The Association Between Social Support Availability and Executive Function in the Canadian Longitudinal Study on Aging

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

While an aging population is a good indication of advances being made in health and life expectancy, demographic change presents new concerns for public health. An older population faces different challenges than a younger one, including an increase in the proportion of the population at risk for age-related declines in cognitive function. This is of particular concern given the importance of cognition in everyday functioning and adaptation to change. Although most risk factors of cognitive decline are determined in early life or develop over the lifespan, some may still be altered in late life. Social support has been previously investigated as a potential area of intervention and has been positively associated with many health outcomes in later life, including cognitive function. However, the role of perceived social support availability (SSA) has not been investigated in depth. Specifically, the relationship between different subtypes of SSA and specific domains of cognitive function—such as executive function—is not well understood. This is particularly true for the association between low levels of different types of SSA and lower cognitive function.

This study utilized cross-sectional baseline data from the comprehensive cohort of the Canadian Longitudinal Study on Aging (CLSA). The CLSA is an ongoing prospective cohort study looking at community-dwelling adults who were between the ages of 45 and 85 years at recruitment. The 30,097 participants in the comprehensive cohort were selected from volunteers living within 25-50 km of one of the 11 different data collection sites across seven provinces. Multiple cognitive measures were used to assess executive function, a key domain of cognition required for controlling behaviour, planning, and purposeful decision making. Bivariate and logistic regression analyses were completed to assess the associations between SSA and executive function. SSA was operationalized using a measure of functional support, which assesses the subjective experience of support—how much support an individual

perceives as available to them when needed. This study builds upon previous research which has largely depended on structural definitions of support—such as marital status and number of relatives—that are more readily available in large population-based studies, but may be less accurate in assessing how much support participants actually receive when needed.

Specific aims of the current study were to investigate whether low SSA (overall and subtypes: tangible, affection, emotional/informational, and positive social interactions) is associated with executive function after stratifying for sex and adjusting for potential confounders (i.e., age group, province, education, household income, urban/rural residence, depression, self-rated health, chronic conditions, marital status, pet ownership, and loneliness). After accounting for said covariates, low affection SSA, emotional/informational SSA and positive social interactions were significantly associated with low executive function in the non-stratified analyses. In women, low tangible SSA and low positive social interactions were also significantly associated with low executive function, as was low emotional/informational SSA in married women. No subtype of SSA was significant in male models after the inclusion of all covariates.

These findings add to existing evidence that psychological and social factors play a role in mid- to later-life and indicate that SSA—particularly specific subtypes—may be beneficial to cognitive function in middle-aged and older adults. Increasing awareness of, and access to, available SSA resources may be one potential strategy to buffer against age-related cognitive decline. By utilizing multiple time points, future work with longitudinal data can build upon the current results by establishing temporality and further investigating the association between specific subtypes of SSA and executive function over time.

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ADL	Activities of Daily Living
AFT	Animal Fluency Test
APOE	Apolipoprotein E
APP	Amyloid Precursor Protein
CA	Census Agglomerations
CATI	Computer-Assisted Telephone Interviews
CCHS	Canadian Community Health Survey
CI	Confidence Intervals
CIHR	Canadian Institutes of Health Research
CLSA	Canadian Longitudinal Study on Aging
CMA	Census Metropolitan Area
COWAT	Controlled Oral Word Association Test
DCS	Data Collection Centre
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
HR	Provincial Health Registries Mail-outs
HR1	Initial Health Registry Mail-outs
HR2	Health Registry Mail-outs Targeting Low-Education Areas
IADL	Instrumental Activities of Daily Living
MCI	Mild Cognitive Impairment
MOS-SSS	Medical Outcomes Survey – Social Support Survey
PFC	Prefrontal cortex
RDD	Random Digit Dialing
RTS	Random Targeted Sampling
SSA	Social Support Availability
Stroop	Victoria Stroop Neurological Screening Test
TMT	Time-based Prospective Memory Test
TS	Targeted Sampling

1.0 Introduction

The population is aging at a national and global level. Internationally for the first time in history, seniors, defined as those 65 or older, will outnumber children under five, with the senior population expected to reach 1.5 billion by 2050 (WHO & US National Institute of Aging (NIA), 2011). At the national level, as of 2015, the proportion of Canadians over the age of 65 has already surpassed the proportion under the age of 15 (Statistics Canada, 2015). Seniors now account for 17.2% of the total national population (Statistics Canada, 2019) and this age group is predicted to reach 20.1% by 2024 due to the aging of the baby boomer generation and improvements in life expectancy (Statistics Canada, 2015). While this aging trend is not uniform across the country, with some provinces experiencing much higher senior populations than others (e.g., 19% in New Brunswick compared to 11.6% in Alberta), it can be expected that these coming changes in demographics will have profound effects on social and health care services and public policy (Statistics Canada, 2015).

While an aging population is a good indication of advances being made in health and life expectancy, demographic change presents new challenges that must be addressed. Non-communicable diseases, which often develop over the lifespan, are more common in older adults, and are now considered the greatest burden on health world-wide (WHO & NIA, 2011). Of Canadian seniors polled in 2009, 89% reported experiencing one or more chronic conditions, including high blood pressure (56%), heart disease (23%) and stroke (4%) (Chief Public Health Officer of Canada, 2010). Further, the percentage of individuals with chronic diseases continues to increase with age within older adult populations. For example, the percentage of individuals with arthritis increased from 44% in those over the age of 65 to 85% in those over the age of 75 (Chief Public Health Officer of Canada, 2010).

In addition to physical changes, cognitive function may be altered over the lifespan. Age-related declines in cognitive function are of particular concern at both an individual and societal level due to the importance of cognition in everyday functioning and adaptation to physical and social changes. These cognitive changes may be minor—having little impact on day-to-day life—or may overwhelmingly devastate all areas of a person's life and limit their ability to live independently, as seen in dementia, a type of neurodegenerative disorder. Nationally, 85% of those aged 45 to 75 living with dementia report that they required informal support for daily activities such as making meals (88%) and transportation (92%) (Wong, Gilmour & Ramage-Morin, 2016). As the disease progresses, higher levels of informal and formal care are required and of those living in long-term care, 45% have been diagnosed with some form of dementia, with the prevalence increasing to 56% for those over the age of 80 (Wong et al., 2016).

There is no cure for the most common forms of dementia, including Alzheimer's disease, and the prevalence increases with age (Wong et al., 2016). In Ontario, the mean age of persons with dementia was 81.5 years, and over 40% of those with the diagnosis were over the age of 85 (Ng et al., 2015). Given that the population is aging, the number of people living with age-related cognitive declines, including dementia, is likely to increase. Already, between 2004/2005 and 2010/2011, the prevalence of dementia has increased from 1.63% to 1.97% in those over 40, and the number of individuals diagnosed with dementia increased by almost 45,000 (Ng et al., 2015). Globally, 25 to 30% of people over the age of 85 are believed to have dementia (WHO & NIA, 2011) and the number of people living with dementia is expected to further double in the coming decades as the overall population ages (Wong et al., 2016).

While these trends demonstrate that the population overall is aging and thus non-communicable diseases and age-related changes in cognitive function are increasing, there is still great diversity in how individuals experience the aging process. As can be seen by the above statistics, while many seniors may be impacted by chronic conditions not everyone will experience them. Some seniors demonstrate generally low levels of physiological and cognitive decline despite advanced age, while others begin to experience increasing fragility in midlife. Understanding what processes permit some individuals to reach older adulthood—or death—without loss of independence, while others experience devastating declines in health beginning in middle age or earlier, is key to the development of public health policy and programs that may help reduce the development of these conditions.

Investigating what factors impact an individual's cognitive function has become even more important in the face of a rapidly aging population. In past work, researchers have discovered a variety of modifiable factors that may influence the risk of dementia or cognitive decline in different domains of cognitive function; however, most require interventions long before the early symptoms of cognitive decline develop. While these factors provide important forms of primary prevention, it is also necessary to have potential secondary and tertiary interventions that can be utilized in those who are at a greater risk for cognitive decline or already experiencing symptoms of low cognitive function

Psychosocial factors, such as social support, are a potential area of intervention that could help buffer the effects of cognitive decline over the lifespan. Largely due to the type of data available, previous research in this area has concentrated more heavily on how structural—or objective—measures of support, such as marital status or number of friends, are associated with outcomes relating to cognitive function. However, functional support,

which considers ratings of an individual's subjective experience of support, may be better able to accurately assess how much support an individual actually perceives themselves as having access to. The mechanism through which social support alters cognitive function is not well understood, and several theories have been proposed to explain the variety of evidence suggesting that the availability of support can impact cognitive outcomes in later life. However, there is still much unknown about what types of social support are associated with the different domains of cognitive function and why they may be associated. In particular, the role that functional support may play in maintaining or improving cognition across the lifespan is an area that requires further attention.

The purpose of this study was to address deficiencies in the current knowledge regarding the association between social support and the executive function domain of cognitive function, and how this association is impacted by key factors. Specific aims of the study were to investigate whether low SSA (overall and subtypes: tangible, affection, emotional/informational, and positive social interactions) is associated with low executive function, stratifying by sex, and adjusting for potential confounders (i.e., age group, province, education, total household income, urban/rural residence, depression, self-rated health, at least one chronic condition, marital status, pet ownership, and loneliness).

To address these aims, the presented research utilized secondary data from the comprehensive cohort of the CLSA. The CLSA is an ongoing prospective cohort study designed with the intention of bettering the understanding of the process of healthy aging in the Canadian population. Participants who were between the ages of 45 and 85 years at recruitment (2010–2015) are being followed for a minimum of 20 years and assessed at approximately three-year intervals, with the first follow-up taking place between 2015 and

2018. In total, over 50,000 Canadians were recruited into the study, which is divided into two cohorts: Comprehensive and Tracking. All 30,097 participants in the Comprehensive cohort were recruited from within 25–50 km of one of the 11 different data collection sites (DCS) across seven provinces and completed at-home and DCS interviews with trained CLSA interviewers who collected physical and cognitive data (Raina et al., 2009).

Perceived SSA was determined using the Medical Outcomes Study Social Support Survey (MOS-SSS), which assesses overall SSA, as well as four subtypes: tangible, affection, emotional/informational, and positive social interactions (Sherbourne & Stewart, 1991). Executive function, a domain of cognitive function that has been shown to be useful in the detection and identification of cognitive decline, was assessed as the outcome. Analyses further assessed for a variety of potential confounders.

As the population continues to age, and a greater proportion of the overall population becomes vulnerable to age-related declines, having a better understanding of how different forms of social support are associated with specific domains of cognitive function may inform late-life public health initiatives. In particular, understanding which types of support are associated with poor cognitive outcomes will help guide future research and initiatives aimed at helping adults maintain their cognitive functioning (e.g., tangible support programs such as shopping assistance services, or programs that teach emotional support skills to children and adults earlier in the lifespan).

2.0 Literature Review

2.1 Cognitive Function

Cognitive function can be understood as a collection of mental processes that permit an individual to complete both basic life-sustaining and complex tasks, and is therefore an important indicator of successful aging. Overall cognitive function is the combination of several different overlapping mental processes and can be measured at the global level, as well as by domain. While there is not a consensus on the number of domains of cognitive function, the Neurocognitive Work Group of the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) defined six domains key to the definition of neurocognitive conditions: executive function, complex attention, learning and memory, language, perceptual-motor function, and social cognition (Sachdev et al., 2014). Of these domains, executive function has been indicated as particularly important to successful aging, given its role in the tasks required for daily independent living (McAlister & Schmitter-Edgecombe, 2016).

2.1.1 Executive Function

Executive function refers to processes that occur when the mind is required to act in a non-automatic way, such as in instances of purposeful decision making (Suchy, 2009). In a review of executive function, Diamond (2013) identifies three generally accepted key subtypes of executive function: inhibition, working memory, and cognitive flexibility. These three key subtypes are included in the six subdomains of executive function identified in the DSM-5: inhibition, working memory, flexibility, planning, decision-making, and responding to feedback (Sachdev et al., 2014).

Inhibition—or self-control—involves suppressing temptations and impulses, and controlling behaviour and attention in order to react appropriately in a given situation while

organizing and coordinating a response (Diamond, 2013). It further allows an individual to ignore unimportant or background stimuli to concentrate on a chosen idea or task. Declines in the inhibition subdomain would lead to increases in impulsivity and impatience, as well as decreases in attention and discipline. Tests used to assess inhibition include the Stroop Neurological Screening Test (Stroop) and delay-of-gratification tasks (Diamond, 2013).

The second subtype of executive function, *working memory*, is necessary for following instructions, communicating with others, connecting and applying ideas to come up with plans or solutions, as well as logical reasoning (Diamond, 2013). Working memory is distinct from the memory domain of cognitive function as it requires an individual to be able to manipulate the information being stored, rather than just remembering it, and the processes have been shown to develop separately: short-term memory is present in very young children, while working memory develops throughout childhood and adolescence (Diamond, 2013). Popular tests of working memory ask participants to reorder a list of memorized items (e.g., alphabetically) or to repeat a series of actions demonstrated by the administrator.

Finally, *cognitive flexibility* involves being able to take on different perspectives and to adjust to new and changing situations or demands (Diamond, 2013). An important part of cognitive flexibility is the ability to task-switch, which has been tested using many different measures, including the Dimensional Card Change Sort Test and the Mental Alternation Test (MAT). Assessments of verbal fluency are also often used to assess cognitive flexibility. These include semantic or categorical fluency tests in which participants must list as many examples as possible of a given category (e.g., animals) within a time period, such as the Animal Fluency Test (AFT). Alternatively, tests may assess letter fluency, such as the

Controlled Oral Word Association Test (COWAT), in which participants list words starting with a specific letter (Diamond, 2013; Tuokko, Griffith, Simard, & Taler, 2017).

The complex nature of executive function is reflected in the brain structures that are believed to be associated with this cognitive domain, including the prefrontal cortex (PFC), which is made up of the dorsolateral PFC, the superomedial PFC, and the ventral PFC (Suchy, 2009). The PFC is divided into the left PFC, responsible for initiation, and the right PFC, associated with inhibition. In addition, the parietal lobe, basal ganglia, thalamus, and cerebellum are also considered to be important neural structures in the integration and activation of executive function responses (Suchy, 2009). Due to the diverse and complex tasks included in executive function and the broad collaboration of different areas of the brain, this domain of cognitive function is of particular concern for research in age-related cognitive decline.

2.1.2 Decline in Cognitive Function

Rather than as a permanent state, overall level of cognitive function can be better understood as a spectrum ranging from optimum function to severe disability. An individual can be situated at different points along the spectrum across their lifespan and may transition back and forth between many stages as they age. In general, however, most people see a worsening of cognitive function over time, and all three subtypes of executive function have been found to decline with age (Diamond, 2013). Although there is less research specific to executive function, overall declines in cognitive function can have overwhelmingly negative impacts on an individual's ability to function and respond to aging-related physical and social changes. Even on brief measures of cognitive function, individuals with more errors demonstrate an increased risk of developing limitations in their activities of daily living

(Moritz, Kasl, & Berkman, 1995). Cognitive function has further been shown to have a negative relationship with frailty (Kim, Park, Hwang, & Kim, 2014), with frailty in older adults further associated with increased risk of functional and cognitive decline as well as mortality (Hoogendijk et al., 2014). Combined, tests of different domains of executive function may be able to identify early declines in cognitive function due to neurodegenerative disorders, such as dementia, before the development of more severe functional symptoms, including lapses in judgement, inappropriate sexual behaviour, motor dysfunction, and stimulus-bound behaviours (Suchy, 2009).

Mild cognitive impairment (MCI)—or mild neurocognitive disorder—which is thought to occur in 12 to 18% of people over the age of 60, refers to declines in one or more cognitive domain that, while requiring increased effort and accommodations, do not affect an individual's ability to complete everyday activities (Petersen, 2016; Sachdev et al., 2014). The identification of MCI, moreso than dementia, requires the use of cognitive assessments as MCI must be differentiated from both normal cognition as well as major neurocognitive disorders (Sachdev et al., 2014). A cut-off score of 1–2 SD below the average on tests of individual cognitive function domains is generally used as an indicator of mild neurocognitive disorder (Sachdev et al., 2014).

While it may have different presentations and multiple trajectories, including complete recovery and long-term stability, MCI is often interpreted as a transitory stage between normal cognition and dementia (Ward, Arrighi, Michels, & Cedarbaum, 2012) and within a year, around 10–33% of MCI cases develop into Alzheimer's disease (Ward, Tardiff, Dye, & Arrighi, 2013). At the clinical level, dementia refers to severe declines in cognitive function that eventually impact the ability of the individual to complete everyday

tasks, such as cooking dinner or getting dressed (Alzheimer's Association, 2016). Alzheimer's disease, the most common form of dementia, is thought to be present in 50 to 75% of dementia cases (Lane, Hardy, & Schott, 2018). Symptoms increase in severity as the disease progresses until the individual is immobile and completely dependent on others. As MCI is often an early indicator of future major cognitive decline, it is beneficial to be able to identify the pre-clinical symptoms as far ahead as possible, and recognize which individuals might be at a greater risk of developing dementias such as Alzheimer's disease while there may still be the potential to increase positive interventions that lower the risk of development of dementia.

2.1.3 Factors Impacting Cognitive Function

Certain variables may increase or decrease both the risk and the timing of declines in cognitive function. While some factors—such as age, sex, and genetics—are not under individual control, many relevant demographic characteristics and lifestyle exposures are considered modifiable. The exact mechanisms by which these factors impact later-life cognitive function are not always clear. One popular theory suggests that some modifiable and non-modifiable variables impact the presentation of cognitive decline symptoms through their influence on cognitive reserve. Cognitive reserve theory describes two interacting processes: the passive loss of the brain's structural reserves until a predetermined threshold is reached where symptoms of cognitive dysfunction become apparent—which is sometimes differentiated from cognitive reserve and labelled as brain reserve—and the brain actively compensating for the loss in reserves by more efficiently using remaining and alternative paths to compensate for the damage (Stern, 2002). As such, protective factors may assist in preserving cognitive function by increasing the brain's total reserve capacity and leaving a

greater window for subclinical declines in cognition before the critical threshold is reached and symptoms appear. Alternatively, protective factors may improve cognitive reserve by increasing the efficiency of remaining resources and improving the brain's ability to recruit alternative mental processes (Stern, 2002).

2.1.3.1 Non-Modifiable Risk Factors for Cognitive Function

While an exhaustive list of risk factors is outside the scope of this thesis, the role of several key non-modifiable variables, including age, sex, and several genetic factors, will be addressed below.

As discussed in the introduction, previous research investigating the effects of age have demonstrated a negative relationship with cognition, with increasing age associated with declines in executive function (Sims et al., 2011; Seeman et al., 2011) and overall cognitive function (Tilvis et al., 2004). Advanced age is also associated with a higher incidence of dementia (Fratiglioni, Wang, Ericsson, Maytan & Winblad, 2000) and higher prevalence of Alzheimer's disease (Fiest et al., 2016). Dementia is found most commonly in older adults, with a prevalence of 0.1% in Canadians between the ages of 45 and 64, compared to 5% in those over the age of 80 (Wong et al., 2016).

While sex has not been found to alter the risk of dementia in all studies, especially those with younger seniors (Khondoker, Rafnsson, Morris, Orrell, & Steptoe, 2017), some studies have found that female sex was associated with a higher incidence of dementia (Fratiglioni et al., 2000). In Ontario, over two-thirds of community-dwelling people diagnosed with dementia are women (Ng et al., 2015), a ratio consistent with estimates for the overall American population as well (Snyder et al., 2016). This difference cannot be fully explained by variations in longevity (Snyder et al., 2016). Biological differences between the

sexes in terms of brain structure, sex chromosomes, hormones, metabolism, and expression of genes, and the interaction of these differences with lifelong exposures (e.g., stress, injury), and lifestyle factors (e.g., education, diet, cultural activities) are believed to impact the relationship between sex and the development of Alzheimer's disease (Snyder et al., 2016).

Several genetic factors have been found to play a role in cognitive decline. The ε4 allele of the apolipoprotein E (*APOE*) gene, which codes for a cholesterol-transporting protein in the blood, is a major risk factor for the development of Alzheimer's disease (Lane et al., 2018) and cognitive decline (Tilvis et al., 2004). Those that have one copy of the allele have three times greater odds of developing the disease than non-carriers and this increases to 12 times for those with homozygous ε4 alleles (Lane et al., 2018). Individuals with the rare amyloid precursor protein (APP), presenilin 1 or presenilin 2 gene mutations also have a higher risk of developing Alzheimer's disease in early to middle age (Lane et al., 2018).

2.1.3.2 Modifiable Risk Factors for Cognitive Function

Many individual characteristics have been investigated as modifiable factors that may impact cognitive decline, particularly in executive function. These include education, income, and various health and lifestyle factors.

Despite the potential length of time between being exposed to these factors and the onset of cognitive decline, education and income are both modifiable exposures that have been shown to have strong effects on late-life cognition. Greater educational attainment has been associated with higher scores on measures of cognitive function in middle-aged adults (Sims et al., 2011) as well as a reduced risk of dementia (Khondoker et al., 2017). In contrast, lower educational attainment is associated with a higher incidence of dementia (Fratiglioni et al., 2000). Higher income beneficially impacts cognitive function (Zhu, Hu &

Efird, 2012), and those with cognitive impairment have lower monthly incomes compared to those with no impairment or borderline impairment (Ramírez et al., 2007). Geographically, while there have been mixed findings in terms of the effects of urban/rural residence on cognitive function (e.g., St. John, Seary, Menec, & Tyas, 2016), some past research demonstrates a potential association between an increased risk of dementia and living in rural areas (Russ, Batty, Hearnshaw, Fenton, & Starr, 2012).

In general, poor physical health, such as a history of a chronic health condition, is associated with greater cognitive decline and mortality (Tilvis et al., 2004). In particular, there is a well established association between cardiovascular diseases and executive function, with many reviews indicating a connection (e.g., Eggermont et al., 2012). In their review on heart failure and cognition, Bauer, Johnson, and Pozehl (2011) reported that those with heart failure had lower scores on measures of delayed recall and executive function. Diabetes has also been shown to increase the chance of developing dementia (Khondoker et al., 2017) and both type 1 and type 2 diabetes are associated with impairment in cognitive function, with type 2 diabetes being negatively associated with executive function, memory and psychomotor speed (Moheet, Mangia, & Seaquist, 2015).

Neurological health also plays a key role in cognitive function in later life. Experiencing a stroke is associated with both immediate declines in cognitive function as well as faster post-stroke declines in global cognitive function and executive function compared to pre-stroke rates of decline (Levine et al., 2015). In their systematic review on the impact of lacunar strokes on domains of cognitive function, Edwards, Jacova, Sepehry, Pratt, and Benavente (2013) found that global cognitive function and executive function were

significantly impaired following a stroke. Traumatic brain injuries (TBI) are also associated with lower scores on measures of cognitive function (Bedard, Taler, & Steffener, 2018).

Some mental health disorders, such as depression, are associated with lower scores on measures of cognitive function (Yeh & Liu, 2003). In longitudinal studies of cognitive function, depressed participants have been found to have worse cognitive scores (e.g., Yeh & Liu, 2003). Barnes et al. (2012) found that having been diagnosed with depression at midlife, late life, or both increased the chance of developing dementia by 20%, 70% and 80%, respectively. Loneliness, a symptom of depression, has also been found to have a negative association with executive function (Zahodne, Nowinski, Gershon, & Manly, 2014).

Marital status, a structural measure of social support, has been repeatedly associated with cognitive function. Married seniors have higher cognitive function (Yeh & Liu, 2003), and being married in midlife halves the risk of developing cognitive impairment in later life (Hakansson et al., 2009). Alternatively, having no spouse in midlife was associated with a greater risk of cognitive impairment (Hakansson et al., 2009) and being single and living alone increased the risk of developing dementia (Fratiglioni et al., 2000). This association, however, may be due to the relationship between marital status and functional support. For example, Seeman et al. (2001) found that, compared to single men, married men experience more social support and larger social networks, although being a married woman is associated with having less support and fewer ties to groups or close others compared to unmarried women. Further, living alone or being unmarried is associated with lower perceived social support scores and greater loneliness (Gow, Corley, Starr, & Deary, 2013). This may be true for the beneficial effects of other close relationships as well: among the unmarried, pet owners who live alone were no less lonely or depressed than non-pet owners,

yet among those who reported high levels of human support, pet owners with dogs reported significantly less loneliness than those without dogs (Antonacopoulos & Pychyl, 2010). The strong association between structural supports and cognitive function may also be a result of reverse causation: those with low executive function may be less likely to marry and will therefore receive less SSA from a spouse across time, further worsening their decline compared to a married person.

Most of these modifiable factors are determined in early life or develop over the lifespan, leaving little room for intervention once an individual is in mid- to late life. However, there may be some variables that can be altered even in later life, either before early symptoms of cognitive decline develop, or in those who are already demonstrating mild symptoms of low cognitive function and are thus at an increased risk of further decline. Social factors, for example, have been suggested as potential areas of intervention for those who may be at a greater risk for cognitive decline due to other non-modifiable or modifiable factors, such as lower educational attainment (Shankar, Hamer, McMunn, & Steptoe, 2013), given their demonstrated association with cognitive function. Support, and specifically the perceived availability of support, may offer an intervention that can be applied at any point in the lifespan or stage of cognitive function to help buffer the effects of decline.

2.2 Social Support

Aging is a time of many social and environmental changes and a person may see great shifts in their social networks as they grow older. Retirement, downsizing homes, having children move away, and the deaths of friends and spouses can leave seniors vulnerable to isolation and limited social connections (Gurung, Taylor & Seeman, 2003;

Shankar et al., 2013). Despite this, the social aspects of the aging process are not well understood.

2.2.1 Social Support Definitions and Concepts

Social support is a complex topic consisting of several different concepts and definitions. At the broadest level, support can be divided into two categories: structural—or quantitative—support, and functional—or qualitative—support. Structural support refers to objective measures of support availability, such as marital status; living arrangement; number of friends, relatives, and neighbours; and the amount of participation and engagement an individual has in the community, as well as how interconnected these resources are (Sherbourne & Stewart, 1991). While these forms of support are easily measured and thus more commonly used in previous epidemiological research, structural support fails to account for how much support the individual actual perceives themselves as receiving (Sherbourne & Stewart, 1991). For example, a person may have many friends and neighbours, but not feel that they can emotionally connect with them. Alternatively, a person with a small social network may feel that their social needs are met.

Functional support, or social support availability (SSA), is a subjective rating of the support that individuals perceive as available to themselves and is based on the perception that one's social resources adequately or inadequately fulfill their specific social needs (Sherbourne & Stewart, 1991). Historically, five distinct areas of functional social support have been identified: emotional support, informational support, affection support, tangible or instrumental support, and positive social interactions (Sherbourne & Stewart, 1991). *Emotional support* consists of the provision of empathy, positive emotions, understanding, and having someone to confide in about feelings and concerns. *Informational support* refers

to having someone who can help you understand and give advice or guidance, while *affection support* is the provision of love, such as making you feel wanted and providing physical affection such as hugs. Having someone who can help with material tasks, such as cooking, shopping, or chores, is considered instrumental or *tangible support*. Finally, *positive social interactions* are assessed by whether individuals report having someone they enjoy being with who provides them with fun or relaxing experiences (Sherbourne & Stewart, 1991). Each of these areas of support may not be needed at all times, but different circumstances and life stages may require more or less of each type, and so overall assessments of functional support should include measures for all five areas (Pillemer & Holtzer, 2016).

Different from—but likely overlapping with—SSA, loneliness can be understood as a separate concept that assesses the feeling or emotional experience of not having your social needs met, rather than a subjective measure of whether support is perceived as available when needed (Ellwardt, Aartsen, Deeg, & Steverink, 2013). Loneliness has been defined as "an emotional state of perceived social isolation" (Stall, Savage, & Rochon, 2019, p. E476). The two concepts—SSA and loneliness—are often combined or mislabeled as the other. An example of this would be in the National Institute of Health's Toolbox, which defined loneliness as the "perception that one is alone, lonely, or socially isolated from others" —a definition that combines both concepts of emotional feelings of loneliness, as well as perceived isolation, which is better understood as SSA (Zahodne et al., 2014, p. 489). Given the inconsistencies and overlap in definitions of both SSA and loneliness, past research that looks at loneliness was also included in this literature review.

Additionally, as described above regarding marital status and pet companionship, there may be an overlap between structural and functional support, such that those with larger social networks report higher levels of emotional and tangible support (Gurung et al., 2003). However, this is not always true, and a discrepancy between the level of support available and the perceived level of support needed can occur regardless of network size (Yeh & Liu, 2003). Feeling dissatisfied with perceived availability of support can lead to feelings of loneliness (Yeh & Liu, 2003). Reported feelings of loneliness have been associated with many negative psychological and physiological outcomes, and being lonely can lead people to isolate themselves from the social resources they do have access to, thus further shrinking their social support networks (Ellwardt et al., 2013). Given the potentially dramatically changing social environments that one must adapt to in one's senior years, it is beneficial to understand how different forms of functional social support may be important for successful aging.

2.2.2 Factors Modifying Social Support

Comprehension of how need of and access to social support may develop and differ across time and individuals is key to understanding how to best use social support as an intervention in an aging population. Two variables in particular have been found to consistently modify social support: age and gender have been shown to both independently, and in combination, alter how social support is perceived and experienced.

2.2.2.1 Age

Tangible support and loneliness have both been found to increase with age, reflecting the conflicting changes in support that occur as part of the aging process (Ellwardt et al., 2013). Older adults may be more inclined to trim their social networks and concentrate their

time and energies on only those most beneficial relationships (Gurung et al., 2003). This has the effect of both shrinking their networks as they cut, and are cut, away from others, but also potentially improving their remaining relationships. This suggestion is supported by Gurung et al. (2003) who found that, while fewer social ties were reported at follow up, these changes did not decrease the level of perceived support seniors received. In their 1988–1991 study of older adults between the ages of 71–79, it was shown that emotional support remained moderately stable, and that instrumental support moderately increased over time (Gurung et al., 2003).

2.2.1.2 Gender

The most well demonstrated modifier of social support is gender. Seeman, Lusignolo, Albert and Berkman (2001) found that men report a higher number of social ties than women, but also more conflict and negative interactions. In contrast, women reported more involvement in groups and that having a greater number of ties and a bigger network was associated with fewer negative interactions and demands (Seeman et al., 2001). In general, women report better overall emotional support (Seeman et al., 2001), but they also report higher levels of loneliness (Shankar et al., 2013).

There additionally appear to be differences in where men and women receive their support. Gurung et al. (2003) found that both sexes receive instrumental support primarily from their spouses, yet for emotional support, women report receiving more support from their children and relatives, while men, again, receive support largely from their spouses. For men, support was found to increase over time from all relationships, while women saw increases from children, friends, and relatives. Women did not see increased support from their spouses, but did report increasing negative experiences from spouses over time,

compared to men. It is possible that this pattern of decreasing support from spouses may explain why previous research has shown that having a wide social network made up of friends, children, and family is more beneficial for women than men (Gurung et al., 2003).

2.2.2.3 Additional Factors Modifying Social Support

There are a number of additional sociodemographic factors that may impact one's individual level of functional SSA that have not been investigated as extensively. Having a higher education, for example, is associated with a reduced risk of loneliness and isolation, while a lower income is associated with a greater risk (Shankar et al., 2013). A higher income may be related to greater risk of negative interactions and high demands from social relationships over time (Gurung et al., 2003). Investigating social support and race, Zahodne, Watson, Seehra, and Martinez (2017) found that Hispanics reported higher levels of social support than Whites or Blacks.

Individual factors such as personality and mental health may also impact one's experience of or access to support. Higher levels of extraversion are associated with higher ratings of perceived emotional support, while openness—understood as being original and creative—and neuroticism are associated with less satisfaction with support (Bourne, Fox, Starr, Deary, & Whalley, 2007). Depressed participants report higher numbers of stressors and negative events, and lower perceived support (Dickinson et al., 2011) and low social support is associated with an increased risk of developing heart disease (review by Lett et al., 2005; Rosengren, Wilhelmsen, & Orth-Gomer, 2004).

Social support has been found to be a strong predictor of physical health for older Canadian females (65+) living in both rural and urban environments, with related concepts such as 'having a sense of belonging in the community' having greater effects on the health

of women living in urban areas compared to women living in rural areas (Wanless, Mitchell, & Wister, 2010). While urban and rural residents do not differ significantly on reports of social isolation, rural residents were more likely to see their relatives at least weekly, and the percentage of residents of large metropolitan areas who hadn't seen any relatives for a month was double that of residents of rural and small town areas (Turcotte, 2005). It is worth acknowledging, however, that this finding was likely due in part to the greater proportions of immigrants in urban areas, and this pattern was not seen in Canadian-born populations (Turcotte, 2005).

2.3 Cognitive Function and Social Support

2.3.1 Theoretical Models of How Social Support Affects Health

While the exact mechanism through which social support influences cognitive function has not been determined, several hypotheses have been proposed. Three theories—the stress-buffering hypothesis, cognitive stimulation theory, and physical activation theory—have been suggested as potential explanations for this association (Eisele et al., 2012). While each theory may be partially correct, it is likely that considering all three in combination is the most useful approach for understanding the association between social support and cognitive function.

The *stress-buffering hypothesis* pertains specifically to emotional support and the provision of positive support, which helps build confidence and self-esteem (Eisele et al., 2012). This theory proposes that emotional support indirectly impacts cognitive function by leading to reduced physiological arousal during periods of stress, thereby producing a sense of calm that inhibits overactive arousal (Sims et al., 2011). Chronic and excessive levels of stress can lead to degeneration in areas of the brain such as the hippocampus, which plays a

significant role in executive function and is often found to be damaged in those with Alzheimer's disease (Eisele et al., 2012). As older adults can be expected to experience many major life stressors, social support, and emotional support in particular, may be a potential intervention as a buffer between stress and its damaging effects on the brain. However, this association is only beneficial if there is a match of the level and type of support needed with the support provided (Sims et al., 2014). For example, Sims et al. (2014) suggest emotional support may be beneficial in some circumstances, such as following the loss of a loved one, but simply increasing the level of emotional support would not reduce stress when material or informational support is needed, such as when one has a flat tire. A significant association between executive function and some functional SSA subtypes, such as emotional/informational SSA, affection SSA, or positive social interactions, would support this hypothesis, given the assessment of perceived positive support in each of these subtypes.

The *cognitive stimulation hypothesis* proposes that social support directly impacts cognitive function through the stimulation of various mental processes required to maintain social relationships (Ellwardt et al., 2013). These mental processes include executive function, memory, processing speed, language and communication (Seeman et al., 2011). This theory is closely related to the concept of cognitive reserve, discussed above, which suggests that the symptoms of cognitive decline seen in dementias such as Alzheimer's disease begin to appear only after a threshold is reached, after which the brain can no longer compensate for the neurodegenerative losses. According to the cognitive stimulation hypothesis, social support and social interactions cause increased usage in most domains of cognitive function, which may help by encouraging the growth of neurons and creating more

efficient pathways in what remains of damaged brain areas, or by permitting the development of alternative processes to compensate for structural losses (Eisele et al., 2012; Stern, 2002).

Relating more to the structural aspects of social support, a third potential theory—*physical activation theory*—suggests that maintaining social relationships, especially in large social networks, leads to an increase in physical activity (Eisele et al., 2012). In order to maintain close relationships, one may be forced to participate in activities outside the home, increasing the level of physical activity one achieves over a lifetime (Eisele et al., 2012). Increasing physical activity should improve overall health, including lowering the risk of developing vascular diseases, which have been shown to increase the risk of developing dementias, including Alzheimer's disease (Eisele et al., 2012). While this theory is less supported by the social support literature and some studies have not found a significant relationship (Eisele et al., 2012), there is support in the literature for an association between physical activity and both cognitive decline and dementia (Erickson, Weinstein, & Lopez, 2012; Wang, Xu, & Pei, 2012).

2.3.2 Reverse Causality

Both social support and cognitive function are complex concepts that develop and change over the lifespan, a fact that has raised concerns about the temporal relationship between the two concepts. While most past research has considered social support as an exposure and cognition as an outcome, it is possible that reductions in social support are reflective of declines in cognition. Individuals who experience cognitive decline may develop issues with communication and other mental processes that are necessary for maintaining social relationships, leading to decreases in support (Sörman, Rönnlund, Sundström, Adolfsson, & Nilsson, 2015). As higher cognitive function in early life has been

shown to play a role in determining not only the level of education a person attains, but also later marital status, it may be that early-life cognitive function is impacting both later-life social support and cognition (Gow et al., 2013). Past research has shown that individuals with lower levels of cognitive function do not experience improved social support over time, and instead report more negative exchanges (Gurung et al., 2003). In contrast, Bourne et al. (2007) found that, compared to those with lower scores, older adults who had scored higher on measures of cognition as children experienced less satisfaction with support, and reported lower levels of support in their sixties. The authors suggest that those with higher cognitive scores may choose to live more isolated lives, and may be satisfied with lower levels of support until they begin to experience declines in their cognitive functioning, leading to increased support needs (Bourne et al., 2007). Although there is no way to completely verify causality, and in this case it is likely that both social support and cognitive function influence each other's development, some previous research has addressed concerns of reverse causality in their results by using cross-domain latent growth models (e.g., Ellwardt et al., 2013). Ellwardt et al. (2013) found that cognitive function did not impact later emotional and instrumental support, but that emotional support had a positive effect on cognitive function. Additional support against reverse causality would require longitudinal studies in which temporality could be demonstrated; however, such studies are thus far lacking (Amieva et al., 2010).

2.3.3 Evidence for an Association between Social Support and Cognitive Function

There is some evidence for a relationship between perceived social support and later-life cognitive function; however, given the lack of consistency in the definitions and operationalization of both social support and cognitive function, results are mixed (e.g.,

Kang, Boss, & Clowtis, 2016). In terms of general functional social support, higher ratings have been found to be correlated with higher scores on measures of cognitive function (Yeh & Liu, 2003; Zhu, Hu, & Efird, 2012) and lower risks of developing dementia (Khondoker et al., 2017; Sörman et al., 2015). Those who reported high levels of satisfaction with support had a lowered risk of developing dementia over a 10 to 15-year period (Amieva et al., 2010) and feeling satisfied that, across the lifespan, one had received more than they gave in their social relationships, reduced the risk of developing dementia and Alzheimer's disease by over half (Amieva et al., 2010). Andrew and Rockwood (2010) found that the risk of developing cognitive decline increased 3% for every additional one-item increase on a 40-item measure of social vulnerability, with lower scores on the same measure associated with incident dementia. Finally, in their review of the current social support literature, Kang et al. (2016) found that higher levels of social engagement were generally associated with better cognitive function in both cross-sectional and longitudinal studies.

Yet, overall functional social support has not always been found to positively contribute to cognition, and it has been proposed that in persons with chronic illnesses, high levels of support may actually be seen as using more energy and resources than they provide (Sims et al., 2014). Perceived negative support or burden from others has been found to increase the risk of dementia (Khondoker et al., 2017). In contradiction, some studies have found that greater levels of reported social strain (Ge, Wu, Bailey, & Dong, 2017) and negative social interactions (Hughes, Andel, Small, Borenstein, & Mortimer, 2008) are actually associated with higher global cognitive function. This finding could be explained by the cognitive stimulation hypothesis, as negative relationships still provide opportunities for the use of cognitive processes.

Looking more closely at specific domains of perceived functional support, emotional support and tangible (or instrumental) support have been the most commonly investigated. Research with tangible support offers inconsistent results: some studies find that reductions in support are associated with worse performance on measures of executive function after controlling for covariates (Dickinson et al., 2011). However, other studies found no direct effects (Ellward et al., 2013) or have found that high levels of tangible support may actually be associated with the development of cognitive impairment (Pillemer et al., 2018).

In contrast, emotional support, compared to other subtypes of perceived social support, is most consistently found to be related to cognitive function (e.g, Zahodne et al., 2014), while still not found to be significant in all studies (e.g., Eisele et al., 2012). Higher reported levels of emotional support are associated with better cognitive function, especially in older adults (Ellwardt et al., 2013; Pillemer & Holtzer, 2016), and these results are found in both cross-sectional and longitudinal investigations (Sims et al., 2014). Both Sims et al. (2014) and Seeman et al. (2001) found that frequency of emotional support was positively associated with cognitive function. Research looking at other subtypes of support indicate that there may be evidence for a beneficial effect of positive social interactions (e.g., Pillemer & Holtzer, 2016) and affection as well, although these subtypes have not been investigated in depth.

While there are many risk factors that influence cognitive function, there are a few variables that have been previously identified as impacting the relationship between social support and cognitive function. Gender in particular has been identified as a likely effect modifier, as the type and level of support available to men and women have been found to differ and change over time (Gurung et al., 2003), and some subtypes of support, such as

emotional support, may only be beneficial to cognitive function in women (Pillemer & Holtzer, 2016). Age may also modify the relationship between social support and executive function with associations being stronger in younger adults (Seeman et al., 2011).

2.4 Conclusion

The association between SSA and cognitive function is complex and past findings are often inconsistent in their conclusions. At this time, no theory is able to explain and connect all the disconnected results, and there are many deficiencies in the current knowledge. Broadly speaking, there appears to be a positive association between social support and cognitive function; however, the relationship seems to vary in strength and direction depending on the type of social support and domain of cognitive function that is investigated. Little research has specifically investigated executive function, a key domain of cognitive function necessary for function and adaptation to change. Additionally, the relationships between various types of support and cognitive function appear to be further modified by the presence of additional risk factors, including age and gender.

3.0 Study Rationale and Research Questions

The association between SSA and cognitive function is complex and past findings are inconsistent. Part of the reason for these inconclusive results is likely the differing definitions of both cognitive function and social support, as well as variations in study design and characteristics of the population and selected samples. Previous research with social support has put a greater emphasis on structural measures of support, and those studies that have investigated functional support have often been limited to only one subtype of support or have not differentiated which subtype of support they are assessing.

In terms of cognitive function, many studies have used a small number of tests of cognition, or have depended on later diagnosis of dementia rather than early subclinical differences across the population. This study addresses some of these limitations by including all subtypes of functional support as well as multiple tests of one domain of cognitive function. This study additionally builds on previous research by investigating how a wide variety of potential confounding factors may modify the above-mentioned associations.

The aim of this project was to determine the association between low SSA (overall and the four subtypes: tangible, affection, emotional/informational, and positive social interactions) and executive function and whether this association is impacted by the inclusion of sociodemographic (i.e., age, province, education, household income, and urban/rural residence), health (i.e., depression, chronic conditions, self-rated health) and social (i.e., marital status, pet ownership, and loneliness) variables. Additionally, given the findings of previous literature, this study aimed to investigate whether the relationship between SSA and executive function would differ in men and women. Based on previous research, it was

hypothesized that, in general, lower levels of support would be associated with poorer scores on executive function, but that the size of these associations would differ depending on the specific SSA subtype.

The specific research questions of this study are:

1. Is low SSA (overall and subtypes: tangible, affection, emotional/informational, and positive social interactions) associated with low executive function after adjusting for confounders?
2. Do the above associations differ by sex?

By examining how different areas of perceived SSA are associated with performance on a specific domain of cognitive function in a large, diverse, community-dwelling population, this thesis increases the evidence for and understanding of the relationships between different types of social support and later-life cognitive function. The findings of this study provide evidence useful to the creation of potential future interventions aimed at increasing access to and awareness of available social support resources.

4.0 Methodology

4.1 Literature Search Strategy

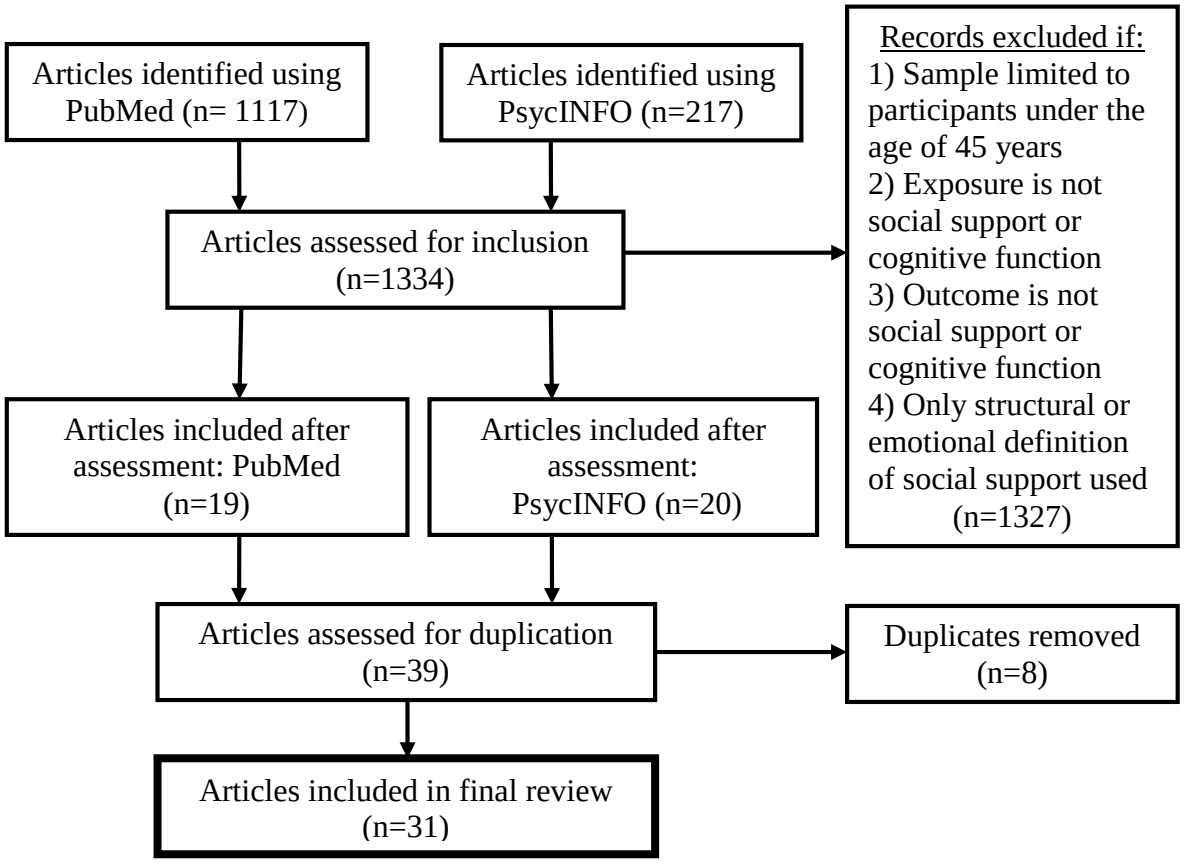
In order to examine prior research into the relationship between SSA and cognitive function, a systematic literature search was completed using the PubMed Medline database in October 2017. The search concepts included terms relating to cognitive function and SSA. After initial review, additional search concepts 'age' (e.g., elderly, older adult, middle age) and 'time' (e.g., aging, longitudinal study, prospective cohort study) were included to further narrow down the retrieved articles to relevant results. A summary of full search terms can be found in Appendix A. The search was limited to human-based, peer-reviewed articles written in French or English. No date limits were set. The initial search resulted in 1018 articles to be further screened.

An additional search was completed using the PsycINFO database in October 2017. Search concepts included SSA, cognitive function, age, and time. A full list of the search terms included under each concept can be found in Appendix A. After the initial search, 204 articles were retrieved, which, when added to the 1018 articles from PubMed, created a total of 1222 articles for screening.

During screening, articles were excluded if the population did not include participants aged 45 or over, if the study did not have social support or cognitive function as the exposure, and if social support or cognitive function were not the outcome. Further, articles that included only structural or emotional definitions of social support were removed. Given the inconsistent definition of many social support terms, papers that claimed to measure broad social support, loneliness, or social networks but had defined these terms as functional measures of SSA were included, despite their labelling. After applying all exclusion criteria and removing duplicate articles, 24 articles remained.

A second search was conducted in July 2018 to identify more recently published articles. The initial search resulted in a total of 1117 articles from PubMed and 217 from PsycINFO, which, after previously assessed articles were removed, left an additional 99 articles from PubMed and 13 articles from PsycINFO to be further screened. After exclusion criteria were applied and duplicates were removed, five articles from PubMed and two articles from PsycINFO were identified. These articles were added to previously included articles and summaries of these 31 articles can be found in the literature summary table in Appendix B.

Figure 1. Flowchart of Literature Search Strategy



4.2 Data Source: Canadian Longitudinal Study on Aging

4.2.1 Background

The Canadian Longitudinal Study on Aging (CLSA) is a national, population-based, prospective cohort study investigating the aging process (Raina et al., 2009). The study was formed under the Canadian Institute of Health Research's (CIHR) Institute of Aging, with additional infrastructure funding provided by the Canadian Foundation for Innovation. The initial project application, put forth by Dr. Susan Kirkland (Dalhousie University, Halifax), Dr. Parminder Raina (McMaster University, Hamilton), and Dr. Christina Wolfson (McGill University, Montreal) in response to a call for submissions, was accepted by the CIHR in 2001. Between 2002 and 2006, the proposed protocol was further developed and reviewed at both the international and national levels, with full ethical approval for the final CLSA protocol being granted in 2011.

4.2.2 Study Design

Data collected by the CLSA includes assessments of physical, cognitive, social, and psychological health, as well as additional diverse measures of lifestyle and demographic factors. The overall CLSA design consists of two separate cohorts, Tracking and Comprehensive, both of which have their own recruitment and data collection process, discussed in further detail below. Although currently only cross-sectional baseline data are available for analyses, the first follow-up assessments were conducted between 2015 and 2018, with data to be released in 2019. All participants recruited into the CLSA will be assessed in approximately three-year intervals following their baseline assessment and will be evaluated for a minimum of 20 years, or until death.

4.2.3 Study Sample and Eligibility Criteria

Participants in the CLSA were recruited through four different sources. Initial recruitment, exclusively for the Tracking cohort, utilized participants recruited from the Canadian Community Health Survey (CCHS) on Healthy Aging and, due to this, the CLSA sample was limited by the selection criteria already determined by the CCHS. For example, the CCHS omitted participants living in the three Canadian territories or living on First Nations reserves, and these populations were therefore also omitted from the full CLSA sample. Additionally, based on the CCHS selection criteria, those living in long-term care facilities requiring 24-hour medical care were excluded, while those living in transitional living institutions or senior apartments were included. Based on the participants available through the CCHS, participation in the CLSA was limited to adults between the ages of 45 and 85. This life-course perspective was chosen by the CLSA to capture the long-term effects of midlife exposures and experiences while also providing an opportunity to follow those already in their senior years as they move into later life or death. Further inclusion criteria required that participants speak either English or French, and not have cognitive impairment at the time of recruitment. The decision as to whether a participant was cognitively capable of giving consent and understanding the study's purpose was determined in each case during the pre-recruitment telephone interview with a CLSA interviewer. Populations that showed indicators of non-permanent residency, including visa holders or those with transitional health care coverage, were also excluded.

Provincial health care registries, which contain almost universal coverage of all people officially residing in a given province, were additionally used in eight provinces for the Tracking cohort, and as the main source of recruitment for five provinces in the Comprehensive cohort (British Columbia, Manitoba, Newfoundland and Labrador, Nova

Scotia, and Ontario). Eligible participants were selected randomly from these registries. Where required, telephone sampling through Random Digit Dialing (RDD) was further used to reach predetermined recruitment levels. This method was limited to landline numbers, which, while likely a greater limitation when recruiting from a younger population, was determined by Statistics Canada and the CLSA to be an acceptable method for recruiting those over the aged 45 years or older, who, overwhelmingly, possess landline phones.

To ensure that the most accurate estimates for the provincial and national population were available in both cohorts, 136 sampling strata, based on sex (male or female), age group (45–54, 55–64, 65–74, and 75-85 years), province, and distance from DCS (DCS catchment area and non-DCS catchment area) were created for the Tracking cohort, and 56 sampling strata, based on sex, age group, and province were created for the Comprehensive cohort (CLSA, 2017). Sampling weights were used to estimate how many people each participant was representative of in their province and in Canada as a whole. In total, 51,338 participants across both Tracking and Comprehensive cohorts were recruited into the study, with a Canada-wide response rate of 9% for the Tracking cohort, and 10% for the Comprehensive cohort. A summary of the provincial response rate for all sources of recruitment for both the Tracking and Comprehensive cohorts can be found under Appendix C.

As discussed above, participants in the Tracking cohort were recruited through Statistics Canada's CCHS on Healthy Aging, which was additionally supplemented by recruitment from provincial healthcare registration databases and RDD. Data from the CLSA Tracking cohort were collected by computer-assisted telephone interviews (CATI), a method that does not require participants to commute to a central study site and thus allows for recruitment of a geographically representative population across all 10 provinces.

Participants in this cohort completed a shortened interview and assessment compared to those in the Comprehensive cohort and did not submit physical measures or biological samples. Recruitment of the participants required for the Tracking cohort began in 2009, with a final total of 21,241 participants included at baseline.

Participants in the Comprehensive cohort were also recruited from provincial healthcare registration databases, supplemented with random digit dialing (RDD). Additional participants between the ages of 75 and 85 were recruited from the Quebec Longitudinal Study on Nutrition and Aging (NuAge) study. All participants lived within 25 to 50 km of one of the 11 data collection sites in 7 of the 10 provinces: British Columbia (Victoria, Vancouver, Surrey), Alberta (Calgary), Manitoba (Winnipeg), Ontario (Hamilton, Ottawa), Quebec (Montreal, Sherbrooke), Nova Scotia (Halifax), and Newfoundland and Labrador (St. John's). Each province recruited approximately 3,000–6,000 participants from within its geographic limits. Due to population size and geographic distribution, the Comprehensive cohort does not include data from three provinces: Prince Edward Island, New Brunswick, and Saskatchewan. All 30,097 participants in the Comprehensive cohort completed both in-home surveys as well as additional interviews and physical examinations at the data collection sites.

4.3 Current Project

4.3.1 Analytical Sample

This thesis utilizes data from the Comprehensive cohort. As participants in the Comprehensive cohort are assessed in person by interviewers at data collection sites, data for a greater number of measures were available compared to the Tracking cohort, including additional tests of executive function.

In addition to the eligibility criteria applied by the CLSA at recruitment, only complete cases—participants with data available on all variables—were included in this study. A visual description of the sampling process can be found in Appendix D. In the initial step, participants who, while still included in the Comprehensive cohort, did not complete their tests at data collection sites were excluded (n=137), as their tests were not completed in the same lab settings as other participants. Those who do not have complete data for either exposures or outcome were excluded (n=4769), as were participants who did not have information on the remaining chosen covariates (n=1700). In total, data from 23,491 participants were included in analyses.

4.3.2 Measures

4.3.2.1 Exposure

SSA in the CLSA was assessed using the 19-item Medical Outcomes Study Social Support Survey (MOS-SSS) developed by Sherbourne & Stewart (1991). The MOS-SSS allows for an assessment of overall perceived SSA, as well as four subscales of support: emotional/informational (e.g., someone you can count on to listen to you when you need to talk), tangible (e.g., someone to take you to the doctor if needed), affectionate (e.g., someone who shows you love and affection), and positive social interactions (e.g., someone to get together with for relaxation). One variable (someone to do things with to help you get your mind off things) is included in the calculation of the overall score of SSA, but is not included in any of the social support subscales (RAND Health, n.d.). An additional item included as part of social support by the CLSA, but not included in the original MOS-SSS (Do you have a household pet that provides you with companionship?), was included as a potential confounder in this study (see Figure 2). A complete list of questions used in the survey can

be found in Appendix E. For each question, participants were asked to rate how often the type of support described was available to them when needed. Possible responses were 1 (none of the time), 2 (a little of the time), 3 (some of the time), 4 (most of the time), and 5 (all of the time), with a higher score indicating greater perceived support. A score for each social support subscale was calculated using the average score of all items in that subscale, while the overall SSA score was calculated by averaging the scores for all 19 items (RAND, n.d.).

As scores on this measure were not normally distributed, each subscale—and overall SSA—was categorized dichotomously into *low support (yes/no)*. No consistent cut-off for low social support was found in the literature for this measure and thus a cut-off score of less than or equal to three (out of five) was chosen based on the distribution of scores. An overall score of three or less was chosen as an indicator of low support given the highly skewed distribution, such that only 6 to 11% of participants scored under this cut-off on any of the subtypes. Using an absolute score allowed for a consistent comparison across subtypes, as well as for comparison across studies.

4.3.2.2 Outcome

This thesis utilized all five measures of executive function available in the Comprehensive cohort of the CLSA (Tuokko, Griffith, Simard, & Taler, 2017) and covered the three most common subtypes of executive function: cognitive flexibility, working memory, and inhibition. Cognitive flexibility was tested using the Animal Fluency Test (AFT), the Mental Alternation Test (MAT), and the Controlled Oral Word Association Test (COWAT), while the Time-based Prospective Memory Test (TMT) assessed working

memory and inhibition, the latter of which was also tested using the Victoria Stroop Neurological Screening Test (Stroop).

In the Animal Fluency Test (AFT), participants had 60 seconds to list as many animals as possible. Each animal name produced by the participant was then coded with seven digits based on their taxonomy. Following this, two coding algorithms were used to calculate the participant's scores. The first algorithm used more conservative scoring techniques to come up with a stricter score that uses the first six digits of the scientific classification code. In this scoring technique, only animals that are different at the species level are counted toward the final score. In the second algorithm, all valid animals are accepted. This thesis utilized scores calculated using the less strict algorithm (Strauss, Sherman, & Spreen, 2006).

The Mental Alternation Test (MAT), a test of cognitive flexibility, first asked participants to count from 1 to 20 and recite the alphabet. Following this, participants were asked to alternate between numbers and letters, beginning with "1A, 2B" and so on, for 30 seconds. A score was calculated for the MAT out of 51.

The Controlled Oral Word Association Test (COWAT) consisted of three sessions during which participants have 60 seconds to list words beginning with a single letter. The task is completed first for the letters 'F' and is then repeated for 'A' and 'S.' Participants received a point for each unique word. In circumstances of duplicated or sister words, such as "long" and "longer," only one point was given. Scores on each of the three tests were combined for an overall COWAT score (Strauss et al., 2006).

The Time-Based Prospective Memory Test (TMT) required participants to complete a task at a predetermined time and assessed the working memory and inhibition subtypes of

executive function (Mioni & Stablum, 2014). At the start of the test, participants were shown a series of numbered cards and told to give the card with the number 17 on it to the interviewer at the determined time. A clock was set for 8:00, and participants were instructed to interrupt at 8:15 to complete their task. Participants were rated from 0 to 3 in each of the following three categories: intention to perform, accuracy of response, and need of reminders, and an overall score was calculated out of 9 (Hernandez Cardenache et al., 2014).

The Victoria Stroop Neurological Screen Test (Stroop) was divided into three tasks during which participants were required to say the colour of the ink printed on stimulus cards. The cards in the first task contained coloured dots, while the second task contained common words printed in the coloured ink. For the final task, colour words (e.g., blue, yellow) were printed in ink of a conflicting colour. Scores were calculated as an average length of response in seconds for each task, as well as number of errors. An interference score was calculated by dividing the score on the final task (colour words) by the score on the first task (coloured dots) (Graf, Uttl, & Tuokko, 1995). On the coloured word task, scores below seven seconds or above 137 seconds—and scores on the coloured dot scores below seven seconds or above 30 seconds—were removed (Strauss et al., 2006). These cut-offs are based on pre-established standards determining which scores are feasible response times and which are likely errors in measurement..

Scores were standardized within each test using z-scores and calculated separately for English and French speakers. Bilingual responses were excluded. An overall score of executive function was calculated by combining the standardized z-scores on the AFT, MAT, COWAT, TMT, and Stroop. As the Stroop is calculated by the time to response, a higher score is an indicator of worse cognitive function, and thus the standardized scores are

reversed for inclusion in the calculation of an overall executive function score (Demnitz et al., 2018).

Normed data and cut-offs have not been established, and thus low executive function was defined during analysis based on the distribution of scores after combining z-scores on the described tests. A cut-off of ≥1.5 SD below the mean for low executive functioning was determined based on previous literature on early cognitive decline and MCI (Sachdev et al., 2014; Petersen et al., 1997). The 1.5 SD cut-off was calculated on a weighted, cognitively healthy sample (n=24,297) that excluded those who reported being diagnosed with Alzheimer's disease (n=68), memory problems (n=519), epilepsy (n=322), stroke or CVA (n=522), multiple sclerosis (n=202), Parkinson disease (n=125), or ministroke or transient ischemic attack (n=965) (O'Connell et al., 2017). Additionally, those who had a positive screen for a traumatic brain injury and reported two or more concussions or any symptoms of a concussion (n=3949) were removed (O'Connell et al., 2017; Bedard et al., 2018). These groups were not mutually exclusive. This cut-off was then applied to the analytical sample.

4.3.2.3 Covariates

Many potential confounders were included in the final models, including sociodemographic variables (i.e., age, sex, education, income, province of residence, urban/rural residence), measures of health (i.e., chronic conditions, depression, self-rated health) and additional measures of social support (i.e., marital status, pet ownership, loneliness). Each of these variables will be described below. A map and list of all variables can be found in Figure 2 and Table 1, respectively.

4.3.2.3.1 Key Sociodemographic Variables

Sex was assessed dichotomously by asking participants if they were male or female. Based on previous research, sex was investigated as an effect modifier.

Age in years was assessed as a categorical variable in regression analyses and was divided into four groups: 45–54 years, 55–64 years, 65–74 years, and 75 years and over.

Education was assessed by a four-level measure of highest obtained degree: less than high school, high school graduate, some post-secondary education, and post-secondary degree/diploma.

Total annual household income was selected as an indicator of financial situation as it is a more accurate measure of economic circumstances in older adults than personal income. Household income was divided into five income levels: < $20,000; ≥ $20,000 and < $50,000; ≥ $50,000 and < $100,000; ≥ $100,000 and < $150,000; and ≥ $150,000.

Province of residence and *urban/rural residence* were included to account for geographical differences in the sample. *Urban/rural residence* was dichotomized into rural or urban based on the participant's postal code. "Urban" encompasses areas identified as core, secondary core, fringe, or population outside of census metropolitan areas (CMAs) or Census agglomerations (CA). CMAs had a population over 100,000, with at least half of the population living in a core, or population centre (CLSA, 2018). CAs required a core population over 10,000. Small population areas within CMAs that have less than 10,000 people were considered to be fringe, and areas that were not small population centres were considered to be rural.

4.3.2.3.2 Health Factors

This study included three health-related covariates. A *chronic conditions* variable was used to assess whether participants were ever diagnosed with a chronic disease. Additionally, a measure of *self-rated health*, as well as *depression* were used to assess health.

A combined measure was used to assess the presence of *chronic conditions*. Based on past CLSA research (O'Connell, personal communication), 11 broad self-reported medical conditions were combined into a dichotomous measure (presence of any chronic disease versus absence). Conditions included were high blood pressure/hypertension; diabetes/borderline diabetes/blood sugar too high; cancer; under-active thyroid gland/hypothyroidism/myxedema; over-active thyroid gland/hyperthyroidism/Grave's disease; chronic obstructive pulmonary disease/emphysema/chronic bronchitis; kidney disease/failure; stroke-related conditions; peripheral vascular disease; asthma; and cardiac chronic conditions (i.e., heart disease/congestive heart failure, myocardial infarction/heart attack/acute myocardial infarction, and angina/chest pain due to heart disease). For each condition participants were asked whether they had ever been diagnosed with that condition. For example, presence of *diabetes* was assessed using the question: "Has a doctor ever told you that you have diabetes, borderline diabetes or that your blood sugar is high?" with the response options of yes or no.

In addition to these objective medical history questions, an individual rating of perceived general health was included. *Self-rated health* may be a good indicator of overall health and daily experiences moreso than diagnoses, and may relate to perceived level of support. Participants were asked 'In general, would you say your health is excellent, very good, good, fair, or poor?' and rated their health on the scale from excellent to poor. Finally,

clinical depression was included and assessed by a yes or no question: “Has a doctor ever told you that you suffer from clinical depression?”

4.3.2.3.5 Social Factors

Based on previous literature, additional measures of social support (marital status, pet companionship, and loneliness) were included. *Marital status*, a structural measure of social support, has been repeatedly associated with cognitive function. Marital status was divided into four categories: single, never married or never lived with a partner; married or living with a partner in a common-law relationship; widowed; and divorced or separated. *Pet companionship* was assessed by asking participants to answer yes or no to “Do you have a household pet that provides you with companionship?” Finally, to assess *loneliness*, participants were asked to select how many days in a week they felt lonely: all of the time (5–7 days), occasionally (3–4 days), some of the time (1–2 days), rarely or never (less than 1 day).

4.3.3 Data Analyses

All analyses were conducted using SAS Studio Enterprise Edition 3.6 (SAS Institute Inc., Cary, North Carolina).

4.3.3.1 Descriptive Analysis

To provide an overall description of the sample, bivariate analyses were conducted for exposure, outcome, and modifying and confounding variables. Sex was included as an effect modifier *a priori*, and analyses were run separately for males and females. Bivariate analyses utilized Pearson chi-square tests to test for significant associations between categorical variables. Descriptive analyses were separately run for weighted and unweighted data. Descriptive analyses were weighted using trimmed weights, which were calculated by

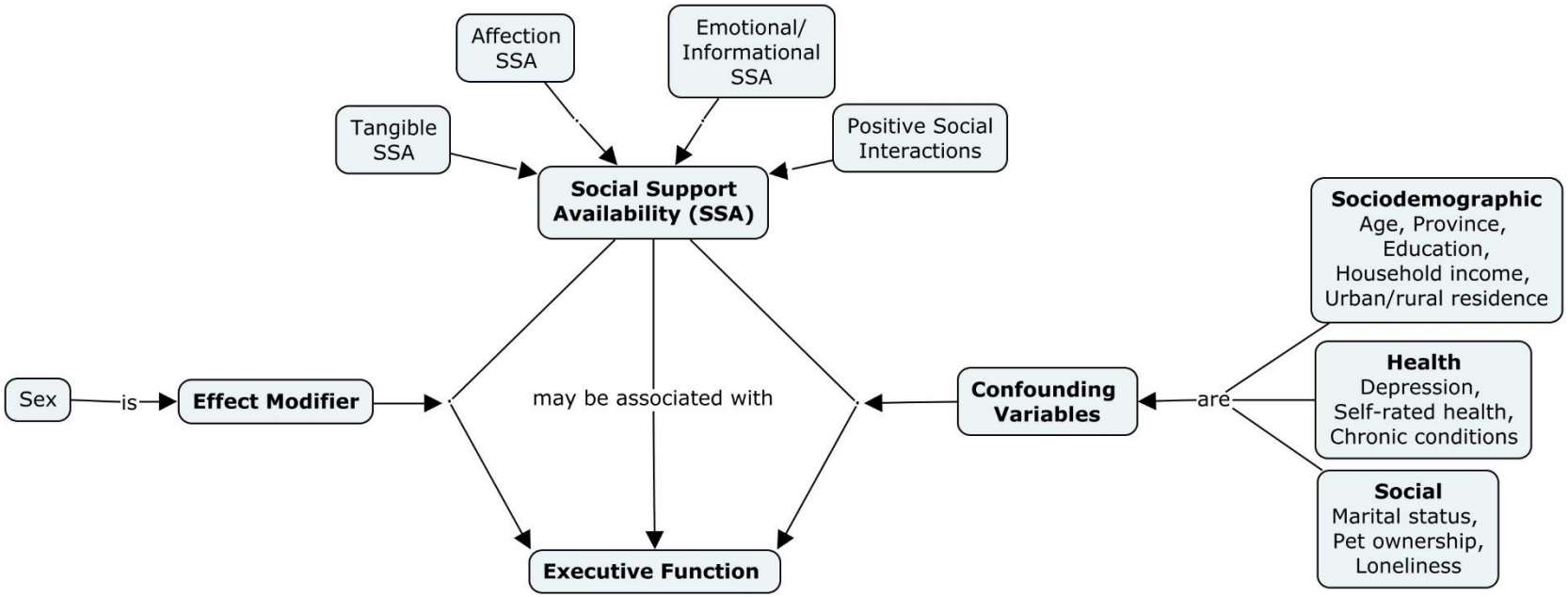
the CLSA based on individual inclusion probability for the Canadian population (provided by Statistics Canada) as well as in the participant's DCS area (CLSA, 2017).

4.3.3.2 Multivariable Analysis

Weighted logistic regression analyses were used to address the stated research questions and odds ratios (OR) and 95% confidence intervals (CI) were used to assess the strength of the associations for the executive function outcome. Logistic regression analyses utilized analytic weights, which rescaled the inflation weights, described above, to sum to the sample size within the DCS (CLSA, 2017). The analytic plan for each research question is presented in Table 1 for the exposure variable 'overall SSA' and the low executive function outcome. These analytic strategies were repeated with each of the four subtypes of social support as the exposure. The covariates that were included in each model are listed in Table 1. Covariates were entered into the model in three themed chunks: sociodemographic, health, and social variables.

First-order interactions with the exposure variable were assessed for all models. Backwards elimination was utilized with a significance (α) level of 0.05 for first-order interaction terms (Tyas, Koval, & Pederson, 2000). Model fit for all final models was assessed using the Mann-Whitney U statistic for the area under the receiver operating characteristic curve. Results demonstrated that all models had a good fit (see Appendix F). Additionally, multicollinearity between exposures and covariates was assessed using a variance inflation factor (VIF), where a score greater than 10 is an indicator that two or more predictor variables are too highly correlated with each other (Kleinbaum, Kupper, Nizam, & Rosenberg, 2013). No concerns with multicollinearity were found.

Figure 2: Conceptual Map of the Association of Executive Function with Social Support Availability, Potential Confounders and Effect Modifiers



Exposure variables:
Overall SSA
SSA subtypes

Outcome variable:
Executive function

Effect modifier:
Sex

Confounding variables:

Sociodemographic:
Age
Province
Education
Household income
Urban/rural residence

Health:
Depression
Chronic conditions
Self-rated health

Social factors:
Marital status
Pet ownership
Loneliness

Table 1: Design for Assessing the Association of Low Overall SSA and Low Executive Function Including Statistical Method Used and Variables Included in Each Model

Overall SSA:[1] Unadjusted	Statistical method:	Logistic regression
	Outcome variable:	Low executive function
	Exposure variable:	Low overall SSA
	Interaction terms:	---
	Confounding variables:	---
Overall SSA:[1] Confounding Variables and Interaction Terms	Statistical method:	Logistic regression
	Outcome variable:	Low executive function
	Exposure variable:	Low overall SSA
	Interaction terms:	Low overall SSA*(Sociodemographic: Age, education, household income, province of residence, urban/rural residence Health: Self-rated health, chronic conditions, depression Social: Marital status, pet ownership, loneliness)
	Confounding variables:	Sociodemographic: Age, education, household income, province of residence, urban/rural residence Health: Self-rated health, chronic conditions, depression Social: Marital status, pet ownership, loneliness
Overall SSA:[1] Confounding Variables *(assuming no interaction terms are significant)*	Statistical method:	Logistic regression
	Outcome variable:	Low executive function
	Exposure variable:	Low overall SSA
	Confounding variables:	Sociodemographic: Age, education, household income, province of residence, urban/rural residence
Overall SSA:[1] Confounding Variables	Statistical method:	Logistic regression
	Outcome variable:	Low executive function
	Exposure variable:	Low overall SSA
	Confounding variables:	Sociodemographic: Age, education, household income, province of residence, urban/rural residence Health: Self-rated health, chronic conditions, depression
Overall SSA:[1] Confounding Variables	Statistical method:	Logistic regression
	Outcome variable:	Low executive function
	Exposure variable:	Low overall SSA
	Confounding variables:	Sociodemographic: Age, education, household income, province of residence, urban/rural residence Health: Self-rated health, chronic conditions, depression Social: Marital status, pet ownership, loneliness

[1]Reflects the set of models used to assess the association between low overall SSA and low executive function. This set of models was repeated with each of the four SSA subtypes as exposure: affection, tangible, emotional/informational, and positive social interactions.
[1]Models were additionally run separately for males and females.
[2]Backwards elimination was utilized with a significance (α) level of 0.05 for interaction terms
Abbreviations: SSA = social support availability

4.3.4 Ethics and Data Access

The CLSA was formed under the Canadian Institute of Health Research's (CIHR) Institute of Aging and is bound by the CIHR requirements for ethical research, the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS). Written, informed consent was obtained from all participants before data collection and the CIHR Advisory Committee on Ethical, Legal and Social Issues was established to provide ethics advice throughout the length of the study. To ensure confidentiality, participants' data were identified by a number code rather than by name.

The current study falls under the scope of a broader project entitled "Profiles of Socially and Cognitively Vulnerable Canadians: A Cross-sectional Analysis of the Canadian Longitudinal Study on Aging (CLSA)," which has received ethics approval from the University of Waterloo (ORE #21398). The research team applied for access from the CLSA in November 2015 and received approval in December 2015. In April 2016, baseline data from the Tracking cohort were received. The data request update was received in February 2017, which included the addition of the baseline Comprehensive data. The author was approved for access from the CLSA in July 2017 and added to the ethics approval as a student investigator by the University of Waterloo in August 2017. Additional data on chronic conditions were received in August 2018. All electronic records at the University of Waterloo are stored on password-protected computers with restricted access given only to researchers who have been approved by the University. The CLSA has research ethics board approval from all of the universities housing Data Collection Centres or CLSA call centres.

5.0 Results

Research question 1 (i.e., Is low SSA (overall and subtypes) associated with low executive function, after adjusting for confounders?) is addressed in section 5.1, beginning with descriptive analyses in Tables 2a and 2b. Descriptive analyses were run separately for weighted and unweighted data. Multivariable regression analyses are then presented separately for overall SSA (Table 3a) and each SSA subtype: tangible (Table 3b), affection (Table 3c), emotional/informational (Table 3d), and positive social interactions (Table 3e).

Research question 2 (i.e., Does the association between low SSA and low executive function differ by sex?) is addressed in section 5.2, beginning with descriptive analyses in Tables 4a and 4b and Tables 5a and 4b. Descriptive analyses were run separately for weighted and unweighted data. Multivariable regression analyses are then presented separately for overall SSA (Tables 6a and 6b) and each SSA subtype: tangible (Tables 7a and 7b), affection (Table 8), emotional/informational (Tables 9a, 9b and 9c), and positive social interactions (Tables 10a and 10b).

5.1 Research question 1: Is low SSA (overall and subtypes) associated with low executive function, after adjusting for confounders?

5.1.1 Descriptive analyses for the association between low SSA and low executive function

Overall SSA (and each subtype of SSA) was significantly ($p<0.001$) associated with executive function in both weighted and unweighted analyses (Table 2a). The prevalence of low executive function was approximately twice as high in participants with low overall SSA (11.67%) compared to those with higher overall SSA (5.87%). In terms of the SSA subtypes, while those reporting low emotional/informational SSA only account for 8.70% of the overall unweighted sample, 14.67% of those with low executive function report low emotional/informational SSA.

5.1.2 Descriptive analyses for the association between covariates and low executive function

The results of the bivariate analyses in the weighted and unweighted analytic samples are presented in Table 2b. Age was negatively significantly associated with executive function, with those in the oldest age group— accounting for 15.99% of the overall unweighted sample— comprising 44.80% of the low executive function sample. In contrast, education was significantly positively associated with executive function: despite accounting for only 5.16% of the overall sample, 17.16% of those with low executive function reported having less than a high school diploma. This positive association was also seen with income: of those with low executive function, 12.93% had a household income of less than $20,000, compared to 5.24% with an income of $150,000 or over. Income was significantly ($p<0.001$) associated with low executive function in both weighted and unweighted analyses. Significant regional differences were also seen. Sex and urban/rural residence were not significantly associated with low executive function.

Reporting a chronic condition was associated with a significantly greater chance of low executive function: 82.04% of those with low executive function reported having at least one chronic health condition, compared to 65.35% of those who did not have low executive function. General self-rated health was also significant: 17.50% of those with low executive function reported poor/fair self-rated health, compared to 7.64% of those without low executive function. Despite this, the bivariate association between clinical depression and executive function was not significant.

There was a significant association between low executive function and loneliness, marital status, and pet companionship. Those who reported feeling lonely all the time accounted for 4.10% of those with low executive function, and 1.77% of those who did not

have low executive function. Among those with low executive function, 31.45% reported having a pet for companionship, compared to 44.35% of those without low executive function. Finally, there was a significant association between marital status and low executive function, with the difference being particularly noticeable for widows: 20.71% of those with low executive function were widows, compared to 7.17% who did not have low executive function.

Table 2a: Distribution of Low SSA by Low Executive Function Status, Canadian Longitudinal Study on Aging

	Frequency (n=23,491)			**Weighted Frequency (n=2,940,843)**		
	Low Executive Function					
Characteristics	Yes (n= 2366)	No (n=21,125)	Total	Yes (n=209,050)	No (n=2,731,792)	Total
Overall SSA						
Low	11.67	5.87***	6.46	10.62	4.93***	5.33
Other	88.33	94.13	93.54	89.38	95.07	94.66
Tangible SSA						
Low	16.78	10.73***	11.34	15.40	8.94***	9.40
Other	83.22	89.27	88.66	84.60	91.06	90.60
Affectionate SSA						
Low	13.61	7.80***	8.39	13.05	6.62***	7.08
Other	86.39	92.20	91.61	86.95	93.38	92.92
Emotional/informational SSA						
Low	14.67	8.03***	8.70	13.90	7.18***	7.65
Other	85.33	91.97	91.30	86.10	92.82	92.35
Positive social interactions						
Low	16.61	9.06***	9.82	15.23	7.99***	8.51
Other	83.39	90.94	90.18	84.77	92.01	91.49

Abbreviations: SSA= social support availability
*p<0.05; **p<0.01; ***p<0.001

Table 2b: Distribution of Covariates by Low Executive Function, Canadian Longitudinal Study on Aging

Sociodemographic Characteristics	Frequency (n=23,491)			Weighted Frequency (n=2,940,843)		
	Low Executive Function					
	Yes (n= 2366)	No (n=21,125)	Total	Yes (n=209,050)	No (n=2,731,792)	Total
Age, groups (%)						
45–54 years	8.54	28.82***	26.78	18.04	45.56***	43.61
55–64 years	17.33	35.30	33.49	18.76	30.93	30.06
65–74 years	29.33	23.11	23.74	26.07	15.60	16.35
75 years and over	44.80	12.76	15.99	37.12	7.91	9.98
Sex (%)						
Female	50.63	50.53	50.54	51.88	49.91	50.05
Male	49.37	49.47	49.46	48.12	50.09	49.95
Education (%)						
Less than high school	17.16	3.82***	5.16	19.56	3.51***	4.65
High school graduate	14.45	8.46	9.07	14.62	8.04	8.51
Some post-secondary	8.83	7.32	7.47	8.30	6.73	6.84
Post-secondary degree/diploma	59.55	80.40	78.30	57.52	81.71	79.99
Annual household income (%)						
< $20k	12.93	4.37***	5.23	13.11	3.73***	4.39
≥ $20k and < $50k	41.93	19.79	22.02	41.79	16.39	2.97
≥ $50k and < $100k	31.53	35.68	35.26	29.99	33.39	33.15
≥ $100k and < $150k	8.37	21.29	19.99	8.70	23.64	22.58
≥ $150k	5.24	18.87	17.50	6.40	22.86	21.69
Province (%)						
Ontario	20.71	21.61***	21.52	13.69	13.34***	13.37
Alberta	7.82	8.74	8.65	8.92	11.32	11.15
British Columbia	17.03	22.53	21.98	24.65	32.17	31.63
Manitoba	11.71	10.67	10.77	10.33	8.56	8.68
NFLD	11.24	7.56	7.93	3.51	2.27	2.36
Nova Scotia	12.13	10.41	10.59	4.62	3.57	3.64
Quebec	19.36	18.48	18.56	34.28	28.77	29.17
Urban/rural residence (%)						
Rural	9.04	9.34	9.31	10.40	9.35	9.43
Urban	90.96	90.66	90.69	89.60	90.64	90.57

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

Table 2b: Distribution of Covariates by Low Executive Function, Canadian Longitudinal Study on Aging, Continued

Health and Social Characteristics	Frequency (n=23,491)			Weighted Frequency (n=2,940,843)		
	Low Executive Function					
	Yes (n= 2366)	No (n=21,125)	Total	Yes (n=209,050)	No (n=2,731,792)	Total
Chronic Condition (%)						
Yes	82.04	65.35***	67.03	79.02	60.22***	61.56
No	17.96	34.65	32.97	20.98	39.77	38.44
Self-rated health (%)						
Poor	2.96	1.21***	1.38	3.13	1.06***	1.20
Fair	14.54	6.43	7.25	14.63	6.39	6.98
Good	36.81	28.48	29.32	39.40	28.96	29.70
Very good	33.01	42.64	41.67	31.07	41.94	41.17
Excellent	12.68	21.24	20.37	11.77	21.64	20.11
Clinical depression (%)						
Yes	15.30	16.61	16.48	17.38	17.34	17.34
No	84.70	83.39	83.52	82.62	82.66	82.66
Loneliness, days/week (%)						
All of the time (5–7)	4.10	1.77***	2.00	4.02	1.59**	1.77
Occasionally (3–4)	11.67	7.92	8.30	11.09	7.27	7.54
Some of the time (1–2)	17.62	14.65	14.95	18.10	14.62	14.87
Rarely or never (<1)	66.61	75.66	74.75	66.78	76.52	75.83
Marital status (%)						
Single, never married	8.07	8.52***	8.38	8.01	7.87***	7.88
Married/common-law	56.68	71.55	70.05	63.00	78.18	77.10
Widowed	20.71	7.19	8.55	15.78	4.19	5.01
Divorced/separated	14.54	12.74	12.92	13.20	9.76	10.01
Pet for companionship (%)						
Yes	31.45	44.35***	43.05	34.56	47.97***	47.01
No	68.55	55.65	56.95	65.44	52.03	52.99

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

5.1.3 Regression analyses for the association between low SSA and low executive function

In the multivariable analyses, there was a significant, positive association between low SSA and low executive function in the crude models for overall SSA and each SSA subtype (Table 3a through 3e), indicating that those who reported lower support had greater odds of having low executive function. The strength of these associations decreased with the inclusion of each new chunk of covariates, with only three subtypes of SSA remaining significant in the full model (Model D) after the inclusion of all covariates: affection (Table 3c, OR=1.24, 95% CI=1.04–1.49), emotional/informational (Table 3d, OR=1.20, 95% CI=1.01–1.42), and positive social interactions (Table 3e, OR=1.27, 95% CI=1.09–1.50). Overall SSA was not significant after the inclusion of the other social covariates in the full model (Table 3a, OR=1.21, 95% CI=0.99–1.47), while tangible support became non-significant in Model C after the inclusion of health covariates, remaining non-significant in the full model (Table 3b, OR=1.13, 95% CI=0.96–1.33).

5.1.4 Regression analyses for the association between covariates and low executive function

5.1.4.1 Sociodemographic covariates

The sociodemographic variables were highly consistent across all subtypes and were not impacted by the type of SSA included in the models. Sex was significantly associated with low executive function in all models, with women consistently having 15–16% lower odds of low executive function compared to men. A significant, positive, dose response was seen with age, such that, compared to the lowest age group (45–54 years) those in the 55–64, 65–74, and 75 and over age groups had greater odds of experiencing low executive function by 34%, 179–180% and 548–552%, respectively.

A significant, negative dose response was seen for income and education, a pattern which remained nearly identical across all models regardless of which SSA subtype was included. Compared to those with less than a high school education, those who graduated from high school, those who had some post-secondary education, and those who had a post-secondary degree had, respectively, 35–36%, 53%, and 61–62% lower odds of having low executive function. In terms of finances, those with higher household incomes had significantly lower odds of experiencing low executive function compared to those with household incomes under $20,000: $20,000 to under $50,000 (30% lower odds), $50,000 to under $100,000 (63% lower odds), $100,000–$150,000 (77% lower odds) and over $150,000 (81% lower odds).

Geographically, compared to Ontario, participants in British Columbia and Quebec had significantly lower odds of low executive function by 29-30% and 31%, respectively. In each of the full models for the SSA subtypes, those from Newfoundland and Labrador had 58–59% greater odds of having low executive function compared to Ontario. Urban/rural residence was not significant in any model.

5.1.4.2 Health covariates

Reporting a chronic disease was associated with significantly greater odds for low cognitive function of 17% across all models. Clinical depression was not significant in any of the models. In addition, there was no significant difference between those who self-rated their health as ‘fair’ compared to ‘poor’; however, compared to those who rated their health as ‘poor’, those who chose ‘good’, ‘very good’, or ‘excellent’ had significantly lower odds of low executive function: 44–43%, 60–61% and 65%, respectively.

5.1.4.3 Social covariates

Compared to those who reported being single and never married, individuals who were married or common-law had greater odds of low cognitive function, although this association was not significant. Widowed participants also had greater odds of low executive function, and this association was close to significance in all models except the affection SSA model where it was significant (Table 3c, OR=1.27, 95% CI=1.01–1.61).

When compared to those who reported feeling lonely all the time, those who reported less loneliness had lower odds of having low executive function, although this association was only significant in the model for tangible SSA for rarely or never being lonely (Table 3b, OR=0.72, 0.52–0.99). Pet companionship was significantly associated with 11–12% lower odds of low executive function in all models.

Table 3a: Multivariable Analysis Assessing the Association Between Low Overall SSA and Low Executive Function, Canadian Longitudinal Study on Aging, n=23,491

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low overall SSA[2]	**2.31 (1.98-2.70)**	**1.35 (1.12-1.62)**	**1.23 (1.02-1.47)**	1.21 (0.99-1.47)
Age group (vs 45–54 years)				
55–64 years		**1.36 (1.13-1.64)**	**1.36 (1.13-1.65)**	**1.34 (1.11-1.62)**
65–74 years		**2.85 (2.37-3.41)**	**2.92 (2.42-3.52)**	**2.80 (2.30-3.40)**
75 years and over		**6.98 (5.82-8.37)**	**7.02 (5.81-8.49)**	**6.48 (5.30-7.92)**
Female vs male		**0.82 (0.73-0.91)**	**0.85 (0.76-0.95)**	**0.85 (0.76-0.95)**
Education (vs less than high school)				
High school graduate		**0.61 (0.49-0.75)**	**0.64 (0.52-0.79)**	**0.65 (0.53-0.80)**
Some post-secondary education		**0.44 (0.35-0.55)**	**0.46 (0.37-0.59)**	**0.47 (0.37-0.60)**
Post-secondary degree/diploma		**0.35 (0.29-0.41)**	**0.38 (0.32-0.45)**	**0.39 (0.32-0.46)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		**0.67 (0.56-0.80)**	**0.73 (0.61-0.88)**	**0.70 (0.58-0.85)**
≥ $50,000 and < $100,000		**0.34 (0.28-0.41)**	**0.39 (0.32-0.47)**	**0.37 (0.30-0.45)**
≥ $100,000 and < $150,000		**0.20 (0.16-0.26)**	**0.25 (0.19-0.32)**	**0.23 (0.18-0.30)**
≥ $150,000		**0.16 (0.12-0.21)**	**0.20 (0.15-0.27)**	**0.19 (0.14-0.25)**
Province (vs Ontario)				
Alberta		1.03 (0.81-1.30)	1.03 (0.81-1.31)	1.03 (0.81-1.31)
British Columbia		**0.71 (0.60-0.84)**	**0.70 (0.59-0.83)**	**0.70 (0.59-0.83)**
Manitoba		0.998 (0.83-1.20)	0.99 (0.82-1.19)	0.99 (0.82-1.19)
Newfoundland and Labrador & Nova Scotia		**1.34 (1.14-1.56)**	**1.31 (1.12-1.54)**	**1.32 (1.13-1.54)**
Quebec		**0.71 (0.60-0.83)**	**0.69 (0.59-0.82)**	**0.69 (0.58-0.82)**
Urban residence (vs rural)		0.86 (0.71-1.04)	0.85 (0.70-1.03)	0.84 (0.70-1.02)

Table 3a: Multivariable Analysis Assessing the Association Between Low Overall SSA and Low Executive Function, Canadian Longitudinal Study on Aging, n=23,491, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model a OR (95% CI)**	**Model a OR (95% CI)**	**Model a OR (95% CI)**
Chronic diseases (yes vs no)			**1.17 (1.02-1.34)**	**1.17 (1.02-1.34)**
Self-rated general health (vs poor)				
Fair			0.82 (0.57-1.17)	0.82 (0.57-1.17)
Good			**0.56 (0.40-0.78)**	**0.56 (0.40-0.79)**
Very good			**0.38 (0.27-0.54)**	**0.40 (0.28-0.55)**
Excellent			**0.34 (0.24-0.48)**	**0.35 (0.24-0.50)**
Clinical depression (yes vs no)			0.90 (0.78-1.04)	0.90 (0.78-1.04)
Marital status (vs single)				
Married/common-law				1.17 (0.93-1.46)
Widowed				1.26 (1.00-1.59)
Divorced/separated				0.89 (0.71-1.12)
Pet for companionship (yes vs. no)				**0.88 (0.78-0.99)**
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.81 (0.57-1.14)
Some of the time (1–2 days)				0.87 (0.62-1.22)
Rarely or never (<1 day)				0.73 (0.53-1.02)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table 3b: Multivariable Analysis Assessing the Association Between Low Tangible SSA and Low Executive Function, Canadian Longitudinal Study on Aging, n=23,491

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low tangible SSA[2]	**1.94 (1.70-2.21)**	**1.20 (1.04-1.40)**	1.13 (0.97-1.32)	1.13 (0.96-1.33)
Age group (vs 45–54 years)				
55–64 years		**1.37 (1.14-1.65)**	**1.37 (1.13-1.65)**	**1.34 (1.11-1.62)**
65–74 years		**2.84 (2.37-3.40)**	**2.91 (2.42-3.51)**	**2.80 (2.31-3.40)**
75 years and over		**6.99 (5.83-8.39)**	**7.04 (5.83-8.51)**	**6.52 (5.33-7.98)**
Female vs male		**0.81 (0.72-0.90)**	**0.84 (0.75-0.94)**	**0.84 (0.75-0.94)**
Education (vs less than high school)				
High school graduate		**0.60 (0.48-0.74)**	**0.64 (0.51-0.79)**	**0.64 (0.52-0.80)**
Some post-secondary education		**0.43 (0.34-0.55)**	**0.46 (0.36-0.58)**	**0.47 (0.37-0.59)**
Post-secondary degree/diploma		**0.34 (0.29-0.41)**	**0.37 (0.32-0.44)**	**0.38 (0.32-0.46)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		**0.66 (0.55-0.80)**	**0.73 (0.61-0.88)**	**0.70 (0.58-0.85)**
≥ $50,000 and < $100,000		**0.33 (0.28-0.41)**	**0.39 (0.32-0.47)**	**0.37 (0.29-0.45)**
≥ $100,000 and < $150,000		**0.20 (0.16-0.26)**	**0.25 (0.19-0.31)**	**0.23 (0.17-0.30)**
≥ $150,000		**0.16 (0.12-0.21)**	**0.20 (0.15-0.26)**	**0.19 (0.14-0.25)**
Province (vs Ontario)				
Alberta		1.03 (0.81-1.30)	1.03 (0.81-1.31)	1.03 (0.81-1.31)
British Columbia		**0.71 (0.60-0.83)**	**0.70 (0.59-0.82)**	**0.70 (0.59-0.83)**
Manitoba		0.995 (0.83-1.20)	0.98 (0.82-1.19)	0.99 (0.82-1.19)
Newfoundland and Labrador		**1.60 (1.32-1.94)**	**1.58 (1.31-1.92)**	**1.58 (1.30-1.92)**
Nova Scotia		1.16 (0.96-1.40)	1.13 (0.93-1.37)	1.14 (0.94-1.38)
Quebec		**0.70 (0.60-0.83)**	**0.69 (0.58-0.82)**	**0.69 (0.58-0.81)**
Urban residence (vs rural)		0.85 (0.71-1.03)	0.84 (0.69-1.01)	0.83 (0.69-1.01)

Table 3b: Multivariable Analysis Assessing the Association Between Low Tangible SSA and Low Executive Function, Canadian Longitudinal Study on Aging, n=23,491, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			**1.17 (1.02-1.34)**	**1.17 (1.02-1.34)**
Self-rated general health (vs poor)				
Fair			0.82 (0.57-1.17)	0.82 (0.57-1.17)
Good			**0.56 (0.40-0.78)**	**0.56 (0.40-0.79)**
Very good			**0.38 (0.27-0.54)**	**0.39 (0.27-0.55)**
Excellent			**0.34 (0.24-0.48)**	**0.35 (0.24-0.50)**
Clinical depression (yes vs no)			0.90 (0.78-1.05)	0.90 (0.78-1.05)
Marital status (vs single)				
Married/common-law				1.17 (0.93-1.46)
Widowed				1.25 (0.99-1.57)
Divorced/separated				0.89 (0.71-1.11)
Pet for companionship (yes vs. no)				**0.89 (0.79-1.00)**
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.79 (0.56-1.12)
Some of the time (1–2 days)				0.85 (0.61-1.20)
Rarely or never (<1 day)				**0.72 (0.52-0.99)**

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table 3c: Multivariable Analysis Assessing the Association Between Low Affection SSA and Low Executive Function, Canadian Longitudinal Study on Aging, n=23,491

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low affection SSA[2]	**2.11 (1.83-2.43)**	**1.36 (1.15-1.60)**	**1.24 (1.05-1.46)**	**1.24 (1.04-1.49)**
Age group (vs 45–54 years)				
55–64 years		**1.37 (1.13-1.64)**	**1.37 (1.13-1.65)**	**1.34 (1.11-1.62)**
65–74 years		**2.84 (2.37-3.41)**	**2.91 (2.42-3.51)**	**2.79 (2.30-3.39)**
75 years and over		**7.04 (5.87-8.45)**	**7.06 (5.84-8.54)**	**6.51 (5.32-7.97)**
Female vs male		**0.82 (0.73-0.91)**	**0.85 (0.76-0.95)**	**0.85 (0.76-0.95)**
Education (vs less than high school)				
High school graduate		**0.59 (0.48-0.73)**	**0.63 (0.51-0.78)**	**0.64 (0.52-0.79)**
Some post-secondary education		**0.43 (0.34-0.55)**	**0.46 (0.36-0.58)**	**0.47 (0.37-0.59)**
Post-secondary degree/diploma		**0.34 (0.29-0.41)**	**0.37 (0.31-0.44)**	**0.38 (0.32-0.46)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		**0.67 (0.56-0.81)**	**0.74 (0.61-0.89)**	**0.70 (0.58-0.85)**
≥ $50,000 and < $100,000		**0.34 (0.28-0.41)**	**0.39 (0.32-4.8)**	**0.37 (0.30-0.45)**
≥ $100,000 and < $150,000		**0.21 (0.16-0.26)**	**0.25 (0.19-0.32)**	**0.23 (0.18-0.30)**
≥ $150,000		**0.16 (0.12-0.21)**	**0.20 (0.15-0.27)**	**0.19 (0.14-0.25)**
Province (vs Ontario)				
Alberta		1.02 (0.81-1.30)	1.03 (0.81-1.31)	1.03 (0.81-1.31)
British Columbia		**0.71 (0.60-0.84)**	**0.70 (0.59-0.83)**	**0.70 (0.59-0.83)**
Manitoba		0.999 (0.83-1.20)	0.99 (0.82-1.19)	0.99 (0.82-1.19)
Newfoundland and Labrador		**1.61 (1.33-1.94)**	**1.59 (1.31-1.92)**	**1.59 (1.31-1.92)**
Nova Scotia		1.15 (0.95-1.40)	1.13 (0.94-0.14)	1.14 (0.94-1.38)
Quebec		**0.70 (0.60-0.83)**	**0.69 (0.58-0.81)**	**0.69 (0.58-0.81)**
Urban residence (vs rural)		0.85 (0.70-1.03)	0.84 (0.69-1.01)	0.84 (0.69-1.01)

Table 3c: Multivariable Analysis Assessing the Association Between Low Affection SSA and Low Executive Function, Canadian Longitudinal Study on Aging, n=23,491, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			**1.17 (1.02-1.34)**	**1.17 (1.02-1.34)**
Self-rated general health (vs poor)				
Fair			0.82 (0.57-1.17)	0.82 (0.57-1.17)
Good			**0.56 (0.40-0.79)**	**0.57 (0.40-0.80)**
Very good			**0.38 (0.27-0.54)**	**0.39 (0.28-0.55)**
Excellent			**0.34 (0.24-0.49)**	**0.35 (0.24-0.50)**
Clinical depression (yes vs no)			0.90 (0.77-1.04)	0.90 (0.77-1.04)
Marital status (vs single)				
Married/common-law				1.19 (0.95-1.50)
Widowed				**1.27 (1.01-1.61)**
Divorced/separated				0.90 (0.72-1.13)
Pet for companionship (yes vs. no)				**0.88 (0.79-0.99)**
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.81 (0.57-1.15)
Some of the time (1–2 days)				0.88 (0.62-1.23)
Rarely or never (<1 day)				0.74 (0.53-1.03)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table 3d: Multivariable Analysis Assessing the Association Between Low Emotional/ Informational SSA and Low Executive Function, Canadian Longitudinal Study on Aging, n=23,491

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low emotional/informational SSA[2]	**2.14 (1.86-2.46)**	**1.33 (1.13-1.57)**	**1.22 (1.04-1.44)**	**1.20 (1.01-1.42)**
Age group (vs 45–54 years)				
55–64 years		**1.37 (1.13-1.65)**	**1.37 (1.13-1.65)**	**1.34 (1.11-1.62)**
65–74 years		**2.83 (2.36-3.39)**	**2.91 (2.41-3.50)**	**2.79 (2.30-3.39)**
75 years and over		**6.95 (5.79-8.34)**	**7.02 (5.80-8.48)**	**6.49 (5.30-7.94)**
Female vs male		**0.82 (0.73-0.91)**	**0.85 (0.76-0.95)**	**0.85 (0.76-0.95)**
Education (vs less than high school)				
High school graduate		**0.60 (0.49-0.74)**	**0.64 (0.52-0.79)**	**0.64 (0.52-0.80)**
Some post-secondary education		**0.43 (0.34-0.55)**	**0.46 (0.36-0.58)**	**0.47 (0.37-0.59)**
Post-secondary degree/diploma		**0.34 (0.29-0.41)**	**0.38 (0.32-0.45)**	**0.38 (0.32-0.46)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		**0.66 (0.55-0.80)**	**0.73 (0.61-0.88)**	**0.70 (0.58-0.85)**
≥ $50,000 and < $100,000		**0.33 (0.28-0.40)**	**0.39 (0.32-0.47)**	**0.37 (0.30-0.45)**
≥ $100,000 and < $150,000		**0.20 (0.16-0.26)**	**0.24 (0.19-0.31)**	**0.23 (0.18-0.30)**
≥ $150,000		**0.16 (0.12-0.26)**	**0.20 (0.15-0.26)**	**0.19 (0.14-0.25)**
Province (vs Ontario)				
Alberta		1.03 (0.81-1.31)	1.03 (0.81-1.31)	1.03 (0.81-1.31)
British Columbia		**0.71 (0.60-0.84)**	**0.70 (0.59-0.83)**	**0.71 (0.60-0.84)**
Manitoba		1.01 (0.84-1.21)	0.99 (0.82-1.19)	0.99 (0.82-1.20)
Newfoundland and Labrador		**1.61 (1.33-1.95)**	**1.59 (1.31-1.93)**	**1.59 (1.31-1.92)**
Nova Scotia		1.16 (0.96-1.41)	1.14 (0.94-1.38)	1.15 (0.95-1.39)
Quebec		**0.70 (0.60-0.83)**	**0.69 (0.58-0.82)**	**0.69 (0.58-0.81)**
Urban residence (vs rural)		0.85 (0.70-1.03)	0.84 (0.69-1.01)	0.83 (0.69-1.01)

Table 3d: Multivariable Analysis Assessing the Association Between Low Emotional/ Informational SSA and Low Executive Function, Canadian Longitudinal Study on Aging, n=23,491, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			**1.17 (1.02-1.34)**	**1.17 (1.02-1.34)**
Self-rated general health (vs poor)				
Fair			0.82 (0.57-1.17)	0.82 (0.57-1.17)
Good			**0.56 (0.40-0.79)**	**0.56 (0.40-0.79)**
Very good			**0.38 (0.27-0.54)**	**0.39 (0.28-0.55)**
Excellent			**0.34 (0.24-0.49)**	**0.35 (0.24-0.50)**
Clinical depression (yes vs no)			0.90 (0.78-1.05)	0.90 (0.78-1.05)
Marital status (vs single)				
Married/common-law				1.15 (0.92-1.43)
Widowed				1.24 (0.99-1.56)
Divorced/separated				0.88 (0.71-1.11)
Pet for companionship (yes vs. no)				**0.88 (0.79-0.99)**
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.81 (0.57-1.14)
Some of the time (1–2 days)				0.87 (0.62-1.22)
Rarely or never (<1 day)				0.73 (0.52-1.02)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table 3e: Multivariable Analysis Assessing the Association Between Low Positive Social Interactions and Low Executive Function, Canadian Longitudinal Study on Aging, n=23,491

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low positive social interactions[2]	**2.09 (1.83-2.39)**	**1.42 (1.22-1.65)**	**1.29 (1.11-1.50)**	**1.27 (1.09-1.50)**
Age group (vs 45–54 years)				
55–64 years		**1.37 (1.14-1.65)**	**1.37 (1.13-1.65)**	**1.34 (1.11-1.62)**
65–74 years		**2.86 (2.38-3.43)**	**2.92 (2.43-3.53)**	**2.80 (1.11-1.62)**
75 years and over		**7.05 (5.87-8.46)**	**7.06 (5.84-8.53)**	**6.51 (5.32-7.97)**
Female vs male		**0.81 (0.73-0.90)**	**0.85 (0.76-0.94)**	**0.85 (0.76-0.95)**
Education (vs less than high school)				
High school graduate		**0.60 (0.49-0.74)**	**0.64 (0.51-0.79)**	**0.64 (0.52-0.80)**
Some post-secondary education		**0.43 (0.34-0.55)**	**0.46 (0.36-0.58)**	**0.47 (0.37-0.60)**
Post-secondary degree/diploma		**0.34 (0.29-0.41)**	**0.37 (0.31-0.44)**	**0.38 (0.32-0.46)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		**0.68 (0.56-0.81)**	**0.74 (0.61-0.89)**	**0.70 (0.58-0.86)**
≥ $50,000 and < $100,000		**0.34 (0.28-0.42)**	**0.40 (0.33-0.48)**	**0.37 (0.30-0.47)**
≥ $100,000 and < $150,000		**0.21 (0.16-0.27)**	**0.25 (0.20-0.32)**	**0.23 (0.18-0.30)**
≥ $150,000		**0.16 (0.12-0.22)**	**0.20 (0.15-0.27)**	**0.19 (0.14-0.25)**
Province (vs Ontario)				
Alberta		1.03 (0.81-1.31)	1.03 (0.81-1.31)	1.03 (0.81-1.31)
British Columbia		**0.71 (0.60-0.84)**	**0.70 (0.59-0.83)**	**0.70 (0.60-0.83)**
Manitoba		1.00 (0.83-1.21)	0.99 (0.82-1.19)	0.99 (0.82-1.19)
Newfoundland and Labrador		**1.61 (1.33-1.95)**	**1.59 (1.31-1.93)**	**1.59 (1.31-1.93)**
Nova Scotia		1.16 (0.96-1.41)	1.14 (0.94-1.38)	1.15 (0.95-1.39)
Quebec		**0.71 (0.60-0.84)**	**0.70 (0.59-0.82)**	**0.69 (0.59-0.82)**
Urban residence (vs rural)		0.85 (0.70-1.02)	0.84 (0.69-1.01)	0.83 (0.69-1.01)

Table 3e: Multivariable Analysis Assessing the Association Between Low Positive Social Interactions SSA and Low Executive Function, Canadian Longitudinal Study on Aging, n=23,491, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			**1.17 (1.02-1.34)**	**1.17 (1.02-1.35)**
Self-rated general health (vs poor)				
Fair			0.82 (0.57-1.17)	0.82 (0.57-1.17)
Good			**0.56 (0.40-0.79)**	**0.57 (0.40-0.80)**
Very good			**0.39 (0.27-0.55)**	**0.39 (0.28-0.55)**
Excellent			**0.34 (0.24-0.49)**	**0.35 (0.24-0.51)**
Clinical depression (yes vs no)			0.89 (0.77-1.03)	0.89 (0.77-1.04)
Marital status (vs single)				
Married/common-law				1.17 (0.94-1.46)
Widowed				1.26 (1.00-1.58)
Divorced/separated				0.88 (0.71-1.11)
Pet for companionship (yes vs. no)				**0.89 (0.79-1.00)**
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.82 (0.58-1.16)
Some of the time (1–2 days)				0.89 (0.63-1.25)
Rarely or never, <1 day				0.76 (0.54-1.05)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

5.2 Research question 2: Does the association between low SSA and low executive function differ in men and women?

Sex-stratified results of the descriptive analysis with low executive function as the outcome are presented in Tables 4a and 4b for SSA and Tables 5a and 5b for covariates. The results of the regression analyses are presented separately for overall SSA (Table 6a-b) and each SSA subtype: tangible (Tables 7a and 7b), affection (Table 8), emotional/informational (Tables 9a, 9b and 9c), and positive social interactions (Tables 10a and 10b).

5.2.1 Descriptive analyses for the association between low SSA and low executive function in males and females

Consistent with the unstratified analyses, descriptive analyses for both the weighted and unweighted samples in females (Table 4a) and males (Table 4b) indicated a significant difference between the frequency of low executive function in those reporting low SSA and those who do not report low SSA, with low SSA being associated with a higher chance of low executive function in all models.

5.2.2 Descriptive analyses for the association between covariates and low executive function in males and females

The results of the bivariate analyses in the weighted and unweighted analytic samples are presented separately for females (Table 5a) and males (Table 5b). Results were consistent with the unstratified analyses with minor exceptions. For example, among those with low executive function, 19.78% of women reported having been diagnosed with depression, compared to 10.70% of men, although depression was not significantly associated with the presence of low executive function in either men or women. In terms of marital status, widowed women accounted for 30.05% of the low executive function sample but only 12.63% of the full sample. In males, widowers accounted for 11.13% of those with low executive function, compared to 3.64% of those without low executive function.

Table 4a: Distribution of Low SSA by Low Executive Function Status in Females, Canadian Longitudinal Study on Aging

	Frequency (n=11,872)			Weighted Frequency (n=1,471,762)		
	Low Executive Function					
Characteristics	**Yes** (n= 1198)	**No** (n=10,674)	**Total**	**Yes** (n=108,447)	**No** (n=1,363,315)	**Total**
Overall SSA						
Low	9.68	5.61***	6.02	9.42	4.59***	4.94
Other	90.32	94.39	93.98	90.58	95.41	95.06
Tangible SSA						
Low	19.12	12.47***	13.14	18.46	10.30***	10.90
Other	80.88	87.53	86.86	81.54	89.70	89.10
Affectionate SSA						
Low	12.60	7.65***	8.15	12.79	6.27***	6.75
Other	87.40	92.35	91.85	87.21	93.72	93.25
Emotional/Informational SSA						
Low	11.69	6.91***	7.40	12.27	5.96***	6.42
Other	88.31	93.09	92.60	87.73	94.04	93.58
Positive Social Interactions						
Low	16.19	9.38***	10.07	15.72	8.10***	8.66
Other	83.81	90.62	89.93	84.28	91.90	91.34

Abbreviations: SSA = social support availability
*p<0.05; **p<0.01; ***p<0.001

Table 4b: Distribution of Low SSA by Low Executive Function Status in Males, Canadian Longitudinal Study on Aging

	Frequency (n=11,619)			Weighted Frequency (n=1,469,080)		
	Low Executive Function					
Characteristics	**Yes** (n= 1168)	**No** (n=10,451)	**Total**	**Yes** (n=100,603)	**No** (n=1,368,477)	**Total**
Overall SSA						
Low	13.70	6.14***	6.90	11.91	5.28***	5.73
Other	86.30	93.86	93.10	88.09	94.72	94.27
Tangible SSA						
Low	14.38	8.95***	9.49	12.10	7.59***	7.90
Other	85.62	91.05	90.51	87.90	92.41	92.10
Affectionate SSA						
Low	14.64	7.95***	8.62	13.33	6.96***	7.40
Other	85.36	92.05	91.38	86.67	93.03	92.60
Emotional/Informational SSA						
Low	17.72	9.18***	10.04	15.66	8.39***	8.89
Other	82.28	90.82	89.96	84.34	91.61	91.11
Positive Social Interactions						
Low	17.04	8.74***	9.57	14.69	7.89***	8.35
Other	82.96	91.26	90.43	85.31	92.11	91.65

Abbreviations: SSA = social support availability
*p<0.05; **p<0.01; ***p<0.001

Table 5a: Distribution of Covariates by Low Executive Function in Females, Canadian Longitudinal Study on Aging, n=11,872

Sociodemographic Characteristics	Frequency (n=11,872)			Weighted Frequency (n=1,471,762)		
	Low Executive Function					
	Yes (n= 1198)	No (n=10,674)	Total	Yes (n=108,447)	No (n=1,363,315)	Total
Age groups (%)						
45–54 years	8.26	29.59***	27.43	15.07	44.17***	42.03
55–64 years	17.03	35.94	34.03	16.89	30.90	29.87
65–74 years	30.97	22.28	23.16	29.90	16.46	17.45
75 years and over	43.74	12.20	15.38	38.14	8.47	10.66
Education (%)						
Less than high school	19.12	4.24***	5.74	22.26	4.05***	5.39
High school graduate	15.28	9.47	10.06	14.98	9.36	9.77
Some post-secondary	8.51	7.64	7.73	8.17	7.14	7.21
Post-secondary degree/diploma	57.10	78.64	76.47	54.59	79.45	77.62
Annual household income (%)						
< $20,000	17.61	5.52***	6.74	17.07	4.56***	5.49
≥ $20,000 and < $50,000	45.41	24.41	26.53	44.02	20.11	21.87
≥ $50,000 and < $100,000	26.63	35.83	34.91	27.14	34.95	34.38
≥ $100,000 and < $150,000	6.76	18.54	17.35	7.46	21.19	20.18
≥ $150,000	3.59	15.69	14.47	4.31	19.19	18.09
Province (%)						
Ontario	20.62	21.26***	21.19	14.26	13.26***	13.33
Alberta	8.35	8.74	8.70	8.32	10.20	10.06
British Columbia	16.61	22.27	21.70	25.03	32.44	31.90
Manitoba	10.68	10.98	10.95	9.69	8.39	8.48
NFLD	12.35	7.53	8.02	3.94	2.46	2.57
Nova Scotia	12.44	10.19	10.42	4.84	3.95	4.01
Quebec	18.95	19.03	19.02	33.93	29.31	29.65
Urban/rural residence (%)						
Rural	8.76	9.69	9.59	10.37	10.17*	10.18
Urban	91.24	90.31	90.41	89.63	89.83	89.82

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

Table 5a: Distribution of Covariates Sample by Low Executive Function in Females, Canadian Longitudinal Study on Aging, n=11,872, Continued

Health and Social Characteristics	Frequency (n=11,872)			Weighted Frequency (n=1,471,762)		
	Low Executive Function					
	Yes (n=1198)	No (n=10,674)	Total	Yes (n=108,447)	No (n=1,363,315)	Total
Chronic condition (%)						
Yes	82.72	66.72***	68.37	80.65	63.04***	64.34
No	17.28	33.24	31.63	19.35	36.96	35.66
Self-rated health (%)						
Poor	3.01	1.20***	1.38	3.15	1.01***	1.16
Fair	14.44	6.14	6.97	15.58	6.13	6.82
Good	37.81	27.26	28.33	40.15	27.52	28.45
Very good	32.22	43.59	42.44	29.75	42.74	41.78
Excellent	12.52	21.81	20.87	11.36	22.61	21.78
Clinical depression (%)						
Yes	19.78	21.37	21.21	22.21	22.06**	22.07
No	80.22	78.63	78.79	77.80	77.94	77.93
Loneliness: days/week (%)						
All of the time (5–7)	4.34	2.13***	2.35	4.05	1.95***	2.11
Occasionally (3–4)	13.69	9.12	9.58	12.74	8.06	8.40
Some of the time (1–2)	18.86	16.23	16.49	18.11	15.60	15.79
Rarely or never (<1 day)	63.11	72.53	71.58	65.10	74.38	73.70
Marital status (%)						
Single, never married	7.93	9.37***	9.22	7.51	8.06***	8.02
Married/common-law	44.07	63.09	61.17	52.09	72.62	71.11
Widowed	30.05	10.67	12.63	23.48	6.50	7.75
Divorced/separated	17.95	16.87	16.98	16.92	12.82	13.12
Pet for companionship (%)						
Yes	33.81	46.39***	45.12	36.36	49.00***	48.06
No	66.19	53.61	54.88	63.64	51.00	51.94

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

Table 5b: Distribution of Covariates by Low Executive Function in Males, Canadian Longitudinal Study on Aging, n=11,619

Sociodemographic Characteristics	Frequency (n=11,619)			Weighted Frequency (n=1,469,080)		
	Low Executive Function					
	Yes (n=1168)	No (n=10,451)	Total	Yes (n=100,603)	No (n=1,368,477)	Total
Age groups (%)						
45–54 years	8.82	28.05***	26.11	21.24	46.95***	45.19
55–64 years	17.64	34.66	32.95	20.78	30.95	30.26
65–74 years	27.65	23.96	24.33	21.95	14.75	15.25
75 years and over	45.89	13.34	16.61	36.03	7.35	9.31
Education (%)						
Less than high school	15.15	3.39***	4.57	16.65	2.97***	3.91
High school graduate	13.61	7.43	8.06	14.23	6.73	7.25
Some post-secondary	9.16	6.98	7.20	8.43	6.34	6.47
Post-secondary degree/diploma	62.07	82.19	80.17	60.68	84.97	82.37
Annual household income (%)						
< $20,000	8.13	3.20***	3.69	8.84	2.89***	3.30
≥ $20,000 & < $50,000	38.36	15.07	17.41	39.40	12.68	14.51
≥ $50,000 & < $100,000	36.56	35.53	35.63	33.07	31.83	31.91
≥ $100,000 & < $150,000	10.02	24.09	22.68	10.04	26.09	24.99
≥ $150,000	6.93	22.11	20.59	8.66	26.51	25.29
Province (%)						
Ontario	20.80	21.98***	21.86	13.07	13.43***	13.41
Alberta	7.28	8.74	8.59	9.56	12.44	12.24
British Columbia	17.47	22.80	22.27	24.25	31.89	31.37
Manitoba	12.76	10.34	10.59	11.03	8.72	8.89
NFLD	10.10	7.59	7.84	3.06	2.09	2.15
Nova Scotia	11.82	10.64	10.76	4.37	3.19	3.27
Quebec	19.78	17.91	18.10	34.67	28.24	28.68
Urban/rural residence (%)						
Rural	9.33	8.99	9.03	10.42	8.54	8.67
Urban	90.67	91.01	90.97	89.58	91.46	91.33

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

Table 5b: Distribution of Covariates by Low Executive Function in Males, Canadian Longitudinal Study on Aging, n=11,619, Continued

Health and Social Characteristics	Frequency (n=11,619)			Weighted Frequency (n=1,469,080)		
	Low Executive Function					
	Yes (n=1168)	No (n=10,451)	Total	Yes (n=100,603)	No (n=1,368,477)	Total
Chronic condition (%)						
Yes	81.34	63.91***	65.66	77.27	57.42***	58.78
No	18.66	36.09	34.34	22.73	42.58	41.22
Self-rated health (%)						
Poor	2.91	1.22***	1.39	3.11	1.11***	1.24
Fair	14.64	6.74	7.53	13.61	6.66	7.14
Good	35.79	29.73	30.34	38.60	30.39	30.96
Very good	33.82	41.67	40.88	32.48	41.16	40.56
Excellent	12.84	20.65	19.86	12.20	20.68	20.10
Clinical depression (%)						
Yes	10.70	11.75	11.64	12.17	12.64	12.61
No	89.30	88.25	88.36	87.83	87.36	87.39
Loneliness, days/week (%)						
All of the time (5–7)	3.85	1.40***	1.64	3.99	1.24***	1.42
Occasionally (3–4)	9.59	6.71	7.00	9.32	6.48	6.67
Some of the time (1–2)	16.35	13.04	13.37	18.09	13.64	13.95
Rarely or never (<1 day)	70.21	78.85	77.98	68.60	78.65	77.96
Marital status (%)						
Single, never married	8.22	7.65***	7.71	8.55	7.69***	7.75
Married/common-law	69.61	80.18	79.12	74.76	83.71	83.10
Widowed	11.13	3.64	4.39	7.49	1.89	2.27
Divorced/separated	11.04	8.53	8.78	9.19	6.71	6.88
Pet for companionship (%)						
Yes	29.02	42.26***	40.93	32.62	46.94***	45.96
No	70.98	57.74	59.07	67.38	53.06	54.04

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

5.2.3 Regression analyses for the association between low overall SSA and low executive function in males and females

Due to significant first-order interactions between SSA and some covariates it was required that some sex-stratified models be further stratified: overall SSA by marital status; affection SSA by pet companionship; and emotional/informational SSA by marital status. If it was necessary to stratify male models due to an interaction, attempts were made to also stratify female models for comparison purposes, but this was not always possible due to further issues with significant interactions (i.e., emotional/informational SSA). Further, in

order to reduce interactions, it was necessary to combine levels on some multilevel variables (e.g., income, province).

5.2.3.1 Low overall SSA and low executive function in females

As can be seen in Table 6a, when the sample was limited to females, the association between overall SSA and low executive function was significant in the crude model (OR=2.07, 95% CI=1.65–2.60) but became nonsignificant after the inclusion of the sociodemographic covariates. Associations with covariates were consistent with the unstratified model, with the exception of pet companionship (OR=0.93, 95% CI=0.79–1.10), and chronic disease (OR=1.14, 95% CI=0.94–1.38), both of which were not significant in females. Loneliness also had a weakened effect in females compared to the unstratified models.

5.2.3.2 Low overall SSA and low executive function in males and females by marital status

Due to a significant interaction, the male models had to be further stratified by marital status, and this was repeated with females for comparison purposes. Full models are presented in Table 6b and sequential models in Appendix G (Table A4–A7). Overall SSA was not significant in any model; however, in men, those who were married had a stronger association between SSA and low executive function (OR=1.49, 95% CI=0.93–2.39) than those who were unmarried (OR=1.22, 95% CI=0.86–1.72). This pattern was also present in married women (OR=1.54, 95% CI=0.87–2.73); however, there was a reversal of direction in unmarried women (OR=0.92, 95% CI=0.69–1.22).

The association between covariates and executive function remained consistent with that of the unstratified model, although chronic disease, which was not significant in any model, had a stronger association in unmarried males and females, and was only significant

in unmarried women (OR=1.39, 95% CI=1.05–1.84). Married women saw a positive association between loneliness and executive function (e.g., rarely or never: OR=1.77, 95% CI=0.66–4.75), which contrasted with their unmarried counterparts (OR=0.68, 95% CI=0.44–1.06). Both of these associations were non-significant. Pet companionship was significantly associated with low executive function in married men (OR=0.81, 95% CI=0.66–0.99) but not unmarried men (OR=0.94, 95% CI=0.67–1.31). Men who were married also saw a dose-response association between self-rated health and executive function, while only excellent health was significantly different from poor/fair health in unmarried men (OR=0.56, 95% CI=0.33–0.92).

5.2.4 Regression analyses for the association between low tangible SSA and low executive function in males and females

5.2.4.1 Low tangible SSA and low executive function in females

Although not significant in Model C (OR=1.20, 95% CI=0.98-1.46), there was a significant association between low tangible support and low executive function in females (Table 7a) after the inclusion of the social covariates in Model D (OR=1.25, 95% CI=1.01-1.53). Associations between covariates and executive function were consistent with the unstratified model; however, widows had significantly greater odds of experiencing low executive function compared to single females (OR=1.41, 95% CI=1.06-1.88).

5.2.4.2 Low tangible SSA and low executive function in males

The association between low tangible SSA and low executive function in males (Table 7b) was significant in the crude model (OR=1.89, 95% CI=1.54-2.31), but was not significant after the inclusion of covariates in Model B, and began to reverse direction after the inclusion of other social variables (OR=0.95, 95% CI= 0.73-1.24). In terms of the other social exposures, however, pet companionship (OR=0.83, 0.70-0.99) and loneliness (e.g., rarely or never, OR=0.47, 95% CI=0.28-0.80) were both significant.

Table 6a: Multivariable Analysis Assessing the Association Between Low Overall SSA and Low Executive Function in Females, Canadian Longitudinal Study on Aging, n=11,872

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low overall SSA[2]	**2.07 (1.65-2.60)**	1.23 (0.95-1.60)	1.09 (0.83-1.42)	1.12 (0.85-1.47)
Age group (vs 45–54 years)				
55–64 years		**1.50 (1.15-1.95)**	**1.52 (1.17-1.99)**	**1.48 (1.13-1.95)**
65–74 years		**3.48 (2.69-4.50)**	**3.66 (2.81-4.75)**	**3.46 (2.62-4.56)**
75 years and over		**7.84 (6.05-10.16)**	**8.08 (6.19-10.56)**	**7.33 (5.47-9.81)**
Education (vs less than high school)				
High school graduate		**0.56 (0.43-0.73)**	**0.59 (0.45-0.77)**	**0.60 (0.46-0.79)**
Some post-secondary education		**0.39 (0.28-0.53)**	**0.41 (0.30-0.57)**	**0.43 (0.31-0.59)**
Post-secondary degree/diploma		**0.36 (0.29-0.45)**	**0.39 (0.31-0.49)**	**0.41 (0.33-0.52)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		**0.60 (0.48-0.75)**	**0.66 (0.53-0.82)**	**0.61 (0.49-0.77)**
≥ $50,000 and < $100,000		**0.32 (0.26-0.41)**	**0.38 (0.30-0.49)**	**0.35 (0.27-0.45)**
≥ $100,000		**0.20 (0.15-0.27)**	**0.26 (0.19-0.35)**	**0.23 (0.16-0.32)**
Province (vs Ontario)				
Alberta & Manitoba		0.99 (0.79-1.24)	1.00 (0.79-1.25)	1.00 (0.79-1.25)
British Columbia		**0.71 (0.57-0.90)**	**0.70 (0.56-0.88)**	**0.70 (0.56-0.89)**
Newfoundland and Labrador & Nova Scotia		**1.40 (1.13-1.74)**	**1.41 (1.13-1.75)**	**1.40 (1.13-1.75)**
Quebec		**0.66 (0.52-0.83)**	**0.63 (0.50-0.79)**	**0.63 (0.50-0.79)**
Urban residence (vs rural)		0.86 (0.67-1.10)	0.84 (0.65-1.08)	0.85 (0.66-1.10)

Table 6a: Multivariable Analysis Assessing the Association Between Low Overall SSA and Low Executive Function in Females, Canadian Longitudinal Study on Aging, n=11,872, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			1.13 (0.94-1.37)	1.14 (0.94-1.38)
Self-rated general health (vs poor/fair)				
Good			**0.67 (0.54-0.84)**	**0.67 (0.54-0.84)**
Very good			**0.40 (0.32-0.50)**	**0.40 (0.31-0.50)**
Excellent			**0.37 (0.28-0.48)**	**0.37 (0.28-0.49)**
Clinical depression (yes vs no)			0.93 (0.78-1.12)	0.95 (0.79-1.15)
Marital status (vs single)				
Married/common-law				1.27 (0.96-1.68)
Widowed				**1.39 (1.04-1.86)**
Divorced/Separated				0.98 (0.73-1.31)
Pet for companionship (yes vs. no)				0.93 (0.79-1.10)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.98 (0.64-1.50)
Some of the time (1–2 days)				0.98 (0.64-1.50)
Rarely or never (<1 day)				0.93 (0.62-1.40)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table 6b: Multivariable Analysis Assessing the Association Between Low Overall SSA and Low Executive Function Stratified by Marital Status, Canadian Longitudinal Study on Aging, n=23,491

	Low Executive Function[1]			
	Females		**Males**	
	OR (95% CI)		**OR (95% CI)**	
	Married (n=7262)	**Unmarried (n=4610)**	**Married (n=9193)**	**Unmarried (n=2426)**
Low overall SSA[2]	1.54 (0.87-2.73)	0.92 (0.69-1.22)	1.49 (0.93-2.39)	1.22 (0.86-1.72)
Age group (vs 45–54 years)				
55–64 years	**1.61 (1.13-2.29)**	1.33 (0.88-2.01)	1.12 (0.82-1.55)	**1.91 (1.19-3.05)**
65–74 years	**4.01 (2.77-5.80)**	**2.97 (2.00-4.42)**	**2.48 (1.80-3.43)**	**2.31 (1.42-3.77)**
75 years and over	**8.55 (5.70-12.83)**	**6.96 (4.68-10.35)**	**6.40 (4.60-8.89)**	**7.08 (4.34-11.54)**
Education (vs less than high school)				
High school graduate	**0.47 (0.31-0.71)**	0.79 (0.56-1.12)	0.80 (0.53-1.20)	0.55 (0.31-1.00)
Some post-secondary education	**0.41 (0.26-0.66)**	**0.42 (0.27-0.64)**	0.68 (0.44-1.05)	**0.24 (0.13-0.44)**
Post-secondary degree/diploma	**0.37 (0.26-0.52)**	**0.44 (0.33-0.58)**	**0.39 (0.28-0.55)**	**0.28 (0.18-0.45)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000	0.66 (0.32-1.39)	**0.61 (0.48-0.78)**	0.52 (0.24-1.11)	1.00 (0.68-1.46)
≥ $50,000 and < $100,000	**0.39 (0.18-0.82)**	**0.33 (0.24-0.44)**	**0.24 (0.12-0.52)**	**0.56 (0.36-0.87)**
≥ $100,000	**0.26 (0.12-0.55)**	**0.25 (0.15-0.44)**	**0.14 (0.06-0.29)**	**0.37 (0.17-0.80)**
≥ $150,000	**-----**	**-----**	**0.13 (0.06-0.28)**	**0.29 (0.11-0.77)**
Province (vs Ontario)				
Alberta & Manitoba	1.07 (0.76-1.49)	0.89 (0.65-1.20)	1.05 (0.79-1.40)	0.89 (0.56-1.42)
British Columbia	**0.67 (0.48-0.95)**	**0.72 (0.53-0.98)**	**0.74 (0.55-0.98)**	0.66 (0.43-1.03)
Newfoundland and Labrador & Nova Scotia	**1.70 (1.25-2.31)**	1.06 (0.79-1.43)	1.14 (0.88-1.49)	**1.64 (1.03-2.60)**
Quebec	0.72 (0.51-1.01)	**0.52 (0.39-0.70)**	0.75 (0.56-1.01)	0.74 (0.47-1.14)
Urban residence (vs rural)	0.85 (0.62-1.16)	0.85 (0.56-1.29)	0.77 (0.56-1.06)	1.06 (0.60-1.90)

Table 6b: Multivariable Analysis Assessing the Association Between Low Overall SSA and Low Executive Function Stratified by Marital Status, Canadian Longitudinal Study on Aging, n=23,491, Continued

	Low Executive Function[1]			
	Females		**Males**	
	OR (95% CI)		**OR (95% CI)**	
	Married (n=7262)	**Unmarried (n=4610)**	**Married (n=9193)**	**Unmarried (n=2426)**
Chronic diseases (yes vs no)	1.02 (0.79-1.32)	**1.39 (1.05-1.84)**	1.14 (0.90-1.43)	1.41 (0.96-2.07)
Self-rated general health (vs poor/fair)				
Good	**0.66 (0.48-0.92)**	**0.68 (0.51-0.91)**	**0.59 (0.44-0.79)**	0.81 (0.53-1.23)
Very good	**0.40 (0.28-0.55)**	**0.40 (0.30-0.54)**	**0.46 (0.34-0.61)**	0.81 (0.53-1.25)
Excellent	**0.38 (0.25-0.56)**	**0.37 (0.26-0.54)**	**0.39 (0.28-0.56)**	**0.56 (0.33-0.92)**
Clinical depression (yes vs no)	1.00 (0.75-1.33)	0.87 (0.69-1.10)	0.80 (0.58-1.07)	0.97 (0.65-1.43)
Pet for companionship (yes vs. no)	1.00 (0.79-1.27)	0.86 (0.70-1.07)	**0.81 (0.66-0.99)**	0.94 (0.67-1.31)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)	2.02 (0.72-5.66)	0.69 (0.43-1.12)	0.49 (0.20-1.22)	0.67 (0.35-1.30)
Some of the time (1–2 days)	1.96 (0.71-5.45)	0.69 (0.43-1.10)	0.56 (0.23-1.33)	0.77 (0.40-1.48)
Rarely or never, (<1 day)	1.77 (0.66-4.75)	0.68 (0.44-1.06)	0.39 (0.17-0.91)	0.68 (0.36-1.29)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table 7a: Multivariable Analysis Assessing the Association Between Low Tangible SSA and Low Executive Function in Females, Canadian Longitudinal Study on Aging, n=11,872

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low tangible SSA[2]	**1.95 (1.64-2.32)**	**1.28 (1.05-1.56)**	1.20 (0.98-1.46)	**1.25 (1.01-1.53)**
Age group (vs 45–54 years)				
55–64 years		**1.50 (1.15-1.95)**	**1.52 (1.16-1.99)**	**1.48 (1.13-1.95)**
65–74 years		**3.51 (2.71-4.53)**	**3.68 (2.83-4.78)**	**3.47 (2.63-4.57)**
75 years and over		**7.86 (6.07-10.19)**	**8.10 (6.20-10.58)**	**7.34 (5.48-9.82)**
Education (vs less than high school)				
High school graduate		**0.56 (0.43-0.73)**	**0.59 (0.45-0.77)**	**0.60 (0.46-0.79)**
Some post-secondary education		**0.39 (0.28-0.53)**	**0.41 (0.30-0.56)**	**0.43 (0.31-0.59)**
Post-secondary degree/diploma		**0.36 (0.29-0.45)**	**0.39 (0.31-0.49)**	**0.41 (0.33-0.52)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		**0.61 (0.49-0.76)**	**0.67 (0.54-0.84)**	**0.62 (0.50-0.78)**
≥ $50,000 and < $100,000		**0.33 (0.26-0.42)**	**0.39 (0.31-0.50)**	**0.35 (0.27-0.46)**
≥ $100,000		**0.21 (0.16-0.29)**	**0.27 (0.20-0.36)**	**0.23 (0.17-0.32)**
Province (vs Ontario)				
Alberta & Manitoba		0.99 (0.79-1.24)	0.99 (0.79-1.25)	0.99 (0.79-1.25)
British Columbia		**0.71 (0.57-0.90)**	**0.70 (0.56-0.88)**	**0.70 (0.56-0.89)**
Newfoundland and Labrador & Nova Scotia		**1.41 (1.14-1.75)**	**1.42 (1.14-1.76)**	**1.41 (1.14-1.76)**
Quebec		**0.66 (0.53-0.83)**	**0.63 (0.50-0.80)**	**0.63 (0.50-0.80)**
Urban residence (vs rural)		0.85 (0.66-1.09)	0.83 (0.64-1.07)	0.85 (0.65-1.09)

Table 7a: Multivariable Analysis Assessing the Association Between Low Tangible SSA and Low Executive Function in Females, Canadian Longitudinal Study on Aging, n=11,872, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			1.14 (0.94-1.38)	1.14 (0.94-1.38)
Self-rated general health (vs poor)				
Fair			0.85 (0.53-1.38)	0.84 (0.52-1.36)
Good			**0.59 (0.37-0.92)**	**0.58 (0.37-0.91)**
Very good			**0.35 (0.22-0.55)**	**0.35 (0.22-0.54)**
Excellent			**0.32 (0.20-0.52)**	**0.32 (0.20-0.53)**
Clinical depression (yes vs no)			0.92 (0.77-1.11)	0.94 (0.78-1.14)
Marital status (vs single)				
Married/common-law				1.32 (1.00-1.73)
Widowed				**1.41 (1.06-1.88)**
Divorced/separated				0.99 (0.74-1.32)
Pet for Companionship (yes vs. no)				0.93 (0.79-1.10)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.99 (0.64-1.54)
Some of the time (1–2 days)				1.00 (0.65-1.52)
Rarely or never (<1 day)				0.96 (0.64-1.44)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table 7b: Multivariable Analysis Assessing the Association Between Low Tangible SSA and Low Executive Function in Males, Canadian Longitudinal Study on Aging, n=11,619

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low tangible SSA[2]	**1.89 (1.54-2.31)**	1.10 (0.87-1.40)	1.04 (0.82-1.32)	0.95 (0.73-1.24)
Age group (vs 45–54 years)				
55–64 years		**1.30 (1.00-1.69)**	1.28 (0.99-1.67)	1.28 (0.98-1.66)
65–74 years		**2.40 (1.86-3.11)**	**2.41 (1.85-3.14)**	**2.38 (1.81-3.12)**
75 years and over		**6.72 (5.22-8.65)**	**6.60 (5.06-8.61)**	**6.30 (4.76-8.33)**
Education (vs less than high school)				
High school graduate		**0.67 (0.48-0.94)**	0.72 (0.52-1.01)	**0.71 (0.51-0.99)**
Some post-secondary education		**0.49 (0.35-0.70)**	**0.53 (0.37-0.75)**	**0.52 (0.37-0.74)**
Post-secondary degree/diploma		**0.33 (0.25-0.43)**	**0.36 (0.28-0.47)**	**0.35 (0.27-0.46)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		0.74 (0.52-1.04)	0.81 (0.58-1.15)	0.85 (0.59-1.24)
≥ $50,000 and < $100,000		**0.34 (0.24-0.48)**	**0.39 (0.28-0.55)**	**0.41 (0.28-0.61)**
≥ $100,000		**0.17 (0.12-0.24)**	**0.21 (0.14-0.30)**	**0.22 (0.14-0.33)**
Province (vs Ontario)				
Alberta & Manitoba		1.03 (0.81-1.31)	1.02 (0.80-1.30)	1.02 (0.80-1.30)
British Columbia		**0.71 (0.55-0.90)**	**0.70 (0.55-0.89)**	**0.71 (0.55-0.91)**
Newfoundland and Labrador & Nova Scotia		1.25 (0.99-1.57)	1.20 (0.96-1.52)	1.21 (0.96-1.53)
Quebec		**0.76 (0.60-0.96)**	**0.76 (0.60-0.97)**	**0.75 (0.58-0.95)**
Urban residence (vs rural)		0.87 (0.66-1.16)	0.87 (0.66-1.16)	0.84 (0.63-1.11)

Table 7b: Multivariable Analysis Assessing the Association Between Low Tangible SSA and Low Executive Function in Males, Canadian Longitudinal Study on Aging, n=11,619, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			1.21 (0.99-1.47)	1.20 (0.98-1.47)
Self-rated general health (vs poor)				
Fair			0.79 (0.47-1.32)	0.80 (0.47-1.35)
Good			**0.52 (0.31-0.85)**	**0.53 (0.32-0.88)**
Very good			**0.41 (0.25-0.69)**	**0.43 (0.26-0.72)**
Excellent			**0.34 (0.20-0.58)**	**0.36 (0.21-0.61)**
Clinical depression (yes vs no)			0.86 (0.67-1.11)	0.84 (0.65-1.07)
Marital status (vs single)				
Married/common-law				1.00 (0.70-1.44)
Widowed				1.16 (0.77-1.73)
Divorced/separated				0.78 (0.55-1.12)
Pet for companionship (yes vs. no)				**0.83 (0.70-0.99)**
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				**0.56 (0.32-0.98)**
Some of the time (1–2 days)				0.65 (0.38-1.12)
Rarely or never (<1 day)				**0.47 (0.28-0.80)**

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

5.2.5 Regression analyses for the association between low affection SSA and low executive function in males and females by pet companionship

Due to significant interactions in both the male and female models, it was necessary to stratify by pet companionship. Full models are presented in Table 8 and all models can be found in Appendix G (Table A8 through to Table A11). Affection SSA was marginally significant for low executive function in women who owned pets (OR=1.47, 95% CI=0.99–2.17), and nonsignificant in women who did not own pets (OR=1.18, 95% CI=0.94–2.43). Marital status had a stronger—and significant—association with low executive function in females with no pets (married: OR=1.56, 95% CI=1.10–2.23, widowed: OR=1.77, 95% CI=1.24–2.54) compared to women with pets (married: OR=1.09, 95% CI=0.68–1.76, widowed: OR=1.04, 95% CI=0.62–1.74).

Affection SSA was not significant in male pet owners (OR=1.51, 95% CI=0.94–2.43) or non-pet owners (OR=0.95, 95% CI=0.69–1.31). Self-rated health was significant for male pet owners (e.g., excellent health: OR=0.18, 95% CI=0.08–0.44), but not for males who did not own a pet (OR=0.63, 95% CI=0.33–1.22), while loneliness was only significant in those who did not own a pet (e.g., rarely or never: OR=0.44, 95% CI=0.23–0.83).

5.2.6 Regression analyses for the association between low emotional/informational SSA and low executive function in males and females

5.2.6.1 Low emotional/informational SSA and low executive function in females

Although significant in the crude model (OR=2.13, 95% CI=1.72–2.63), low emotional/informational support was not significantly associated with low executive function in females after the inclusion of covariates (Table 9a). Covariates were consistent with the unstratified model; however, chronic disease and pet companionship were no longer significant. Widowed women had significantly greater odds of having low executive function compared to single women (OR=1.38, 95% CI=1.03–1.85).

Table 8: Multivariable Analysis Assessing the Association Between Low Affection SSA and Low Executive Function in Males and Females Stratified by Pet Companionship, Canadian Longitudinal Study on Aging, n=23,491

	Low Executive Function[1]			
	Females		**Males**	
	OR (95% CI)		**OR (95% CI)**	
	Pet (n=5357)	**No Pet (n=6515)**	**Pet (n=4756)**	**No Pet (n=6863)**
Low affection SSA[2]	1.47 (0.99-2.17)	1.18 (0.86-1.62)	1.51 (0.94-2.43)	0.95 (0.69-1.31)
Age group (vs 45–54 years)				
55–64 years	**1.95 (1.37-2.77)**	1.08 (0.71-1.63)	1.14 (0.77-1.70)	1.36 (0.95-1.95)
65–74 years	**4.27 (2.97-6.14)**	**2.73 (1.81-4.10)**	**3.04 (2.01-4.58)**	**2.10 (1.46-3.03)**
75 years and over	**9.92 (6.52-15.10)**	**5.64 (3.74-8.52)**	**6.23 (3.91-9.94)**	**6.12 (4.25-8.83)**
Education (vs less than high school)				
High school graduate	0.69 (0.43-1.09)	**0.54 (0.39-0.76)**	0.68 (0.38-1.20)	0.73 (0.48-1.09)
Some post-secondary education	0.63 (0.38-1.07)	**0.32 (0.21-0.49)**	0.76 (0.42-1.39)	**0.40 (0.26-0.61)**
Post-secondary degree/diploma	**0.45 (0.30-0.66)**	**0.38 (0.29-0.51)**	**0.33 (0.21-0.54)**	**0.37 (0.27-0.51)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000	**0.52 (0.35-0.78)**	**0.68 (0.51-0.91)**	0.93 (0.48-1.82)	0.83 (0.53-1.29)
≥ $50,000 and < $100,000	**0.36 (0.24-0.56)**	**0.34 (0.24-0.47)**	**0.48 (0.24-0.96)**	**0.39 (0.25-0.61)**
≥ $100,000	**0.23 (0.14-0.39)**	**0.22 (0.15-0.35)**	**0.26 (0.12-0.56)**	**0.21 (0.12-0.34)**
Province (vs Ontario)				
Alberta & Manitoba	1.15 (0.79-1.68)	0.90 (0.68-1.21)	0.82 (0.52-1.29)	1.16 (0.87-1.56)
British Columbia	0.71 (0.49-1.03)	**0.70 (0.52-0.94)**	**0.64 (0.42-0.98)**	0.76 (0.57-1.03)
Newfoundland and Labrador & Nova Scotia	1.37 (0.97-1.94)	**1.46 (1.10-1.93)**	1.10 (0.74-1.64)	1.30 (0.98-1.72)
Quebec	0.78 (0.53-1.14)	**0.55 (0.41-0.75)**	0.73 (0.47-1.13)	0.77 (0.57-1.03)
Urban residence (vs rural)	0.87 (0.59-1.28)	0.84 (0.59-1.19)	0.95 (0.62-1.44)	0.76 (0.51-1.12)

Table 8: Multivariable Analysis Assessing the Association Between Low Affection SSA and Low Executive Function in Males and Females Stratified by Pet Companionship, Canadian Longitudinal Study on Aging, n=23,491, Continued

	Low Executive Function[1]			
	Females		**Males**	
	OR (95% CI)		**OR (95% CI)**	
	Pet (n=5357)	**No Pet (n=6515)**	**Pet (n=4756)**	**No Pet (n=6863)**
Chronic diseases (yes vs no)	1.10 (0.81-1.49)	1.17 (0.91-1.51)	1.08 (0.76-1.53)	1.26 (0.99-1.61)
Self-rated general health (vs poor)				
Fair	0.91 (0.45-1.82)	0.85 (0.44-1.64)	0.57 (0.26-1.26)	1.19 (0.62-2.30)
Good	0.53 (0.28-1.01)	0.66 (0.35-1.24)	**0.33 (0.15-0.70)**	0.88 (0.47-1.65)
Very good	**0.31 (0.16-0.60)**	**0.39 (0.21-0.74)**	**0.24 (0.11-0.53)**	0.74 (0.39-1.40)
Excellent	**0.35 (0.17-0.70)**	**0.33 (0.17-0.64)**	**0.18 (0.08-0.44)**	0.63 (0.33-1.22)
Clinical depression (yes vs no)	0.91 (0.69-1.19)	0.97 (0.75-1.26)	0.70 (0.45-1.07)	0.92 (0.68-1.24)
Marital status (vs single)				
Married/common-law	1.09 (0.68-1.76)	**1.56 (1.10-2.23)**	0.76 (0.40-1.46)	1.19 (0.77-1.82)
Widowed	1.04 (0.62-1.74)	**1.77 (1.24-2.54)**	0.68 (0.31-1.51)	1.49 (0.93-2.36)
Divorced/separated	0.74 (0.45-1.20)	1.27 (0.88-1.83)	0.54 (0.26-1.11)	0.93 (0.61-1.41)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)	0.96 (0.48-1.91)	1.04 (0.58-1.84)	0.74 (0.26-2.10)	**0.49 (0.25-0.95)**
Some of the time (1–2 days)	1.07 (0.54-2.11)	0.98 (0.57-1.71)	0.84 (0.31-2.23)	0.56 (0.29-1.10)
Rarely or never (<1 day)	1.20 (0.64-2.26)	0.87 (0.51-1.48)	0.58 (0.22-1.52)	**0.44 (0.23-0.83)**

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

5.2.6.2 Low emotional/informational SSA and low executive function in males and females, stratified by marital status

As can be seen in the full models presented in Table 9b (sequential models in Appendix G: Table A13–14), emotional/ informational SSA was not significant for married or unmarried males. Owning a pet for companionship (OR=0.81, 95% CI=0.66–0.99), and rarely or never feeling loneliness (OR=0.37, 0.16–0.84) were only significant for married men. Other covariates were consistent with the unstratified model.

It was not possible to stratify the female models by marital status due to significant interactions in the models for married women; however, models were run for unmarried women (Table 9b, Appendix G: Table A12). Emotional/informational SSA was not found to be significant in unmarried women (OR=0.84, 95% CI=0.64–1.12), and the association was in the opposite direction to what was seen in the unstratified female model. It was thus predicted that the association between emotional/informational SSA and low executive function in married women would likely be significant in the expected direction, so a crude model was run (Table 9c). As predicted, married women showed a significant association (OR=2.77, 95% CI=1.93–3.96) between emotional/informational SSA and executive function, while unmarried women did not (OR=1.25, 95% CI=0.97–1.60). Attempts to further stratify married women by loneliness to address significant interactions were not successful due to further interactions and only models for married women who reported loneliness were able to be investigated (Appendix G: Table A15). The association between low emotional/informational SSA and low executive function was significant in married women who experienced loneliness (OR=2.17, 95% CI=1.17–4.02).

Table 9a: Multivariable Analysis Assessing the Association Between Low Emotional/Informational SSA and Low Executive Function in Females, Canadian Longitudinal Study on Aging, n=11,872

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low emotional/informational SSA[2]	**2.13 (1.72-2.63)**	1.26 (0.98-1.62)	1.13 (0.88-1.45)	1.14 (0.88-1.47)
Age group (vs 45–54 years				
55–64 years		**1.50 (1.15-1.95)**	**1.52 (1.17-1.99)**	**1.49 (1.13-1.95)**
65–74 years		**3.47 (2.69-4.49)**	**3.65 (2.81-4.75)**	**3.45 (2.62-4.56)**
75 years and over		**7.80 (6.01-10.12)**	**8.06 (6.17-10.54)**	**7.31 (5.45-9.80)**
Education (vs less than high school)				
High school graduate		**0.56 (0.43-0.73)**	**0.59 (0.45-0.77)**	**0.60 (0.46-0.79)**
Some post-secondary education		**0.39 (0.28-0.53)**	**0.41 (0.30-0.57)**	**0.43 (0.31-0.59)**
Post-secondary degree/diploma		**0.36 (0.29-0.45)**	**0.39 (0.31-0.49)**	**0.41 (0.33-0.52)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		**0.60 (0.48-0.75)**	**0.66 (0.53-0.82)**	**0.62 (0.49-0.77)**
≥ $50,000 and < $100,000		**0.32 (0.26-0.41)**	**0.38 (0.30-0.49)**	**0.35 (0.27-0.45)**
≥ $100,000		**0.20 (0.15-0.28)**	**0.26 (0.19-0.35)**	**0.23 (0.16-0.32)**
Province (vs Ontario)				
Alberta & Manitoba		1.00 (0.79-1.25)	1.00 (0.79-1.26)	1.00 (0.80-1.26)
British Columbia		**0.72 (0.57-0.90)**	**0.71 (0.56-0.89)**	**0.71 (0.56-0.89)**
Newfoundland and Labrador & Nova Scotia		**1.41 (1.14-1.75)**	**1.41 (1.14-1.76)**	**1.41 (1.13-1.75)**
Quebec		**0.66 (0.52-0.83)**	**0.63 (0.50-0.79)**	**0.63 (0.50-0.79)**
Urban residence (vs rural)		0.86 (0.67-1.10)	0.83 (0.65-1.08)	0.85 (0.66-1.10)

Table 9a: Multivariable Analysis Assessing the Association Between Low Emotional/Informational SSA and Low Executive Function in Females, Canadian Longitudinal Study on Aging, n=11,872, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			1.13 (0.94-1.37)	1.14 (0.94-1.38)
Self-rated general health (vs poor/fair)				
Good			**0.67 (0.54-0.84)**	**0.67 (0.54-0.84)**
Very good			**0.40 (0.32-0.50)**	**0.40 (0.32-0.50)**
Excellent			**0.37 (0.28-0.49)**	**0.37 (0.28-0.49)**
Clinical depression (yes vs no)			0.93 (0.78-1.12)	0.95 (0.79-1.15)
Marital status (vs single)				
Married/common-law				1.27 (0.96-1.67)
Widowed				**1.38 (1.03-1.85)**
Divorced/separated				0.98 (0.73-1.31)
Pet for companionship (yes vs. no)				0.94 (0.73-1.31)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.99 (0.64-1.53)
Some of the time (1–2 days)				0.99 (0.64-1.51)
Rarely or never (<1 day)				0.94 (0.63-1.41)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table 9b: Multivariable Analysis Assessing the Association Between Low Emotional/ Informational SSA and Low Executive Function in Males and Females Stratified by Marital Status, Canadian Longitudinal Study on Aging, n=23,491

	Low Executive Function[1]			
	Females		Males	
	OR (95% CI)		OR (95% CI)	
	Married (n=7262)	Unmarried (n=4610)	Married (n=9193)	Unmarried (n=2426)
Low emotional/informational SSA[2]	0.84 (0.64-1.12)	1.18 (0.85-1.64)	1.31 (0.95-1.82)	
Age group (vs 45–54 years)				
55–64 years	1.33 (0.88-2.01)	1.13 (0.82-1.55)	**1.89 (1.18-3.03)**	
65–74 years	**2.97 (2.00-4.42)**	**2.49 (1.81-3.43)**	**2.28 (1.40-3.70)**	
75 years and over	**6.99 (4.70-10.39)**	**6.43 (4.63-8.93)**	**6.93 (4.25-11.31)**	
Education (vs less than high school)				
High school graduate	0.80 (0.56-1.13)	0.80 (0.53-1.20)	0.56 (0.31-1.01)	
Some post-secondary education	**0.42 (0.27-0.64)**	0.68 (0.44-1.04)	**0.24 (0.13-0.44)**	
Post-secondary degree/diploma	**0.44 (0.33-0.58)**	**0.39 (0.28-0.55)**	**0.28 (0.18-0.45)**	
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000	**0.61 (0.48-0.78)**	0.50 (0.24-1.07)	0.99 (0.68-1.45)	
≥ $50,000 and < $100,000	**0.32 (0.24-0.44)**	**0.24 (0.11-0.50)**	**0.56 (0.37-0.86)**	
≥ $100,000	**0.25 (0.15-0.43)**	**0.13 (0.06-0.27)**	**0.34 (0.18-0.66)**	
Province (vs Ontario)				
Alberta & Manitoba	0.88 (0.64-1.19)	1.05 (0.79-1.40)	0.90 (0.57-1.44)	
British Columbia	**0.72 (0.52-0.98)**	**0.74 (0.55-0.98)**	0.67 (0.43-1.04)	
Newfoundland and Labrador & Nova Scotia	1.06 (0.79-1.42)	1.14 (0.87-1.49)	**1.66 (1.05-2.63)**	
Quebec	**0.52 (0.38-0.70)**	0.75 (0.56-1.00)	0.74 (0.48-1.15)	
Urban residence (vs rural)	0.85 (0.55-1.29)	0.77 (0.56-1.07)	1.06 (0.59-1.89)	

Table 9b: Multivariable Analysis Assessing the Association Between Low Emotional/ Informational SSA and Low Executive Function in Males and Females Stratified by Marital Status, Canadian Longitudinal Study on Aging, n=23,491, Continued

	Low Executive Function[1]			
	Females		Males	
	OR (95% CI)		OR (95% CI)	
	Married (n=7262)	Unmarried (n=4610)	Married (n=9193)	Unmarried (n=2426)
Chronic diseases (yes vs no)	**1.39 (1.05-1.85)**	1.14 (0.90-1.43)	1.41 (0.96-2.08)	
Self-rated general health (vs poor/fair)				
Good	**0.68 (0.51-0.91)**	**0.59 (0.44-0.79)**	0.81 (0.53-1.22)	
Very good	**0.40 (0.30-0.54)**	**0.45 (0.34-0.61)**	0.81 (0.53-1.25)	
Excellent	**0.37 (0.26-0.54)**	**0.39 (0.28-0.56)**	**0.57 (0.33-0.97)**	
Clinical depression (yes vs no)	0.87 (0.69-1.10)	0.79 (0.58-1.07)	0.97 (0.66-1.43)	
Pet for companionship (yes vs. no)	0.86 (0.70-1.06)	**0.81 (0.66-0.99)**	0.93 (0.67-1.30)	
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)	0.68 (0.42-1.10)	0.46 (0.19-1.14)	0.67 (0.35-1.30)	
Some of the time (1–2 days)	0.68 (0.43-1.09)	0.53 (0.22-1.25)	0.77 (0.40-1.49)	
Rarely or never (<1 day)	0.67 (0.43-1.04)	**0.37 (0.16-0.84)**	0.68 (0.36-1.29)	

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** (p<0.05)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table 9c: Crude Models Assessing the Association Between Low Emotional/ Informational SSA and Low Executive Function in Females Stratified by Marital Status, n=11,872

	Low Executive Function	
	OR (95% CI)	OR (95% CI)
	Married (n=7262)	Unmarried (n=4610)
Low emotional/informational SSA	**2.77 (1.93-3.96)**	1.25 (0.97-1.60)

Statistically significant values are **bolded** (p<0.05)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

5.2.7 Regression analyses for the association between low positive social interactions and low executive function in males and females

The models assessing the association between low positive social interactions and low executive function are presented separately for females (Table 10a) and males (Table 10b). Positive social interactions were significantly associated with low executive function in females (OR=1.29, 95% CI=1.04–1.60). The association between covariates and low executive function was consistent with the unstratified model, with the exception of pet companionship, which was not significant (OR=0.93, 95% CI=0.79–1.10).

In males, low positive social interactions were significantly associated with low executive function in the crude model (OR=2.14, 95% CI=1.77–2.59), but not after the inclusion of other social variables (OR=1.23, 95% CI=0.96–1.56), consistent with other SSA subtypes. Pet companionship remained significant after stratification by sex (OR=0.83, 95% CI=0.70–0.99). Males who reported rarely or never feeling lonely had significantly lower odds of having low executive function compared to males who felt loneliness all the time (OR=0.51, 95% CI=0.30–0.88).

Table 10a: Multivariable Analysis Assessing the Association Between Low Positive Social Interactions and Low Executive Function in Females, Canadian Longitudinal Study on Aging, n=11,872

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low positive social interactions[2]	**2.04 (1.70-2.45)**	**1.42 (1.15-1.75)**	**1.25 (1.02-1.55)**	**1.29 (1.04-1.60)**
Age group (vs 45–54 years)				
55–64 years		**1.50 (1.15-1.95)**	**1.52 (1.16-1.98)**	**1.48 (1.13-1.94)**
65–74 years		**3.52 (2.72-4.55)**	**3.68 (2.83-4.78)**	**3.46 (2.63-4.56)**
75 years and over		**7.92 (6.11-10.26)**	**8.11 (6.21-10.59)**	**7.33 (5.47-9.81)**
Education (vs less than high school)				
High school graduate		**0.56 (0.43-0.73)**	**0.59 (0.45-0.77)**	**0.60 (0.46-0.79)**
Some post-secondary education		**0.39 (0.28-0.53)**	**0.41 (0.30-0.56)**	**0.42 (0.31-0.59)**
Post-secondary degree/diploma		**0.36 (0.29-0.45)**	**0.39 (0.31-0.49)**	**0.41 (0.32-0.51)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		**0.61 (0.49-0.76)**	**0.67 (0.54-0.84)**	**0.62 (0.49-0.78)**
≥ $50,000 and < $100,000		**0.34 (0.26-0.43)**	**0.39 (0.31-0.50)**	**0.35 (0.27-0.46)**
≥ $100,000		**0.21 (0.16-0.29)**	**0.27 (0.20-0.36)**	**0.23 (0.17-0.32)**
Province (vs Ontario)				
Alberta & Manitoba		0.99 (0.79-1.24)	0.99 (0.79-1.25)	0.99 (0.79-1.25)
British Columbia		**0.71 (0.57-0.90)**	**0.70 (0.56-0.89)**	**0.70 (0.56-0.89)**
Newfoundland and Labrador & Nova Scotia		**1.42 (1.14-1.76)**	**1.42 (1.14-1.76)**	**1.41 (1.14-1.76)**
Quebec		**0.66 (0.53-0.83)**	**0.63 (0.50-0.80)**	**0.63 (0.50-0.80)**
Urban residence (vs rural)		0.85 (0.66-1.10)	0.83 (0.64-1.07)	0.85 (0.66-1.10)

Table 10a: Multivariable Analysis Assessing the Association Between Low Positive Social Interactions and Low Executive Function in Females, Canadian Longitudinal Study on Aging, n=11,872, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic disease (yes vs no)			1.14 (0.94-1.38)	1.14 (0.94-1.38)
Self-rated general health (vs poor)				
Fair			0.85 (0.52-1.38)	0.84 (0.52-1.37)
Good			**0.59 (0.37-0.93)**	**0.58 (0.37-0.92)**
Very good			**0.35 (0.22-0.56)**	**0.35 (0.22-0.55)**
Excellent			**0.33 (0.20-0.53)**	**0.33 (0.20-0.53)**
Clinical depression (yes vs no)			0.92 (0.76-1.11)	0.94 (0.78-1.14)
Marital status (vs single)				
Married/common-law				1.30 (0.98-1.71)
Widowed				**1.41 (1.05-1.88)**
Divorced/separated				0.98 (0.73-1.32)
Pet for companionship (yes vs. no)				0.93 (0.79-1.10)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				1.02 (0.66-1.57)
Some of the time (1–2 days)				1.02 (0.67-1.56)
Rarely or never (<1 day)				0.99 (0.66-1.49)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table 10b: Multivariable Analysis Assessing the Association Between Low Positive Social Interactions and Low Executive Function in Males, Canadian Longitudinal Study on Aging, n=11,619

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low positive social interactions[2]	**2.14 (1.77-2.59)**	**1.42 (1.14-1.77)**	**1.32 (1.06-1.65)**	1.23 (0.96-1.56)
Age group (vs 45–54 years				
55–64 years		**1.31 (1.01-1.69)**	1.29 (0.99-1.67)	1.28 (0.98-1.66)
65–74 years		**2.43 (1.88-3.15)**	**2.43 (1.87-3.17)**	**2.38 (1.81-3.13)**
75 years and over		**6.78 (5.26-8.73)**	**6.63 (5.09-8.65)**	**6.29 (4.75-8.31)**
Education (vs less than high school)				
High school graduate		**0.67 (0.48-0.93)**	0.72 (0.51-1.01)	**0.71 (0.51-0.99)**
Some post-secondary education		**0.49 (0.35-0.70)**	**0.53 (0.37-0.75)**	**0.52 (0.37-0.74)**
Post-secondary degree/diploma		**0.33 (0.25-0.43)**	**0.36 (0.28-0.47)**	**0.35 (0.27-0.47)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		0.77 (0.55-1.09)	0.85 (0.60-1.19)	0.87 (0.60-1.27)
≥ $50,000 and < $100,000		**0.36 (0.26-0.51)**	**0.41 (0.29-0.58)**	**0.42 (0.29-0.62)**
≥ $100,000		**0.18 (0.13-0.26)**	**0.22 (0.15-0.32)**	**0.23 (0.15-0.34)**
Province (vs Ontario)				
Alberta & Manitoba		1.04 (0.81-1.32)	1.02 (0.80-1.31)	1.02 (0.80-1.30)
British Columbia		**0.71 (0.56-0.91)**	**0.70 (0.55-0.90)**	**0.71 (0.56-0.91)**
Newfoundland and Labrador & Nova Scotia		1.26 (1.000-1.58)	1.22 (0.97-1.53)	1.22 (0.97-1.54)
Quebec		**0.77 (0.61-0.98)**	**0.77 (0.61-0.98)**	**0.76 (0.60-0.97)**
Urban residence (vs rural)		0.86 (0.65-1.15)	0.86 (0.65-1.15)	0.84 (0.63-1.11)

Table 10b: Multivariable Analysis Assessing the Association Between Low Positive Social Interactions and Low Executive Function in Males, Canadian Longitudinal Study on Aging, n=11,619, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			1.21 (0.99-1.47)	1.20 (0.98-1.47)
Self-rated general health (vs poor)				
Fair			0.79 (0.47-1.33)	0.80 (0.47-1.36)
Good			**0.53 (0.32-0.87)**	**0.54 (0.32-0.90)**
Very good			**0.42 (0.26-0.70)**	**0.44 (0.26-0.74)**
Excellent			**0.35 (0.21-0.59)**	**0.37 (0.21-0.63)**
Clinical depression (yes vs no)			0.85 (0.66-1.09)	0.83 (0.65-1.06)
Marital status (vs single)				
Married/common-law				1.06 (0.75-1.51)
Widowed				1.18 (0.79-1.77)
Divorced/separated				0.78 (0.55-1.12)
Pet for companionship (yes vs. no)				**0.83 (0.70-0.99)**
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.58 (0.33-1.03)
Some of the time (1–2 days)				0.68 (0.39-1.19)
Rarely or never (<1 day)				**0.51 (0.30-0.88)**

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

6.0 Discussion

6.1 Study Findings

This study investigated the association between low levels of SSA— overall and four subtypes—and a key domain of cognitive function, executive function, and assessed whether this association was altered by the inclusion of a variety of sociodemographic, health, and social confounders. Both descriptive and multivariable analyses demonstrated that those who reported low levels of support had greater odds of having low executive function. In weighted logistic regression analyses, three subtypes of SSA (affection, emotional/informational, and positive social interactions) maintained their significant association with executive function after the inclusion of all sociodemographic, health and social covariates. In sex-stratified analyses, while descriptive analyses showed that all forms of SSA were significantly associated with the prevalence of low executive function in both men and women, the logistic regression analyses found that no SSA subtype was significantly associated with executive function in men after the inclusion of all covariates. Among women, low tangible support and low positive social interactions were significantly associated with low executive function. Additionally, in married women, there was a significant association between low emotional/informational SSA and low executive function.

6.1.1 Discussion of Unstratified Results

After the inclusion of all covariates, low affection SSA, low emotional/informational SSA, and low positive social interactions were significantly associated with low executive function. As each of these SSA subtypes reflect positive connections with others, these results appear to be consistent with the stress-buffering hypothesis (Eisele et al., 2012): the

comforting nature of SSA reduces anxiety and, through this, reduces the long-term physiological results of stress on the brain, buffering declines in cognitive function.

Given that these three subtypes are often not explicitly differentiated in past research—with affection SSA in particular being assessed as emotional SSA in many studies (e.g. Gurung et al., 2003)—it is hard to reflect on literature for each SSA subtype specifically. In general, these results are consistent with previous research showing a positive association between emotional support and cognition (e.g., Seeman et al., 2001; Zahodne et al., 2014; Ellwardt et al., 2013). Positive support from friends (Hughes et al., 2008) or reporting having a friend (Yeh & Liu, 2003) has also been found to be associated with better cognitive function in both longitudinal and cross-sectional studies, respectively.

Consistent with the results of this study, when assessed using the MOS-SSS, both positive social interactions and emotional/informational SSA were found to be associated with better cognitive function in cross-sectional analyses, (Pillemer & Holtzer, 2016). The same study did not find significant results for affection SSA. Further, a follow-up longitudinal study by the same authors using the same sample found that, over a median follow-up of 4 years, both affection SSA and positive social interactions—as well as tangible and overall SSA—were associated with an *increased* risk of incident cognitive impairment (Pillemer, Ayers, & Holtzer, 2018).

There are several possible explanations for the discrepancy between those results and what was found in this study. Of particular importance is that, although looking at cognitive impairment, both Pillemer and Holtzer (2016) and Pillemer et al. (2018) assessed the visuospatial, language, attention and memory domains of cognitive function. They did not investigate executive function and used a more conservative cut-off for low function (1 SD

below baseline average score). Additionally, these studies used a small (n=355), highly selective sample of participants over the age of 65 (average age of 76 at baseline) who had no history of neurological conditions or dementia, despite their age. In contrast, this thesis utilized a large, diverse sample of participants across a wide age range and did not exclude those with previous cognitive conditions in order to maximize generalizability and clinical relevance. Finally, consistent with the data utilized in this study, Pillemer & Holtzer (2016) had highly skewed SSA data: the average scores for emotional/informational SSA (3.99/5), tangible SSA (3.99/5), affection SSA (4.08/5) and positive social interactions (4.33/5) indicate that 50% of participants were over 4/5 for any subtype. This study approached this issue by dichotomizing SSA and using logistic regression to look at low SSA, while Pillemer & Holtzer (2016) used linear regression. As they utilized a selectively cognitively healthy sample with very high levels of SSA and further applied a stricter definition of low cognition to said sample, the results provided by their study, although using the same measure of SSA and looking at a cognitive outcome, may not be as relevant to a more general or clinical population as the results of this project. However, it is almost a stronger argument for the impact of SSA on cognition that, even with a highly selective cognitively healthy sample with high levels of SSA and a strict cut-off, Pillemer and Holtzer (2016) did find that some subtypes of social support were still significantly associated with cognitive function. Had they had a more cognitively diverse sample, like the one used in this study, perhaps they also would have had more subtypes of SSA reach significance, as was found in this study.

Regarding Pillemer et al., (2018), disregarding the sample and measure differences discussed above, the dissimilarities in the longitudinal results may suggest that there are distinct relationships between subtypes of SSA and specific domains of cognition, and that

these distinct domains may be more or less impacted by the level of SSA available. Although investigating the longitudinal relationship between SSA and executive function is outside the scope of this thesis, future work with the CLSA may be able to further address these relationships over time.

Neither overall SSA or tangible SSA were significantly associated with low executive function after the inclusion of all covariates, although the direction of the association indicated that those who had higher levels of SSA also had higher odds of having low executive function. This is somewhat consistent with the literature: Pillemer & Holtzer (2016), discussed above, found that overall SSA has been shown to be associated with better general cognitive function in cross-sectional analyses, and higher social support has been found to be associated with higher scores of executive function (Liao & Scholes, 2016). In addition to the design differences discussed above, the reason for the discrepancy with the current study's results may be the inclusion of the social covariates, which neither Pillemer & Holtzer (2016) nor Liao & Scholes (2016) adjusted for and the inclusion of which in this study caused the association of low overall SSA and low executive function to become non-significant.

6.1.2 Discussion of Sex-stratified Results

6.1.2.1 Discussion of Sex-stratified Results: Men

No subtype of SSA was significantly associated with low executive function in males after the inclusion of all covariates. This is consistent with some studies that did not find significant results for men for overall social support (e.g., Kotwal et al., 2016) or for specific SSA subtypes, such as emotional/informational (Pillemer & Holtzer, 2016). Pillemer et al. (2018) found that reporting high tangible SSA could be a negative indicator for men, as it was associated with significant increased chance of developing cognitive impairment five

years later. The authors suggest that, in men, awareness of their social support resources may be a potential indication that they are already in need of these resources—which may be of particular concern with tangible support, which assess whether supports would be available to help on concrete everyday needs such as shopping for groceries. However, this may again reflect differences in the association between SSA and different cognitive domains, as other research has found that men with higher positive supports experienced slower declines in executive function (Liao & Scholes, 2016).

In terms of affection SSA, there was a stronger association between low SSA and low executive function in both men and women who owned pets, compared to those who did not; however, these associations were not significant. While the exact relationship between social support and pet companionship is not known, it may be that a person who seeks out animal companionship is more likely to value or need a sense of love and affection, and thus would see a stronger impact of low affection SSA on their cognitive health. While purely speculation, this is consistent with previous research indicating a multiplicative effect between dog ownership and high social support in reducing loneliness, and that pet owners with high attachment to their pets and low social support from humans experience higher levels of loneliness and depression compared to those who did not own a dog (Antonacopoulos & Pychyl, 2010). Interestingly, in almost all the male analyses, men who reported that they owned a pet that provided them with companionship had significantly lower odds of having low executive function, after the inclusion of all other variables. This pattern was not seen in the analyses of women and pet companionship was not included in any of the reviewed social support literature.

6.1.2.2 Discussion of Sex-stratified Results: Women

In analyses of women, reporting low levels of several subtypes of SSA—including positive social interactions and tangible SSA—was significantly associated with greater odds of low executive function. This is generally consistent with previous research, which has found a significant association between social support and executive function in women. For example, Kotwal et al. (2016) found that lower social support was only associated with lower cognition (i.e., domains of executive function, orientation, visuospatial skills, attention, and language) in women, and Liao & Scholes (2016) found that women who reported higher positive social support from children or friends had higher executive function. Additionally, Pillemer et al. (2018) found that baseline high SSA was not significantly associated with later cognitive impairment in women, unlike in men.

In the current study, low emotional/informational SSA was only significantly associated with executive function in married women. This is partially consistent with previous research that has found a significant association between emotional/informational SSA and cognitive function in women (Pillemer & Holtzer, 2016). However, in the current study, low emotional/informational SSA was never significantly associated with low executive function in unmarried women. While previous literature has investigated where married women receive their support (e.g., Gurung et al., 2003), there appears to be a significant difference in the role that social support plays in terms of cognitive function for married and unmarried women that has not been investigated in the reviewed literature.

6.2 Strengths

The most notable strength of this study is the large and diverse sample available in the CLSA. In terms of sample size, no reviewed study included a sample as large as was utilized in these analyses. During recruitment, sampling strata based on province, sex, and

age were used to select a nationally representative sample, with additional targeted recruitment completed in low-education areas to compensate for an initial selection bias toward highly educated participants. The inclusion of a wide age range, from 45 to 85 years, provides a window into how the associations of interest may be relevant across the life span or across cohorts. By providing access to a large, contemporary sample of diverse community-dwelling aging adults from across multiple provinces, the CLSA allows for results that will be generalizable to the aging Canadian population.

In addition to the large number of participants, the CLSA included extensive assessments of health and sociodemographic factors that previous cross-sectional and longitudinal research on social support has not been able to investigate simultaneously within a single study. Thus, this study was able to investigate a considerable list of potential confounders whose inclusion in the logistic regression models influenced the association between exposure and outcome and may assist future research in explaining the process through which social support affects executive function. Some of these covariates—such as pet companionship and rural/urban residence—are variables that have not been investigated in depth previously. Further, rather than including only objective measures of health and social support, this study was able to also include variables that reflect the subjective experiences (i.e., SSA and self-rated health) and perspectives of aging adults. Finally, this study included several distinct measures of executive function that assessed this key domain of cognitive function in depth, allowing for a more complete and accurate assessment than a single test or broad tests of overall cognitive function.

6.3 Limitations

Despite best attempts to recruit a sample reflective of the Canadian population, as with any study, the CLSA is not flawlessly generalizable. In terms of recruitment, for the

Comprehensive cohort, participants were enrolled from within a small geographic region around 11 data collection sites in the seven most populous provinces, with those living in indigenous reserves, long-term care facilities, or military bases specifically excluded. Overall, the response rate across the country was only around 10%, and, because of this, it can be predicted that there were self-selection biases. One example of this is that 95.6% of the CLSA sample identify as white, which is not representative of the country as a whole: only 78% of Canadians identified as 'not a visual minority' in 2016 (Statistics Canada, 2017). Finally, the heterogeneity of a diverse sample itself poses issues by increasing the risk of unknown confounding factors that are not accounted for in this study. Thus, while diverse, the CLSA sample cannot perfectly reflect the entire country, and care must be given to keep that in mind when generalizing to the greater Canadian population.

The use of secondary data sometimes creates a limitation as researchers cannot control how and what variables are assessed. For example, interpretation of the question "Are you male or female?" is somewhat ambiguous. Based on the wording, there is no way to know if this question was interpreted by participants as referring to one's birth-assigned sex or gender identity, which may not be the same (Ontario Human Rights Commission, 2014). However, as the CLSA will be adding in further gender variables at follow-up data collection, this study chose to keep the label "sex" to describe the male/female assessment question in order to be consistent with other CLSA research using said variable and to avoid confusion with later research using these gender variables.

Finally, at the time of this thesis, only baseline cross-sectional data have been made available by the CLSA, and, as such, this study was limited in its ability to assess the temporal relationship between the exposure and outcome. Due to this, the issue of reverse

causality, discussed in the literature review, cannot be addressed and any conclusions made are based on previous findings on the association between social support and cognitive function. With that said, it is probable that there is a cyclical relationship between these variables, and that both SSA and executive function impact the occurrence of each other over time.

6.4 Implications and Future Directions

Current results support previous research indicating that strategies directed toward increasing awareness of, and access to, available social supports may help prevent or buffer age-related declines—or the further worsening of declines—in executive function. Given that the strongest associations were seen in emotional/informational SSA and positive social interactions, intervention programs that facilitate the growth of these supports may provide the greatest impact on cognitive health, especially for women. In contrast, further investigation may be needed on the role of SSA and cognitive health in men, as the results of this study indicate that there may be limited benefits to that population.

Future research using the CLSA may be able to help address this area of investigation by using longitudinal data to determine whether the different subtypes of social support are associated with cognitive decline and cognitive outcomes such as dementia. By utilizing multiple time points, prospective work should be able to address the issue of reverse causality and more clearly determine the relationship between social support and executive function. The exact nature of the beneficial impact of social support on cognitive function has not been established (e.g., does social support prevent, buffer, or improve cognitive function?) and this question can only be answered with longitudinal data.

Future work could build upon the current research by investigating how the need for each type of support may change across the life span or across situations. It is likely that

support may be perceived differently at different stages in the lifespan, and that these changes can be expected to differ in men and women. This knowledge would help to inform the creation of new—or the evaluation of current—social support interventions. Additional investigations into whether those who utilize different types of social support services (e.g., legions, volunteer chore services) report higher levels of the subtypes of SSA and demonstrate benefits to their cognitive health would assist in the development of programs that can provide interventions for those who may be at risk for cognitive decline or already showing symptoms of cognitive impairment.

In terms of potential confounders, the findings of this study were largely consistent with the literature. However, they also provide an indication that there is still much to be explored in this area. For example, the association of pet companionship with affection SSA—as well as that of sex and marital status with emotional/informational SSA—demonstrated that there are interesting subtype-specific relationships between social support and covariates in the association with low executive function that warrant further investigation. Finally, there were also interesting patterns seen in the models with the inclusion of covariates. For example, in women, there was usually an increase in the strength of the association between low social support and low executive function after the inclusion of social variables, with some associations returning to significance in the final model.

6.5 Conclusion

As the population ages, having a better understanding of how social support impacts cognitive function is essential for guiding public health policies and future research directed at helping adults maintain their independence and adapt to changes. By investigating all the subtypes of SSA within the same sample, this study contributes to the understanding of how each subtype interacts with other variables to influence executive function, while controlling

for sociodemographic, health, and social confounders. The results of the analyses indicate that SSA may be beneficial to executive function in middle-aged and older adults, but that this association likely differs by SSA subtype and sex. These findings add to previous research by investigating functional SSA which has not been examined in as much depth as structural support, and—where it has been investigated—has not included all subtypes of SSA as exposures. Future longitudinal research using the CLSA can build upon this study to determine whether the different subtypes of social support are associated with executive function over time, and whether these associations differ in men and women.

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8.0 Appendix

Appendix A. Literature Search Constructs

Table A1: Literature Search Strategy: PubMed

	Search Strategy #1			
Database:	**Cognitive Function**	**Social Support Availability**	**Age**	**Time**
PubMed/Medline	Cognitive Function* OR Memory OR Cognitive Abilit* OR Cognition[MeSH:noexp] OR Cognition Disorders OR Cognitive Impairment* OR Dementia	Social Support[MeSH] OR Social Support[tiab] OR Support Relations* OR Interpersonal Relations[MeSH:noexp] OR Interpersonal Relations* OR Social Interaction* OR Social Engagement* OR Social Isolation[MeSH]	Aged[MeSH] OR Elderly[TW] OR Older Adult* OR Middle Age* OR Middle Aged	Aging[MeSH] OR "Ageing" OR Follow-up stud* OR Prospective Stud* OR Prospective Cohort Stud* OR Longitudinal Cohort Stud* OR Longitudinal Stud* OR Cognitive Aging[MeSH]

Overall search strategy: #1 AND #2 AND #3 AND #4

#4 Aging[MeSH] OR "Ageing" OR Follow-up stud* OR Prospective Stud* OR Prospective Cohort Stud* OR Longitudinal Cohort Stud* OR Longitudinal Stud* OR Cognitive Aging[MeSH]
#3 Aged[MeSH] OR Elderly[TW] OR Older Adult* OR Middle Age* OR Middle Aged
#2 Social Support[MeSH] OR Social Support[tiab] OR Support Relations* OR Interpersonal Relations[MeSH:noexp] OR Interpersonal Relations* OR Social Interaction* OR Social Engagement* OR Social Isolation[MeSH]
#1 Cognitive Function* OR Memory OR Cognitive Abilit* OR Cognition[MeSH:noexp] OR Cognition Disorders OR Cognitive Impairment* OR Dementia

Search performed October, 2017 and retrieved 1018 records.

Updated search performed July, 2018 and retrieved 1117 records.

Table A2: Literature Search Strategy: PsycINFO

	Search Strategy #1			
Database:	**Cognitive Function**	**Social Support Availability**	**Age**	**Time**
PsycINFO	"Cognitive Function" OR Memory OR "Cognitive Abilit*" OR Cognition OR "Cognitive Disorders" OR "Cognitive Impairment" OR Dementia	"Social Networks" OR "Social Support*" OR "Social Relations*" OR "Interpersonal Relations*" OR "Social Interaction" OR "Social Engagement" OR "Social Isolation"	Elderly OR "Older Adult*" OR Senior* OR "aged (65 yrs & older)" OR "very old (85 yrs & older)" OR "Middle Age (40-64 yrs)"	Aging OR "Follow-up stud*" OR "Prospective Stud*" OR "Prospective Cohort Stud*" OR "Longitudinal Stud*" OR "Longitudinal Cohort Stud*" OR "Cognitive Aging" OR Ageing

Overall search strategy: #1 AND #2 AND #3 AND #4

#4 Keywords: (Aging) OR Keywords: ("Follow-up stud*") OR Keywords: ("Prospective Stud*") OR Keywords: ("Prospective Cohort Stud*") OR Keywords: ("Longitudinal Stud*") OR Keywords: ("Longitudinal Cohort Stud*") OR Keywords: ("Cognitive Aging") OR Keywords: (Ageing) OR abstract: (Aging) OR abstract: ("Follow-up stud*") OR abstract: ("Prospective Stud*") OR abstract: ("Prospective Cohort Stud*") OR abstract: ("Longitudinal Stud*") OR abstract: ("Longitudinal Cohort Stud*") OR abstract: ("Cognitive Aging") OR abstract: (Ageing)
#3 Keywords: (Elderly) OR Keywords: ("Older Adult*") OR Keywords: (Senior*) OR abstract: (Elderly) OR abstract: ("Older Adult*") OR abstract: (Senior*)) OR Any Field: ("aged (65 yrs & older)") OR Any Field: ("very old (85 yrs & older)") OR Any Field: ("Middle Age (40-64 yrs)")
#2 Keywords: ("Social Networks") OR Keywords: ("Social Support*") OR Keywords: ("Social Relations*") OR Keywords: ("Interpersonal Relations*") OR Keywords: ("Social Interaction") OR Keywords: ("Social Engagement") OR Keywords: ("Social Isolation")
#1 Keywords: ("Cognitive Function") OR Keywords: (Memory) OR Keywords: ("Cognitive Abilit*") OR Keywords: (Cognition) OR Keywords: ("Cognitive Disorders") OR Keywords: ("Cognitive Impairment") OR Keywords: (Dementia)

Search performed October, 2017 and retrieved 204 records.

Updated search performed July, 2018 and retrieved 217 records.

Appendix B: Literature Review Summary Table

Table A3: Summary Table for Findings on the Association between Social Support and Cognitive Function

Study	Study Population, Sample Characteristics, & Study Design	Exposure and Covariates	Outcome or Dependent Variable	Analysis	Results
Amieva, Stoykova, Matharan, Helmer, Antonucci & Dartigues (2010). What aspects of social network are protective for dementia? Not the quantity but the quality of social interactions is protective up to 15 years later	This study utilizes data from the prospective cohort study PAQUID, which investigates aging and the brain among community-dwelling seniors in the Gironde and Dordogne areas of France. The study began in 1988 with 3777 participants over the age of 65, and continued for 15 years with 7 follow-up evaluations after baseline. 2089 participants were included in final analysis.	Social network was assessed by marital status, size and composition (friends compared to family). Satisfaction in social networks was analyzed categorically ('satisfied' or 'poorly or not satisfied'). Also assessed was feelings of being either understood or misunderstood by most of your social network, as well as a 3-level measure of relationship reciprocity (e.g., I receive more than I take). Covariates were sex, education, global cognitive status (MMSE), IADL, chronic diseases (i.e., diabetes, heart	Dementia was evaluated at each follow-up, and a neurologist assessed all participants who met criteria for dementia during the interview. Confirmed dementia cases were categorized by an expert panel into Alzheimer's disease (NINCDS-ADRDA criteria), vascular dementia (NINDS-AIREN criteria), frontotemporal dementia, Lewy body disease, and Parkinson dementia.	Cases diagnosed during the first two follow-ups (1 & 3 years after baseline) were omitted due to concerns about reverse causality. Risk for future dementia was tested using Cox proportional hazard models. Univariate & multivariate analyses were used to assess the relationship between the social network variables and dementia, adjusting for covariates.	Only satisfaction and reciprocity were significantly associated with dementia after adjustment. High satisfaction was associated with a lowered risk (RR = 0.77, 95% CI = 0.6-0.9). Receiving more than you gave had a significantly lower risk of overall dementia (RR = 0.45, CI = 0.2-0.9) and nearly significant for AD (RR = 0.47, CI = 0.2-1.0) than those who gave and received equally in their relationships. Giving more than you got was not significant for

		disease), and positive affect.			dementia (RR=1.05, 0.8-1.3) or AD (RR= 1.16, CI = 0.9-1.4)
Andrew & Rockwood (2010). Social vulnerability predicts cognitive decline in a prospective cohort of older Canadians	Prospective cohort data came from the Canadian Study of Health and Aging (CSHA). This population used data from 2468 English- or French-speaking participants aged 65 or older who were followed for 10 years, and interviewed every 5 years, starting in 1991-1992. In this case, CSHA-2 (5-year follow-up) data was used as the baseline, and thus all participants were aged 70 and over.	Social vulnerability was assessed at baseline by a 40-item interview on ability to communicate (read and write), living situation (marital status, living alone), various measures of perceived social support (e.g., someone to turn to for advice), leisure activities (e.g., how often visit friends or relatives), ratings of Ryff scales (e.g., maintaining close relationships is difficult and frustrating), home ownership, education, and subjective ratings of different social and demographic variables (e.g., how do you feel about your life in terms	The modified mini-mental state (3MS) exam was used to assess cognition. Memory (immediate and remote), language and verbal fluency, as well as executive function, concentration and orientation are tested in this measure, with scores falling between 0 to 100. Participants were considered to have cognitive decline if their score lowered by 5 or more points during the 5-year follow-up. Cognitive impairment was assessed if scored below 78 on 3MS. Dementia was diagnosed in	The association between baseline social vulnerability and cognitive decline 5 years later was investigated using logistic regression. To investigate the impact of each of the 40 social vulnerability variables, a "jackknife by variables" method was used, with the index being run 40 times, with one variable removed each time, and logistic regression then being used for each of these new models.	Participants with higher levels of social vulnerability had an increased risk of cognitive decline, and the addition of each one of the 40 social vulnerability variables increased the risk. In addition, those with low social vulnerability at baseline were more likely to be missing cognitive measures at follow-up.

		of…friendships, housing, etc.) Covariates included age, sex, baseline cognition, and frailty.	clinical examination.	This procedure was also used to investigate the 8 different domains.	
Bourne, Fox, Starr, Deary, & Whalley (2007). Social support in later life: Examining the roles of childhood and adulthood cognition.	In this retrospective cohort study, 266 adults from the Aberdeen Birth Cohort 1936 study, who had participated in the Scottish Mental Health Survey in 1947 at age 11, were recruited into this study at the age of 64.	A test of general cognition, the Moray House Test, was administered at age 11 as part of the Scottish Mental Health Survey. At age 64, participants were assessed on non-verbal and fluid reasoning using 60 items from Raven's standard progressive matrices. Sex, living group (living alone or with someone), marital status, and personality (assessed by NEO Five-Factor Inventory) were included as predictors.	The Significant Others Scale (SOS) was used to assess social support. Participants listed up to 7 of their most important social relationships and rated the quantity and quality of the emotional and practical support they received from each person. Quality of support was calculated as the difference between how much support they reported receiving and how much support they would ideally want from each relationship, with a positive score indicating higher satisfaction.	Hierarchical blocked stepwise multiple linear regression was used, with the covariates entered in the first block, followed by childhood and adult cognitive ability entered in the second. Separate analyses were run for each of the 4 social support measures (amount and satisfaction of both emotional and practical support).	Those who had higher cognitive function scores at age 11 reported lower levels of received support and greater dissatisfaction for both emotional and practical support. Emotional support quantity was greater for those with higher levels of extraversion, while openness was associated with lower satisfaction. Neuroticism was significantly associated with less practical support received, and less satisfaction. Those living with another person reported less satisfaction with

			Separate totals were calculated for emotional and practical support.		emotional and practical support compared to those living alone. Cognitive score at age 64 was not significant for any analysis.
Dickinson, Potter, Hybels, McQuoid & Steffens (2011). Change in stress and social support as predictors of cognitive decline in older adults with and without depression	112 depressed patients over the age of 60 were recruited from Duke University's psychiatric services and medical clinic in the National Institutes of Health-supported Neurocognitive Outcomes of Depression in the Elderly (NCODE), a prospective cohort study. Patients were excluded if they had another major psychiatric or cognitive disorder (e.g., schizophrenia, substance abuse,	The DDES assesses depression, cognitive function, and 4 measures of social support. These 4 measures make up the Duke Social Support Index (DSSI) and include instrumental social support (rated yes or no), social network size, subjective social support (e.g., do you feel you are being listened to?) and social interaction, which had 4 items rated from 0 to 7 (e.g., how many times during the past week did you spend time with someone who did not live with you?) The Life Events	The CERAD neuropsychological battery was used to assess cognitive function in both depressed and non-depressed participants. Measures include the MMSE, Animal Naming and object naming, constructional praxis activity, and immediate and delayed recall of a word list, as well as a recognition/ discrimination test for said words. The Logical Memory subtest of the WMS-R, Trail Making Tests A (TMT-A) and B	Change in social support measures and stress over the first year and cognitive changes over the second year were assessed using Pearson's correlation coefficients. Significant measures were included in the linear regression models.	Depressed participants had worse cognitive scores at the start of the study, and reported higher numbers of stressors and negative events. Participants who reported a decline in stressors saw improvements in their cognitive function. Even after the inclusion of covariates, it was found that decreasing social interaction was associated with worsening scores on CERAD TS and Digit Span Forward, while decreasing instrumental social

	dementia, Parkinson disease). Patients were assessed every 3 months. 101 non-depressed participants were recruited from Duke's Center for Aging Subject Registry.	Scale assessed the number of stressors (positive and negative) and negative events in the last year (e.g., change in work, living situations). Change was calculated by subtracting the scores at Year 1 from baseline, with a positive score indicating positive change. Change scores were calculated for all social measures (year 1 – baseline). Age, sex, race, depression status, and education were considered as covariates.	(TMT-B), Symbol Digit Modalities Test (SDMT), Digit Span Forward and Backward from the WAIS-R, and an additional digit span task, were also administered. The CERAD total score (TS) was calculated including all measures except the MMSE.		support showed worsening scores on the SDMT and the Ascending Digit Span.
Eisele, Zimmermann, Köhler, Wiese, Heser, Tebarth, Weeg, Olbrich, Pentzek, Fuchs, Weyerer, Werle, Leicht, König, Luppa, Riedel-	In this prospective cohort study, 1869 participants, all aged 75 or older and community-dwelling, were assessed over 4, 18-month intervals for the Ageing,	Perceived social support was measured using a 14-item survey in which patients rated statements such as 'I know several people with who I enjoy to spend time with' on a 5-item scale.	Cognitive function and cognitive change was assessed using the 55-item Structured Interview for the Diagnosis of Dementia of the Alzheimer type,	In investigating the association between social support and cognitive change, Mulifactorial ANCOVA was used to control for all	While there was an overall average decline in cognition between baseline and the final follow-up regardless of level of support, those who experienced low social support were

Heller, Maier & Scherer (2012). Influence of social support on cognitive change and mortality in old age: results from the prospective multicentre cohort study AgeCoDe	Cognition and Dementia in Primary Care Patients (AgeCoDe) study based in Germany. This study utilizes data from the second and final follow-ups. Data was collected by in-home interviews, as well as from the patient's general physician.	Physical (e.g., riding a bicycle twice a week) and cognitive activity (e.g., solving crossword puzzles) were considered as confounders. Information on health status (e.g., number of chronic diseases, IADL) was also collected from patient's general physician. Marital status, social engagement, smoking status, and sensory impairment were further included.	Multi-infarct Dementia and Dementia of other Aetiology according to DSM-III-R, DSM-IV and ICD-10 (SIDAM). Mortality was also investigated as an outcome.	covariates. Mortality and survival outcomes were tested using multifactorial Cox and logistic regression.	at a significantly higher risk. Perceived social support was not significant in the final ANCOVA models. Social support was also not found to be significant for mortality and survival time.
Ellwardt, Aartsen, Deeg & Steverink (2013). Does loneliness mediate the relation between social support and cognitive functioning in later life?	This sample consists of 2255 participants from the Netherland-based Longitudinal Aging Study Amsterdam (LASA). Starting in 1992, participants aged 55 to 85 were interviewed every 3 years, with a second cohort,	Participants were asked about their top 9 social contacts (partner excluded). Emotional support was assessed by how often in the last year they spoke to each contact about their personal experiences and feelings. Instrumental support was assessed by how often, in the past year,	Cognitive functioning was assessed using the Mini-Mental State Examination (MMSE). Mental processing speed was tested using timed naming of characters in the Coding Task (adapted). The Raven Coloured Progressive	Latent growth mediation models were used for time-varying variables.	Instrumental support and loneliness were found to increase with age. Higher levels of both emotional and instrumental social support were associated with better cognitive functioning; however, this effect occurred indirectly

	aged 55 to 64 joining the study in 2002. This study utilizes the 2001-2003 (T1), 2005-2006 (T2), and 2008-2009 (T3) follow-ups.	each listed social contact helped the participant with daily tasks around the house. Ratings ranged from "never" (1) to "often" (4), with a maximum possible score of 36. Loneliness was considered as a mediating variable, and age, sex, education, and physical functioning were treated as possible confounders.	Matrices (RCPM) test was used to measure abstract reasoning and non-verbal abilities through increasingly difficult pattern matching.		through the reduction of loneliness. When looking only at those over age 65, no indirect effects were found; although, emotional support was found to have a direct effect. An increase over time in emotional, but not instrumental, support was found to directly increase cognitive function.
Fratiglioni, Wang, Ericsson, Maytan & Winblad (2000) Influence of social network on occurrence of dementia: a community-based longitudinal study	1203 non-demented participants over the age of 75 were recruited from the Kungsholmen Project, a prospective cohort study of aging and dementia begun in 1987 in Stockholm, Sweden. There were 176 cases of incident dementia	Baseline interviews were used to assess the structural (marital status, living arrangements, having children) and functional (frequency of contact, satisfaction with contacts) aspects of participants' social networks. Age, sex, education, and cognition at baseline were	Incident dementia, defined by DSM-III-R, was assessed approximately 3 years after baseline data were collected.	Cox proportional hazard models and multivariable models were used to assess the association between different social-network variables and incident dementia. Dementia onset was calculated	Being female, older, or having less education or lower cognitive scores was associated with higher levels of dementia risk. Structural indicators of smaller social networks (being single, not having close ties to friends or relatives, living alone) increased the risk of developing dementia, as did

	at follow-up, 3 years later.	considered as confounders. Physical functioning, symptoms of depression, and vascular disease at baseline were also considered covariates.		as the midpoint between baseline and diagnosis.	low satisfaction and less frequency of contact.
Frith & Loprinzi (2017) Social Support and Cognitive Function in Older Adults	1,874 community-dwelling adults aged 60-85 years from the 1999-2002 National Health and Nutrition Examination Survey (NHANES). Participants excluded if they had heart disease, heart failure, heart attack or stroke.	Social support was assessed using 4 questions: "can you count on anyone to provide you with emotional support such as talking over problems or helping you make a difficult decision?"; "In the last 12 months, who was the most helpful in providing you with emotional support?" (spouse, son, daughter, and sibling); "If you need some extra help financially, could you count on anyone to help you?"; and "In general, how many close friends do you have?"	Cognitive function —specifically, executive function —was assessed using the Digit Symbol Substitution Test (DSST). Participants were required to match numbers with previously paired symbols, and then later recall and draw as many of these symbols as possible within a two-minute period.	Multivariable linear regression models were run separately for each source of support (spouse, son, daughter, sibling, financial) and for size of support network.	Receiving any type of support was significantly associated with a higher DSST score compared to no support. In terms of sources of support, only spousal was significantly associated with cognitive function. Having a large social support network (5 or 6 close friends), but not smaller social networks (1-4 close friends) was significantly associated with higher cognitive function.

		Covariates were age, race, BMI, C-reactive protein, self-reported smoking status, diabetes, measured mean arterial pressure, physical activity			
Ge, Wu, Bailey, & Dong (2017). Social support, social strain, and cognitive function among community-dwelling U.S. Chinese older adults	3159 community-dwelling seniors aged 60 or older were studied as part of the Population Study of Chinese Elderly in Chicago (PINE), a cross-sectional study investigating cultural determinants of health.	The Health and Retirement Study (HRS) social support scale was used to measure social support and social strain. For support, participants rated how often they could "open up to" or "rely on" the different members of their support network. For social strain, participants rated how often they felt criticized or that their relationships demanded too much from them. Items were rated from 1 (hardly ever) to 3 (often). Covariates included demographic characteristics (e.g.,	Cognitive function was assessed using multiple measures, which were combined to create a global cognitive score. These measures included the Chinese Mini-Mental Status Exam (C-MMSE), as well as the Symbol Digit Modalities Test (SDMT) to measure executive function. Memory, immediate and delayed, was assessed by the East Boston Memory Test (EBMT), and the Digit Span Backwards test.	The relationships between social measures and cognitive function were investigated using linear regression adjusted for covariates. Interactions between social variables were also examined.	More social support was associated with better cognitive scores across all domains (global, episodic and working memory, and executive function). Interestingly, social strain from friends, family, and spouse was also associated with cognitive function. The authors suggest this may be due to a positive assessment of social strain being more common in Chinese culture.

		sex, age, education, marital status, income), acculturation, depression, medical conditions, and physical function.	.		
Gow, Corley, Starr, Deary (2013). Which social network or support factors are associated with cognitive abilities in old age?	1091 participants born in 1936 were recruited at age 70 into the longitudinal Lothian Birth Cohort 1936 (LBC1936) study in Scotland. Participants had previously completed mental testing at age 11.	Social support was assessed by level of support available (6 items) and satisfaction (6 items), adapted from the Social Support Questionnaire (Short Form). Social contact was measured by 7 items assessing the type and amount of contact participants received over the past 2 weeks (e.g., had contact by telephone or letter with a friend). Social class was assessed by Classification of Occupations. Additional variables included age, sex, marital status, living situation, loneliness and depression.	At ages 11 and 70 participants completed the Moray House Test No. 12 (MHT). Additional testing was done at age 70, including the Wechsler Adult Intelligence Scale-III UK and the Wechsler Memory Scale-III UK, as well as tests of reaction time and inspection time.	ANCOVAs were used to assess the variance in cognition accounted for by all social support measures. Social support measures were run separately and simultaneously. Social support was treated as a dichotomous variable, comparing highest level to all other levels combined, due to a positive skew in data.	Living alone or being unmarried was associated with lower social support scores and greater loneliness. Social contact was negatively associated with IQ at age 70. When considered independently in separate analyses, social support and loneliness, but not social contact, were significantly positively associated with cognition (IQ, general cognitive ability and processing speed) at age 70. Neither was significant for memory after

					adjustment. When the social variables were run simultaneously, the association between all measures and cognitive outcomes were nonsignificant after the inclusion of a depressive symptoms score. The one exception was the association between processing speed and living arrangements.
Gow & Mortensen (2016) Social resources and cognitive ageing across 30 years: the Glostrup 1914 Cohort	802 participants born in 1914 and belonging to the Glostrup 1914 Cohort completed assessments of cognition and social support. Assessments were repeated ever 10 years starting at age 50, and every 5 years from age 75–90. The sample was refreshed at age 75. This study utilizes the data	Social resources assessed differently across time. Marital status and living arrangements (number of people lived with, number of rooms in house) were assessed at all ages. At age 70 and 80 frequency of contacts was assessed (children, grandchildren, siblings, friends, acquaintances, and neighbours),	Cognitive function was assessed using 4 tests from the Wechsler Adult Intelligence Scale: digit symbol, block design, digit span, and picture completion. All raw scores were scaled to the age 50 norms. A combined score of general cognitive function was calculated using the 4 tests for	Latent growth curve analyses were used to model change from age 50 to 80. The models investigated the intercept (level of cognitive ability) and slope (the change in cognitive ability across time) as outcomes.	Cognitive function declined over time, but starting level of cognitive function did not predict later declines. Being married at 60, 70 and 80 was positively associated with cognitive function, while living alone at any age, being lonely at 70 or 80, and having telephone contact at 70 were negatively

	collected at age 50 (n=787), age 60 (n=663), age 70 (n=735), and age 80 (n= 498 to 505)	frequency of telephone contact (children, grandchildren, siblings, friends, other), support to others (e.g., taking care of family, housework) and loneliness (yes/no at age 70, 4-point scale at age 80) were assessed. Instrumental support was assessed by 14-tems at age 70. Covariates were sex, education, and social class.	age 50, 60, 70 and 80.		associated. In terms of decline, those who were married at 50 or 60 or had telephone contact at 70 had less decline, while those who were lonely at 70 had greater cognitive declines. Instrumental support and support to others were not significant.
Gurung, Taylor & Seeman (2003). Accounting for changes in social support among married older adults: Insights from the MacArthur studies of successful aging	Of the 4030 adults included in the prospective cohort MacArthur Successful Aging Study (MSAS), 1189 met physical and cognitive screening criteria and gave consent at baseline in 1988/1989 and at follow-up in 1991. Only those who had a living spouse	Social measures included number of social ties, ratings of self-efficacy (interpersonal and instrumental beliefs) mastery (relating to feelings of control), and depression. Cognitive ability was assessed using the Boston Naming Test, with delayed recall, the delayed Recognition Span	Social support was assessed from 3 sources: spouse, children, and friends and family. Each group was rated on emotional support (how often do they make you feel loved and cared for, how often they listen to your worries), instrumental support, and	Mixed ANOVA was used to test for variation in social support across type, source, and sex between baseline and follow-up. To investigate predictors of change in SSA, hierarchical multiple	Both sexes received instrumental support primarily from their spouses. Men received their emotional support from their wives, while women reported that children, friends and family were their major sources. Further, men experienced increasing support

	at both baseline and follow-up were included in the analysis, leaving a total of 439 seniors who were between the ages of 71 to 79 at baseline.	Test, the Similarities subtest of WAIS-R, and an activity where participants had to recreate a geometric drawing. Sex, age, income, physical functioning, and somatization (distress caused by physical symptoms such as headaches within the last week) were included as covariates.	negative interactions (e.g., how often they made too many demands). All items were rated on a 4-point scale from 0 to 3 ('never' to 'frequently').	regression was used.	from all three sources, while women saw increases from children, and friends and relatives. A high number of social ties was associated with larger increases from children, family and friends. Negative interactions with spouses increased more for women than men, and also increased more for those with higher incomes, younger age, greater depression, and lower cognition for their relationships with their friends and family.
Hughes, Andel, Small, Borenstein & Mortimer (2008). The association between social	417 participants over the age of 60 were recruited in 1997/1998 to the Charlotte County Healthy Aging Study, a	Social resources were assessed in 7 areas: social network of family and friends (number of contacts per month, frequency of contact with closest	Cognition was assessed using the MMSE, the Stroop Test, the Hopkins Verbal Learning Tests for cued recall, free recall,	Researchers used mixed linear regression to investigate the unique contribution to	At baseline, global cognition was significantly, positively, associated with the negative interactions and

resources and cognitive change in older adults: evidence from the Charlotte County Healthy Aging Study.	prospective cohort study based in Florida. Participants were reassessed at 5 years. After loss to follow-up due to death, cognition cut-offs, and withdrawal, data from 239 participants were included in this study.	member, and total number of contacts for each category), emotional support, instrumental support, informational support, satisfaction with support, and negative social interactions. Attrition, age, sex, education, marital status, scores on the NEO Five-Factor Inventory of personality, and number of years living in Charlotte County, Florida were investigated as covariates.	and recognition, and Part A and B of the perceptual speed Trailmaking Test.	variance of each factor. All social resource variables, and each variable's interaction with continuous age, were entered simultaneously and adjusted for by covariates. Years of follow-up time were also modelled. Age was stratified at the median (between age 73/74) into young-old and old-old.	satisfaction with support. Speed and attention were associated with satisfaction with support. Stratifying for age revealed differences between the two groups in terms of satisfaction (in speed and attention at baseline, and in memory at follow-up), and in social networks of family and friends (for global cognition at baseline and follow-up, and for speed and attention at follow-up)
Kats, Patel, Palta, Meyer, Gross, Whitsel, Knopman, Alonso, Mosley & Heiss (2016). Social Support and cognition in a community-	In the ARIC study, community dwelling participants aged 45-64 years were assessed 5 times: 1987-89 (baseline), 1990-92 (Visit 2), 1993-95 (Visit 3), 1996-98 (Visit 4),	Social support was assessed at visit 2 using the Interpersonal Support Evaluation List (ISEL-SF) and the Lubben Social Network Scale (LSNS). The ISEL-SF measures perceived	Cognition was tested at visits 2, 4, and 5, using the Digit Symbol Substitution Test (DSST, tests executive function and processing speed), Delayed Word Recall Test	Cross-sectional associations were assessed using generalized linear models, stratified by race. Generalized estimating	In fully adjusted models, being in the highest (vs. lowest) quartile of interpersonal support or having a low risk of social isolation was significantly associated with

based cohort: The Atherosclerosis risk in communities (ARIC) study	and 2011-2013 (Visit 5). Visit 2 cross-sectional analysis was completed with 13,119 participants, and longitudinal analysis was completed using visits 4 and 5 data for 5,195 participants.	support and rates questions on a 4-point scale with scores then added together. No cut-offs were available, so scores were divided into quartiles. The LSNS measures the size of their social network, with 10 questions. Scores were used to categorize responses into 3 levels of social isolation: social isolated/high risk for isolation, moderate risk for isolation, and low risk for isolation. Covariates were race, age, sex, study centre, education, cigarette smoking, alcohol consumption, hypertension, diabetes.	(DWRT, tests verbal learning and immediate memory), and Word Fluency Test (WFT, executive function and expressive language). Scores for each test were standardized (z-score) and a global z-score representing global cognitive function was calculated for each visit by averaging the z-scores for all 3 tests.	equation models were used for longitudinal associations.	better cognitive function for both races (only female African Americans). Longitudinal models were not significant.
Khondoker, Rafnsson, Morris, Orrell & Steptoe (2017). Positive and negative	10,055 community-dwelling participants, all aged 50 or older, were followed for a period of 10	Measured at baseline, participants were required to complete a rating of social support (positive and negative) for at least one of their	Dementia incidence was determined by physician diagnosis (reported by participant or informant) or by score on the	Ratings of social support were reverse coded so that a higher number indicated a higher score.	340 cases of incident dementia were reported during the study. Those who were older and male were more likely to have

experiences of social support and risk of dementia in later life: An investigation using the English Longitudinal Study of Ageing.	years as part of ELSA (English Longitudinal Study of Aging). The study began with wave 1 in 2002/2003 and ended with wave 6 in 2012. Only participants who were dementia-free and had completed a baseline measure of positive and negative support were included in the study.	relationships: spouse, children, friend, other immediate family, or other family. The measure consists of 6 items, with half of the items reflecting positive experiences of support, and the other half concerning negative experiences. Each relationship was rated individually. Separate total positive and total negative scores were calculated for all relationships. Combined scores were also calculated for 1) Spouse and children, 2) Spouse, children, and family, 3) Family and friends, 4) Overall (spouse, child, family, and friend). Age, sex, education, comorbid conditions (e.g., diabetes, stroke, cancer) and net wealth were included as covariates.	IQCODE (Informant Questionnaire on Cognitive Decline in the Elderly), which assesses reported change in ability on performance of common tasks over 10 years (e.g. remembering names of family members). The 16 items are rated from 1 (much improved) to 5 (much worse).	Proportional hazards regression models were used to investigate the impact of positive and negative social support on dementia incidence. Time-to-dementia was calculated from baseline to the two-year interval between the last wave where the participant did not have dementia and the next wave, and was calculated as months (e.g., someone who developed dementia between wave 3 and 4 would have a rating of 24, 48 months).	develop dementia. Only positive support from children was found to significantly reduce the risk for dementia. More negative support was found to increase the risk of dementia, with all 4 combination scores (including combined scores for all relationships) and other family demonstrating significant increases. Education was found to decrease risk in some models, while diabetes increased risk. Sex was not significant, possibly because of the young age of the cohort (Mean = 65 years, SD = 10 years).

Kotwal, Kim, Waite, & Dale (2016). Social Function and Cognitive Status: Results from a US Nationally Representative Survey of Older Adults	Data from 3,310 community-dwelling participants from wave 2 (2010-2011) of the National Social life Health and Aging Project (NSHAP) aged 62-90 years were used in the study. Some participants were selected as co-residents (spouses or partners).	Social networks were assessed by size (name up to 5 people whom they had discussed important matters with within the last year), density (frequency of interaction with each network member and possible pair of network members, divided by network size). Perceived social support was assessed for spouse, family and friends (how much they could rely on them; open up to them) on a scale from 0 (never) to 3 (often). Perceived social strain was assessed using 3 questions for spouse, family, friends (how often they make too many demands, criticize you, get on your nerves). Social engagement was assessed using community	Cognitive status was evaluated using the Montreal Cognitive Assessment (MoCA), a screening tool for early dementia or MCI. The MoCA assesses orientation, executive function (abstraction, modified Trails-b), visuospatial skills, memory (delayed recall), attention, and language.	Separate linear regression models were run for each of the 6 exposures: network size, network density, social support, social strain, community engagement, and socializing.	Screening as at risk for MCI and dementia was significantly associated with smaller network sizes, higher density, lower social strain (overall and from spouses), and lower community involvement. Social support was modified by gender: lower social support was associated with lower cognition in women only. Women saw the largest decrease in support from friends, while men saw greatest decreases from spouses. Higher socialization (overall and with family/friends) was significantly associated with lower cognition in men only.

		involvement and socializing with relatives and friends. Covariates were age, gender, ethnicity, education, marital status, health status, comorbidity, depressive symptoms, health behaviours (tobacco use, exercise, alcohol consumption)			
La Fleur & Salthouse (2017) Which aspects of social support re associated with which cognitive abilities for which people?	2,613 participants aged 18-96 were recruited from the Virginia Cognitive Aging Project. Participants were excluded if they scored below a 24 on the MMSE.	Social Network Questionnaire assessed social contact (friends, family), received support (emotional, tangible, information), provided support (emotional, tangible, information), perceived support (satisfaction, anticipated, negative). All scales were rated from 1 (never or not at all) to 4 (very often, a great deal) except for satisfaction with social	The tests of cognitive function measured vocabulary (Wechsler Adult Intelligence Scale, a picture-naming task, and a multiple-choice synonym and antonym task), speed (letter and pattern comparison task and a digit symbol task), reasoning (letter set tasks, Shipley's Abstraction, and matrix reasoning), space (form boards	A composite score was calculated for each exposure and outcome by averaging the z-scores. Linear regression models were used to assess the associations between social support exposures and cognitive function outcomes.	When all covariates were included in the model, family contact was negatively associated with vocabulary, received emotional support was positively associated with memory, and provided emotional support was associated positively with vocabulary and negatively with reasoning. Provided informational

		exchanges, which was rated as yes or no. Covariates included age, sex, education, health limits, and general social support.	task, paper folding task, and spatial relations task), and memory (logical memory task, a free recall task, and paired associates task).		support was positively associated with vocabulary. Anticipated support was associated negatively with vocabulary and positively with reasoning. Education predicted vocabulary, reasoning, and space. Age predicted vocabulary, space, memory, and speed. Sex predicted space, memory, and speed. Age and sex did not significantly moderate the associations between support and cognition, except for age x contact with family (predicted speed) and age x negative interactions (predicted space).
Liao & Scholes (2016).	Participants were recruited from the	Social support was assessed separately	Executive function consisted of verbal	Between-person associations	Higher average positive support was

Association of social support and cognitive aging modified by sex and relationship type: A prospective investigation in the English Longitudinal Study on Ageing	English Longitudinal Study on Ageing (ELSA). Included participants had at least 1 cognitive assessment from the first 5 waves, and had not been diagnosed with Alzheimer or Parkinson disease, dementia or memory impairment at wave 1 (2002-2003). 10,241 participants were included in tests of executive function, and 10,336 for memory.	for spouse/partners, children, friends, and extended family members. 3 questions were used to assess positive social support (how much they understand the way you feel about things, how much they can be relied on if you have a serious problem, and how much you can open up to them to talk about worries) and negative support (how much they criticize you, how much they let you down when you are counting on them, how much they get on your nerves). Responses ranged from 0 (not at all) and 3 (a lot). Covariates include sex, age, socioeconomic status (education and wealth), health factors, and depressive symptoms.	fluency (animal naming) and letter-cancellation tasks. Memory was assessed with 3 tasks: time orientation, verbal learning, and prospective memory. For both executive function and memory, scores for each test were combined to create a composite score.	were assessed using an average score across all waves. Within-person associations subtracted each person's score for each wave from their average level. Linear mixed models were used to estimate change in cognition as a function of change in a participants' level of social support.	associated with higher executive function and slower decline in memory. High social support became positively significant with memory overtime. Higher within-person negative social support was associated with higher baseline memory, but higher between person negative social support was associated with lower baseline memory. Men with higher negative social support experienced faster declines in executive function, while men with higher levels of positive social support had slower declines. Men with high positive support from spouses also had

					slower declines in memory. Higher within-person negative support was associated with declines in executive function in women, but not men, and women who reported high positive social support from children or friends had higher executive function. In women, higher memory scores were associated with lower negative support from children.
Millán-Calenti, Sánchez, Lorenzo-López, Cao & Maseda (2013). Influence of social support on older adults with cognitive impairment, depressive	In this cross-sectional study, 579 participants over the age of 65 (Mean = 75.1, SD = 7.5 years) were recruited from the Municipal Register of Narón Council in A Coruña, Spain).	Social support and social resources were assessed using the 7-item Spanish version of the Older Americans Resources and Services (OARS) Social Resources Scale. All 7 items are rated on a 6-point scale (excellent, good, mild impairment,	The 30-point Mini Mental State Exam (MMSE) was used to assess cognitive status, with cut-offs determined after accounting for age and education for better consistency with the modified Spanish 35-point Lobo's Mini-	Multinomial logistic regression was used to investigate the association between social support and cognitive impairment and depression. Odds ratios and	56.3% of participants with cognitive impairment reported limited contact with others. Those with limited contact were more likely to develop impaired cognitive function (OR = 2.26, CI: 1.17-4.38). Fair or

symptoms, or both coexisting.	The sample included participants reporting depressive symptoms (17.3%), cognitive impairment (12.6%), and both (7.9%).	moderate impairment, severe impairment, and total impairment). The three subscales include contact with others (e.g., times talking to someone on phone per week), satisfaction with contacts (e.g., feelings of loneliness, satisfaction with contact), and availability of help. Scores on each subscales were transformed into categories from 1 (few) to 3 (extensive). Age, sex, education, ADL, IADL, and medical history, (Charlson comorbidity index, CCI) were included as covariates.	Examen Cognoscitivo (MEC). Depression was assessed using the Geriatric Depression Scale-Short Form (GDS-SF).	confidence intervals were calculated for covariates.	low satisfaction with contacts was significantly related to both depression (OR = 2.88, CI = 1.64-5.05, and OR = 7.99, CI = 3.66-17.47) and having depression and impaired cognitive function (OR = 4.22, CI = 1.61-11.04, and OR = 7.88, CI = 2.30-26.97). However, the relationship with low satisfaction was reversed for those who were only cognitively impaired (OR = 0.07, CI = 0.01-0.58).
Pillemer & Holtzer (2016). The differential relationships of dimensions of perceived social	355 community-dwelling seniors over the age of 65 (Mean = 76.58) were recruited as part of the cross-sectional Central	Perceived social support was assessed by the Medical Outcomes Study-Social Support Survey (MOS-SSS). The 19 items are	The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) was used to assess the visuospatial,	Principal component analysis revealed 4 factors of social support in the MOS-SSS, each	Higher perceived social support was associated with better cognitive function. This relationship was also true at the

support with cognitive function among older adults.	Control of Mobility in Aging study, based in Westchester County, New York. Participants were excluded if they required assistance or mobility devices (e.g., to cross a room) or if they had any impairments that could interfere with cognitive tests (e.g., severe auditory or visual impairments, medical history or neurological disorder).	divided into 4 subscales concerning access to support: emotional (e.g., empathy and understanding), informational (e.g., availability of guidance), tangible (e.g., access to physical aid), affectionate (e.g., receiving love), and positive social interactions (e.g., people to do fun things with). Items were rated from 1 (a little of the time) to 5 (all of the time), with a higher score indicating a higher perceived level of support. Covariates included age, education, sex, depression (Geriatric Depression Scale), and comorbidity (e.g., diabetes, hypertension, stroke).	language, attention, and memory domains of cognition function.	of which was examined using linear regression for its association with scores on the RBANS.	factor level for the emotional/ informational and positive social interactions dimensions; however, when stratified by sex, emotional/ informational support was only significant for women.

Saito, Murata, Saito, Takeda, Kondo (2017). Influence of social relationship domains and their combinations on incident dementia: A prospective cohort study	13,984 participants from the Aichi Gerontological Evaluation Study completed a self-administered survey in 2003. All participants were over the age of 65, and were followed for incident dementia for 9.4 years (3436 days) from November 1, 2003. Participants were excluded if they reported ADL limitations, no ADL data, or experienced incident dementia within 1 year of baseline.	Exposures were social networks (marital status, contact with relatives, and contact with friends), social activity (participation in community groups, engagement in paid work), and social support. Social support was assessed for each co-resident (family member, relative, friend, neighbour) using 4 questions (e.g., Do you have someone who looks after you when you are sick and confined to bed for a few days?). Covariates were diabetes, stroke, depression, subjective cognitive impairment, IADLs, physical activity, leisure activity, education, household income, gender, and age.	Incident dementia was assessed by the Degree of Autonomy in the Daily Lives of Elderly Individuals with Dementia scale which measures how much activities of daily living are impacted by dementia symptoms. Care-need levels were determined by home visits from healthcare professionals and an examination by a primary physician. Participants above level II (demonstrating some symptoms, behaviours or communication difficulties which may hinder daily activities) were considered to have dementia.	Cox proportional hazard models were used to investigate the association between social variables and incident dementia.	In models controlling for other social relationship variables and all covariates, 5 social relationship variables associated with a decreased risk of incident dementia: being married, having contact with friends, participating in groups, paid work, and having support from family. When a cumulative score on these 5 variables was created (1 = yes, 0 = no; scores from 0-5), those with a score 2 or higher were increasingly less likely to develop dementia (score of 2=14% less likely, 3=25%, 4=35%, 5=46%) compared to those who scored 0 or 1, demonstrating a significant dose-

					response relationship. Gender modified the association between marriage and incident dementia, with the association being stronger for men.
Seeman, Lusignolo, Albert & Berkman (2001). Social relationships, social support, and patterns of cognitive aging in healthy, high-functioning older adults: MacArthur studies of successful aging.	4030 seniors were screened on cognition and physical health as part of the prospective cohort MacArthur Studies of Successful Aging (MASA), based in NC, MA, and CT. The top third of participants were selected for inclusion in the study. In total, 1189 participants, aged between 70 and 79, completed baseline interviews in 1988/1989. 829 participants completed further follow-up	Social support was assessed structurally (e.g., marital status, participation in a group, number of close friends, family members, and children), as well as subjectively, through measures of emotional support (e.g., how often does your spouse make you feel loved and cared for?), instrumental support, and perceived frequency of negative social interactions. How much support the participant provided to others was also measured. Age, sex, education, ethnicity	Cognition was assessed in 6 areas: language (Boston Naming Test), abstraction (similarities subset from the Wechsler Adult Intelligence Scale—Revised), spatial ability (copying activity), delayed spatial recognition, as well as delayed recall of names and a story. A summary score was also calculated.	Subgroups were created for analysis of structural social supports based on the role of the person providing the support (e.g., spouse). Linear regression models were used to assess in relationships between the exposures and outcome at baseline (cross-sectional) and the longitudinal changes in cognitive function. Residual change	At baseline, women had significantly higher emotional support and number of groups. Men reported a greater number of ties overall, but also more negative interactions and provision of support to others. Married men experienced more social support and larger social networks, but married women reported less support and fewer ties to groups or close others. Cross-sectional multivariable analysis showed

	interviews in 1991 and 1996.	(white or black), income, as well as physical health (e.g., number of chronic conditions) and mental health (depressive symptoms, and self-efficacy beliefs) were included as covariates.		scores were calculated to investigate the relationship between baseline social measures and cognitive change. A backward-stepwise procedure was used. Results were stratified by sex. Dummy variables were used for those missing data.	that emotional support was significantly and positively associated with better cognitive outcomes, as was being unmarried or reporting higher levels of conflict and demands. Emotional support was also the only social environment variable found to significantly and independently contribute to later cognition in longitudinal analysis.
Seeman, Miller-Martinez, Stein Merkin, Lachman, Tun & Karlamangla (2011). Histories of social engagement and adult cognition:	Participants were part of the MIDUS (Midlife in the United States) study, and were between the ages of 25-74 when recruited into the study in 1994/1995 (MIDUS I). Of the original 7,108 participants, 4,963	Frequency of social contact was assessed for both family and friends. Reported social support was calculated using an average score of how much perceived support was received from a spouse, family, and friends (e.g., how much they provided	The Brief Test of Adult Cognition by Telephone (BTACT) was used to assess 6 areas of cognition, including reasoning, as well as both working and episodic memory (assessed using immediate	Linear regression mixed models were used to assess the relationship between social variables and cognitive function. Interactions between age and	Both domains of cognitive function showed steady declines with age. Having more social relationships was associated with better support, but more conflict. More contacts associated with better executive

Midlife in the U.S. study	completed reassessment in 2005/2006 (MIDUS II).	understanding, appreciation, or esteem support). Social strain or conflict was also assessed for spouses, family and friends (e.g., how often they felt these relationships were sources of tension, demands, or let them down). Both social support and social strain were assessed on the same scale (not at all, a little, some, a lot). Covariates included education, age, sex, race, heath status (reported illnesses, disabilities, and a measure of depression) and health behaviour (smoking, physical activity).	and delayed recall for word lists). A test of category fluency was used to measure semantic memory and executive functioning. Speed of processing was measured by backwards counting. Cognitive function was also assessed using the Stop and Go Switch Task (SGST). Cognitive measures were organized into two domains: episodic memory (delayed and immediate recall), and executive function (all other measures).	each social domain were considered for all cognitive outcomes. For social variables, changes between MIDUS I and MIDUS II were categorized with dummy variables.	functioning. Greater conflict in relationships was associated with worse executive function. Episodic memory positively associated with number of social contacts and support. When run simultaneously, reporting less conflict and strain, or a high number of social contacts was associated with executive function. Associations of social support and conflict with executive function showed an age interaction (stronger in younger participants). Also true for social strain and episodic memory. Decline in the number of contacts significantly negatively related to

					both cognitive domains. Depression, heart disease were not significant for any models. Stroke & Diabetes were negatively associated with executive function for all social exposures.
Shankar, Hamer, McMunn & Steptoe (2013). Social isolation and loneliness: relationships with cognitive function during 4 years of follow-up in the English Longitudinal Study of Ageing	In 2002, the first wave of the English Longitudinal Study of Aging (ELSA) was conducted with community-dwelling participants over the age of 50, with participants being re-assessed every 2 years. Loneliness was included as a measure in Wave 2 (2004/2005, n = 8688) which is used as a baseline for this study. After exclusions for missing	Social isolation was rated from 0 to 5, and assessed by marital status, whether the participant had telephone, face-to-face, or email contact less than once a month with their children, friends, or family (rated as yes/no for each type of contact), and participation in any form of social groups. Loneliness was assessed by answers to three questions from a revised version of the UCLA Loneliness Scale,	Cognitive function was assessed with measures of memory and executive function. Memory was assessed as immediate recall and delayed recall for 10 words provided verbally by a computer. For executive function, verbal fluency was calculated by number of animals participants could name in a minute.	Regression was used to compare social scores at baseline to cognitive scores at follow-up. Missing values were assigned using PROC MI in SAS and the imputed data were used as the estimates did not differ substantially from the incomplete data set. Correlations between predictors and covariates were	Cognition overall decreased between baseline and follow-up. At baseline, loneliness was higher among women. Smoking, depression, and low activity were associated with both increased loneliness and social isolation. Working and having a higher education was negatively associated with both social outcomes. Social isolation was associated with loneliness, and both were associated

	cognition data and loss to follow-up, 6034 participants were included at Wave 4 (2008/2009).	with each question being rated from 1-3 ("hardly ever or never", "some of the time," or "often"). These questions included how often the person felt they lacked companionship. Covariates included education (low versus high), age, sex, wealth (as a measure of SES, includes debt, value of home, as well as physical and financial assets), marital status-adjusted wealth, working status, depression (CES-D, with the loneliness item excluded), CVD, diabetes, smoking, and physical activity.		examined. Regression models were run for each measure of cognitive function in three stages: all covariates and baseline cognitive scores were added, then social isolation and loneliness. Finally, interactions were added in separate models (social isolation x loneliness, social isolation x education, and loneliness x education)	with executive function, as well as both immediate and delayed recall at baseline. At follow-up, an increase in reported social isolation was related to lower scores for all cognitive outcomes. Only memory was found to be significantly associated with loneliness and the interaction between loneliness x isolation and recall worsened as loneliness category increased. The social variables had less of an impact on cognition for those with higher education compared to those with lower education.
Sims, Levy, Mwendwa, Callender, & Campbell (2011).	In this cross-sectional study, 139 participants were community-dwelling adult	Perceived social support was assessed using the Interpersonal Support Evaluation List	In the Wisconsin Card Sorting Test (WCST), participants have to match cards and	The positive skew in the WCST data was addressed using a square root	All dimensions of social support (tangible, belonging, appraisal, and self-

The influence of functional social support on executive functioning in middle-aged African Americans.	African Americans with an average age of 45.60 (SD = 11.56) who lived in Washington, DC and had been part of the Minority Organ Tissue Transplant Education Program's (MOTTEP) Stress and Psychoneuro-immunological Factors in Renal Health and Disease Study.	(ISEL), a 40-item questionnaire that assesses 4 dimensions of support: tangible, belonging, appraisal, and self-esteem (e.g., positive self-image when compared to others). Each item is rated on a point from 1 (definitely false) to 4 (definitely true). Covariates included age, education, income, marital status, and health status (e.g., hypertension, diabetes).	infer the grouping rules based on feedback they received. After 10 cards are successfully matched, the rules are changed. Scores on number of perseverative errors (repetitive errors) and categories (10 responses in a row that aligned based on colour, number, or shape) were used to score. The Stroop Color and Word test was also used to assess executive function, with the Stroop Colour-Word (CW) and interference scores used for analysis.	transformation. Bivariate correlations and hierarchical regression models were used to assess the association between social support variables and cognitive function measures.	esteem) were significantly associated with better scores on the Stroop Color test for both interference and Colour-Word score. Tangible support was significantly associated with perseverative errors and completed categories, with higher ratings of tangible support predicting higher scores on the WCST.
Sims, Hosey, Levy, Whitfield, Katzel & Waldstein (2014).	175 community-dwelling adults (87.7% white) were recruited from the Baltimore Veterans Affairs Medical Center (B-	The general population Interpersonal Support Evaluation List (ISEL) scale was used to assess perceived support available in 4	Cognitive function was assessed with measures of response inhibition (Stroop Color-Word Test), visuospatial ability	Multiple linear regression was used to assess the relationship between social support and the measures of	Total social support, self-esteem support and belonging support were negatively associated with scores on Stroop

Distinct functions of social support and cognitive function among older adults.	VAMC), and local advertisements into this cross-sectional study. The average age of participants was 66.32, and ages ranged from 54 to 83 years. Participants were excluded based on medical history if they had a major medical disorder (e.g., cardiovascular disease (CVD), diabetes), neurological disease, dementia, stroke, head injury, or psychiatric disorder. Heavy use of alcohol (defined as 14 or more drinks per week), or medications that might impact mental functioning were also included in the exclusion criteria.	areas: appraisal (e.g., availability of another person to discuss problems with), self-esteem (relating to positive comparisons with others), belonging (e.g availability of others whom they can do things with), and tangible support (e.g availability of material support). Each area was rated on 10 items rated on a 4-item true-or-false scale. Covariates included depressive symptoms, blood pressure, weight, height, BMI, and cholesterol and glucose (fasting levels).	(Judgement of Line Orientation), visuoconstructional ability (Wechsler Adult Intelligence Scale – Revised (WAIS-R), Block Design subscale), nonverbal memory (Wechsler Memory Scale – Revised (WMS-R): recall of line drawings from the Visual Reproductions I and II subsets), attention and working memory (WAIS-R: Digit Span Forward, Digit Span Backwards, Visual Span Forward, and Visual Span Backward subscales), and verbal memory (Logical Memory I and II of the WMS-R). Finally, the Grooved Pegboard measured speed and dexterity, and the	cognition. Models were run for each of the social support measures and were adjusted for all covariates. Variables with non-normal distributions were log transformed.	Interference. Total social support, tangible support and belonging were also negatively associated with Visual Reproductions I. Appraisal support was not significantly related to any cognitive outcomes. There were no other significant associations between any measure of cognitive function and the social support domains.

			Trailmaking Test measured executive function and speed.		
Sörman, Rönnlund, Sundström, Adolfsson & Nilsson (2015). Social relationships and risk of dementia: a population-based study.	1769 non-demented participants over the age of 65 were recruited as part of the prospective cohort Betula study based in Umea, Sweden. The study began in 1988 and was repeated at approximately 5-year intervals, for a total of 6 follow-ups completed by 2013-2014. 1715 participants were included in the final analysis after exclusion criteria for missing data and a survival time of less than 1 year. Participants were recruited at 5 sample points throughout the duration of the	Social relationships were assessed by living status, presence of a close friend with whom the participant felt comfortable talking to about anything, and whether they believed they saw their friends and family enough. Each measure was coded as 0 or 1. Participants also rated how often they visited with their friends and family, as well as how often they had any contact with them (once a week or more = 1, less than once a week = 0). The maximum possible score was 5. Covariates included age, sex, education, smoking status, obesity, alcohol use, perceived stress, depressive symptoms, score on the MMSE,	All-cause dementia and Alzheimer's Disease (AD) were diagnosed by a research psychiatrist using DSM-V criteria and were assessed by repeated neuropsychological tests, interviews, and investigation of medical records.	Cox proportional hazards regression was used to assess the relationship between each social relationship variable (and sum-index) with all-cause dementia and AD. Time to event was calculated from first assessment to final assessment (diagnosis with dementia, death, or end of study). Delayed entry of covariates was used, with 3 models run for both dementia and AD.	373 participants developed dementia during the course of the study (6.50 years mean onset), of which 207 were diagnosed with AD (6.23 years mean onset). The variable visiting/visits from friends was associated with reduced risk of all-cause dementia. Further, a higher value on the relationships index (sum of all variables) was associated with reduced risk of all-cause dementia and AD. However, in analyses with delayed entry, restricted to participants with a survival time of 3 years or

	study to refresh the sample.	global cognition, as well as a history of cardiovascular risk factors (e.g., stroke, diabetes).			more, none of the social relationship variables was associated with all-cause dementia or AD.
Yeh & Liu (2003) Influence of social support on cognitive function in the elderly	In this cross-sectional study, 4989 non-demented, community-dwelling adults over the age of 65 from Kaohsiung City, southern Taiwan, were interviewed by registered nurses.	Participants were assessed on whether they had a spouse, whether they lived alone, and if they felt they had a friend they could talk to. Participants were also asked to rate their loneliness (1 = strong, 2 = some, 3 = little). Control variables included age, sex, religion, occupation, education, as well as functional status (defined as score on self-report ADL & IADL measure), depression, and reported health conditions (i.e., Parkinson disease, heart disease, hypertension, chronic lung diseases, Diabetes, and stroke)	The 10-item Short Portable Mental Status Questionnaire (SPMSQ) was used to assess cognitive function through items measuring remote memory, calculations, orientation, and personal history.	Descriptive analysis was used to examine the relationship between cognitive function and demographic measures. Chi-square tests were used on all binary health and demographic measures. The association between social support, cognitive function, and covariates was assessed using multiple linear regression.	Being female, older, or less educated; working as a farmer or in a blue-collar job (compared to white-collar); or reporting IADLs, depression, or vision problems was associated with lower cognitive scores. In terms of social support, having a friend and being married both related significantly to higher cognition scores.

Zahodne, Nowinski, Gershon & Manly (2014). Which psychosocial factors best predict cognitive performance in older adults?	482 community-dwelling participants were recruited from the NIH Toolbox norming study into this cross-sectional study. Participants were between the ages of 55 to 85 and able to understand and complete test instructions. Participants were not excluded for mental disorders or impairments in cognitive function, but were excluded for neurological conditions (e.g., dementia, seizures).	Negative affect, including anger (anger affect, anger hostility, anger physical aggression), anxiety (fear affect, fear somatic arousal), and depression (sadness), and positive psychosocial factors such as well-being (positive affect, life satisfaction, meaning and purpose), social support (emotional support, instrumental support) companionship (friendship, loneliness), and self-efficacy were assessed by the Emotion module of the NIH toolbox. Covariates included age, sex, primary language (Spanish or English), education, illness burden (e.g., diabetes, joint problems), and negative affect.	The Cognition module of NIH toolbox was used to assess several domains of cognition, including executive function, working and episodic memory, and processing speed. Tests completed were List Sorting, the Cognition module include the Flanker test (indicating the direction of an arrow encircled with distraction arrows), the Dimensional Change Card Sort test (DCCS, picking the matching pictures on cards), the Pattern Comparison test (distinguish matching pairs in 90s), and the Picture Sequence Memory test (place	Confirmatory Factor Analysis was used to confirm the conceptual differences between the negative and positive social factors. Structural Equation Modeling was used to investigate the association between the 5 cognitive measures and the 8 social domains. Path analysis tested was used to assess the relationship between all exposures and cognitive function.	Bivariate correlations showed negative affect, except anger affect, was negatively associated with scores on executive function, and processing speed, but not episodic memory. Anger hostility and anger physical aggression were also significant for working memory. Loneliness, emotional support, and self-efficacy were associated with scores on executive function, working memory, and processing speed, but not episodic memory, with loneliness having a negative relationship. Processing speed was also associated with life satisfaction, positive

			pictures in order they were previously shown).		affect, and friendship, which was also significant for working memory. In the structural equation model, meaning and purpose was significantly negatively associated with scores on executive functioning (DCCS and Flanker) and processing speed. Emotional support was significantly positively associated with scores on the DCCS and processing speed, and higher self-efficacy was related to higher scores on the working memory task (list sorting). Education was significantly positively associated with all measures of

					cognitive function except memory.
Zahodne, Watson, Seehra, & Martinez (2017). Positive psychosocial factors and cognition in ethnically diverse older adults	This study uses cross-sectional data from community-dwelling adults over the age of 65 who were recruited into the Washington Heights-Inwood Columbia Aging Project (WHICAP), a longitudinal study. The 548 participants included in this study all lived in northern Manhattan and completed baseline data in 2009 and follow-up 18-24 months later between 2013-2016. It is these follow-up data that are included in this study. Participants were excluded if they had a	The NIH Emotion Module was used to assess positive psychological features, including social support (emotional, instrumental), companionship (friendship, loneliness), self-efficacy, and well-being (life satisfaction, meaning and purpose, positive affect). Covariates included sex, age, education, language of test (English or Spanish), health (hypertension, diabetes, heart disease, stroke), and depressive symptoms (NIH Toolbox Sadness survey). Some participants also had information on school quality, monthly income, acculturation (for	Cognitive functioning was assessed by the WHICAP neuro-psychological battery, which included measures of language (naming, fluency, repetition, verbal abstract reasoning, comprehension) and episodic memory (immediate and delayed recall, recognition), which was tested with the Selective Reminding Test. Visuospatial abilities were tested with the Benton Visual Retention Test, the Rosen Drawing Test, and the Dementia Rating Scale (Identities and Oddities subtest). The NIH Toolbox	ANOVAs, Tukey's honest significant difference tests (continuous) and chi square tests (categorical) were used for descriptive analysis. Multiple-group regression was used to investigate the associations between the psychological variables and the scores on cognitive tests between ethnic groups. .	Not controlling for covariates, white participants scored higher on cognitive tests, and reported higher income and education, and Hispanic participants reported higher levels of social support. In terms of the associations between the exposure and outcome, there were no significant differences between white and black participants. Self-efficacy was associated with greater language skills across all ethnic groups, but the bivariate analysis was not significant for Hispanics. White and Hispanic participants were

	diagnosis of dementia, or if they did not identify as one of the eligible races (Black or African American, Hispanic or Latino, or white).	Spanish speaking participants).	Cognition module was also used to test for executive function (e.g., Flanker Inhibitory Control), working memory (List Sorting), and processing speed (Pattern Comparison).		significantly different on List Sorting for emotional support, friendship, and meaning and purpose. Black and Hispanic participants were significantly different for associations on Flanker (self-efficacy) and List sorting (emotional support). While white and black participants had a positive relationship with emotional support and working memory, Hispanics had a negative association with both emotional support and purpose in life and working memory.
Zhu, Hu, & Efird (2012). Role of social support in	Cross-sectional data were collected from 120 community-dwelling seniors	The Multidimensional Scale of Perceived Social Support (MSPSS) was used to measure social	Cognition was assessed using the 30-item MMSE, which assesses immediate and	The association between social support and cognition was assessed using	Support from friends had the highest average rating for all of the subgroups, while

cognitive function among elders	aged between 60 and 86 living in Shiyan city, Hubei province, China. Having no history of mental health problems, and being able to communicate (speak and write) in Chinese were inclusion criteria for this study.	support. The MSPSS consists of 12 items rated from 1 (very strongly disagree) to 7 (very strongly agree) and assesses 3 dimensions of social support: support from family, friends, or from a significant other. Covariates included age, sex, education, marital status, chronic disease presence, income, and living status.	delayed recall, attention, language, and orientation, with a higher score indicating better cognitive function. A cut-off of 24 was used to distinguish cognitive impairment.	hierarchical linear regression analysis. ·	family support was lowest. Cognitive function was significantly positively associated with education, income, total social support, and family support. In the regression models, age, education, and family support were the best predictors of cognitive function.

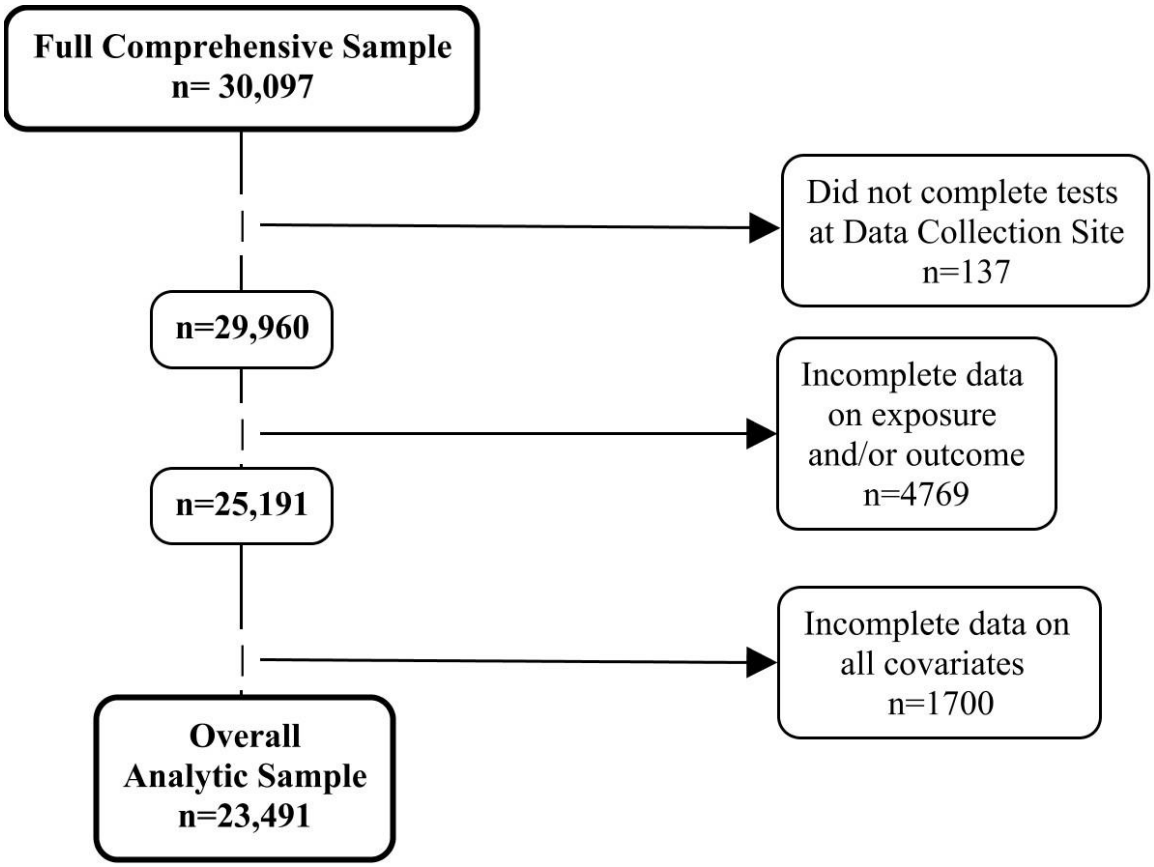
Appendix C: Provincial Response Rates for the Tracking and Comprehensive Cohorts[1]

	Province										
Tracking Cohort	**AB**	**BC**	**MB**	**NB**	**NL**	**NS**	**ON**	**PEI**	**QC**	**SK**	**Canada**
CCHS	0.12	0.11	0.15	0.12	0.11	0.13	0.11	0.13	0.13	0.14	0.12
TS	0.07	0.10	0.09	0.10	0.08	0.02	0.09	0.13	0.13	0.07	0.10
RDD	0.09	0.11	0.10	0.13	0.09	-	0.10	0.13	0.15	0.09	0.11
RTS	0.01	0.01	0.01	0.01	0.01	0.02	0.01	-	0.02	0.01	0.01
HR	-	0.02	0.07	0.05	0.05	0.10	0.04	0.05	-	0.09	0.06
HR1	-	-	0.08	0.07	0.06	0.12	0.04	0.06	-	0.09	0.07
HR2	-	0.02	0.03	0.02	0.01	0.08	-	0.02	-	-	0.03
Overall	0.08	0.09	0.09	0.08	0.07	0.10	0.08	0.09	0.13	0.08	0.09
Comprehensive Cohort	**AB**	**BC**	**MB**	**NB**	**NL**	**NS**	**ON**	**PEI**	**QC**	**SK**	**Canada**
TS	0.11	0.10	0.10	-	0.15	0.12	0.09	-	0.10	-	0.10
RDD	0.11	0.10	0.13	-	0.19	0.16	0.10	-	0.12	-	0.11
RTS	0.01	0.01	0.01	-	0.01	0.01	0.01	-	0.03	-	0.02
HR	-	0.02	0.09	-	0.06	0.14	0.09	-	-	-	0.09
HR1	-	0.02	0.09	-	0.06	0.16	0.09	-	-	-	0.09
HR2	-	-	-	-	-	0.08	-	-	-	-	0.08
Overall	0.11	0.09	0.10	-	0.12	0.13	0.09	-	0.10	-	0.10

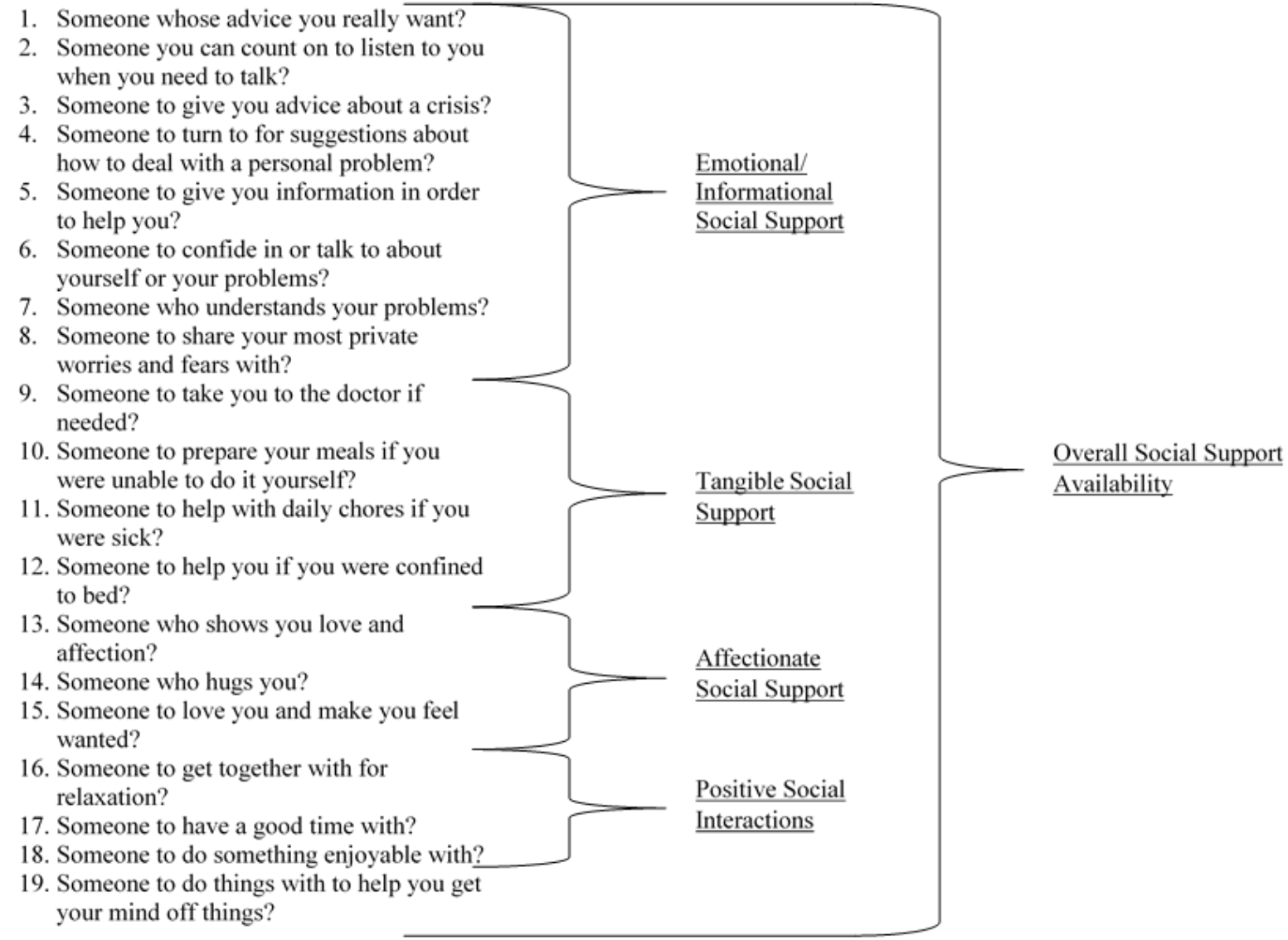
CCHS = Canadian Community Health Survey
TS = Targeted Sampling
RDD = Random Digit Dialing
RTS = Random Targeted Sampling
HR = Provincial Health Registry Mail-outs
HR1 = Initial Health Registry Mail-outs
HR2 = Health Registry Mail-outs Targeting Low-Education Areas

[1]Canadian Longitudinal Study on Aging (2017).

Appendix D: Flowchart of Analytic Sample



Appendix E: Questions on Medical Outcomes Study Social Support Survey (MOS-SSS)[1]



[1]Participants were asked "How often is each of the following kinds of support available to you if you need it?"

Appendix F: Diagnostics of Model Fit in Final Weighted Logistic Regression Models for All Non-Stratified and Sex-Stratified Analyses

	Mann-Whitney			
Final model*	**Area****	**Standard Error**	**95% Wald Confidence Limits**	
Model	0.50	0	0.50	0.50
Overall SSA				
Unstratified	0.81	0.005	0.80	0.81
Women	0.81	0.006	0.80	0.82
Women (Married)	0.80	0.010	0.78	0.82
Women (Unmarried)	0.79	0.009	0.77	0.80
Men (Married)	0.81	0.008	0.79	0.82
Men (Unmarried)	0.79	0.012	0.76	0.81
Tangible SSA				
Unstratified	0.81	0.005	0.80	0.81
Women	0.81	0.006	0.80	0.82
Men	0.81	0.006	0.79	0.82
Affection SSA				
Unstratified	0.81	0.005	0.80	0.81
Women (Pet companionship)	0.79	0.012	0.77	0.81
Women (No pet companionship)	0.81	0.008	0.80	0.83
Men (Pet companionship)	0.82	0.012	0.80	0.84
Men (No pet companionship)	0.79	0.008	0.78	0.81
Emotional/Informational SSA				
Unstratified	0.81	0.005	0.80	0.81
Women	0.81	0.006	0.80	0.82
Women (Unmarried)	0.79	0.009	0.77	0.81
Men (Married)	0.81	0.008	0.79	0.82
Men (Unmarried)	0.79	0.012	0.76	0.81
Positive Social Interactions				
Unstratified	0.81	0.005	0.80	0.81
Women	0.81	0.006	0.80	0.82
Men	0.81	0.006	0.79	0.82

*Regression diagnostics were run on the final model (Model D) for all analyses
**Reflects the area under the receiver operating characteristic curve

Appendix G: Sex-Stratified Result Tables Not Included in Main Text

Table A4: Multivariable Analysis Assessing the Association Between Low Overall SSA and Low Executive Function in Married Females, Canadian Longitudinal Study on Aging, n=7,262

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low overall SSA[2]	**2.56 (1.59-4.09)**	1.71 (0.97-3.01)	1.46 (0.83-2.58)	1.54 (0.87-2.73)
Age group (vs 45–54 years)				
55–64 years		**1.56 (1.11-2.19)**	**1.61 (1.14-2.27)**	**1.61 (1.13-2.29)**
65–74 years		**3.78 (2.68-5.32)**	**4.02 (2.84-5.71)**	**4.01 (2.77-5.80)**
75 years and over		**8.26 (5.74-11.90)**	**8.62 (5.93-12.54)**	**8.55 (5.70-12.83)**
Education (vs less than high school)				
High school graduate		**0.47 (0.31-0.71)**	**0.48 (0.31-0.72)**	**0.47 (0.31-0.71)**
Some post-secondary education		**0.41 (0.26-0.65)**	**0.42 (0.26-0.68)**	**0.41 (0.26-0.66)**
Post-secondary degree/diploma		**0.36 (0.26-0.50)**	**0.38 (0.27-0.53)**	**0.37 (0.26-0.52)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		0.55 (0.27-1.13)	0.67 (0.32-1.38)	0.66 (0.32-1.39)
≥ $50,000 and < $100,000		**0.29 (0.14-0.60)**	**0.39 (0.19-0.81)**	**0.39 (0.18-0.82)**
≥ $100,000		**0.18 (0.09-0.38)**	**0.26 (0.12-0.54)**	**0.26 (0.12-0.55)**
Province (vs Ontario)				
Alberta & Manitoba		1.08 (0.77-1.51)	1.07 (0.77-1.50)	1.07 (0.76-1.49)
British Columbia		**0.69 (0.49-0.97)**	**0.68 (0.48-0.95)**	**0.67 (0.48-0.95)**
Newfoundland and Labrador & Nova Scotia		**1.71 (1.26-2.33)**	**1.71 (1.26-2.33)**	**1.70 (1.25-2.31)**
Quebec		0.78 (0.55-1.09)	0.72 (0.51-1.02)	0.72 (0.51-1.01)
Urban residence (vs rural)		0.86 (0.63-1.18)	0.85 (0.62-1.16)	0.85 (0.62-1.16)

Table A4: Multivariable Analysis Assessing the Association Between Low Overall SSA and Low Executive Function in Married Females, Canadian Longitudinal Study on Aging, n=7,262, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			1.02 (0.79-1.31)	1.02 (0.79-1.32)
Self-rated general health (vs poor/fair)				
Good			**0.67 (0.49-0.94)**	**0.66 (0.48-0.92)**
Very good			**0.40 (0.29-0.56)**	**0.40 (0.28-0.55)**
Excellent			**0.38 (0.25-0.56)**	**0.38 (0.25-0.56)**
Clinical depression (yes vs no)			0.99 (0.75-1.31)	1.00 (0.75-1.33)
Pet for companionship (yes vs. no)				1.00 (0.79-1.27)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				2.02 (0.72-5.66)
Some of the time (1–2 days)				1.96 (0.71-5.45)
Rarely or never (<1 day)				1.77 (0.66-4.75)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table A5: Multivariable Analysis Assessing the Association Between Low Overall SSA and Low Executive Function in Unmarried Females, Canadian Longitudinal Study on Aging, n=4610

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low overall SSA[2]	1.23 (0.96-1.59)	1.07 (0.82-1.41)	0.96 (0.72-1.26)	0.92 (0.69-1.22)
Age group (vs 45–54 years)				
55–64 years		1.37 (0.91-2.06)	1.36 (0.90-2.05)	1.33 (0.88-2.01)
65–74 years		**2.99 (2.05-4.38)**	**3.06 (2.07-4.54)**	**2.97 (2.00-4.42)**
75 years and over		**7.33 (5.03-10.67)**	**7.28 (4.93-10.74)**	**6.96 (4.68-10.35)**
Education (vs less than high school)				
High school graduate		**0.71 (0.50-1.00)**	0.78 (0.55-1.10)	0.79 (0.56-1.12)
Some post-secondary education		**0.38 (0.25-0.58)**	**0.41 (0.26-0.62)**	**0.42 (0.27-0.64)**
Post-secondary degree/diploma		**0.39 (0.29-0.51)**	**0.43 (0.32-0.57)**	**0.44 (0.33-0.58)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		**0.55 (0.43-0.70)**	**0.61 (0.48-0.78)**	**0.61 (0.48-0.78)**
≥ $50,000 and < $100,000		**0.28 (0.21-0.38)**	**0.34 (0.24-0.44)**	**0.33 (0.24-0.44)**
≥ $100,000		**0.20 (0.12-0.35)**	**0.25 (0.15-0.43)**	**0.25 (0.15-0.44)**
Province (vs Ontario)				
Alberta & Manitoba		0.86 (0.64-1.16)	0.88 (0.65-1.20)	0.89 (0.65-1.20)
British Columbia		**0.71 (0.52-0.97)**	**0.72 (0.53-0.98)**	**0.72 (0.53-0.98)**
Newfoundland and Labrador & Nova Scotia		1.04 (0.78-1.38)	1.06 (0.79-1.43)	1.06 (0.79-1.43)
Quebec		**0.53 (0.40-0.72)**	**0.53 (0.39-0.71)**	**0.52 (0.39-0.70)**
Urban residence (vs rural)		0.93 (0.61-1.41)	0.86 (0.56-1.31)	0.85 (0.56-1.29)

Table A5: Multivariable Analysis Assessing the Association Between Low Overall SSA and Low Executive Function in Unmarried Females, Canadian Longitudinal Study on Aging, n=4610, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			**1.39 (1.05-1.84)**	**1.39 (1.05-1.84)**
Self-rated general health (vs poor/fair)				
Good			**0.67 (0.50-0.90)**	**0.68 (0.51-0.91)**
Very good			**0.40 (0.29-0.53)**	**0.40 (0.30-0.54)**
Excellent			**0.36 (0.25-0.53)**	**0.37 (0.26-0.54)**
Clinical depression (yes vs no)			0.88 (0.70-1.11)	0.87 (0.69-1.10)
Pet for companionship (yes vs. no)				0.86 (0.70-1.07)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.69 (0.43-1.12)
Some of the time (1–2 days)				0.69 (0.43-1.10)
Rarely or never (<1 day)				0.68 (0.44-1.06)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table A6: Multivariable Analysis Assessing the Association Between Low Overall SSA and Low Executive Function in Married Males, Canadian Longitudinal Study on Aging, n=9193

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low overall SSA[2]	**2.47 (1.67-3.64)**	**1.91 (1.22-2.98)**	**1.75 (1.13-2.70)**	1.49 (0.93-2.39)
Age group (vs 45–54 years)				
55–64 years		1.13 (0.82-1.56)	1.13 (0.82-1.55)	1.12 (0.82-1.55)
65–74 years		**2.45 (1.80-3.33)**	**2.50 (1.83-3.43)**	**2.48 (1.80-3.43)**
75 years and over		**6.52 (4.79-8.87)**	**6.58 (4.78-9.06)**	**6.40 (4.60-8.89)**
Education (vs less than high school)				
High school graduate		0.75 (0.50-1.14)	0.81 (0.54-1.22)	0.80 (0.53-1.20)
Some post-secondary education		0.67 (0.44-1.02)	0.71 (0.46-1.08)	0.68 (0.44-1.05)
Post-secondary degree/diploma		**0.37 (0.26-0.52)**	**0.41 (0.29-0.57)**	**0.39 (0.28-0.55)**
Annual household income (vs <$20,000)				
≥ $20,000 and < $50,000		**0.44 (0.21-0.94)**	0.48 (0.22-1.03)	0.52 (0.24-1.11)
≥ $50,000 and < $100,000		**0.20 (0.09-0.41)**	**0.22 (0.11-0.47)**	**0.24 (0.12-0.52)**
≥ $100,000 and <$150,000		**0.10 (0.05-0.22)**	**0.12 (0.06-0.27)**	**0.14 (0.06-0.29)**
≥ $150,000		**0.09 (0.04-0.20)**	**0.11 (0.05-0.25)**	**0.13 (0.06-0.28)**
Province (vs Ontario)				
Alberta & Manitoba		1.08 (0.81-1.43)	1.06 (0.80-1.41)	1.05 (0.79-1.40)
British Columbia		**0.74 (0.56-0.99)**	**0.73 (0.55-0.98)**	**0.74 (0.55-0.98)**
Newfoundland and Labrador & Nova Scotia		1.17 (0.90-1.52)	1.13 (0.86-1.47)	1.14 (0.88-1.49)
Quebec		0.77 (0.58-1.03)	0.76 (0.57-1.02)	0.75 (0.56-1.01)
Urban residence (vs rural)		0.80 (0.58-1.10)	0.79 (0.57-1.09)	0.77 (0.56-1.06)

Table A6: Multivariable Analysis Assessing the Association Between Low Overall SSA and Low Executive Function in Married Males, Canadian Longitudinal Study on Aging, n=9193, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			1.13 (0.90-1.43)	1.14 (0.90-1.43)
Self-rated general health (vs poor/fair)				
Good			**0.59 (0.44-0.78)**	**0.59 (0.44-0.79)**
Very good			**0.45 (0.34-0.59)**	**0.46 (0.34-0.61)**
Excellent			**0.38 (0.27-0.53)**	**0.39 (0.28-0.56)**
Clinical depression (yes vs no)			0.83 (0.60-1.13)	0.80 (0.58-1.07)
Pet for companionship (yes vs. no)				**0.81 (0.66-0.99)**
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.49 (0.20-1.22)
Some of the time (1–2 days)				0.56 (0.23-1.33)
Rarely or never (<1 day)				**0.39 (0.17-0.91)**

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table A7: Multivariable Analysis Assessing the Association Between Low Overall SSA and Low Executive Function in Unmarried Males, Canadian Longitudinal Study on Aging, n=2426

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low overall SSA[2]	**1.82 (1.38-2.41)**	1.33 (0.96-1.86)	1.27 (0.91-1.76)	1.22 (0.86-1.72)
Age group (vs 45–54 years)				
55–64 years		**1.97 (1.24-3.12)**	**1.91 (1.20-3.05)**	**1.91 (1.19-3.05)**
65–74 years		**2.40 (1.51-3.83)**	**2.34 (1.44-3.79)**	**2.31 (1.42-3.77)**
75 years and over		**7.69 (4.90-12.06)**	**7.18 (4.43-11.63)**	**7.08 (4.34-11.54)**
Education (vs less than high school)				
High school graduate		**0.53 (0.30-0.94)**	0.57 (0.32-1.03)	0.55 (0.31-1.00)
Some post-secondary education		**0.22 (0.12-0.42)**	**0.24 (0.13-0.44)**	**0.24 (0.13-0.44)**
Post-secondary degree/diploma		**0.27 (0.17-0.42)**	**0.29 (0.19-0.45)**	**0.28 (0.18-0.45)**
Annual household income (vs <$20,000)				
≥ $20,000 and < $50,000		0.92 (0.63-1.34)	0.98 (0.67-1.42)	1.00 (0.68-1.46)
≥ $50,000 and < $100,000		**0.49 (0.32-0.77)**	**0.55 (0.36-0.85)**	**0.56 (0.36-0.87)**
≥ $100,000 and <$150,000		**0.33 (0.15-0.70)**	**0.36 (0.17-0.78)**	**0.37 (0.17-0.80)**
≥ $150,000		**0.26 (0.10-0.69)**	**0.28 (0.11-0.76)**	**0.29 (0.11-0.77)**
Province (vs Ontario)				
Alberta & Manitoba		0.86 (0.54-1.37)	0.88 (0.56-1.40)	0.89 (0.56-1.42)
British Columbia		0.65 (0.41-1.01)	0.65 (0.42-1.02)	0.66 (0.43-1.03)
Newfoundland and Labrador & Nova Scotia		**1.65 (1.03-2.64)**	**1.66 (1.04-2.63)**	**1.64 (1.03-2.60)**
Quebec		0.72 (0.47-1.12)	0.75 (0.48-1.16)	0.74 (0.47-1.14)
Urban residence (vs rural)		1.14 (0.64-2.03)	1.10 (0.62-1.96)	1.06 (0.60-1.90)

Table A7: Multivariable Analysis Assessing the Association Between Low Overall SSA and Low Executive Function in Unmarried Males, Canadian Longitudinal Study on Aging, n=2426, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			0.79 (0.53-1.19)	1.41 (0.96-2.07)
Self-rated general health (vs poor/fair)				
Good			0.79 (0.53-1.19)	0.81 (0.53-1.23)
Very good			0.78 (0.51-1.20)	0.81 (0.53-1.25)
Excellent			**0.54 (0.32-0.92)**	**0.56 (0.33-0.92)**
Clinical depression (yes vs no)			0.99 (0.67-1.46)	0.97 (0.65-1.43)
Pet for companionship (yes vs. no)				0.94 (0.67-1.31)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.67 (0.35-1.30)
Some of the time (1–2 days)				0.77 (0.40-1.48)
Rarely or never (<1 day)				0.68 (0.36-1.29)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table A8: Multivariable Analysis Assessing the Association Between Low Affection SSA and Low Executive Function in Female Pet Owners, Canadian Longitudinal Study on Aging, n=5357

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low affection SSA[2]	**2.43 (1.74-3.39)**	**1.55 (1.07-2.24)**	1.35 (0.94-1.94)	1.47 (0.99-2.17)
Age group (vs 45–54 years)				
55–64 years		**1.92 (1.36-2.72)**	1.95 (1.37-2.78)	**1.95 (1.37-2.77)**
65–74 years		**4.12 (2.90-5.87)**	**4.33 (3.02-6.23)**	**4.27 (2.97-6.14)**
75 years and over		**9.30 (6.35-13.63)**	**10.05 (6.75-14.96)**	**9.92 (6.52-15.10)**
Education (vs less than high school)				
High school graduate		0.66 (0.42-1.04)	0.67 (0.42-1.07)	0.69 (0.43-1.09)
Some post-secondary education		**0.57 (0.35-0.95)**	0.61 (0.36-1.03)	0.63 (0.38-1.07)
Post-secondary degree/diploma		**0.39 (0.27-0.57)**	**0.43 (0.29-0.63)**	**0.45 (0.30-0.66)**
Annual household income (vs <$20,000)				
≥ $20,000 and < $50,000		**0.53 (0.36-0.77)**	**0.58 (0.39-0.84)**	**0.52 (0.35-0.78)**
≥ $50,000 and < $100,000		**0.37 (0.25-0.54)**	**0.43 (0.29-0.63)**	**0.36 (0.24-0.56)**
≥ $100,000 and <$150,000		**0.23 (0.14-0.37)**	**0.29 (0.18-0.47)**	**0.23 (0.14-0.39)**
Province (vs Ontario)				
Alberta & Manitoba		1.13 (0.78-1.64)	1.15 (0.80-1.67)	1.15 (0.79-1.68)
British Columbia		0.70 (0.49-1.02)	0.72 (0.49-1.04)	0.71 (0.49-1.03)
Newfoundland and Labrador & Nova Scotia		1.35 (0.96-1.91)	1.38 (0.97-1.96)	1.37 (0.97-1.94)
Quebec		0.77 (0.53-1.12)	0.78 (0.54-1.14)	0.78 (0.53-1.14)
Urban residence (vs rural)		0.86 (0.59-1.25)	0.83 (0.57-1.22)	0.87 (0.59-1.28)

Table A8: Multivariable Analysis Assessing the Association Between Low Affection SSA and Low Executive Function in Female Pet Owners, Canadian Longitudinal Study on Aging, n=5357, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			1.09 (0.81-1.48)	1.10 (0.81-1.49)
Self-rated general health (vs poor)				
Fair			0.89 (0.44-1.80)	0.91 (0.45-1.82)
Good			0.53 (0.28-1.00)	0.53 (0.28-1.01)
Very good			**0.31 (0.16-0.59)**	**0.31 (0.16-0.60)**
Excellent			**0.34 (0.17-0.69)**	**0.35 (0.17-0.70)**
Clinical depression (yes vs no)			0.88 (0.67-1.15)	0.91 (0.69-1.19)
Marital status (vs single)				
Married/common-law				1.09 (0.68-1.76)
Widowed				1.04 (0.62-1.74)
Divorced/separated				0.74 (0.45-1.20)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.96 (0.48-1.91)
Some of the time (1–2 days)				1.07 (0.54-2.11)
Rarely or never (<1 day)				1.20 (0.64-2.26)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table A9: Multivariable Analysis Assessing the Association Between Low Affection SSA and Low Executive Function in Females without Pets, Canadian Longitudinal Study on Aging, n=6515

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low affection SSA[2]	**1.88 (1.45-2.43)**	1.26 (0.93-1.69)	1.13 (0.83-1.53)	1.18 (0.86-1.62)
Age group (vs 45–54 years)				
55–64 years		1.10 (0.73-1.65)	1.10 (0.73-1.66)	1.08 (0.71-1.63)
65–74 years		**2.81 (1.90-4.15)**	**2.88 (1.94-4.29)**	**2.73 (1.81-4.10)**
75 years and over		**6.32 (4.28-9.34)**	**6.25 (4.20-9.30)**	**5.64 (3.74-8.52)**
Education (vs less than high school)				
High school graduate		**0.50 (0.36-0.70)**	**0.54 (0.38-0.75)**	**0.54 (0.39-0.76)**
Some post-secondary education		**0.30 (0.20-0.45)**	**0.31 (0.21-0.47)**	**0.32 (0.21-0.49)**
Post-secondary degree/diploma		**0.34 (0.26-0.45)**	**0.37 (0.28-0.49)**	**0.38 (0.29-0.51)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		**0.66 (0.50-0.86)**	**0.72 (0.55-0.95)**	**0.68 (0.51-0.91)**
≥ $50,000 and < $100,000		**0.31 (0.23-0.42)**	**0.37 (0.27-0.50)**	**0.34 (0.24-0.47)**
≥ $100,000 and <$150,000		**0.20 (0.13-0.29)**	**0.25 (0.17-0.37)**	**0.22 (0.15-0.35)**
Province (vs Ontario)				
Alberta & Manitoba		0.90 (0.68-1.20)	0.90 (0.67-1.20)	0.90 (0.68-1.21)
British Columbia		**0.72 (0.54-0.96)**	**0.69 (0.52-0.93)**	**0.70 (0.52-0.94)**
Newfoundland and Labrador & Nova Scotia		**1.46 (1.11-1.93)**	**1.46 (1.10-1.94)**	**1.46 (1.10-1.93)**
Quebec		**0.60 (0.45-0.80)**	**0.55 (0.41-0.73)**	**0.55 (0.41-0.75)**
Urban residence (vs rural)		0.85 (0.60-1.19)	0.83 (0.58-1.17)	0.84 (0.59-1.19)

Table A9: Multivariable Analysis Assessing the Association Between Low Affection SSA and Low Executive Function in Females without Pets, Canadian Longitudinal Study on Aging, n=6515, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			1.18 (0.92-1.51)	1.17 (0.91-1.51)
Self-rated general health (vs poor)				
Fair			0.86 (0.45-1.67)	0.85 (0.44-1.64)
Good			0.67 (0.36-1.25)	0.66 (0.35-1.24)
Very good			**0.39 (0.21-0.74)**	**0.39 (0.21-0.74)**
Excellent			**0.33 (0.17-0.63)**	**0.33 (0.17-0.64)**
Clinical depression (yes vs no)			0.98 (0.76-1.26)	0.97 (0.75-1.26)
Marital status (vs single)				
Married/common-law				**1.56 (1.10-2.23)**
Widowed				**1.77 (1.24-2.54)**
Divorced/separated				1.27 (0.88-1.83)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				1.04 (0.58-1.84)
Some of the time (1–2 days)				0.98 (0.57-1.71)
Rarely or never (<1 day)				0.87 (0.51-1.48)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table A10: Multivariable Analysis Assessing the Association Between Low Affection SSA and Low Executive Function in Male Pet Owners, Canadian Longitudinal Study on Aging, n=4756

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low affection SSA[2]	**3.31 (2.30-4.76)**	**1.80 (1.16-2.79)**	**1.73 (1.11-2.70)**	1.51 (0.94-2.43)
Age group (vs 45–54 years)				
55–64 years		1.11 (0.75-1.65)	1.12 (0.76-1.65)	1.14 (0.77-1.70)
65–74 years		**2.76 (1.86-4.11)**	**2.90 (1.95-4.32)**	**3.04 (2.01-4.58)**
75 years and over		**5.57 (3.61-8.59)**	**5.78 (3.70-9.03)**	**6.23 (3.91-9.94)**
Education (vs less than high school)				
High school graduate		0.66 (0.37-1.16)	0.69 (0.39-1.22)	0.68 (0.38-1.20)
Some post-secondary education		0.69 (0.38-1.26)	0.76 (0.42-1.38)	0.76 (0.42-1.39)
Post-secondary degree/diploma		**0.31 (0.19-0.50)**	**0.34 (0.21-0.54)**	**0.33 (0.21-0.54)**
Annual household income (vs <$20,000)				
≥ $20,000 and < $50,000		0.80 (0.44-1.46)	0.89 (0.49-1.64)	0.93 (0.48-1.82)
≥ $50,000 and < $100,000		**0.37 (0.20-0.68)**	**0.45 (0.25-0.83)**	**0.48 (0.24-0.96)**
≥ $100,000 and <$150,000		**0.19 (0.10-0.35)**	**0.25 (0.13-0.47)**	**0.26 (0.12-0.56)**
Province (vs Ontario)				
Alberta & Manitoba		0.82 (0.53-1.29)	0.83 (0.53-1.29)	0.82 (0.52-1.29)
British Columbia		0.66 (0.44-1.01)	0.65 (0.43-0.99)	**0.64 (0.42-0.98)**
Newfoundland and Labrador & Nova Scotia		1.15 (0.77-1.70)	1.11 (0.74-1.66)	1.10 (0.74-1.64)
Quebec		0.75 (0.49-1.15)	0.75 (0.49-1.16)	0.73 (0.47-1.13)
Urban residence (vs rural)		0.98 (0.65-1.47)	0.97 (0.64-1.47)	0.95 (0.62-1.44)

Table A10: Multivariable Analysis Assessing the Association Between Low Affection SSA and Low Executive Function in Male Pet Owners, Canadian Longitudinal Study on Aging, n=4756, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			1.08 (0.77-1.54)	1.08 (0.76-1.53)
Self-rated general health (vs poor)				
Fair			0.57 (0.26-1.22)	0.57 (0.26-1.26)
Good			**0.32 (0.15-0.67)**	**0.33 (0.15-0.70)**
Very good			**0.24 (0.11-0.50)**	**0.24 (0.11-0.53)**
Excellent			**0.17 (0.08-0.41)**	**0.18 (0.08-0.44)**
Clinical depression (yes vs no)			0.73 (0.47-1.12)	0.70 (0.45-1.07)
Marital status (vs single)				
Married/common-law				0.76 (0.40-1.46)
Widowed				0.68 (0.31-1.51)
Divorced/separated				0.54 (0.26-1.11)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.74 (0.26-2.10)
Some of the time (1–2 days)				0.84 (0.31-2.23)
Rarely or never (<1 day)				0.58 (0.22-1.52)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table A11: Multivariable Analysis Assessing the Association Between Low Affection SSA and Low Executive Function in Males without Pets, Canadian Longitudinal Study on Aging, n=6863

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low affection SSA[2]	**1.60 (1.26-2.04)**	1.09 (0.82-1.44)	1.01 (0.77-1.34)	0.95 (0.69-1.31)
Age group (vs 45–54 years)				
55–64 years		1.40 (0.98-1.99)	1.36 (0.95-1.95)	1.36 (0.95-1.95)
65–74 years		**2.16 (1.52-3.06)**	**2.10 (1.46-3.02)**	**2.10 (1.46-3.03)**
75 years and over		**6.68 (4.77-9.37)**	**6.30 (4.39-9.05)**	**6.12 (4.25-8.83)**
Education (vs less than high school)				
High school graduate		0.67 (0.44-1.01)	0.72 (0.47-1.08)	0.73 (0.48-1.09)
Some post-secondary education		**0.38 (0.25-0.58)**	**0.39 (0.26-0.60)**	**0.40 (0.26-0.61)**
Post-secondary degree/diploma		**0.34 (0.25-0.46)**	**0.37 (0.27-0.50)**	**0.37 (0.27-0.51)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		**0.76 (0.51-1.14)**	0.82 (0.54-1.23)	0.83 (0.53-1.29)
≥ $50,000 and < $100,000		**0.35 (0.23-0.53)**	**0.39 (0.26-0.58)**	**0.39 (0.25-0.61)**
≥ $100,000 and <$150,000		**0.18 (0.12-0.28)**	**0.21 (0.13-0.32)**	**0.21 (0.12-0.34)**
Province (vs Ontario)				
Alberta & Manitoba		1.16 (0.87-1.55)	1.16 (0.87-1.55)	1.16 (0.87-1.56)
British Columbia		0.75 (0.56-1.01)	0.75 (0.56-1.01)	0.76 (0.57-1.03)
Newfoundland and Labrador & Nova Scotia		**1.32 (1.00-1.75)**	1.29 (0.98-1.70)	1.30 (0.98-1.72)
Quebec		0.77 (0.57-1.03)	0.77 (0.57-1.03)	0.77 (0.57-1.03)
Urban residence (vs rural)		0.76 (0.51-1.12)	0.76 (0.51-1.13)	0.76 (0.51-1.12)

Table A11: Multivariable Analysis Assessing the Association Between Low Affection SSA and Low Executive Function in Males without Pets, Canadian Longitudinal Study on Aging, n=6863, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			1.27 (0.99-1.62)	1.26 (0.99-1.61)
Self-rated general health (vs poor)				
Fair			1.14 (0.59-2.20)	1.19 (0.62-2.30)
Good			0.82 (0.44-1.55)	0.88 (0.47-1.65)
Very good			0.68 (0.36-1.29)	0.74 (0.39-1.40)
Excellent			0.58 (0.30-1.11)	0.63 (0.33-1.22)
Clinical depression (yes vs no)			0.95 (0.69-1.29)	0.92 (0.68-1.24)
Marital status (vs single)				
Married/common-law				1.19 (0.77-1.82)
Widowed				1.49 (0.93-2.36)
Divorced/separated				0.93 (0.61-1.41)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				**0.49 (0.25-0.95)**
Some of the time (1–2 days)				0.56 (0.29-1.10)
Rarely or never (<1 day)				**0.44 (0.23-0.83)**

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table A12: Multivariable Analysis Assessing the Association Between Low Emotional/Informational SSA and Low Executive Function in Unmarried Females, Canadian Longitudinal Study on Aging, n=4610

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low emotional/informational SSA[2]	1.25 (0.97-1.60)	0.96 (0.73-1.26)	0.88 (0.67-1.16)	0.84 (0.64-1.12)
Age group (vs 45–54 years)				
55–64 years		1.37 (0.91-2.06)	1.36 (0.90-2.05)	1.33 (0.88-2.01)
65–74 years		**2.99 (2.04-4.37)**	**3.07 (2.07-4.54)**	**2.97 (2.00-4.42)**
75 years and over		**7.33 (5.03-10.67)**	**7.31 (4.95-10.78)**	**6.99 (4.70-10.39)**
Education (vs less than high school)				
High school graduate		**0.71 (0.50-1.00)**	0.78 (0.55-1.10)	0.80 (0.56-1.13)
Some post-secondary education		**0.38 (0.25-0.58)**	**0.41 (0.26-0.63)**	**0.42 (0.27-0.64)**
Post-secondary degree/diploma		**0.39 (0.29-0.51)**	**0.43 (0.32-0.57)**	**0.44 (0.33-0.58)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		**0.54 (0.43-0.69)**	**0.61 (0.48-0.78)**	**0.61 (0.48-0.78)**
≥ $50,000 and < $100,000		**0.28 (0.20-0.37)**	**0.32 (0.24-0.44)**	**0.32 (0.24-0.44)**
≥ $100,000		**0.20 (0.12-0.34)**	**0.25 (0.15-0.43)**	**0.25 (0.15-0.43)**
Province (vs Ontario)				
Alberta & Manitoba		0.86 (0.63-1.16)	0.88 (0.65-1.19)	0.88 (0.64-1.19)
British Columbia		**0.71 (0.52-0.97)**	**0.72 (0.53-0.97)**	**0.72 (0.52-0.98)**
Newfoundland and Labrador & Nova Scotia		1.03 (0.77-1.37)	1.06 (0.79-1.42)	1.06 (0.79-1.42)
Quebec		**0.53 (0.40-0.71)**	**0.52 (0.39-0.70)**	**0.52 (0.38-0.70)**
Urban residence (vs rural)		0.93 (0.61-1.41)	0.86 (0.56-1.31)	0.85 (0.55-1.29)

Table A12: Multivariable Analysis Assessing the Association Between Low Emotional/Informational SSA and Low Executive Function in Unmarried Females, Canadian Longitudinal Study on Aging, n=4610, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			**1.39 (1.05-1.84)**	**1.39 (1.05-1.85)**
Self-rated general health (vs poor/fair)				
Good			**0.67 (0.50-0.90)**	**0.68 (0.51-0.91)**
Very good			**0.39 (0.29-0.53)**	**0.40 (0.30-0.54)**
Excellent			**0.36 (0.25-0.52)**	**0.37 (0.26-0.54)**
Clinical depression (yes vs no)			0.88 (0.70-1.11)	0.87 (0.69-1.10)
Pet for companionship (yes vs. no)				0.86 (0.70-1.06)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.68 (0.42-1.10)
Some of the time (1–2 days)				0.68 (0.43-1.09)
Rarely or never (<1 day)				0.67 (0.43-1.04)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table A13: Multivariable Analysis Assessing the Association Between Low Emotional/Informational SSA and Low Executive Function in Married Males, Canadian Longitudinal Study on Aging, n=9193

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low emotional/informational SSA[2]	**1.78 (1.34-2.37)**	**1.44 (1.05-1.99)**	1.31 (0.96-1.80)	1.18 (0.85-1.64)
Age group (vs 45–54 years)				
55–64 years		1.14 (0.83-1.56)	1.13 (0.82-1.55)	1.13 (0.82-1.55)
65–74 years		**2.45 (1.80-3.34)**	**2.50 (1.83-3.43)**	**2.49 (1.81-3.43)**
75 years and over		**6.57 (4.83-8.92)**	**6.61 (4.81-9.09)**	**6.43 (4.63-8.93)**
Education (vs less than high school)				
High school graduate		0.75 (0.50-1.13)	0.81 (0.53-1.22)	0.80 (0.53-1.20)
Some post-secondary education		0.66 (0.43-1.01)	0.70 (0.45-1.07)	0.68 (0.44-1.04)
Post-secondary degree/diploma		**0.37 (0.26-0.51)**	**0.40 (0.29-0.57)**	**0.39 (0.28-0.55)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		**0.42 (0.20-0.90)**	**0.46 (0.22-0.98)**	0.50 (0.24-1.07)
≥ $50,000 and < $100,000		**0.19 (0.09-0.39)**	**0.21 (0.10-0.45)**	**0.24 (0.11-0.50)**
≥ $100,000		**0.09 (0.05-0.20)**	**0.11 (0.05-0.24)**	**0.13 (0.06-0.27)**
Province (vs Ontario)				
Alberta & Manitoba		1.08 (0.81-1.43)	1.06 (0.80-1.41)	1.05 (0.79-1.40)
British Columbia		**0.74 (0.56-0.99)**	**0.74 (0.55-0.98)**	**0.74 (0.55-0.98)**
Newfoundland and Labrador & Nova Scotia		1.17 (0.90-1.52)	1.12 (0.86-1.46)	1.14 (0.87-1.49)
Quebec		0.77 (0.58-1.03)	0.76 (0.57-1.01)	0.75 (0.56-1.00)
Urban residence (vs rural)		0.80 (0.58-1.10)	0.79 (0.57-1.09)	0.77 (0.56-1.07)

Table A13: Multivariable Analysis Assessing the Association Between Low Emotional/Informational SSA and Low Executive Function in Married Males, Canadian Longitudinal Study on Aging, n=9193, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			1.13 (0.90-1.43)	1.14 (0.90-1.43)
Self-rated general health (vs poor/fair)				
Good			**0.59 (0.44-0.78)**	**0.59 (0.44-0.79)**
Very good			**0.45 (0.33-0.59)**	**0.45 (0.34-0.61)**
Excellent			**0.38 (0.27-0.53)**	**0.39 (0.28-0.56)**
Clinical depression (yes vs no)			0.83 (0.60-1.14)	0.79 (0.58-1.07)
Pet for companionship (yes vs. no)				**0.81 (0.66-0.99)**
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.46 (0.19-1.14)
Some of the time (1–2 days)				0.53 (0.22-1.25)
Rarely or never, <1 day				**0.37 (0.16-0.84)**

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table A14: Multivariable Analysis Assessing the Association Between Low Emotional/Informational SSA and Low Executive Function in Unmarried Males, Canadian Longitudinal Study on Aging, n=2426

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Low emotional/informational SSA[2]	**2.00 (1.52-2.64)**	**1.41 (1.03-1.93)**	1.35 (0.98-1.85)	1.31 (0.95-1.82)
Age group (vs 45–54 years)				
55–64 years		**1.95 (1.23-3.09)**	**1.89 (1.18-3.03)**	**1.89 (1.18-3.03)**
65–74 years		**2.35 (1.48-3.74)**	**2.30 (1.42-3.72)**	**2.28 (1.40-3.70)**
75 years and over		**7.51 (4.79-11.77)**	**7.03 (4.34-11.39)**	**6.93 (4.25-11.31)**
Education (vs less than high school)				
High school graduate		**0.53 (0.29-0.94)**	0.58 (0.32-1.03)	0.56 (0.31-1.01)
Some post-secondary education		**0.22 (0.12-0.42)**	**0.24 (0.13-0.45)**	**0.24 (0.13-0.44)**
Post-secondary degree/diploma		**0.26 (0.17-0.42)**	**0.29 (0.19-0.46)**	**0.28 (0.18-0.45)**
Annual household income (vs < $20,000)				
≥ $20,000 and < $50,000		0.91 (0.62-1.32)	0.97 (0.67-1.41)	0.99 (0.68-1.45)
≥ $50,000 and < $100,000		**0.49 (0.32-0.75)**	**0.55 (0.36-0.84)**	**0.56 (0.37-0.86)**
≥ $100,000		**0.31 (0.16-0.58)**	**0.34 (0.18-0.64)**	**0.34 (0.18-0.66)**
Province (vs Ontario)				
Alberta & Manitoba		0.87 (0.55-1.39)	0.90 (0.57-1.43)	0.90 (0.57-1.44)
British Columbia		0.65 (0.42-1.02)	0.66 (0.42-1.02)	0.67 (0.43-1.04)
Newfoundland and Labrador & Nova Scotia		**1.67 (1.05-2.66)**	**1.67 (1.06-2.65)**	**1.66 (1.05-2.63)**
Quebec		0.73 (0.47-1.12)	0.75 (0.49-1.16)	0.74 (0.48-1.15)
Urban residence (vs rural)		1.13 (0.63-2.01)	1.09 (0.61-1.95)	1.06 (0.59-1.89)

Table A14: Multivariable Analysis Assessing the Association Between Low Emotional/Informational SSA and Low Executive Function in Unmarried Males, Canadian Longitudinal Study on Aging, n=2426, Continued

	Low Executive Function[1]			
	Model a OR (95% CI)	**Model b OR (95% CI)**	**Model c OR (95% CI)**	**Model d OR (95% CI)**
Chronic diseases (yes vs no)			1.42 (0.97-2.08)	1.41 (0.96-2.08)
Self-rated general health (vs poor/fair)				
Good			0.79 (0.53-1.19)	0.81 (0.53-1.22)
Very good			0.78 (0.51-1.20)	0.81 (0.53-1.25)
Excellent			**0.55 (0.32-0.93)**	**0.57 (0.33-0.97)**
Clinical depression (yes vs no)			0.99 (0.67-1.46)	0.97 (0.66-1.43)
Pet for companionship (yes vs. no)				0.93 (0.67-1.30)
Loneliness (vs 5–7 days/week)				
Occasionally (3–4 days)				0.67 (0.35-1.30)
Some of the time (1–2 days)				0.77 (0.40-1.49)
Rarely or never, <1 day				0.68 (0.36-1.29)

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability

Table A15: Multivariable Analysis Assessing the Association Between Low Emotional/ Informational SSA and Low Executive Function in Married Females Who Report Loneliness, n=1442

	Low Executive Function[1]		
	OR (95% CI)		**OR (95% CI)**
Low emotional/informational SSA[2]	**2.17 (1.17-4.02)**	*Urban residence (vs rural)*	1.10 (0.51-2.34)
Age group (vs 45–54 years)		*Chronic disease (yes vs no)*	1.38 (0.78-2.47)
55–64 years	1.15 (0.58-2.28)	*Self-rated general health (vs poor/fair)*	
65–74 years	**2.90 (1.44-5.83)**	Good	0.57 (0.30-1.07)
75 years and over	**8.76 (4.09-18.76)**	Very good	**0.42 (0.21-0.82)**
Education (vs less than high school)		Excellent	0.61 (0.26-1.44)
High school graduate	0.51 (0.21-1.21)	*Clinical depression (yes vs no)*	0.96 (0.56-1.65)
Some post-secondary education	0.43 (0.17-1.12)	*Pet for companionship (yes vs. no)*	0.70 (0.43-1.15)
Post-secondary degree/diploma	**0.31 (0.15-0.65)**		
Annual household income (vs < $20,000)			
≥ $20,000 and < $50,000	1.07 (0.31-3.70)		
≥ $50,000 and < $100,000	0.84 (0.24-2.92)		
≥ $100,000	0.49 (0.13-1.88)		
Province (vs Ontario)			
Alberta & Manitoba	1.10 (0.53-2.28)		
British Columbia	0.80 (0.39-1.66)		
Newfoundland and Labrador & Nova Scotia	**2.86 (1.45-5.61)**		
Quebec	0.86 (0.41-1.77)		

[1] Low executive function was defined as a score ≥1.5 SD below the mean of the cognitively healthy sample.
[2] Low SSA was defined as an average score of ≤3.
Statistically significant values are **bolded** ($p<0.05$)
Abbreviations: CI = confidence interval; **OR** = odds ratio; **SSA** = social support availability