

AMERICAN UNIVERSITY OF BEIRUT

SOCIAL RELATIONSHIPS AND THE RATE OF COGNITIVE
DECLINE AMONG OLDER ADULTS IN LEBANON:
DIFFERENCES BY GENDER

by
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AN ABSTRACT OF THE THESIS OF

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Title: SOCIAL RELATIONSHIPS AND THE RATE OF COGNITIVE DECLINE
AMONG OLDER ADULTS IN LEBANON: DIFFERENCES BY GENDER

Introduction:

Dementia is an increasing public health problem worldwide. Cognitive decline is a defining feature of the disease. The aim of this study was to assess the effect of social network and social engagement on cognitive decline and to explore differences by gender among older adults in Lebanon.

Methods:

Data were derived from the COLDS' study (Cohort of Older Adults in Lebanon: A Dementia Study). Out of 508 older adults, the eligible sample for this longitudinal study was 273 participants who were at risk of cognitive decline at baseline. The outcome variable, cognitive decline, was estimated using the Arabic version of the IQCODE (A-IQCODE). The social network dimension consisted of the participant's marital status and his /her contact with relatives, friends, and neighbors. The following variables were used to evaluate social engagement: attending religious meetings, engaging in any community activities, and involvement in any kind of paid work. Social network score and social engagement score were generated by adding up the responses of items comprising each concept. Simple and multiple logistic regression models were performed adjusting for cluster effect. To explore the effect of Gender on the association between exposure variables and cognitive decline, stratification by gender was done at the bivariate and multivariate level. Interaction terms were added to logistic regression models to check for statistical significance of the interaction with gender. The same analyses was run on the baseline sample (502 participants) to check for any significant association between social relations variables and cognitive decline at baseline.

Results:

Adjusting for age, gender, educational level, depression, difficulties in performing daily activities, and other social factors, only frequent contact with children or other relatives was significantly associated with lower odds of cognitive decline after 3 years of follow-up. No evidence of difference by gender was found.

Conclusion:

Frequent contact with children and close relatives protects against cognitive decline. Th study underlines the need for further studies exploring the effect of social relations on cognitive decline using a larger sample and over a longer follow-up period.

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ABBREVIATIONS

MENA	Middle East and North Africa
CD	Cognitive decline
AD	Alzheimer's disease
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
MCI	Mild cognitive impairment
APOE	Apo lipoprotein E
ADLs	Activities of daily living
IADLs	Instrumental activities of daily living
COLDS' study	Cohort of Older Adults in Lebanon: A Dementia Study
A-IQCODE	Arabic version of the Informant questionnaire on cognitive decline in Elderly
GMS-AGECAT package	Geriatric Mental State-Automated Geriatric Examination for Computer Assisted Taxonomy
OR	Odds ratio
Baltimore (ECA)	Baltimore Epidemiologic Catchment Area
CI	Confidence interval

CHAPTER I

INTRODUCTION

Globally, the prevalence of dementia in 2015 was over 46 million, and the number is expected to increase to 131.5 million by 2050 (Alzheimer's Disease International, 2019). In the Middle East and North Africa (MENA), the number of people living with dementia is estimated to grow exponentially from 1.2 million in 2010 to 2.6 million by 2030 (Alzheimer's Disease International, 2019). This increase is alarming especially in a region that lacks social and healthcare policies tailored to the elderly population (Mirkin, 2010).

The main defining attribute of Alzheimer's disease (AD) and other forms of dementia is cognitive decline (CD) (Prince, Wu & Guo., 2015). CD not only limits the individual's independence, but also increases social care costs and poses a serious burden on caregivers (ibid). To date, no effective treatments are available for dementia. Therefore, identifying risk factors of cognitive decline is critical to develop preventive interventions for the well-being of individuals and crucial for the aging society (Obisesan & Gillum, 2009). Evidence suggests that cognitive function might be influenced by several modifiable factors including diet, smoking, physical activity, cognitive stimulation and social relationships (Baumgart, Snyder, Carrillo, Fazio, Kim, & Johns, 2015).

Several studies have shown that being socially isolated is associated with higher rates of cognitive decline in the elderly (Bassuk et al., 2006). Still, differences in definitions and measurement tools across studies have led to inconclusive findings over

what specific aspects of social relationships affect cognitive decline the most (Hughes, Flatt, Fu, Chang & Ganguli, 2013). For example, social relationships contain structural features like the number of social ties and functional aspects like the level of social support. Differentiation is important as each aspect can influence cognitive function through different mechanisms (Hughes et al., 2013).

Moreover, most of the evidence comes from studies conducted on Western population. Therefore, it might not be applicable to other populations with social and cultural differences (Glei et al., 2005). Furthermore, while men and women have different needs and maintain social ties in different ways, only a few studies assessed associations between social relationships and cognitive function stratified by gender (Liao, 2017). More specifically, several studies have revealed that the emotional support provided by close friends would be more protective against cognitive decline for women than for men; while formal roles in community activities and social organizations would be more protective against cognitive decline for men than for women (Zunzunegui et al., 2003).

Lebanon provides an interesting context for exploring this topic because its social structure differs from that of western countries: social interaction is more family-centered and older-adults are more likely to reside with their children (Ajrouch et al., 2015).

Moreover, most of the studies on social relationships and cognitive decline globally have used a cross sectional design, and a few were prospective. (Bassuk et al., 2006).

Our research was carried out to assess the effect of social network and social engagement on cognitive decline and to explore differences by gender among older adults in Lebanon. Hence, the research question this study attempted to answer was: “Are social network and social engagement associated with cognitive decline among Lebanese older adults? And how does the association differ by Gender”.

CHAPTER II

LITERATURE REVIEW

A. Cognitive decline

1. Cognitive function and cognitive decline

Cognitive function the main outcome of the study, is defined as the brain capacity of processing and interpreting information of daily living. It involves multiple domains such as attention, reasoning, memory, planning of tasks and information processing speed (Petersen et al., 2001).

Cognitive function changes over the lifespan: rapid development in childhood, relative stabilization during mid-life, followed by perceptible declines in old age (Craik & Bialystok, 2006). Graduated cognitive decline starts as early as middle age (45-49 years) and is considered as part of normal ageing. It affects multiple cognitive domains (mostly attention, processing speed, and memory) and occurs at different rates and timing among individuals (Seshadri et al, 2011). However, when it happens at an accelerated rate or it reaches a level that is greater than expected for a person's age and education, it is considered as cognitive impairment and is further classified as mild cognitive impairment (MCI) or dementia (McKhann GM et al, 2011). In other words, cognitive decline can be described as a spectrum of cognitive changes (Brayne and Calloway, 1988) that ranges from normal ageing to crossing the limit into mild cognitive impairment (Petersen et al., 2001) and further advancing toward dementia (DSM-5, 2013).

2. Dementia vs. MCI

According to the fifth edition of Diagnostic and Statistical Manual of Mental Disorders (DSM-5), Dementia is renamed into “major neurocognitive disorder” and is defined as a neurodegenerative disease resulting in a significant deterioration in cognitive function, which interferes with the individual’s ability to carry out everyday activities (American Psychiatric Association, 2013). It is further classified according to the DSM-5 into: Alzheimer’s disease (AD) (the most common form of dementia accounting for 50-75% of the cases), vascular dementia (20-30%), frontotemporal dementia (5-10%), and dementia with Lewy bodies (<5%) (Petersen et al., 2009). The prevalence of dementia increases exponentially with age, affecting around 5% of individuals above 65 years, 20% at the age of 75+, and 50% at the age of 90+(Teixeira et al., 2011). In Lebanon, according to a study done on a national representative sample, the crude prevalence of dementia is 7.4 % (Phung et al, 2017). Dementia is usually, but not always, preceded by mild cognitive impairment (MCI) (Harrison et al., 2014). The prevalence of MCI is around 10-20% among elderly from the general population (Anstey et al., 2007).

The difference between dementia and MCI is that the latter does not interfere with individual’s independency in conducting daily activities (Cheng et al., 2012). MCI often, but not always, develops into dementia. The rate of progression from MCI to dementia is between 6% and 10% per year (Beydoun et al., 2014).

3. Determinants of cognitive decline

Currently, there are no effective treatments for cognitive decline (Teixeira et al., 2011). Interventions aimed at preventing cognitive impairment at very early stage could be beneficial in slowing the process of cognitive decline (Stern et al., 2000). For this purpose, it is important to identify factors that might cause or accelerate cognitive decline (Petersen et al., 2009).

Cognitive decline is multifactorial. The most important non-modifiable risk factor is age followed by family history and the presence of the apolipoprotein E (APOE) ϵ 4 allele (Williams et al., 2010). Studies have shown that this allele contributes to 15% -20% of dementia cases (Fratiglioni et al., 2004).

Cognitive function in elderly is influenced by several modifiable risk factors (Kelly et al., 2014), which are of particular importance for cognitive aging researchers as recent studies have suggested that interventions targeting modifiable risk factors could prevent up to a third of dementia cases (Crous-Bou et al., 2017).

Before elaborating on modifiable risk factors, it is worth noting that there is still no sufficient evidence to support the association of any individual risk factor and cognitive decline (Plassman et al., 2010; Daviglus et al., 2011).

Modifiable risk and protective factors for dementia and cognitive decline include health related factors, cognitive reserve, and lifestyle related factors.

Health related factors

Cardiovascular diseases and their associated risk factors have been linked to faster declines in cognitive function (Savva & Stephan, 2010; Dregan et al., 2012). Particularly, adults who have diabetes, hypertension, hyperlipidemia, obesity and metabolic syndrome are at a higher risk of cognitive decline compared to their healthier counterparts (Livingston et al., 2017). Those risk factors can start affecting cognition as early as middle age (Dregan et al., 2012).

A history of depression is also positively associated with cognitive decline (Plassman et al., 2010) and dementia (Ownby et al., 2006). However, to date, questions remain regarding whether depression is a risk factor or an early symptom of dementia (Mirza et al., 2014).

Cognitive reserve

Cognitive reserve is defined as the capacity to compensate for pathological neurodegeneration thus mitigating its impact on cognitive performance (Mondini et al., 2016). It is suggested that, for the same amount of brain damage, older adults with higher cognitive reserve levels will cope better than those with low levels (Cosentino and Stern, 2013).

Higher levels of education, engaging in cognitively stimulating activities, and higher occupational complexity are considered as “markers of cognitive reserve”, hence delaying the manifestation of cognitive decline (Fratiglioni and Wang, 2007). Additionally,

cognitive reserve plays a role in the relationship between social relations and cognitive function. According to Evans (2018), cognitive reserve is an effect moderator in the association between cognitive function at older age and social relations.

Lifestyle related factors

Adopting a healthy lifestyle is linked to a better cognitive function (Lee et al., 2010). Systematic reviews have reported that engaging in physical activity (Hamer & Chida, 2009), smoking cessation (Anstey et al., 2007), consuming alcohol moderately (Anstey et al., 2009), having healthy dietary habits (Gillette-Guyonnet et al., 2007), and social integration (Fratiglioni et al., 2004) may protect against cognitive decline. Among those behaviors, physical activity exhibits the most consistent protective effect against cognitive decline (Lee et al., 2010). There is still no consensus, however, on the optimal duration, type, and intensity required to maximize the benefits of physical activity (Colcombe and Kramer, 2003).

B. Social relationships

1. Concepts and definitions

The relationship between social capital and health has been studied since 1901, when Emile Durkheim found an association between suicide rates and the level of social integration. However, there is still no consensus among researchers on a clear definition of social relationships (Gottlieb and Bergen, 2010). Therefore, emphasis shifted to the components of social relationships.

Six relevant concepts mainly addressed in the social relationship literature are summarized in the table below.

Table 2.1: Social Relationships Related Concepts and Definitions.

Concepts	Definitions
Social network	The web of social ties that surrounds an individual, representing the structural aspect of social relationships (Berkman <i>et al.</i> , 2000).
Social support	Social resources that are perceived by an individual to be available or that are actually provided to them through their social relations (Cohen <i>et al.</i> , 2001).
Perceived support	An individual's history of receiving effective support, which involves cognitive appraisal and having reliable connections with others (Barrera, 1986).
Enacted support	The actions that actually take place when the person needs help and support (Barrera, 1986).
Social integration	The existence of social relations and the extent to which an individual embeds in informal (e.g. marital status) and formal social interactions (e.g. community involvement) (Gottlieb and Bergen, 2010), with social isolation pointing to its flipside (Barrera, 1986).
Social cohesion	A set of collective characteristics that keep the society able to function as one unit like the absence of social conflicts; and the presence of strong social bonds. <i>Social capital</i> is a subset of social cohesion, indicating norms of reciprocity and levels of trust (Kawachi and Berkman, 2000).

Berkman and colleagues (2000) attempted to tackle the issue of defining and conceptualizing social relationships by suggesting a framework that defines social factors and clarifies how they are interconnected together to influence health.

Social networks, defined as “the web of social relationships that surrounds an individual” (p.847), are embedded in a larger social and cultural environment (Berkman. Et al., 2000). Upstream forces like social stratification, political economy, and gender roles condition them (Berkman Et al., 2000). Moving downward, social networks act at the behavioral level through primary pathways, mainly “social engagement” and “social support”. These mechanisms in-turn operate at more proximal biologic and psychological pathways, to shape individuals’ health. Therefore, social relations are mainly influenced by social networks”, “social activities” and “social support” (Berkman. Et al., 2000).

Social networks are characterized by their size, the frequency of contact between members, and the nature of relationships between them (friends, relatives, children...etc.). Social activity, also known as “social participation” or “social engagement” might be informal, like meeting friends and attending events, or formal like participating in occupational tasks (Berkman. Et al., 2000). As for social support, it is often subdivided into emotional, instrumental, informational and appraisal support. *Emotional support* involves provision of empathy, trust, and reassurance. *Instrumental support* includes tangible aid like money, time, or any kind of help. *Informational support* is related to guidance and advice; and *appraisal support* represents help in decision-making and self-evaluation (Gottlieb and Bergen, 2010).

According to Kuiper and colleagues, social networks and social activity represent structural (i.e. quantitative) aspects of social relationships, while social support constitutes their functional (i.e. qualitative) aspects. In this thesis, we will address the structural aspects of social relations and their association with cognitive decline (Kelly et al., 2017).

2. Determinants of social relationships

Individual's social relationships are influenced by several socioeconomic, demographic and psychological factors (Umberson and Montez, 2010). For example, a higher socioeconomic class allows greater opportunity for individuals to create and maintain diverse social relations beyond the circle of close relatives (Ajrouch et al., 2005). Similarly, evidence suggests that individuals with higher education levels have less family centered and more diverse social networks (Ajrouch et al., 2005). Gender also is a determinant of social relations with women showing a greater tendency to have larger social networks and to receive support from many sources (Fuhrer and Stansfeld, 2002). On the other hand, men maintain close relations with fewer persons, mainly their spouse, therefore receiving most support from those intimate relationships (Fuhrer and Stansfeld, 2002). Furthermore, studies have shown that individuals who are married have extensive social networks and are more socially active compared to individuals who are non-married (Ertel et al., 2009). In addition, personality impacts individuals' capacity to establish and preserve social relations as well as the amount of support they need (Gleason et al., 2008). For instance, personality influences the individual's patterns of feelings and thoughts

arising in social situations (Barrett & Pietromonaco, 1997). Therefore, while for some, social relations might be regarded as stimulating, enjoyable, and necessary for well-being, for others, the relationships may be burdensome or simply not meaningful (Segel-Karpas et al., 2013).

Some physical and psychological health conditions can also affect social relations (Ofstedal et al., 1999). Studies revealed that individuals who suffer from depression, restricted activities of daily living (ADLs), or limitations on instrumental activities of daily living (IADLs) have fewer social connections and less social activities than their healthier counterparts (Bassuk et al., 1999).

3. Social relationships transitions from middle to old age

As people get older, their social relationships change (Wrzus et al., 2013). Several life events like bereavement, retirement, and increased functional limitations restrain social networks and might increase their risk of losing social relations (Charles and Carstensen, 2010). On the other hand, health problems and widowhood may consolidate individual's social network and mobilize support (McLaughlin et al., 2010). Furthermore, since individuals in their Third Age have fewer obligations and responsibilities, they have more time and freedom to engage in social activities they like (Higgs et al., 2003). Several studies have shown that age does not necessarily restrict social relations. Some older adults expand their social network and experience an improved quality of their social relations via

frequent contact with friends and neighbors, volunteering, and membership in religious groups (Cornwell et al., 2008).

Several theoretical frameworks have been developed to explore social relationships in the elderly (Gurung et al., 2003). The theories of activity (Knapp, 1977), continuity (Atchley et al., 1989) and socioemotional selectivity (Carstensen, 1992) are the most studied.

The activity theory emerged as a result of observations associating greater levels of social engagement with life satisfaction among older adults (Knapp, 1977). According to this theory, successful aging relies on the individual ability of older adults to keep active and take on productive roles in the society, replacing the ones that have been lost. These productive roles involve community-based social activities, such as volunteering, membership in social or religious groups, and paid work (Knapp, 1977).

The continuity theory suggests that, although older people adapt to the aging process by adjusting the mode, duration, and distribution of activities, they tend to engage in similar activities and to keep the same lifestyle adopted during middle age (Atchley et al., 1989). In other words, social activity patterns remain relatively stable during one's life course (Atchley et al., 1989). Therefore, any observed dynamism in the patterns and levels of social engagement is attributed to personal motivations and preferences for activities rather than age.

Following the life course perspective, the socioemotional selectivity theory assumes that people actively adjust their social network in old age by selecting relationships and

activities that are meaningful and that provide support, pleasure, and satisfaction. On the other hand, they set aside relationships and activities that are complex, burdensome, or stressful. This selection process is an important mechanism of adaptation in the goal of maintaining emotional well-being (Carstensen et al., 2003).

Together, these theories suggest that, although (Gurung et al., 2003) age-related changes in social relationships are inevitable; they should be regarded as the shifting in social interactions rather than a loss of social connections.

C. The association of social relationships and cognitive decline

Published studies suggest that poor social relations increase the risk of cognitive decline. The evidence, however, is inconclusive due to the lack of consistency in the terminology used (Baumgart et al., 2015).

In addition, few studies assessed structural and functional aspects of social relations separately and some considered aspects of social relations as part of lifestyle factors like intellectual or leisure activities. This prevents drawing conclusion regarding the distinct effects of specific social relations domains on cognitive decline (Cornwell et al., 2009).

Similarly, the measure of cognitive outcome differs across studies. While some studies tested global cognition (Simning et al., 2014), or domain-specific measures like attention (DiNapoli et al., 2014); others relied on cognitive batteries that assess multiple

cognitive domains (Seeman et al., 2011). This in turn complicates comparing empirical findings.

The few studies examining the effects of specific domains of social relationships on older adults' cognitive function most commonly assessed the frequency of engagement in social activities (Bielak et al., 2007), followed by social network size and structure (Holtzman et al., 2004), and social support (Ellwardt et al., 2013). The findings of those studies have been mixed. For example, a study based in the U.S. found that older adults with smaller social networks (measured by size and frequency of contact) had less cognitive decline than those living in larger social networks (Barnes et al., 2004). On the other hand, several studies found no evidence that social network is a predictor of cognitive decline (Amieva et al., 2010).

As for social engagement, the PAQUID study revealed that, after 3 years of follow-up, leisure activities (like knitting and gardening) lowered the risk of cognitive decline while social activity did not (Fabrigoule et al., 1995). On the other hand, a study done in Spain concluded that poor social engagement was a risk factor for cognitive decline among community-dwelling elderly (Zunzunegui et al., 2003).

The validity and reliability of instruments and measures used to study social relations are also of concern (Victor et al., 2000). Although some studies have evaluated social relations using reliable and valid tools (Hughes et al., 2008), scales have been modified (word changes, combining items...etc) or dichotomized according to the research

findings (Golden, Conroy, & Lawlor, 2009). This might alter the psychometric properties of the measures (Schwarz, 1998).

While it is well known that men and women have different needs and maintain social ties in different ways, only a few studies assessed associations between social relationships and cognitive function stratified by gender (Liao et al., 2017). In addition, most studies evaluating the association between social relations and cognitive decline are cross-sectional, making the assessment of temporality impossible. Moreover, most were conducted on Western populations. These findings suggest that further longitudinal studies are needed which use larger sample sizes and focus on non-Western countries where social and cultural concepts differ from Western countries (Glei et al., 2005).

The inconsistent findings stated above leave several questions to be answered.

First, which aspects of social relations prevent cognitive decline? Lack of detail in the assessments of functional and structural aspects of social relationships impedes the distinction of cognitively protective elements. For example, different types of social networks may not be equally cognitively beneficial. Since friendships are usually built based on shared interests and needs, friend networks might be more cognitively stimulating and diverse compared with relative networks which mainly involve routine tasks (Fiori and Jager, 2012). Understanding the extent to which specific aspects of social relations impact cognitive decline would generate well-targeted intervention.

Second, what is the temporal order of the association between social relations and cognitive decline? The direction of social relations-cognitive decline association needs to be further investigated.

Third, how does the association between social relations and cognitive decline differ by gender?

Accordingly, the aim of this thesis is to investigate the longitudinal associations between structural aspects of social relations (i.e. social network and social engagement) and cognitive decline. Also, differences by gender will be verified.

The corresponding hypotheses are:

Hypothesis 1: Structural aspects of social relationships have protective effects against cognitive decline. Specifically, older adults who have larger social networks and greater social engagement are at lower risk of cognitive decline.

Hypothesis 2: the relationship of social network and engagement with cognitive decline differs by gender.

CHAPTER III

METHODS

A. Study design/data source

Data were derived from the COLDS' study (Cohort of Older Adults in Lebanon: A Dementia Study), the first community-based cohort study conducted on Lebanese older adults to assess the risk of dementia in terms of incidence and to provide an update on its prevalence (Phung et al., 2015). The study also evaluates risk factors of dementia, mortality and morbidity of older adults and other outcomes such as institutionalization and health services utilization. In addition, it aims at measuring the caregivers' mental health and burden of care.

B. Study population and Sampling

The COLDS' study is a follow-up to a cohort of older adults aged 65 and above, who participated in an initial prevalence study in 2013. The cohort consisted of representative sample 508 community based older adults 65 years and above, residing in two areas in Beirut and two districts of Mont Lebanon, the largest governorate. The participants were chosen based on a stratified multistage cluster sampling with sample size in each area was proportional to its size in the population. Each participant identified an informant, who knew him/her very well and who could provide information on his/her wellbeing. Therefore 508 dyads of older adults and informants were chosen. Out of 508 older adult participants

in 2013, 476 initially consented to take part in follow up studies and were re-contacted in 2016-2017. Among the latter group, 69 refused to participate upon a phone call or home visit, 63 were lost to follow-up (30 were not found, 23 changed their address, seven traveled, and three were dead). Information was collected on 344 participants who were reachable and who completed themselves &/or their informants the follow-up interviews. The average follow up period was 3 years.

For this study, of the 344 participants, 71 were excluded according to the exclusion criteria or due to missing data: Three had missing data on their baseline cognitive state, one had a missing IQCODE score at follow-up, and 67 had dementia or cognitive decline (IQCODE greater than 3.34) at baseline. The final eligible sample for this longitudinal study was 273 older adults who were at risk of cognitive decline in 2013 (Appendix 1).

C. Concepts and Measures

1. Cognitive decline

The outcome variable, cognitive decline, was estimated using the Arabic version of the IQCODE (A-IQCODE), a reliable and validated informant-based instrument for assessing changes in everyday cognitive function (Phung et al., 2015). A-IQCODE has excellent psychometric properties for dementia screening among community older adults as well as those in hospitals or nursing homes. Its 16 items showed a high level of internal consistency (Cronbach's $\alpha= 0.97$). A total score of greater than 3.34 indicates cognitive decline. Sensitivity analysis showed that cutoff point of >3.34 has excellent predictive

power of dementia with 92.5% sensitivity, 94.4% specificity, and 91.5% Positive predictive value (Phung et al., 2015). The outcome was treated as a binary variable (“decline” vs. “no decline”).

2. Social network and Social engagement

This study investigated the structural aspects of social relationships: social network and social engagement.

The social network dimension consisted of the participant’s marital status (currently married vs non-married), and his/her contact with relatives, friends, and neighbors. Participants were asked: How often they see any of their children or other relatives to speak to, and how often they have a chat or do something with any of their friends and neighbors. Answers were dichotomized into two groups (frequently (i.e. at least once weekly) vs less frequently or never).

We used the following variables to evaluate social engagement: attending religious meetings (regularly vs. no or occasionally), engaging in any community activities such as going to clubs or attending lectures (regularly vs. no or occasionally), and involvement in any kind of paid work (yes vs. no).

Social network score and social engagement score were generated by adding up the responses of items comprising each concept. Scores ranged from 0 to 3.

Social network score included the participant's responses about marital status (1 for married and 0 for non-married) and the frequency of social contacts (1 for frequently and 0 for less frequently or never) across the two domains: relatives and friends.

The social engagement score was calculated by adding up the participant's answers to the frequency of engagement in the social activities cited above: 1 for "regularly" or "yes" and 0 for "no or occasionally".

3. Covariates

The selection of covariates for inclusion in the analysis was based on prior studies proving that they could be potential confounders (i.e. have been associated with both cognition and social relations) (Seeman et al., 2010). These included socio-demographic characteristics, health related factors, and health behaviors.

The sociodemographic variables that were considered for the study were: Age (categorized into three groups: 65 to 74 years, 75 to 84 and 85 years and above), gender and educational level (grouped into three categories: informal, primary/intermediate/vocational and secondary or higher).

Health-related factors included individual's physical wellbeing assessed by asking the elderly about any difficulties interfering with daily life activities (Yes vs. No), and depression (depressed vs. non-depressed) which was diagnosed using the GMS-AGECAT package. The latter is a standardized tool to assess mental state through which data are used

in a computer-assisted method to come-up with clinically based diagnoses of the principal types of dementia, depression and other mental disorders (Copeland & Dewey, 1991).

Health behavior variables included: Smoking status (never smoker vs. ever smoker) and physical activity (“physically active” or “not active”) assessed by asking older adults if they were doing any of the following activities for at least 30 minutes such as gardening, going to the gym, walking and other sports activities for 30 minutes that made them feel tired or sweat.

D. Statistical analysis

Descriptive analysis was performed to study the distribution of exposure variables (aspects of social network and social engagement) and covariates (sociodemographic, health-related and behavioral factors). The incidence of cognitive decline at 3 years of follow-up was calculated.

Chi-square test was used to assess the bivariate association of the main exposure variables and the potential covariates with cognitive decline. Unadjusted odds-ratios with their 95% Confidence intervals (CI) were reported using logistic regression models.

We calculated and reported adjusted Odds Ratios and their respective 95% CI for cognitive decline, using multiple logistic regression models. All exposure variables and covariates were considered for the multiple regression model. We performed pairwise correlations to check for collinearity to avoid the inclusion of redundant variables. Goodness

of fit of the final model was tested using Hosmer-Lemeshow test. All regression models were adjusted for cluster (geographical cluster) effect.

To explore the effect of Gender on the association between exposure variables and cognitive decline, stratification by gender was done at the bivariate and multivariate level for all the exposure variables. Unadjusted odds ratios (OR) along with their 95% confidence intervals (CI) were reported for females and males separately. Interaction terms were added to logistic regression models taking each social relationship variable into account to check for statistical significance of the interaction with gender.

Although the main focus of the study is to assess prospectively the association of social relations with cognitive decline, we ran same analyses on the baseline sample (502 participants) to check for any significant association between social relations variables and cognitive decline at baseline. This is in line with other cross-sectional studies that looked at the association between social relations and cognitive decline. It is worth noting that the characteristics of the 502 are similar to the follow up sample (273), the main focus in this study.

The significance level was set at $p < 0.05$. Stata version 14, and SPSS version 24 were used to perform all statistical analyses.

CHAPTER IV

RESULTS

A. Introduction

This chapter presents results of the statistical analysis and is organized as follows:

The first part focuses on the cohort sample which consists of 273 individuals. It includes descriptive statistics of the sample, bivariate and multivariate analyses.

The second part considered all older adults at baseline and the analysis was done cross-sectionally. Bivariate and multivariate analyses are included.

B. Longitudinal analysis

1. Descriptive analysis of the study population

The distribution of the study participants based on baseline sociodemographic, behavioral, and health-related factors of the respondents are presented in Table 4.1. There were 43 (15.7%) incident cases of cognitive decline after 3 years of follow-up. Females represented a little more than half of our sample (52.01%). The highest proportion of participants were aged between 64 and 74 years (66.6%). The majority (61.2%) have completed primary, intermediate, or vocational education. Little less than half (46.5%) reported a monthly income of L.L. 1,000,000 or above, equivalent to \$660.83.

As for the health status of respondents, one-fifth (20.6%) had disabilities affecting their daily life, and only 7.3% had depression. Around 73% of the participants were physically inactive, and 41% were ever smokers.

Distribution of participants according to main exposure variables are presented in Table 4.2.

Regarding the social network of participants, 60.7% were currently married. The majority (86%) had children or other relatives they frequently speak to, almost half of them (55.4%) have a chat or do something with any of their friends frequently, and about two thirds of them (60.5%) have a chat or do something with any of their neighbors frequently. As for social engagement, 54.7% of the respondents attended regular religious meetings. A small proportion (16.2%) was engaged in regular community activities and around 34.9% had a paid job.

Social network score was on average 2.4 ± 1.24 whereas the mean social engagement score was 1.36 ± 1.103 (table 4.5).

2. Bivariate analysis

Being a female and having difficulties interfering with daily life significantly increased the risk of cognitive decline (p-values 0.027 and 0.043 respectively) (Table 4.1).

Among factors related to the social network of older adults, a significantly smaller proportion of those who frequently saw/spoke to any of their children or other relatives developed cognitive decline compared to those who see their children or other relatives less frequently or never (14.29% compared to 29.41%, p-value=0.031) (Table 4.2). The odds of cognitive decline among those who contact their children or other relatives frequently was

0.4 times that of participants who contact their children or other relatives less frequently (95%CI=(0.17-0.91)) (Table 4.3). None of the social engagement factors was significantly associated with cognitive decline (Tables 4.2 and 4.3).

The association between social network score and cognitive decline was borderline significant (unadjusted OR=0.75, p-value=0.058) (Table 4.4). Social engagement score was not associated with cognitive decline (unadjusted OR=0.86, p-value=0.696) (Table 4.4).

3. Multivariate analysis

Table 4.3 shows the results of the multiple logistic regression of cognitive decline with social network and engagement factors adjusting for confounders.

The absence of statistical significance of the interaction terms created for each social relation variable (social relation variable*Gender) suggest no difference in the association between social relationships aspects and cognitive decline by gender. Thus, multivariate analyses were conducted with men and women combined.

Pairwise correlations revealed a statistically significant correlation between “being currently employed” and the covariate “income”. The covariate “income” was therefore dropped from the final model. Contact with neighbors was also excluded from the final model due to its high correlation with “contact with friends” ($r>0.6$, $p\text{-value}<0.05$).

Adjusting for age, gender, educational level, depression, difficulties in performing

daily activities, and other social factors, frequent contact with children or other relatives was significantly associated with lower odds of cognitive decline. In fact, the odds of cognitive decline among those who frequently see any of their children or other relatives to speak to was 0.37 times that of participants who see their children or other relatives less frequently (95%CI=(0.14-0.97)) after accounting for confounders.

None of the remaining social factors was significantly related to cognitive decline after adjusting for confounders. Using the Hosmer-Lemeshow test the p-value was 0.528 indicating that the model fits the data well.

Neither the social network score nor the social engagement score were statistically significantly associated with cognitive decline after accounting for gender, age, education, depression, physical activity, smoking, and disabilities affecting daily life (adjusted ORs and 95%CI respectively: 0.76(0.49-1.18) for social network score and 0.94(0.52- 1.69) for social engagement score) (Table 4.5).

B. Cross-sectional analysis

1. Bivariate analysis

Females and older age were significantly more likely to have cognitive decline (p-values for gender and for age<0.001). Higher level of education and higher income were significantly associated with less cognitive decline (p-values respectively=0.002 and 0.019) (Appendix 4).

Conversely, depression, having disabilities affecting daily life, and smoking were significantly associated with more cognitive decline (p-values respectively <0.001, <0.001 and 0.001). Physical activity was not associated with cognitive decline (p-value=0.254) (Appendix 4).

The absence of statistical significance of the interaction terms created for each social relation variable (social relation variable*Gender) suggest that the association between social relationships aspects and cognitive decline does not differ by gender. Thus, multivariate analyses were conducted with men and women combined (p-values not reported).

Similarly, the association between social network score and cognitive decline did not differ by gender (p-value for the interaction term=0.453) (table 4.9). Thus bivariate and multivariate analyses were conducted with men and women combined for the specific aspects of social network and social engagement as well as for the social network score.

The association between social engagement score and cognitive decline was significantly different between females vs males (p-value for the interaction term=0.021) (table 4.9). Therefore, bivariate and multivariate analyses were stratified by gender.

Regarding social network of elderly, a significantly smaller proportion of those who were currently married had cognitive decline compared to those who were non-married (19.35% compared to 11.84%, p-value=0.023) (Appendix 5). In fact, the odds of cognitive decline among those who were currently married was 0.55 times that of non-married participants (95% CI = (0.33-0.92)) (Table 4.6). In addition, a significantly larger proportion

of those who had a chat or did something with any of their neighbors had cognitive decline compared to those who contacted their neighbors less frequently or never (15.6% compared to 8.1%, p -value=0.028) (appendix 5). In fact, the odds of cognitive decline among those who frequently contact their neighbors was 2.08 times that of participants who contact their neighbors less frequently or never (95% CI=(1.08-4.02)) (table 4.6). Having frequent contact with children or other relatives and having frequent contact with friends were not significantly associated with cognitive decline (p -values= 0.154 and 0.371 respectively) (Appendix 5).

Social engagement variables were negatively associated with having cognitive decline: Those who frequently attended religious meetings and community activities were less likely to have cognitive decline (unadjusted ORs and 95% CI respectively: 0.08(0.02-0.26) and 0.132(0.03-0.55)). Likewise, being employed was significantly associated with less cognitive decline (unadjusted ORs and 95% CI=0.41(0.25-0.70) (Appendix 5).

The association between social network score and cognitive decline was not statistically significant (unadjusted OR and 95% CI=0.79(0.61-1.02)) (Table 4.8).

Social engagement score was associated with lower odds of cognitive decline in males and females. Among females, as social engagement score increased by 1 point, the odds of cognitive decline is multiplied by 0.51 (95% CI= (0.3-0.86)) (Table 4.9). Among males, as social engagement score increased by 1 point, the odds of cognitive decline is multiplied by 0.13 (95% CI= (0.05-0.36)) (table 4.9).

2.Multivariate analysis

Table 4.6 represents the results of the multiple logistic regression of cognitive decline with social network and engagement variables after controlling for confounders:

After adjusting for age, gender, education, depression, difficulties in daily life, smoking, physical activity, and other social factors, none of the social network indicators was significantly associated with cognitive decline. As for social engagement variables, only being currently employed remained significantly associated with lower odds of cognitive decline (OR=0.13, 95% CI (0.03-0.56)). Attending religious and community meetings were not significantly associated with cognitive decline after adjusting for confounders.

Hosmer-Lemeshow test reported p-value was 0.528 indicating that the model fits well our data.

The social network score was not significantly associated with cognitive decline after accounting for gender, age, education, depression, physical activity, smoking, and disabilities affecting daily life (adjusted OR and 95%CI=1.31(0.9-1.9)) (table 4.8).

After adjusting for confounders, social engagement score was significantly associated with cognitive decline only among males. As engagement score increased by 1 point, the odds of cognitive decline among males is multiplied by 0.16 (95%CI= (0.04-0.53)) (table 4.9).

CHAPTER V

DISCUSSION

A. Discussion of main findings

This study explored for the first time the relationship between cognitive decline and social network and engagement among older adults in Lebanon and the region.

Results have shown that frequent contact with children and close relatives, one aspect of social network, was negatively related to incident cognitive decline three years later. This association was independent of the influence of age, gender, education, income, depression, smoking, physical activity, and disabilities affecting daily life.

Our results agree with findings from Asian (Zhu et al., 2012) and Mediterranean countries (Ajrouch, Yount, Sibai, & Roman, 2013; Béland et al., 2005). They highlight the importance of support received from children and close relatives particularly in a country like Lebanon where the social life of elderly is centered on the family, while friends and neighbors play a lesser role.

While friends and neighbors are important to older adults' wellbeing in western countries (Fiori et al., 2008), no significant association with cognitive decline was found in the case of older adults in Lebanon.. This finding provides evidence for the important role of cultural context in shaping the social environment.

According to Ajrouch, Abdulrahim, and Antonucci (2013), since its independence in 1943, Lebanon has witnessed many political instabilities that have undoubtedly served as a source of stress over the life course. Lebanese elderly today went through the civil war (1975–1990) as well as ongoing political conflicts. In addition to causing stress, such events reduced the government’s ability to provide security in old age. As a result, family members are the major resource to meet the social and health needs of elderly. Therefore, social relations in Lebanon are based on instrumental rather than emotional needs (Ajrouch, Akiyama, & Antonucci, 2007).

None of the social activities assessed in our study was protective against incident cognitive decline. This is in line with the PAQUID study (1995), A cohort study of 2040 older community residents living in Gironde (France) who were followed-up one and three years after a baseline screening for dementia. Authors of the latter study revealed that active participation in leisure activities like gardening and knitting predicted lower risk of dementia, whereas participation in social activities and group memberships were not associated with less cognitive decline after three years of follow-up. They suggested that leisure activities require more control and attention than social activities and have a more powerful effect on delaying dementia (ibid). In contrast, the Honolulu Asia Aging Study, which followed 2,513 Japanese-American men since 1965, showed that social engagement and participation in activities like volunteer work and paid work could decrease the risk of dementia in older adults (Balfour et al., 2001).

Moving from specific indicators to the use of aggregated scores to reflect on social network size and the extent of social engagement, there was no evidence that larger social network or greater social engagement protect against cognitive decline. On the other hand, findings from the Baltimore Epidemiologic Catchment Area (ECA) study which suggested a significant association between large social networks and better cognitive function (Holtzman et al. 2004). One possible explanation for our finding is a lack of statistical power leading to a non-statistically significant association of social network size and the extent of social engagement with cognitive decline. Similarly, the limited variability in social network and engagement characteristics among participants could have decreased the likelihood of detecting a relationship. Another possible explanation is that the quality of social relations (i.e. social support) is more important than quantity. We did not assess, however, the qualitative aspects of social factors in our study. Lastly, even though memory is a main issue in cognitive decline, other functions like change in personality, attention and language are also part of the definition (Langlois & Belleville, 2014). While the IQCODE addresses mainly memory and instrumental activities of daily living (IADLs) (Grober, Wakefield, Ehrlich, Mabie & Lipton, 2017), social relations could affect other cognitive functions that the IQCODE focuses less on. This could have reduced the probability of capturing an association between social relations and cognitive decline in our sample.

One main objective of the study was to examine whether the association between cognitive decline and social factors differs by gender because of the marked distinction between the social roles of men and women in a patriarchal society such as the Lebanese

one (Ajrouch et al., 2013). We found no evidence of difference by gender. This is in line with previous findings suggesting that, due to the nature and dominance of family in Lebanon, there are few gender differences in either network structure or relationship quality in the elderly population (Antonucci et al., 2014).

There are several possible explanations for our findings. As the following theories were generated to explain the effect of social relations in general on cognitive decline, they could also be used to understand how contact with relatives particularly affects cognition.

Good social relations with relatives, throughout the life course generally, and in the late life specifically might generate continuous mental stimulation through recalling shared experiences and solving problems (Stern, 2012). This relates to the “use it or lose it” hypothesis which goes hand in hand with the cognitive reserve theory. The latter suggests that social interaction affects the brain structure by increasing neural growth and synaptic density thus delaying cognitive impairment. (Fratiglioni et al., 2004)

Second, Stress has been associated with cognitive decline as a result of structural changes in the hippocampus (Bassuk et al., 1999). The stress-buffering hypothesis suggests that the support provided by children and close relatives mitigates the harmful responses of the nervous system to stress (Fratiglioni et al., 2004).

Third, children and close relatives may influence older people’s health by motivating positive health behaviors like healthy dietary habits and better medication adherence which have a beneficial effect on cognitive function. Moreover, family members present multiple sources of information for the elderly that can help access health

information and make effective use of the available health services (Rizzuto and Fratiglioni, 2014). Encouraging a healthy lifestyle protects the mental and physical health of elderly (Beydoun et al., 2014).

However, these theories remain hypothetical because the mechanisms linking social relations and cognitive decline remain unclear. Future research should explore the detailed pathways to cognitive decline by taking into account physiological markers and factors reflecting mental stimulation (Saito et al., 2018).

B. Strengths and limitations

Our study is one of the few studies that used the IQCODE to estimate the incidence of cognitive decline. IQCODE is a validated tool used to assess cognitive decline and has very good psychometric properties. This minimizes measurement bias thus enhancing the internal validity of the study. Out of 273 individuals, 43 developed cognitive decline after 3 years of follow-up based on the IQCODE. However, a direct comparison of our results with other studies is not possible due to methodological issues like a difference in the study follow-up period and variability in the IQCODE cut-off score used to define cases with cognitive decline.

Furthermore, this study has used longitudinal data over 3 years from a nationally representative cohort of Lebanese older adults. Most previous studies have typically used community-based samples and have generally been cross-sectional (Fratiglioni et al., 2000; Zunzunegui et al., 2003). Contrary to most other studies based in western countries, this

analysis gives new insights into the effect of social factors on elderly cognitive function in a non-western population. It also mitigates the problem of reverse causality by excluding elderly who had cognitive decline at baseline. However, causality cannot be established since the gold standard for establishing a causal effect is a randomized control study. The latter is difficult to implement because the exposure is a constituent of the individuals' own social environment. In addition, rigorous analytical methods were adopted. As an example, in the multivariate analysis, multiple logistic regression was used adjusting for cluster effect. This has generated narrower confidence intervals thus increasing precision.

Our study has also some limitations. First, the absence of statistically significant associations between cognitive decline and several aspects of social relations in our study might be due to the small sample size that resulted in a lack of statistical power. For instance, the follow-up period of three years might not be sufficient to observe cognitive change. Second, although many covariates were taken into account and were accurately measured, the effect of other potential confounders like personality traits and cardiovascular risk factors might still be present. For example, cardiovascular diseases are known to increase the risk of cognitive decline (Lin, Yang, Fillit, Cohen & Neumann, 2014), therefore they could act as positive confounders in the association between social relations and cognitive decline. Third, measures of social network and engagement relied on self-report which could be subject to recall-bias. Another potential issue related to self-report is social desirability bias. Despite assuring anonymity and confidentiality, older adults might be unwilling to provide accurate information about topics they deem sensitive

like having low levels of support from children and close family members, and having few or no close friends. Even if some misclassification has resulted, it is unlikely that it affected the results in a differential pattern as the data were collected and subjects were followed-up irrespective of their IQCODE score. Therefore, the relationship between social relations and cognitive decline could be underestimated. Fourth, while empirical evidence has indicated that both qualitative and quantitative aspects of social relations are important to predict health outcomes (Voils et al., 2007), the use of secondary data allowed measuring social network and engagement only based on frequency. The available data did not include information about some important features reflecting the quality of social relations like burden and satisfaction. Future studies should rely on measures that include both quantity and quality of social relations in order to come-up with more accurate findings on how they affect cognitive decline in late life. Lastly, while the aim of our study was to explore the effect of social network and engagement at baseline on incident cognitive decline after 3 years, it did not assess the influence of a change in social interaction on the incidence of cognitive decline.

C. Study implications

In light of our finding on the link between cognitive decline and relations with children and close relatives, complaints by older adults about low levels of support from their family might act as psychosocial risk factors for future cognitive decline. Thus, they may require more attention on the part of healthcare professionals while addressing the

mental health needs of older adults. Moreover, some emerging trends need to be considered while assessing the social environment of elderly. For example, new technologies like webcams and smartphones allow older adults to maintain contacts with family members and close friends and to develop new social connections. This aspect of social relations needs to be further explored in terms of its inclusion into scales measuring social networks of elderly. In addition, these new means of communication may trigger cost effective interventions to keep the elderly connected with people. This is especially important in Lebanon to decrease the influence of youth migration and the reduced availability of children next to their old parents. Finally, the role of family members in Lebanon extends beyond the provision of basic care and emotional support to the elderly. These responsibilities pose a great burden on the caregiver in addition to the psychological, physical, and financial consequences that could result especially when the elderly is cognitively impaired. Therefore, country stakeholders need to recognize the importance of implementing well-tailored interventions to reduce the burden of informal elderly care and supplement it by formal care provision.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

As people live longer, there is an increased need to explore factors affecting physical and mental health in later life. Dementia characterized by gradual cognitive decline is one of the consequences of population ageing .This study contributes to the understanding of the complexity of social relations and their influence on cognitive function among Lebanese older adults. It provides evidence that frequent contact with children and close relatives protects against cognitive decline likely through cognitive stimulation, stress buffering, and promotion of healthy behaviors.

Our study underlines the need for further studies exploring both the structural and functional aspects of social relations and their association with cognitive decline using a larger sample and over a longer follow-up period. For instance, in efforts towards successful ageing, more attention needs to be given to psychosocial factors in future observational and interventional studies on cognitive decline and dementia locally and globally. Moreover, future longitudinal studies should explore in a comprehensive framework how social interactions and cognitive status would change throughout the follow-up period and the dynamics through which they would influence each other. It is also important to highlight the need to define and measure cognitive decline and social relationships more clearly and to achieve consistency across studies that allows the comparison of results and the generation of stronger evidence based recommendations. In

fact, qualitative studies are needed to develop conceptualized tools for the measurement of social relations since many of their aspects are context specific.

In addition, our findings are of critical importance for health professionals as they must consider the availability of social resources while addressing the health needs of elderly patients. Physicians should focus on social and physical factors equally during patient assessment for the risk of cognitive decline.

Finally, the healthcare system in Lebanon needs to prioritize mental health of elderly. The primary focus of policy makers should shift away from acute care towards greater investment in the provision of on-going support to older adults and their families.

TABLES

Table 4.1: Socio-demographic, health-related, and behavioral risk factors among study participants and their bivariate associations with cognitive decline (N = 273).

Variables	Categories	Total N (%)	Cognitive decline N=43 (15.75%)	P value of the Chi-square test
Socio-demographic factors				
Age	Below 75	182 (66.6)	26(14.2)	0.643
	75-84	75(27.4)	14(18.6)	
	85 and above	16(5.8)	3(18.7)	
Gender	Female	142(52)	29(20.2)	0.027
	Male	131(47.9)	14(10.6)	
Educational level	none or informal	56(21)	9(16)	0.984
	primary, intermediate, vocational	163(61.2)	26(15.9)	
	secondary or higher	47(17.6)	8(17)	
Monthly income	<1,000,000 L.L.(equivalent to 660.83\$)	116(53.4)	22(18.9)	0.102
	1,000,000 L.L. and above	101(46.5)	11(10.9)	
Health indicators				
Disability	No	200(79.3)	27(13.5)	0.043
	Yes	52(20.6)	13(25)	
Depression	No	253(92.6)	39(15.4)	0.589
	Yes	20(7.3)	4(20)	
Behavioral risk factors				
Physical activity	No	173(73)	30(17.3)	0.546
	Yes	64(27)	9(14)	
Smoking	Never smoker	157(59)	25(15.9)	0.898
	Ever smoker	109(40.9)	18(16.5)	

Table 4.2: Social network and engagement characteristics of study participants at follow-up and their bivariate associations with cognitive decline (N = 273)

Variables	Categories	N (%)	N(%) declined	P-value of the chi-square test
Social network				
Marital status	Non-married	104(39.2)	20(19.2)	0.288
	Married	161(60.7)	23(14.2)	
How often do you see any of your children or other relatives to speak to?	frequently	210(86)	30(14.2)	0.031
	Less frequently or never	34(13.9)	10(29.4)	
How often do you have a chat or do something with any of your friends?	frequently	147(55.4)	19(12.9)	0.184
	Less frequently or never	118(44.5)	23(19.4)	
How often do you have a chat or do something with any of your neighbors?	frequently	138(60.5)	17(12.3)	0.176
	Less frequently or never	90(39.4)	17(18.8)	
Social engagement				
Attending religious meetings	No or occasionally	120(45.2)	20(16.6)	0.860
	Yes regularly	145(54.7)	22(15.8)	
Attending community meetings	No or occasionally	221(83.7)	36(16.2)	0.999
	Yes regularly	43(16.2)	7(16.2)	
Do you have a job	No	173(65)	33(19)	0.083
	Yes	93(34.9)	10(10.7)	

Table 4.3: Unadjusted and adjusted odds ratios (OR) of cognitive decline and their 95% confidence interval (CI) for social network and engagement variables among a sample of Lebanese older adults (N= 273)

Social network and engagement variables	Unadjusted OR (95%CI)	adjusted OR (95% CI) §
Are you currently married? (non-married) Married	0.7(0.36-1.35)	1.03(0.42-2.49)
How often do you see any of your children or other relatives to speak to? (less frequently or never) frequently	0.4(0.17-0.91)	0.37(0.14-0.97)
How often do you have a chat or do something with any of your friends?(less frequently or never) frequently	0.61(0.31-1.18)	0.59(0.25-1.39)
How often do you have a chat or do something with any of your neighbors?(less frequently vs never) frequently	0.6(0.29-1.25)	-
Do you have a job?(no) Yes	0.51(0.23-1.09)	0.96(0.27-3.43)
Membership in community meetings(No or Occasionally) Yes, regularly	0.99(0.41-2.42)	1.41(0.43-4.55)
Religious meetings (No or Occasionally) Yes, regularly	0.94(0.48-1.81)	0.53(0.2-1.36)
§adjusted for age, gender, education, and physical activity. The model is a good fit with a p-value of 0.8472 Note: contact with neighbors was dropped from the final model due to the high correlation between “contact with neighbors” and “contact with friends”		

Table 4.4: Summary statistics for follow-up social network and engagement scores among sample of Lebanese older adults (N= 273) and their bivariate association with cognitive decline

Scores	Mean (+/- SD)	Mean+/-SD among newly declined	P value
Social network score*	2.4(+/-1.24)	2.46+/-1.24	0.058
Social engagement score‡	1.36(+/-1.103)	1.30+/-1.05	0.696
*Social network score involves marital status, frequent contact with relatives, and frequent contact with friends.			
‡Social engagement score involves having a job, involvement In community meetings and involvement in religious meetings.			

Table 4.5: Unadjusted and adjusted odds ratios (OR) of cognitive decline and their 95% confidence interval (CI) for social network score, social engagement score, and social relations score among sample of Lebanese older adults at follow-up (N= 273)

Scores	Unadjusted OR (95%CI)	adjusted OR (95% CI) §
Social network score (continuous)	0.75(0.54-1.05)	0.76(0.49-1.18)*
Social engagement score (continuous)	0.86(0.59-1.25)	0.94(0.52- 1.69)**
§ adjusted for gender, age, Depression, physical activity, smoking, education, difficulties in daily life. *The model is a good fit with a p-value of 0.8637 **The model is a good fit with a p-value of 0.947		

Cross sectional analysis (n=502)

Table 4.6: Unadjusted and adjusted odds ratios (OR) of cognitive decline and their 95% confidence interval (CI) for social network and engagement variables among sample of Lebanese older adults at baseline (N= 502)

Social network and engagement variables	Unadjusted OR (95%CI)	adjusted OR (95% CI) §
Are you currently married? (non-married)		
Married	0.55(0.33-0.92)	1.65(0.76-3.57)
How often do you see any of your children or other relatives to speak to? (less frequently or never)		
frequently	1.98(0.76- 5.15)	1.44(0.46-4.48)
How often do you have a chat or do something with any of your friends? (less frequently or never)		
frequently	0.79(0.48- 1.31)	0.88(0.42-1.84)
How often do you have a chat or do something with any of your neighbors? (less frequently vs never)		
frequently	2.08(1.08-4.02)	-
Do you have a job?(no)		
Yes	0.08(0.02-0.26)	0.13(0.03-0.56)
Membership in community meetings (No or Occasionally)		
Yes, regularly	0.132(0.03-0.55)	0.48(0.09-2.47)
Religious meetings (No or Occasionally)		
Yes, regularly	0.41(0.25-0.70)	0.54(0.25-1.16)
§adjusted for age, gender, education, depression, difficulties in daily life, smoking and physical activity. The model is a good fit with a p-value of 0.5286		

Note: contact with neighbors was dropped from the final model due to the high correlation between “contact with neighbors” and “contact with friends”

Table 4.7 : Summary statistics for baseline social network and engagement scores among sample of Lebanese older adults (N= 502) and their bivariate association with cognitive decline

Scores	Mean (+/- SD)	Mean+/-SD among newly declined	P-value of t-test
Social network score	1.9(+/-0 .94)	1.72(+/-0.95)	0.071
Social engagement score	0.99(+/-0.89)	0.42(+/-0.54)	0.000

Table 4.8: Unadjusted and adjusted odds ratios (OR) of cognitive decline and their 95% confidence interval (CI) for social network score, social engagement score among sample of Lebanese older adults at baseline (N= 502)

Scores	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Social network score (continuous)	0.79(0.61-1.02)	1.31(0 .90-1.90)*
Social engagement score (continuous)	0.31(0.20-0.46)	0.36(0.21- 0.61)**

*Adjusted for gender, age, Depression, physical activity, smoking, education, difficulties in daily life.
The model is a good fit with a p-value of 0.768
** Adjusted for gender, age, Depression, smoking, and difficulties in daily life
The model is a good fit with a p-value of 0.5174.

Table 4.9: Unadjusted odds ratios (OR) of cognitive decline and their 95% confidence interval (CI) for social network and engagement scores stratified by gender at baseline (N=502)

Covariates	Females		Males		p-value*
	Unadjusted OR (95%CI)	Adjusted OR (95%CI)	Unadjusted OR (95%CI)	Adjusted OR (95%CI)	
Social network score (cont.)	1.00(0.73- 1.38)	1.2(0.84-1.89)	0.79(0.45-1.36)	1.8(0.62-5.19)	0.453
Social activity score (cont.)	0.51(0 .3-0.86)	0.56(0.28-1.12)	0.13(0.05-0.36)	0.16(0.04-0.53)	0.021
* p-value for the interaction term					

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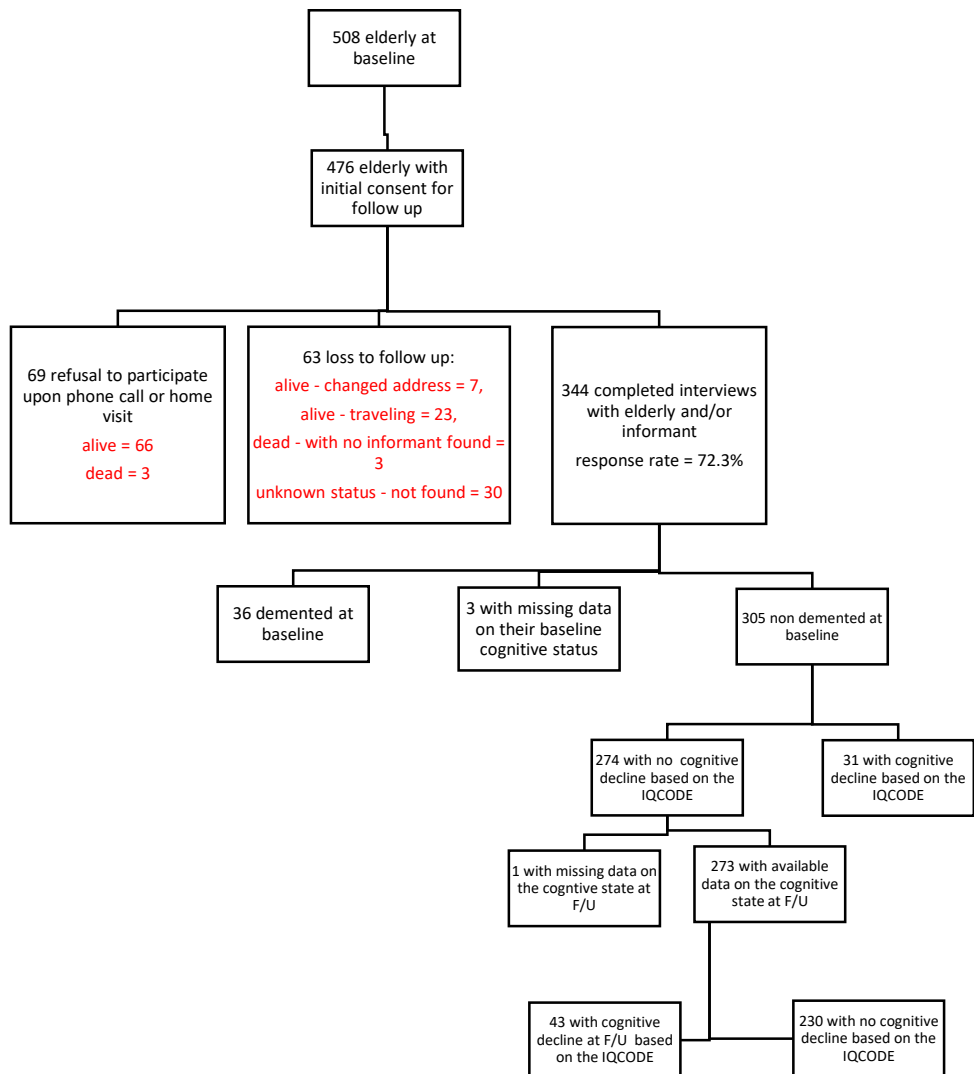
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APPENDIX

I. Flowchart of study participants



Unadjusted odds ratios (OR) of cognitive decline and their 95% confidence interval (CI) for social network and engagement variables stratified by gender at follow-up (N=273)

Covariates	Females	Males	p-value*
	Unadjusted OR (95%CI)	Unadjusted OR (95%CI)	
Are you currently married? (non-married) Married	0.78(0.33-1.85)	2.4(0.30- 20.23)	0.320
How often do you see any of your children or other relatives to speak to? (less frequently or never) frequently	0.38 (0.12-1.3)	0.46(0.1-2.96)	0.830
How often do you have a chat or do something with any of your friends?(less frequently or never) frequently	0.53(0.22-1.2)	1.2(0.34-4.1)	0.293
How often do you have a chat or do something with any of your neighbors?(less frequently vs never) frequently	0.59(0.23-1.4)	0.61(0.18-2.05)	0.955
Do you have a job?(no) Yes	0.288(0-1.9)	1.28(0.34- 5.97)	0.989
Membership in community meetings(No or Occasionally) Yes, regularly	1.22(0.53- 2.8)	0.58(0.18-1.79)	0.297
Religious meetings (No or Occasionally) Yes, regularly	0.83(0.16- 4.07)	1.72(0.53-5.6)	0.468
* p-value for the interaction term			

Unadjusted odds ratios (OR) of cognitive decline and their 95% confidence interval
 III. (CI) for social network and engagement scores stratified by gender at follow-up
 (N=273)

Covariates	Females	Males	p-value*
	Unadjusted OR (95%CI)	Unadjusted OR (95%CI)	
Social network score (cont.)	0.72(0.5-0.99)	1.04(0.68-1.58)	0.167
Social activity score (cont.)	0.92(0.45-1.87)	1.09(0.63-1.88)	0.700
* p-value for the interaction term			

IV. Socio-demographic, health-related, and behavioral risk factors among study participants and their bivariate associations with cognitive decline at baseline (N=502)

Variables	Categories	Total N(%)	Cognitive decline N=75 (14.9%)	P value of the Chi-square test
Socio-demographic factors				
Age	Below 75	330(65.7)	30 (9)	0.000
	75-84	138 (27.4)	33(23.9)	
	85 and above	34 (6.7)	12(35.2)	
Gender	Female	282(56.1)	57(20.2)	0.000
	Male	220(43.8)	18(8.18)	
Educational level	none or informal	106(21.6)	23(21.7)	0.002
	primary, intermediate, vocational	292(81.2)	45(15.4)	
	secondary or higher	92(18.7)	4(4.3)	
Health status				
Disability	No	333(71.4)	19(5.7)	0.000
	Yes	133(28.5)	52(39.1)	
Depression	No	449(89.4)	54(12)	0.000
	Yes	53(10.5)	21(39.6)	
Behavioral risk factors				
Physical activity	No	399(81.2)	62(15.5)	0.254
	Yes	92(18.7)	10(10.8)	
Smoking	Never smoker	302(61.5)	58(19.2)	0.001
	Ever smoker	189(38.4)	14(7.4)	

V. Social network and engagement characteristics of study participants and their bivariate associations with cognitive decline at baseline (N = 502)

Variables	Categories	N (%)	N(%) declined	P-value of the chi-square test
Social network				
Marital status	Non-married	186(37.9)	36 (19.3)	0.023
	Married	304(62)	36 (11.8)	
How often do you see any of your children or other relatives to speak to?	Less frequently or never	61(13.6)	5 (8.2)	0.154
	frequently	386(86.3)	58(15)	
How often do you have a chat or do something with any of your friends?	Less frequently or never	224(45.8)	36 (16)	0.371
	frequently	265 (54.19)	35(13.2)	
How often do you have a chat or do something with any of your neighbors?	Less frequently or never	159 (37.2)	13 (8.1)	0.028
	frequently	268 (62.8)	42 (15.6)	
Social engagement				
Attending religious meetings	No or occasionally	217(44.2)	45(20.7)	0.001
	Yes regularly	273(55.7)	27 (9.8)	
Attending community meetings	No or occasionally	411(84.2)	69 (16.7)	0.001
	Yes regularly	77 (15.7)	2 (2.6)	
Do you have a job	No	341(69.4)	69 (20.2)	0.000
	Yes	150(30.5)	3 (2)	

