervention, but nevertheless influenced by the intervention due to network contagion. If it can be assumed that it is possible to design interventions that are effective up to three degrees of separation in a population social network, the implication is that it may be possible to design interventions specifically to facilitate network contagion, thereby utilizing minimum resources while at the same time reaching maximum impact.

Future directions

The role of online social networks in health

Technological progress is currently moving at an incredibly rapid pace, continuously enhancing the possibilities for social connections and communication. For example, some studies have demonstrated the possibility of direct long-distance brain-to-brain communication with the use of electroencephalogram and transcranial magnetic stimulation technologies (Grau et al., 2014; Rao et al., 2014; Stocco et al., 2015). Facebook AI research is currently developing artificial intelligence systems that can be trained to associate specific words with corresponding images, thus making it possible for visually impaired people to understand the content of images posted by their connections on social media by means of auditory descriptions (Metz, 2016). The development of new technologies continues to break social barriers between people and connect people digitally. In this context, some words ought to be said about the implication of information technology and online social media, which have come to play a more and more essential role in social relationships and interaction.

As mentioned previously, it is important to keep in mind that although related to each other, social networks are not the same as *online* social networks. The term ‘social networks’ generally refers to real “in-person” social relationships. ‘Online social networks’ on the other hand, is a term that encompasses social interactions that take place via the internet, and that may or may not develop into real personal relationships. Importantly, online social networks can have very real implications for health and wellbeing. For example, research has reported that online social networking sites designed to facilitate smoking cessation can foster supportive communities, which in turn has been effective to help people quit smoking more easily (Phua, 2013). Conversely, online social networks can have detrimental consequences for health. For example, a study conducted during a syphilis epidemic in San Francisco showed that people who found a sexual partner through an online social network site were three times more likely to contract a sexually transmitted disease than someone who found a sexual partner the “old-fashioned way” (Klausner, Wolf, Fischer-Ponce, Zolt, & Katz, 2000). Thus, online social networks can sometimes augment associations to health, whether the outcomes are favorable or detrimental.

Interestingly, online social networking behavior appears to have many similarities to the way real social networks operate. For example, while it is possible to have hundreds of online social ties (connections, friends, followers, etc.), people appear to still selectively focus on a core of online close relationships as they do in real in-person relationships. For Facebook users, the average number of friends is approximately 110-150. However, several studies have shown that even in spite all these digital connections, people still tend to keep close friend groups small, with about 4-6 close online friends that they regularly interact with (Dunbar, 2016; Lewis, Kaufman, Gonzalez, Wimmer, & Christakis, 2008). Further, research has also shown that online social network users tend to have a limit to the number of close relationships they have by maintaining a manageable group of close contacts. They do this by instituting an unconscious “one in, one out” rule, where more close relationships are continuously replacing less close ones. In other words, even though the size of online social networks can be virtually ever-expanding, the capacity for maintaining emotionally close online social ties appears to be finite (Saramaki et al., 2014).

Interestingly, the average number of close online social contacts is remarkably similar to the number of close contacts people tend to have in the non-digital world (Dunbar, 2016; Marsden, 1987). This means that online social networks do not in and of themselves automatically expand our social relationships in a qualitative way. On the contrary, the rules that operate appear to be similar whether our social relationships are digital or not. For example, a number of studies have indicated that more time on Facebook is linked to both high and low levels of social connectedness, and that although Facebook can be an effective platform for increasing social support networks among people that are already highly socially connected, it may also at the same time make those who are isolated or depressed feel even more so (Appel, Crusius, & Gerlach, 2015; Sheldon, Abad, & Hinsch, 2011; Teppers, Luyckx, Klimstra, & Goossens, 2014). This again seems to tell us that the use of online social networks does not automatically translate into any improvements in terms of social or psychological wellbeing, and may depend on the way people use online social networks to interact with others.

Finally, one way that online social networks appear to be similar to in-person social networks relate to the spread of emotions. Research has been able to demonstrate that emotional contagion occurs in online social networks similarly to the way they operate in in-person social interaction (Coviello et al., 2014; Kramer, Guillory, & Hancock, 2014). All this shows how similar

online social networks are to in-person social networks, which means that public health agendas may be able to take advantage of online social network data in order to affect social relationships and ultimately improve population health. There is at least some evidence from systematic reviews to suggest that online social network interventions can have favorable outcomes on mental health (Rice et al., 2014) and health behaviors (Laranjo et al., 2015; Maher et al., 2014).

Current challenges to be considered in the context of online social network interventions

Several challenges exist and must be overcome in order to utilize online social networks for health purposes. First, there are some ethical problems relating to interventions conducted in online social networks. For example, Facebook was confronted with some serious criticism as a consequence of an experimental study conducted by Kramer et al. (2014), who investigated the facilitation of emotion contagion across online social networks. These authors allegedly manipulated users' newsfeeds without their consent in order to study the effects of the experimental manipulation on emotions in the social network. Clearly, the lack of consent from users crossed an ethical boundary, especially given that the study turned out to confirm that the manipulation indeed was effective in terms of spreading positive or negative emotions through the network. Naturally, such ethical issues must be overcome in order to design online social network interventions in the first place. There are now legal and ethical guidelines for data scientists to consult before conducting experiments or interventions in online social networks, and research proposals should go through a formal review process in order to ensure that the research is ethical and sound in areas of privacy and security (Jetten & Sharon, 2016).

A second challenge to consider is that, according to the literature, the benefits of social networks can be achieved when people's social networks expand into larger and more diverse networks. It is well known that people generally tend to establish connections with other people based on shared characteristics and interests (homophily) (McPherson, Smith-Lovin, & Cook, 2001), which then typically evolves into longer lasting relationships when there is a sustained opportunity for social interaction (Christakis & Fowler, 2011). Importantly, some studies have discovered that Facebook use is protective against loneliness or declines in subjective wellbeing when used as a tool to make new friends or maintain contact with close connections through direct social network interaction (Kross et al., 2013; Teppers et al., 2014), while appearing to reinforce

feelings of loneliness when used to compensate for social skills (Teppers et al., 2014). Thus, it is key that interventions are designed specifically to facilitate the expansion of people's close social relationships and to reinforce the development or maintenance of close relationships on a long-term basis.

Last, the quality of social relationships is perhaps the most difficult challenge to address, since it may not be easy to influence *how* people interact with each other. However, since there is evidence that emotions, mental states, and behaviors can spread through social networks, it may also be possible to use social media as a means to influence people's attitudes towards social interaction and support provision to social ties. Facebook recently launched a feature designed to aid users in providing support in situations where connections post concerning updates relating to suicide or self-harm. Upon discovering a concerning update from a connection, users may now notify Facebook. Facebook then guides the user in terms of supporting the at-risk individual through a number of options, such as notifying emergency services (if person perceived to be in immediate danger), contacting the person directly (Facebook will make suggestions regarding content of messages), or anonymously reporting the post to Facebook, in which case Facebook will attempt to provide the support (Miners, 2015). Although there is not yet evidence to show that this feature is effective in terms of reducing suicidal attempts or ideation, it is certainly a step in the right direction. As mentioned previously, social support networks can be a vital source for health in all contexts, and especially so in developing economies. Online social network interventions offer new opportunities for reaching vulnerable individuals, facilitating social connectedness, and improving social support networks, which ultimately could lead to better health.

The role of advancing technologies and artificial intelligence research

As new technological innovations continue to make their way into the area of medicine and psychiatry, one relevant future step could lie in the use of machine learning (artificial intelligence) in the context of online social networking and mental health. With the use of machine learning, it may become possible to create algorithms that can effectively calculate risk for mental disorder based on indicators of risk derived from social media use, or they may be used to calculate how social network interventions can be tailored to become the most effective in reducing adverse

health outcomes. Recently, in the context of psychiatry specifically, studies have demonstrated that machine learning could not only help to predict the characteristics of a person's mental disorder as well as treatment response, but could also do so more effectively than traditional medical approaches and with less information (Chekroud et al., 2016; Dipnall et al., 2016; Kessler et al., 2016; Passos et al., 2016).

In the context of social media, there is evidence that machine learning algorithms can be used to effectively predict personality based on online social network interactions (Chapsky, 2011; Solinger, Hirshfield, Hirshfield, Friendman, & Leper, 2014; Youyou, Kosinski, & Stillwell, 2015). Given that personality can have implications for propensity for loneliness (Ernst & Cacioppo, 1999; Russell, 1996) and mental disorder (Krueger, 1999), such machine learning models applied to the analysis of online social networking could become useful in identifying users at risk of social isolation, which by extension could provide an opportunity to prevent mental health problems associated to chronic loneliness (Cacioppo, Cacioppo, Dulawa, & Palmer, 2014; Russell, 2014). Similar research has used algorithms to predict life satisfaction based on Twitter data (Yang & Srinivasan, 2016). Yet others have developed promising machine learning frameworks to extract online social network data in order to identify potential cases of problematic internet use or internet addiction (Shuai et al., 2016), which is a growing social issue that can have very real negative life consequences (Cash, Rae, Steel, & Winkler, 2012), and also associated with a range of psychiatric disorders (Ho et al., 2014; Schou Andreassen et al., 2016).

The evidence for the potential benefits of using online social network data as an aid to improve public health has only started to emerge. So far, there is evidence to suggest that statistical techniques in the field of predictive analytics can be used with online social network data to provide useful insights and model predictions of biomedical outcomes, health-related behaviors, disease outbreaks, or public health and safety threats (Young, 2014), such as in the context of sexually transmitted diseases (Young, 2015; Young, Rivers, & Lewis, 2014), influenza transmission (Broniatowski, Paul, & Dredze, 2013), smoking behaviors (Myslin, Zhu, Chapman, & Conway, 2013), and even major violent events or terrorist attacks (Johnson et al., 2016). In one noteworthy study, researchers were able to link online social network data to medical records, which has shown to be effective in terms of providing useful insights into health status and health outcomes (Padrez et al., 2015). The long-term goal is to develop technologies and algorithms that

can utilize social network content, link it to medical data, and ultimately improve the assessment of health status and predict diseases. Importantly, people appear to be quite willing to have social media content used for medical purposes if just informed properly. According to Padrez et al. (2015), 71 percent of their participants consented to share their social media activity and have it linked to electronic medical records. Thus, if people are informed that their social media data can be used to benefit their health, researchers may just need to inform and obtain consent properly in order to access this kind of digital information.

Finally, artificial intelligence research is continuously advancing in the field of creating social robots or robot companions that possess the social-behavioral skills to interact with humans on a personal level (Dautenhahn, 2007). This kind of research is still in its infancy, but social robots may one day offer an alternative to otherwise lacking social relationships, capable of providing instrumental and emotional support equivalent to that of a human being – or perhaps even better (Gallego-Pérez, Lohse, & Evers, 2013, 2014). Thus, an exciting time is approaching where novel innovative methods offer new ways to work with social media data. All this may be used in public health and social network science as a means to improve social support networks, which in turn could constitute a sustainable and low cost approach to addressing or preventing poor physical and mental health.

The role of genetics, epigenetics, and epidemiology in human health and social connectedness

Finally, some words should be said about our current knowledge regarding human social connectedness and its place in the broader nature/nurture debate. While the literature reviewed so far has made the case for demonstrating the importance of considering the social context in health research, this is not to say that biological or genetic factors are not important. In fact, there is evidence to show that genetic factors can very much be implicated in human social connectedness, and by extension, health. Recently, research has concluded that genetic factors account for about half of the variation of network size, network transitivity, and loneliness (Boomsma, Willemsen, Dolan, Hawkey, & Cacioppo, 2005; Fowler, Dawes, & Christakis, 2009). These findings demonstrate that biological and genetic factors are indeed important to consider in the context of social relationships and health.

The argument for this can be further sustained with recent findings in the area of epigenetics. It is now becoming clear that life experiences can affect genetic activity, involving hundreds of proteins, enzymes, and other chemicals that regulate cells. For example, it has been shown that being exposed to stressful events can result in various epigenetic modifications that lead to significant suppression of gene expression and impaired behavioral adaptation of those genes (Saunderson et al., 2016). Such modifications have been linked to differences in gene activity associated with various disease markers and biological processes that are also related to the development of physical and mental health problems (Weder et al., 2014; Yang et al., 2013). Moreover, a body of recent research involving animals as well as humans have demonstrated that various social and environmental conditions, such as stress or trauma, can result in heritable genetic modifications, implying that the predisposition to disease brought about by life experiences can be passed on genetically to subsequent generations (Dias & Ressler, 2014; Feinberg et al., 2015; Gapp et al., 2014; Hackett et al., 2013; Houry-Ze'evi et al., 2016; Teperek et al., 2016; Yehuda et al., 2015; Yu et al., 2014). Thus, it is increasingly becoming clear that genetics have an essential role to play in terms of social circumstances and, at the same time, that social-environmental conditions can affect genetic activity in people as well as their offspring.

The 20th century was largely dominated by medical research focusing on identifying single genetic or environmental agents that could explain disease variability. However, huge advances in health research the past few decades have demonstrated the vastly complex interaction of genetic and environmental conditions, all suggesting that it is time to move beyond a simplistic and dichotomous nature/nurture debate (Fitzgerald, Rose, & Singh, 2016; Hernandez & Blazer, 2006). Rather, much can be done in future research to incorporate measures of social environment factors into genetic studies and also to incorporate genetic measures into social epidemiological studies. Social network analysis has much to offer to advance current knowledge in this area.

Chapter 5: Conclusions

Three main conclusions can be derived from the research carried out: First, the project has been able to identify key indicators of social support networks in relation to depression. Generally, studies have found protective effects of perceived social support and large, diverse social networks against outcomes of depression in the general population. We were able to derive some recommendations for future research, for example the incorporation of both structure and function of social support networks into mental health research for a more comprehensive assessment. Second, we have demonstrated that human social connectedness is an important protective factor for survival. In our study, survival time was significantly reduced in individuals embedded in restricted social networks. The immediate implication is that social support networks is a vital resource for survival, and especially so in contexts where formal health or social care is lacking. Third, we have demonstrated that significant associations between social support networks and mental disorders can be identified on a large-scale epidemiological level. For older Irish adults in intimate relationships, we found that worse relationship quality with the spouse is positively associated with depression, anxiety, and suicidal ideation, and that restricted social network integration is positively associated with depression. It is possible that public mental health strategies could benefit by designing interventions targeted towards enhancing social networks and addressing the quality of intimate relationships, especially social strain, in order to improve mental health.

These main findings taken together with the broader social support literature suggest that public health agendas may benefit substantially by incorporating methods relating to social network science in health research as a means to optimize disease identification and intervention. The literature reviewed also indicates that social connectedness may be assessed relatively early in adult life, which implies opportunities for early intervention. Importantly, interventions into social support networks offer a non-pharmacological approach to public health, and should be taken into consideration as a means to limit or reduce drug complications and the adverse effects that are often associated with the consumption of medicines, particularly psychiatric drugs. In terms of modern information technology, online social network platforms and machine learning applications offer novel, potentially low-cost, and possibly game-changing ways for researchers to intervene in human health and social connectedness. Finally, recent scientific advances indicate

that it may be time to abandon a simplistic nature/nurture discourse regarding the causality of diseases, and instead look beyond to evidence demonstrating that human health is product of complex interactions between genetic, biological, psychological, social, and environmental factors. The future of medicine and public health lies in our ability to invent or design new cutting-edge methods that can take a multitude of biological, psychological and social factors into account at the same time in order to improve health on a global scale. While the way to get there is undoubtedly long and complex, the end goal is a simple one that pertains to a basic human desire – to live a long healthy life with meaningful social relationships.

Activities and fieldwork during the doctorate research program

In January 2014, I was enrolled in the Maratone network—a leading European mental health initial training network funded by a Marie Curie grant awarded by the European Commission (FP7-PEOPLE-2012-ITN; grant agreement number 316795). I was recruited to take part in Dr. Josep Maria Haro’s research group at the Parc Sanitari Sant Joan de Déu in Barcelona, Spain for the next three years of my life. These are the activities and the fieldwork I have been engaged with since I started the program:

- Role as lead author and investigator on several research projects, some of which are included in this dissertation. Also collaboration and co-authorship on other projects within and external to the research group.
- Participation in the specialized training program organized by Maratone, including E-learning and coursework hosted at partner institutions and universities. Coursework also included a number of courses relevant to mental health organized by the Johns Hopkins University and hosted at the Pompeu Fabra University in Barcelona.
- Presentation of research results at the seminary held at the Parc Sanitari Sant Joan de Déu, and the annual Early Stage Researcher conferences organized by Maratone. Also participation and presentation of research results at international conferences, including the European Health Forum Gastein (EHFG2015), and the European Congress of Psychiatry 2016 (EPA2016).
- Participation in fieldwork relating to data collection in the Sant Boi Study and the Collaborative Research on Ageing in Europe study (COURAGE), and organization of meta-data in relation to the ATHLOS study (Ageing Trajectories of Health: Longitudinal Opportunities and Synergies). Also taken on the role as a project manager on the writing of a Horizon 2020 EU project proposal relating to the potential for Big Data to support public health policies (project BigAPPLE).
- Two secondments of three months’ duration each. The first secondment was held at the King’s College London, Institute of Psychiatry, Psychology, and Neuroscience (IoPPN). The last secondment was held at the Adelphi University, Gordon F. Derner Institute for Advanced Psychological Studies. Both secondments involved the role as lead author on research projects relating to social support networks using population-based data.

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