The Association Between Depressive Symptoms 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

Populations around the world are aging at a rapid pace, presenting new challenges for health services. This is because older adults encounter a different set of challenges than younger age groups, such as an increase in the proportion of the population at risk for age-related cognitive decline. As cognitive function is one of the most commonly referenced indicators of health because it is necessary for everyday functioning and adaptation to change, and studying factors that influence cognitive function is important. To date, most of the factors associated with cognitive decline are determined in early life, or develop across the lifespan. However, there may be some factors that can be altered at any point of the lifespan, including later life.

Depressive symptoms have been previously examined as a potential area of intervention because they have been shown to be positively associated with many health outcomes in later life, including cognitive function. While the relationship between major depression and cognitive function has been investigated, much of the research focuses on older adults and global cognitive impairment. As such, the relationship between depressive symptoms and specific domains of cognitive function, such as executive function, is not well understood.

This study used baseline cross-sectional data from the Comprehensive cohort of the Canadian Longitudinal Study on Aging (CLSA). The CLSA is an ongoing prospective cohort study of community-dwelling adults who were between 45 to 85 years of age at recruitment. The 30,097 participants in the Comprehensive cohort lived within 25–50 km of 1 of 11 Data Collection Sites across seven provinces. Depressive symptoms were measured using the Center for Epidemiological Studies Short Depression Scale. A neuropsychological battery was used to assess executive function, a key domain of cognitive function required for purposeful decision making, planning, and behaviour. Bivariate and multivariable logistic regression were used to

examine the association between depressive symptoms and executive function. This study builds on previous research that has largely focused on the association between major depression and global cognitive impairment.

Specific aims of the current study were to examine whether the presence of depressive symptoms was associated with low executive function after stratifying by age group and sex, and adjusting for confounders (i.e., province, education, household income, urban/rural residence, self-rated general health, chronic conditions, medication for depression, marital status, social support availability, smoking status, and alcohol use). In descriptive analyses, the prevalence of depressive symptoms was found to be highest among those 45–54 years compared to other age groups, and higher in females compared to males. The prevalence of low executive function was highest among those 75 years and over compared to other age groups and was approximately equal among males and females.

In multivariable analyses, depressive symptoms were associated with low executive function overall. As social support availability (SSA) was identified as an effect modifier, those with higher SSA who reported depressive symptoms had significantly greater odds of low executive function compared to those who did not report depressive symptoms. In contrast, those with low SSA who reported depressive symptoms had lower odds of low executive function, although this finding was not significant. When stratified by age group, those 45–54 years, 55–64 years, and 75 years and over with higher SSA had significantly greater odds of low executive function when reporting depressive symptoms compared to not. A positive association between depressive symptoms and low executive function was found in those 65–74 years, although this finding was not significant. The direction of the association in those 75 years and over with low SSA was reversed, where reporting depressive symptoms was associated with lower odds of low

executive function compared to not reporting depressive symptoms. In males, both current and former/never drinkers had significantly greater odds of low executive function when reporting depressive symptoms compared to not. In females, those with higher SSA and depressive symptoms had significantly greater odds of low executive function, whereas those with low SSA and depressive symptoms had lower odds of low executive function, although this was not significant.

Findings from this study add to existing evidence that psychosocial factors are important to the health of middle-aged and older adults, and that depressive symptoms are associated with specific domains of cognitive function. Overall, the presence of depressive symptoms appears to negatively affects cognitive function, and that the association differs by age group and sex. As well, SSA may be another important psychosocial factor closely linked with depressive symptoms and cognitive function. Future work should examine the longitudinal association between depressive symptoms and executive function, and investigate whether this longitudinal association differs by age, sex, and SSA.

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List of Abbreviations

AD	Alzheimer's Disease
AFT	Animal Fluency Test
APOE	Apolipoprotein E
BDNF	Brain-Derived Neurotrophic Factor
CA	Census Agglomeration
CCHS	Canadian Community Health Survey
CES-D10	Center for Epidemiological Studies Short Depression Scale
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 Sites
DSM-5	Diagnostic 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
LLD	Late-life Depression
MAT	Mental Alternation Test
MCI	Mild Cognitive Impairment
MOS-SSS	Medical Outcomes Study-Social Support Survey
NuAge	Quebec Longitudinal Study on Nutrition and Aging
OR	Odds Ratio
ORE	Office of Research Ethics
PFC	Prefrontal Cortex
RDD	Random Digit Dialing
RTS	Random Telephone Sampling
SES	Socioeconomic Status
SSA	Social Support Availability
Stroop	Stroop Neurological Screening Test, Victoria Version
TMT	Time-Based Prospective Memory Test
TS	Targeted Sampling
VIF	Variance Inflation Factor

1.0 Introduction

Populations around the world are aging at a rapid pace. Today, 13% of the global population is 60 years and older. By 2020, for the first time in history, the proportion of older adults will outnumber children younger than five (He, Goodkind, Kowal, & U.S. Census Bureau, 2016; World Health Organization, 2017). By 2050, the proportion of older adults will contribute to 22% (two billion) of the global population (World Health Organization, 2015). The population aging observed at the global level is also reflected at the national level. In Canada, 17% of the population is currently 65 years or older, and this proportion is expected to increase to 25% by 2036 (Canadian Institute for Health Information, 2011; Statistics Canada, 2019). These demographic transitions, driven by a decrease in fertility rates and an increase in life expectancy, present new challenges to social and health services, as an older population has different needs than a younger one. Now more than ever, it is crucial that research be conducted to examine ways to promote healthy aging.

In general, living longer provides opportunities that are beneficial to the individual and society. For example, older adults contribute to society as mentors, caregivers, consumers, and members of the workforce (World Health Organization, 2017). In turn, this engagement may reinforce the health and well-being of the individual. However, the extent to which these opportunities are beneficial is dependent on the health of the older population. If the increase in life expectancy is marked by substantial declines in physical and mental abilities, then the consequences of aging are more negative than positive, at both the individual and population level (World Health Organization, 2017). Declines in physical function may result in reduced functional independence for the individual, as well as an increased demand for health services. In

contrast, high cognitive and physical function, low probability of disability and disease, and active engagement and participation in life may promote better health (Rowe & Kahn, 1997).

Cognitive function is one of the most commonly referenced indicators of health because it is necessary for everyday functioning and adaptation to change (Meyers, 2012; Murman, 2015; Rowe & Kahn, 1997). While some changes in cognitive function are expected in later life, some individuals experience declines in cognitive function that are not part of the normal aging process. For example, mild cognitive impairment is a condition characterized by problems in memory or thinking that are greater than the changes normally expected with aging. Although these changes are not severe enough to interfere with activities of daily living and functional independence, having MCI may increase the risk of developing dementia (Alzheimer's Society of Canada, 2018). Dementia, a chronic and progressive condition, can affect an individual's memory, thinking, orientation, comprehension, learning capacity, and judgement (World Health Organization, 2012). Worldwide, it is estimated that 5–8% of people 60 years and older are living with dementia (World Health Organization, 2015). In Canada, the prevalence of dementia in people 65 years and older doubles every five years, from 1% for those ages 65–69, to 25% for those 85 years and older (Canadian Institute for Health Information, 2018). There are also differential effects between sexes, both nationally and globally. Overall, dementia is more prevalent in females than males, and this difference increases with age (Canadian Institute for Health Information, 2018).

Declines in overall cognitive function, as well as declines in specific domains of cognitive function, are also important indicators of health for middle-aged and older adults. For example, declines in executive function, a key domain of cognitive function responsible for controlling behaviour, planning, and purposeful decision making, can negatively affect

functional independence and reduce the ability of an individual to perform activities of daily living (Diamond, 2014).

While overall trends suggest that population aging is associated with increases in the proportion of individuals at risk for age-related cognitive decline, there are still variations in how certain populations, or individuals, experience aging (World Health Organization, 2015). In general, the variation may be attributed to differences in genetics, demographic factors, health factors, social factors, and health behaviours. It is likely that these factors are not mutually exclusive. Therefore, a better understanding of which factors allow some individuals to reach older age without functional declines, while others experience declines by midlife, is key to alleviating the demand on social and health services, and to promoting more sustainable population aging.

While there are a number of modifiable factors that are associated with MCI, dementias, and cognitive function in specific domains, many of these factors require early intervention, long before symptoms of cognitive decline develop. This means that for a proportion of the population, it may be too late to intervene. Although primary prevention is important, secondary and tertiary prevention methods should be available for those with greater risk for cognitive decline, or who have already begun to show symptoms of cognitive decline.

One possible factor that is modifiable across the lifespan is mental health, and in particular, depressive symptoms. Depression is a common mood disorder that affects more than 300 million people worldwide. It is the leading cause of disability and contributes to a large portion of the global disease burden (World Health Organization, 2018). In Canada, 11.3% of adults reported experiencing depressive symptoms that met criteria for clinical depression at some point in their lifetime. Adults 65 years and older contributed to the highest proportion of

the population who reported subclinical symptoms of depression (Public Health Agency of Canada, 2016). As both depression and dementia are common disorders in the older population, past research has heavily focused on the association between depression and global cognitive impairment. However, the association between depressive symptoms and specific cognitive domains, such as executive function, is not well understood. In addition, depressive symptoms are often underreported in the older adult population and cannot be as readily captured without a substantial investment of time and resources. Due to these limitations, the possible modifying effects of age and sex on the association between depressive symptoms and domain-specific cognitive function have not been explored either, although depressive symptoms have been described to affect age groups, as well as males and females, differently.

The purpose of this study was to examine the association between depressive symptoms and executive function, a key domain of cognitive function, and to explore how this association is impacted by factors, such as age and sex. The first objective was to examine if the presence of depressive symptoms was associated with low executive function, adjusting for potential confounders (i.e., age, sex, education, annual household income, province, urban/rural residence, self-rated general health, chronic conditions, medication for depression, marital status, social support availability, smoking status, and alcohol use). Other research objectives included stratifying the association across age groups (45–54, 55–64, 65–74, and 75 years and over) and by sex (males and females) to explore possible effect modification by these factors.

This research project used secondary data from the Canadian Longitudinal Study on Aging (CLSA). The CLSA is an ongoing prospective cohort study designed to better understand the aging process in Canadians. The CLSA is comprised of approximately 50,000 Canadian residents, who were between the ages of 45 to 85 years at recruitment (2010-2015) (Raina,

Wolfson, & Kirkland, 2009). Separated into the Tracking cohort and the Comprehensive cohort, participants will be followed for at least 20 years, with repeated waves of assessment every three years (first follow-up occurred between 2015 and 2018). This study focused on data from the Comprehensive cohort at baseline, which consists of 30,097 participants who were recruited and lived within 25–50 km of the 11 Data Collection Sites (DCS) across seven provinces. Participants in the Comprehensive cohort provided physical and cognitive data by completing at-home and DCS interviews with trained CLSA personnel. Depressive symptoms were determined using the Center for Epidemiological Studies Short Depression Scale. Executive function, a key cognitive domain, was assessed using a neuropsychological battery consisting of five tests. A variety of confounding variables were also assessed.

Overall, an aging population will ultimately experience age-related declines in cognitive function. Since cognitive function is an important determinant of health and depressive symptoms are more common in later life, a better understanding of the relationship between depressive symptoms and cognitive function may inform public health initiatives that can be applied at any point throughout the lifespan, but especially in later life. Understanding how depressive symptoms affect specific domains of cognitive function will help to reduce poorer cognitive outcomes for middle-aged and older adults.

2.0 Literature Review

2.1 Cognitive Function

Cognitive function refers to the range of mental processes that permit information processing and knowledge application (Meyers, 2012). Cognitive function underpins many of the actions an individual performs on a daily basis throughout the life course. It is integral to overall well-being and functional independence (Meyers, 2012; Murman, 2015; St. John, Montgomery, Kristjansson, & McDowell, 2002). Declines in cognitive function are associated with decreased autonomy, increased frailty, and inability to adapt to functional and social changes (Clegg, Young, Lliffe, Rikkert, & Rockwood, 2013; Depp & Jeste, 2006; World Health Organization, 2015).

Cognitive function can be measured as an overall entity (i.e., globally) or by domain (Sachdev et al., 2014). Global cognitive function and performance on measures that assess specific domains of cognitive function, are important determinants of successful aging (Depp & Jeste, 2006; Sachdev et al., 2014; Wlodarczyk, Brodaty, & Hawthorne, 2004). While the number of domains of cognitive function that exist has been debated, the Diagnostic Statistical Manual of Mental Disorders (DSM-5) defines six domains that best describe neurocognitive conditions, based on the type of action being performed and the brain circuits being activated. The six domains of cognitive function are executive function, perceptual-motor function, language, learning and memory, complex attention, and social cognition (American Psychiatric Association, 2013; Sachdev et al., 2014). Across the six domains, executive function is particularly important to successful aging as it involves many brain regions and allows for persons to engage in independent, appropriate, purposeful, and self-serving behaviours (Harada, Love, & Triebel, 2013).

2.1.1 Executive Function

Executive function refers to a set of top-down mental processes that occur when behaviour is guided by intention and requires effort (Diamond, 2014; Miller & Cohen, 2001). For example, executive function is activated when individuals plan future actions or goal-oriented behaviours. These actions can span from simple to complex. Diamond (2014) identifies three subcategories of executive function: 1) inhibition, 2) working memory, and 3) cognitive flexibility. These subcategories of executive function align with the six subdomains of executive function described in the DSM-5: inhibition, working memory, cognitive flexibility, planning, decision-making, and responding to feedback (Sachdev et al., 2014).

Inhibition, the first subcategory of executive function, requires individuals to selectively attend to given stimuli while inhibiting a predominant response and controlling one's attention, behaviour, and emotions. Inhibition allows individuals to practice self-control and voluntarily ignore background stimuli that may hinder goals or intentions. Examples of measures of inhibition include the Stroop Neurological Screening Test or delay-of-gratification tasks (Diamond, 2014; Tuokko, Griffith, Simard, & Taler, 2017). Declines in inhibition result in errors of impulsivity (e.g., impatience), poor self-control, and poor self-discipline (Diamond, 2014).

Working memory requires individuals to hold information in their mind and selectively remain focused on the information although it may not be perceptually present. Working memory is often used when following instructions, communicating with others, problem solving, and connecting ideas logically (Diamond, 2014). This subcategory of executive function is distinct from the domain of cognitive function called memory. Working memory requires information to be remembered and then manipulated (e.g., reordering remembered objects based on size for sorting), whereas memory requires information to just be held (e.g., remembering

objects) (Diamond, 2014). They are also distinct from one another from a developmental standpoint. Memory is present in very young children and may require no effort. In contrast, working memory develops during adolescence through adulthood, and grows as individuals start to connect ideas and apply past knowledge to new surroundings (Diamond, 2014). Measures of working memory include repeating a list of tasks demonstrated by an administrator or re-ordering remembered objects (Diamond, 2014).

Cognitive flexibility, the final subcategory of executive function, requires individuals to adjust to new and changing situations or demands, and to take on new perspectives while considering rewards and punishments (Diamond, 2014). It develops after inhibition and working memory as it requires individuals to be able to deactivate previous perspectives (inhibition) and activate newer perspectives based on spatial and interpersonal awareness (working memory). Tests that measure cognitive flexibility include those that examine task-shifting, semantic or categorical fluency, and word or letter fluency. These include the Mental Alternation Test, the Animal Fluency Test, and the Controlled Oral Word Association Tests, respectively (Diamond, 2014; Tuokko et al., 2017).

Although three subcategories of executive function have been defined, they generally co-occur (Diamond, 2014). The connectivity between the subcategories of executive function are also reflected anatomically. That is, the prefrontal cortex (PFC), a brain structure with widespread connectivity to other cortical (cortico-cortical) and subcortical (cortico-subcortical) brain areas, is believed to be responsible for executive function (Chung, Weyandt, & Swentosky, 2014). A meta-analysis by Alvarez & Emory (2006) suggests that the PFC is divided into three circuits, the dorsolateral, ventromedial, and orbitofrontal circuits, that send and receive information from nearly all major sensory and motor systems (Gilbert & Burgess, 2013). Across

these brain circuits, the left PFC is responsible for cognitive flexibility and the right PFC is linked to inhibition (Alvarez & Emory, 2006). Other important brain structures associated with executive function include the basal ganglia, thalamus, cerebellum, and the parietal lobe (Alvarez & Emory, 2006).

Declines in executive function result in symptoms of impulsivity; inability to inhibit reflective actions (Gilbert & Burgess, 2013; Takeuchi et al., 2013); inappropriate social behaviours; hyper- or hypo-sexual arousal; motor dysfunction; and increased reckless behaviour, drug use, and aggression (Suchy, 2009; Takeuchi et al., 2013). Given that executive function is critical for independent daily living, and is associated with a number of brain regions that span all sensory and motor systems in the body, it is important that research focusing on age-related cognitive decline investigate factors that may influence executive function.

2.1.2 Declines in Cognitive Function

Global and domain-specific levels of cognitive function can range from normal function to severe declines that may represent the onset of progressive neurodegenerative disorders, such as dementia. Levels of cognitive function can also change across the lifespan. For example, some individuals may transition from normal cognitive function to mild cognitive impairment, and then back at different points throughout their life course (Iraniparast et al., 2016; Koepsell & Monsell, 2012). However, the general trend is to observe worsening global and domain-specific cognitive function in later life. While most research has focused on global cognitive impairment, overall executive function and its subcategories have been also shown to decline in older age (Diamond, 2014; Harada et al., 2013). Although some age-related cognitive decline is expected, normal cognitive aging can still result in subtle declines that negatively impact functional independence (Harada et al., 2013). In addition, cognitive scores, even within the normal range,

can predict morbidity, mortality, and institutionalization (St. John et al., 2002). Therefore, testing the subcategories and overall executive function in healthy middle-aged and older adults may identify those at risk for further cognitive decline before the onset of severe symptoms that significantly reduce functional independence (St. John et al., 2002; Suchy, 2009).

More severe forms of cognitive decline include mild cognitive impairment (MCI) and dementia. MCI, also known as mild neurocognitive disorder, is considered an intermediate stage, positioned between normal cognition and dementia (Petersen, 2004; Petersen et al., 1999). It is characterized by an initial decline in executive function and memory although the ability to perform activities of daily living is not affected (Hugo & Ganguli, 2015). MCI is believed to occur in 16–20% of individuals over 60 years (R. Roberts & Knopman, 2013). Some individuals with MCI may convert back to normal cognitive function, but the majority of studies report that 20–40% of those with MCI will progress to dementia (R. Roberts & Knopman, 2013). Diagnosing MCI requires the use of global and domain-specific cognitive tests. A cut-off of 1–2 SD below the average score on a test is generally used as part of the diagnostic criteria (R. Roberts & Knopman, 2013; Sachdev et al., 2014).

Dementia is a descriptive term that refers to a set of clinical symptoms associated with severe declines in both cognitive function and the ability to perform activities of daily living (Alzheimer's Association, 2019). There are several forms of dementia and each is classified by symptom etiology (Sachdev et al., 2014). While most forms are progressive, with permanent and fatal pathophysiological changes, there are some exceptions. When treated or addressed, symptoms of dementia caused by depression, thyroid problems, vitamin deficiencies, medication side effects, or excessive use of alcohol (i.e., thiamine deficiency) may be reversed (Alzheimer's Association, 2019). Otherwise, the majority of the types of dementia are a result of abnormal and

irreversible damage to brain cells in different brain regions (Alzheimer's Society of Canada, 2019). Alzheimer's disease (AD) is the most common cause of dementia and accounts for more than two-thirds of the cases (Tyas & Gutmanis, 2015; World Health Organization, 2012). AD is associated with severe declines in executive function, memory, and perceptual-motor function (Alzheimer's Society of Canada, 2019). Symptoms of AD will increase in severity over time, with marked declines in functional independence (Alzheimer's Association, 2019; Alzheimer's Society of Canada, 2019). As dementia is progressive and develops over time, it is necessary to be able to identify pre-clinical symptoms as early as possible. This may provide a sufficient window to intervene and lower the risk of dementia.

2.1.3 Factors Influencing Cognitive Function

To date, research has shown a variety of factors that are associated with cognitive function. Common examples of non-modifiable factors include age, sex, and genetics. Common examples of modifiable factors include various demographic, health, and lifestyle factors. The mechanism(s) that connect these factors to cognitive function have long been debated because the relationship between neuropathology and its clinical manifestation is not direct (Stern, 2002). That being said, a commonly referenced theory that describes how certain factors may influence cognitive function is the reserve theory. It consists of two interacting components: brain reserve theory and cognitive reserve theory (Stern, 2002).

Brain reserve theory describes the passive loss of brain structure until a threshold, that is predetermined, is reached and symptoms of brain loss become clinically apparent (Stern, 2002). It relies on the physical structure of the brain, such as brain weight and the number of synapses (Stern, 2002, 2012). In contrast, the cognitive reserve theory describes both the passive loss of brain structure and also the ability of the brain to actively recruit other brain structures and

synaptic pathways to compensate for these losses in an efficient manner (Stern, 2002). Cognitive reserve differs across individuals and depends on factors that enhance cognitive stimulation and promote efficient use of brain networks, such as higher educational attainment (Stern, 2002, 2012). A better understanding of factors that influence cognitive function may identify ways to improve cognitive reserve by 1) protecting the brain's physical health despite passive structural loss, and 2) increasing the brain's efficiency and ability to recruit alternative mental processes, when needed.

2.1.3.1 Non-modifiable Factors for Cognitive Function

Cognitive function is associated with several non-modifiable risk factors. Age is the most established non-modifiable risk factor, displaying a negative association with cognition in later life. Older age is associated with declines in executive function (Buckner, 2004; van Hooren et al., 2007) and overall cognitive function (Tilvis et al., 2004). Also, advanced age is associated with increased risk for MCI and dementias (Wang & Blazer, 2015). Among population-based studies, the prevalence of MCI is approximately 19% in adults over the age of 65 years, with more than half of these cases progressing to dementia within five years (Gauthier et al., 2006). The prevalence of dementia increases exponentially with age, and incidence increases steadily until 85 years of age, after which it continues to rise, but less rapidly (Hugo & Ganguli, 2015). Even cognitively healthy adults, who have no typical risk factors for AD (e.g., genetic predisposition, vascular risk factors, or previous traumatic brain injury), can still develop AD in later life because of increasing age (Honjo, Black, & Verhoeff, 2012).

There is some debate about sex as a risk factor for cognitive decline and dementia. While some studies have not observed sex differences (Barnes et al., 2003), others have found females to be at higher risk for cognitive impairment (Alvarado, Zunzunegui, Del Ser, & Béland, 2013;

Z. Zhang, 2006). Based on population statistics, approximately two-thirds of individuals living with dementia in Canada and the United States are female (Alzheimer's Association, 2019; Public Health Agency of Canada, 2017). While the prevailing argument was that females, on average, lived longer than males, there is evidence that sex differences may also be attributed to the combination of biological and genetic variations alongside life experiences (Snyder et al., 2016; Z. Zhang, 2006). Biological differences between males and females include the tendency for females to have a smaller head circumference; experience hormonal changes, particularly after menopause; and respond differently to stress (Snyder et al., 2016). Males and females also experience differences in access to education and highly skilled occupations, cultural expectations, diet, and social networks, all of which are believed to impact the association between sex and cognitive outcomes (Alvarado et al., 2013; Z. Zhang, 2006).

Genetics also influences risk for cognitive decline. The apolipoprotein E (*APOE*) gene on chromosome 19 codes a plasma protein whose major functions include transportation of lipids (e.g., cholesterol) and participation in processes implicated in neuronal repair (Small, Rosnick, Fratiglioni, & Bäckman, 2004). One of its allelic variations, *APOE*-ε4, is the best-established genetic risk factor for the development of AD (Hugo & Ganguli, 2015). *APOE*-ε4 is also associated with poorer performance on tests of global cognitive function and executive function in healthy adults (Small et al., 2004). Other genetic risk factors for early-onset (or familial) AD include inherited autosomal dominant mutations in presenilin 1, presenilin 2, and the amyloid precursor protein gene (Alzheimer's Society of Canada, 2019; Borchelt et al., 1996).

2.1.3.2 Modifiable Factors for Cognitive Function

There are a number of modifiable risk factors associated with declines in cognitive function and its domains, such as executive function. These include demographic, health, social, and lifestyle factors.

The association between educational attainment, often measured as years of formal education completed, and risk of cognitive decline is well known (Anstey & Christensen, 2000; Barnes & Yaffe, 2011; Caamaño-Isorna, Corral, Montes-Martínez, & Takkouche, 2006). Higher educational attainment is shown to be associated with slower declines in scores on tests measuring specific cognitive domains, including executive function (Anstey & Christensen, 2000). Higher educational attainment and higher intelligence scores are also associated with a reduced risk for dementia. In contrast, low educational attainment is associated with an increased risk for AD and other dementias (Barnes & Yaffe, 2011).

Socioeconomic status (SES), often measured using educational attainment, income, and occupational complexity, is also associated with cognitive function. Adults with lower SES were shown to have poorer performance on tests for overall cognitive function and domain-specific cognitive function (Gallacher et al., 1999). Compared to higher income or higher occupational complexity, low income and low occupational attainment are also associated with greater risk for AD and dementia (Alzheimer's Association, 2019; Fratiglioni & Wang, 2007). Geographical location of residence may also be an important factor, although findings are mixed. While some studies have shown that the prevalence of AD and dementia is significantly higher in those living in rural regions versus urban (Jia et al., 2014), more recent findings found no difference in the risk of dementia (St. John, Seary, Menec, & Tyas, 2016).

Chronic health conditions, and lower reported physical health, are associated with poorer performance on measures of executive function and overall cognitive function, as well as an increased risk for AD and other dementias. In fact, cardiovascular disease, a common health condition, is recognized as an independent risk factor for executive dysfunction, global cognitive impairment, and dementias (e.g., Benisty et al., 2009; Brands, Biessels, de Haan, Jaap Kappelle, & Kessels, 2005; Brickman et al., 2011).

Other chronic conditions associated with cognitive function include diabetes, high blood pressure, and stroke. Diabetes is associated with reduced performance in executive function, memory, and perceptual-motor function (Kodl & Seaquist, 2008; Weinger et al., 2008). A meta-analysis demonstrated even mild to moderate deficits in executive function in those with diabetes significantly impacted everyday functioning (Brands et al., 2005).

High blood pressure disrupts the structure and function of blood vessels, leading to an increase in brain atrophy from ischemic damage, an increase in the number of senile plaques, and a decrease in brain weight (Barnes & Yaffe, 2011; Iadecola et al., 2016). In adults over the age of 60 years, high blood pressure is believed to initiate cognitive impairment (Knopman et al., 2001). Other studies have shown it is associated with a two-fold increase in odds of cognitive decline (Honjo et al., 2012; Tzourio, Dufouil, Ducimetière, & Alpérovitch, 1999). However, the risk of cognitive decline has been shown to decrease in those taking antihypertensive medication on at least one occasion versus those who did not (Tzourio et al., 1999).

Strokes are also associated with cognitive function by affecting neurological health. Large and small vessel damage following a stroke has shown to be associated with severe cognitive decline and increased risk for dementia (Honjo et al., 2012; Marchant et al., 2012). In addition, both white matter lesions and lacunar infarcts can be observed in cognitively normal

adults and are associated with worsening executive function (Benisty et al., 2009; Brickman et al., 2011), poorer global cognition (van der Flier et al., 2005), and increased risk for dementia (Honjo et al., 2012; Marchant et al., 2012).

Besides health conditions, social factors (such as social support and marital status) are associated with cognitive function. Compared to those who were married, those who were single and living alone were shown to have an increased risk for developing dementia (Fratiglioni, Wang, Ericsson, Maytan, & Winblad, 2000). In contrast, being married, living with a partner, or being in a satisfying relationship by midlife was associated with reduced risk for cognitive impairment by 65 years of age compared to those who were widowed, divorced, or separated (Håkansson et al., 2009). Perceived social support, regardless of marital status, is also important. Regardless of frequency of contact with social network(s), older adults who reported a poor or limited social network showed a 60% increased risk for dementia compared to older adults who reported having a moderate or extensive social network (Fratiglioni et al., 2000). Among adults who reported being socially isolated and having greater perceived loneliness, lower overall cognitive function and lower domain-specific cognitive function in late life were observed in comparison to adults who reported no loneliness (Boss, Kang, & Branson, 2015; Wilson et al., 2007).

Other notable modifiable factors include various lifestyle behaviours. Physical activity is associated with cognitive impairment and dementia (Barnes & Yaffe, 2011; Langa, 2015). Compared to individuals who do not partake in physical activity, participating in regular or highly frequent physical activity protects against cognitive impairment, all-cause dementia, and AD (Barnes & Yaffe, 2011; Hugo & Ganguli, 2015; Laurin, Verreault, Lindsay, MacPherson, & Rockwood, 2001).

Smoking is another lifestyle factor that can affect cognitive function. Nicotine, the primary psychoactive constituent in tobacco and cigarette smoke, has plausible mechanisms for improving cognitive function by improving executive function, attention, reaction time, and short-term memory in a dose-response manner (Murray & Abeles, 2002; Peters, Peters, Warner, Beckett, & Bulpitt, 2008b). Despite nicotine presenting a potential neuroprotective role, cigarette smoke contains approximately 4,700 compounds (Borgerding & Klus, 2005). As such, the other compounds in cigarette smoke, alongside the pharmacological factors and behaviours associated with smoking, may increase the risk of cognitive decline (Swan & Lessov-Schlaggar, 2007) and AD (Tyas et al., 2003). Compared to never smokers, current and former smokers had greater yearly declines in global cognitive function (Anstey, Von Sanden, Salim, & O'Kearney, 2007; Duron & Hanon, 2008; Peters et al., 2008b). There is also a strong dose-response effect between amount smoked and risk of cognitive impairment, AD, and all-cause dementia, with heavy smokers being more at risk than light smokers (Duron & Hanon, 2008; Tyas et al., 2003). While the most likely mechanism between smoking and subsequent cognitive decline is underlying vascular disease (Barnes & Yaffe, 2011), the neurotoxins in smoke could contribute to the risk for AD through oxidative stress and free radical formation, inflammatory processes, or other mechanisms (Barnes & Yaffe, 2011; Tyas et al., 2003).

Alcohol consumption is another modifiable lifestyle behaviour that has been widely studied. Two separate meta-analyses found that light to moderate drinkers had a 25–32% reduced risk for AD and other dementias compared to non-drinkers (Anstey, Mack, & Cherbuin, 2009; Peters, Peters, Warner, Beckett, & Bulpitt, 2008). Moderate drinkers also had a reduced risk for cognitive decline and MCI (Anttila et al., 2004; Zuccala et al., 2006). The J-shaped relationship between alcohol consumption and risk for declines in cognitive function has been consistently

reported in these studies. The J-shape curve suggests that moderate consumption is associated with the lowest risk for adverse cognitive and overall health outcomes, whereas no consumption or excessive alcohol consumption is associated with higher risk for adverse and deleterious effects on cognitive function (Alzheimer's Association, 2019; Andreasson, 1998; Anstey et al., 2009; Ballard & Lang, 2018; Schwarzinger et al., 2018; Tyas, 2001). The potential mechanisms underlying the relationship between alcohol use and cognitive function include the direct neurotoxic effect of ethanol and metabolites; thiamine deficiency; and hepatic encephalopathy, epilepsy or head injuries from intoxication (Schwarzinger et al., 2018). However, many cohort studies vary in their considerations of the types of alcohol consumed and the thresholds of consumption assessed (Anstey et al., 2009; Ballard & Lang, 2018). Many studies also face the challenge of distinguishing alcoholic dementia from other dementias as alcoholic dementia is generally not an outcome considered in epidemiological studies (Ballard & Lang, 2018; Tyas, 2001). In addition, alcohol consumption is associated with depression and various lifestyle behaviours, including poorer diet, smoking, lower adherence to medical treatments, and social isolation (Ballard & Lang, 2018; Schwarzinger et al., 2018; Tyas et al., 2000). Therefore, there may be a spurious association and the full effect of alcohol consumption on cognitive function is not fully understood.

Overall, the majority of the modifiable factors for cognitive function discussed above affect processes that occur in early life or have additive effects over the lifespan. However, it may be possible that some factors can be modified at any point throughout the lifespan, including later life, to either prevent cognitive decline by preventing the pre-clinical systems, or to prevent further decline, such as transition to MCI or dementia, in those already demonstrating symptoms. A potential area of focus is mental health and, in particular, depressive symptoms. In addition to

the fact that mental health has become a public health priority in recent years, given that depressive symptoms can occur at any point throughout the lifespan and levels of cognitive function may also change across the lifespan, intervention on depressive symptoms may reduce the risk of cognitive decline.

2.2 Depressive Symptoms

Older age is associated with important life changes, such as retirement, bereavement, and declines in health. These changes may cause feelings of sadness, stress, and uneasiness. While the prevalence of clinically diagnosed depression decreases in older age, the prevalence of depressive symptoms increases, where depressive symptoms are most frequently reported among the oldest old (Chui, Hoppmann, Gerstof, & Luszcz, 2015). Given the relatively higher prevalence of depressive symptoms, compared to depression, among older adults, depressive symptoms are an important factor to study when considering later-life health outcomes.

2.2.1 Depressive Symptoms, Depression, and Diagnostic Criteria

Depression, also known as major depressive disorder or clinical depression, is a common mental disorder that can occur any time throughout the life course. Depression accounts for 4.3% of the global burden of disease and is the largest single cause of worldwide disability (World Health Organization, 2016). Compared to the general population, individuals with depression are at increased risk for declines in cognitive function and have a 40% greater chance of premature death, primarily due to unattended physical health problems (World Health Organization, 2016).

In the DSM-5, depression is defined as experiencing depressive symptoms nearly every day, for most of the day, for a minimum of two weeks. Depressive symptoms that can result in a diagnosis of depression include, but are not limited to: persistent sadness; irritability; decreased energy or fatigue; feeling hopeless, helpless, restless, or worthless; difficulty concentrating,

remembering, or making decisions; appetite and weight changes; inability to perform activities of daily living; and aches or pains, headaches, or digestive issues without clear physical causes that alleviate after treatment (American Psychiatric Association, 2013). It is important to note that individuals with depression may not experience every symptom listed. Some individuals may experience many of the symptoms listed, while others do not. Also, not all individuals who experience depressive symptoms will receive a clinical diagnosis of depression (National Institute of Mental Health, 2018). Therefore, it is important to differentiate whether an individual has depression, or more broadly, is experiencing depressive symptoms. This is because it may have implications on the type of intervention needed to mitigate the effects of depressive symptoms versus depression.

2.2.2 Factors Influencing Depressive Symptoms

A variety of genetic, biological, environmental, and psychosocial factors for depression and depressive symptoms have been discussed (National Institute of Mental Health, 2018). Of these factors, there are two important variables that have been known to consistently modify both depression and depressive symptoms. These variables are age and sex. It is believed that age and sex work independently, and in combination, to influence depression and depressive symptoms.

2.2.2.1 Age and Depressive Symptoms

Contrary to common perception, while depression is associated with increased risk for morbidity, mortality, and decreased cognitive, social, and physical functioning, depression is less frequent among older adults than younger adults (Blazer, 2003). The prevalence of depression in community-dwelling adults is between 1–5%, with higher prevalence (10–12%) among those hospitalized for medical or surgical reasons (Fiske, Loeback Wetherell, & Gatz, 2009; Koenig, Bhalla, & Butters, 2014). While the prevalence of depression decreases in older age, longitudinal

studies show an increase in depressive symptoms in older age (Chui et al., 2015; Zhang, Kahana, Kahana, Hu, & Pozuelo, 2009). The prevalence of depressive symptoms has been reported to be 8–16% among community-dwelling older adults and greater than 30% among those hospitalized (Blazer, 2003). Other studies have reported the prevalence of depressive symptoms as high as 34–58% in community-dwelling adults over 65 years of age (Minicuci, Maggi, Pavan, Enzi, & Crepaldi, 2002). Despite this, few studies have been able to show the association between age and depressive symptoms in both middle-aged and older adults. For example, one 20-year study was able to show that depressive symptoms were persistently high and that the prevalence of depressive symptoms increased with age. However, the study population contained only women 65 years and over (Byers et al., 2012). Therefore, findings cannot be generalized to men, and do not explain how depressive symptoms differ between middle-aged and older adults as the study population focused on those 65 years and over.

Age also impacts the types of depressive symptoms experienced. For example, younger adults generally report symptoms related to irritability or behavioural problems, whereas older adults are more likely report symptoms related to anxiety, agitation, physical and memory problems, or somatic issues, like gastrointestinal issues, insomnia, and fatigue (Koenig et al., 2014).

In addition, etiology and prognosis of depressive symptoms and depression differs with age. Depression or depressive symptoms that occur in younger adults are associated with a higher likelihood of family history of depression, possibly implying the condition is genetically influenced. In contrast, depression or depressive symptoms that occur in late life (i.e., after the age of 60 years) appear to be related to structural brain changes or vascular risk factors (Fiske et

al., 2009). As such, it is possible that depressive symptoms that arise in older age are relatively modifiable compared to depressive symptoms experienced in younger age.

Although the majority of evidence supports an association, there are some studies that have not observed an association between age and depression (Cole & Dendukuri, 2003; Livingston, Watkin, Milne, Manela, & Katona, 2000). One possible explanation for this discrepancy is that disability confounds the relationship. Disability is independently and positively associated with both older age and depression (Berkman et al., 1986). Since depression in older age is frequently comorbid with other physical conditions, and the diagnostic criteria for depression omits symptoms attributable to other medical conditions or disability, the influence that age has on depression may not be evident (Blazer et al., 1991; Blazer, 2003). Overall, the likelihood of feeling depressive symptoms differs across the lifespan, where older adults are more likely to report depressive symptoms. Age should be considered as having an influence on risk for depressive symptoms and experiences unique to older age (e.g., retirement) may trigger more depressive symptoms than previously present (Alexopoulos, 2005).

2.2.2.2 Sex and Depressive Symptoms

Sex has also been shown to be associated with depression and depressive symptoms. Globally, the prevalence, incidence, and morbidity risk for depression are higher in females than males (Fiske et al., 2009; Piccinelli & Wilkinson, 2000). This is a similar pattern to that seen in Canada, where females reported a higher rate of depression (5.8%) than males (3.6%) in the last 12 months (Pearson, Janz, & Ali, 2017). Compared to males, females are twice as likely to develop depression, with some studies reporting a three- to four-fold increase in risk for depression (Culbertson, 1997; Nolen-Hoeksema, 2001). In addition, the number and severity of depressive symptoms affect males and females differently across the life course (Albert, 2015;

Koenig et al., 2015; Lugtenburg et al., 2017), where females generally exhibit higher cumulative depressive symptoms and are more likely to report depressive symptoms than males (Albert, 2015; Zeki Al Hazzouri et al., 2014). Males are also more likely to report depressive symptoms related to irritability or anger, whereas females are more likely to report depressive symptoms related to sadness (Public Health Agency of Canada, 2016). One possible explanation for this difference is that compared to males, females experience more feelings of powerlessness and lack of societal status; traumas and sexual abuse; and chronic strains, such as poverty, harassment, lack of respect, and constrained choices. Even if males and females experience the same stressors, females may have an increased risk for depressive symptoms because of biological responses to stress, self-concepts, and copying styles unique to females (Nolen-Hoeksema, 2001). It is also possible that since males are generally less likely to report depressive symptoms than females, males less frequently meet the clinical criteria for depression, and therefore their depressive symptoms go underreported (Angst et al., 2002).

Overall rates of depression are also higher in older females than older males compared to younger females and males, respectively (Fiske et al., 2009). One possible explanation is that women experience more chronic conditions and are more likely to be widowed in older age (Chui et al., 2015). Although females are at higher risk of developing depressive symptoms and comprise a larger proportion of those 85 years and over with depressive symptoms, gender differences in the trajectories of depressive symptoms are important, particularly as targets for intervention (Byers et al., 2012). That is, among older adults, the development and trajectory of depressive symptoms in males may primarily be attributable to perceived health and disability, whereas in females, it may be attributable to perceived social support and disability (Byers et al., 2012)

2.2.2.3 Other Factors Affecting Depressive Symptoms

Genetics is a factor thought to influence depressive symptoms, and family history of depression increases the risk for depression, as previously mentioned (Gatz, Pedersen, Plomin, Nesselroade, & McClearn, 1992). Although there is an apparent link between genetics and depression, definitive genetic markers for depression have yet to be identified (Alexopoulos, 2005). Previous studies have shown an association between the serotonin 2A receptor gene promoter and depression in males, but this finding did not extend to females (Jansson et al., 2003). Other studies have explored the effects of the *APOE-ε4* allele on depression although an association was not observed (Blazer, Burchett, & Fillenbaum, 2002; Köhler et al., 2010).

Other factors that may influence the occurrence of depressive symptoms include various demographic factors, health factors, and social factors, including social support. Regarding socioeconomic status, an increased number of depressive symptoms was observed among individuals, especially older adults, experiencing impoverishment and economic strain. Higher educational attainment was associated with a reduced risk of loneliness, a depressive symptom, whereas low income was associated with increased risk for loneliness (Shankar, Hamer, McMunn, & Steptoe, 2013). For urban or rural living status, a significantly higher prevalence for psychiatric disorders (38%) and mood disorders (39%) has been found among those living in urban areas (Peen, Schoevers, Beekman, & Dekker, 2010). Similarly, a significantly lower prevalence of depression was observed among those living in rural areas (Wang, 2004). However, the temporality of this relationship is unknown and it is possible that individuals with depression move to urban areas for better access to treatment.

Physical health is also a significant predictor of depressive symptoms. The prevalence of depression and depressive symptoms is higher among individuals who are hospitalized for

medical conditions or surgery (Blazer, 2003; Fiske et al., 2009; Koenig et al., 2015). Greater deficits in instrumental activities of daily living, disability, and functional impairment are significantly associated with depressive symptoms (Alexopoulos, 2005; Steffens, Hays, & Krishnan, 1999).

Depressive symptoms are also associated with social isolation, and the strength of the association increases when considering the oldest-old, as they generally report less frequent contact with their social networks (Blazer et al., 1991). Other forms of social isolation include widowhood, bereavement, and associated loneliness (Alexopoulos, 2005; Cole & Dendukuri, 2003). Approximately 10–20% of older adults develop depressive symptoms following the first year of bereavement and more than half will go on to develop major depression (Alexopoulos, 2005). Perceived social support is also associated with depressive symptoms, where higher perceived support is negatively associated with depressive symptoms in older age (Adams et al., 2016; Stafford, McMunn, Zaninotto, & Nazroo, 2011; X. Wang, Cai, Qian, & Peng, 2014).

2.3 Depressive Symptoms, Depression, and Cognitive Function

2.3.1 Potential Theoretical Models Linking Depression and Depressive Symptoms with Cognitive Function

While the exact pathophysiological mechanism linking depressive symptoms to cognitive function has yet to be identified, possible explanations propose that depressive symptoms are: i) a psychological reaction to worsening cognitive function, ii) an early preclinical symptom of an adverse cognitive outcome, iii) the consequence of vascular risk factors or diseases that are predictive of subsequent cognitive impairment, or iv) a true causal risk factor linked to the pathophysiology of adverse cognitive outcomes (Alexopoulos et al., 1997; Bennett & Thomas, 2014; Butters et al., 2008; Jorm, 2001; Krishnan, Hays, & Blazer, 1997). These theories can be

categorized into two overarching hypotheses: i) the risk factor hypothesis, and ii) the prodromal hypothesis.

The risk factor hypothesis suggests that individuals who develop depressive symptoms are at an increased risk for declines in cognitive function (Figure 1a). In contrast, the prodromal hypothesis suggests that depressive symptoms are one of the earliest symptoms of cognitive decline, indicating the onset of decline (Figure 1b).

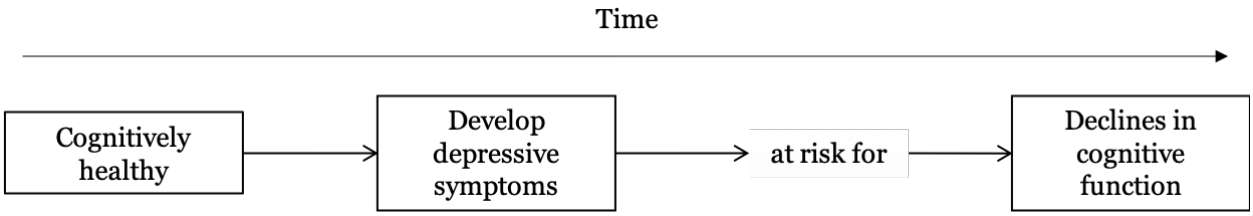

Figure 1a. Conceptual diagram of the risk factor hypothesis

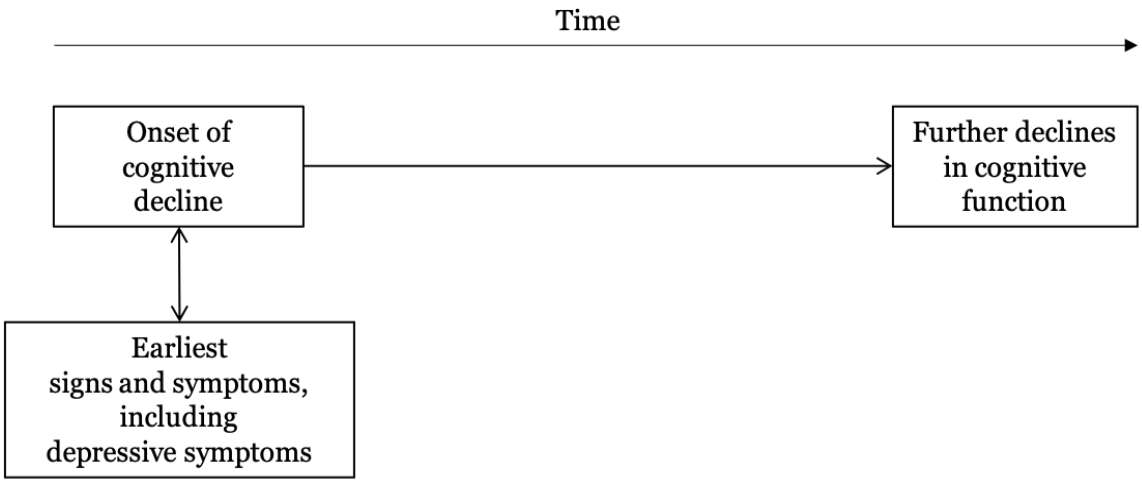

Figure 1b. Conceptual diagram of the prodromal hypothesis

Although these two hypotheses have been proposed, the temporal relationship between depressive symptoms and cognitive function is not well established. Most studies have considered depressive symptoms as an exposure and changes in cognitive function as an outcome. However, it is possible that depressive symptoms are a result of worsening cognitive function or an early preclinical symptom of cognitive decline (i.e., the prodromal hypothesis) (Bennett & Thomas, 2014; Geda et al., 2006). In general, evidence suggests that the risk factor hypothesis and the prodromal hypothesis are not mutually exclusive. Findings from longitudinal studies are promising, but limited. While there is evidence building to suggest that depressive symptoms are risk factors, it is believed that the relationship between depressive symptoms and cognitive function is bidirectional (Wang & Blazer, 2015).

2.3.2 Potential Biological Mechanisms Linking Depression and Depressive Symptoms with Cognitive Function

Both the risk factor hypothesis and the prodromal hypothesis have been linked to potential underlying biological mechanisms that explain how depressive symptoms are related to biological changes in the brain that result in declines in cognitive function. The potential biological mechanisms that may contribute to the structural and functional alterations are: 1) vascular disease, 2) cortisol-hippocampal pathway, 3) amyloid plaque formation, 4) inflammatory changes, and 5) nerve growth factors.

Vascular disease

The relationship of depressive symptoms with cognitive outcomes is best explained by vascular disease. This explanation is grounded in the vascular depression hypothesis, which suggests that vascular disease, vascular lesions, and structural brain changes cause depressive symptoms in older age (Alexopoulos et al., 1997; Krishnan et al., 1997). However, it is likely that depressive symptoms and vascular disease exist in a bidirectional relationship, in which each

condition is associated with an increased risk of developing the other. Vascular disease can also contribute to the development of cognitive impairment and dementia. In particular, the ischemic damage caused by vascular disease can lead to damage in the frontotemporal regions of the brain and the PFC. This can result in significant cognitive deficits and explains declines in executive function in older adults with depression (Taylor, Aizenstein, & Alexopoulos, 2013).

Cortisol-Hippocampal Pathway

Cortisol is a glucocorticoid steroid hormone that is produced by the adrenal glands in response to stress (Butters et al., 2008). Depressive symptoms can activate the hypothalamic-pituitary-adrenal axis and increase glucocorticoid production. In turn, this can damage the hippocampus, a key brain structure necessary for executive function and formation of glucocorticoid receptors. As a result of hippocampal damage, glucocorticoid receptors are down-regulated and the abundance of cortisol causes hippocampal atrophy and subsequent cognitive deficits (Jorm, 2001; Ownby, Crocco, Acevedo, John, & Loewenstein, 2006). It is possible that cortisol is not the only factor mediating the pathway, and other mechanisms may work alongside elevated cortisol levels.

Amyloid Plaque Formation

Some studies have observed that individuals with AD and depression have a greater accumulation of amyloid plaques and neurofibrillary tangles in their hippocampus compared to individuals with AD and no depression (Rapp et al., 2006, 2008). Amyloid plaque formation can result from stress and experiencing depressive symptoms. In parallel, amyloid plaques are known to promote neuronal death and are associated with an increased risk for AD (Butters et al., 2008; Rapp et al., 2006). In addition, a specific type of amyloid, called β-amyloid peptide 40, has also

been observed in individuals with depression and has been linked to impairments in executive function (Byers & Yaffe, 2012)

Inflammatory Changes

Chronic inflammation of the central nervous system influences the neurological changes associated with depression and dementia (Bennett & Thomas, 2014; Leonard, 2007). There are two possible pathways by which inflammation causes central nervous system changes. First, depression may signal an increase in cytokines. This signals for a decrease in anti-inflammatory and immunosuppressant responses and increase pro-inflammatory responses in the central nervous system. Ultimately, this inflammation leads to cognitive deficits and dementia (Leonard, 2007). The second mechanism suggests that depression reduces synaptic plasticity and promotes hippocampal atrophy via pro-inflammatory cytokines. The pro-inflammatory cytokines interfere with serotonin metabolism, which is a neurotransmitter thought to regulate emotions, and motor, cognitive, and behavioural functions (Lucki, 1998). As such, low serotonin levels lead to poorer cognitive outcomes.

Nerve Growth Factors

Nerve growth factors, such as brain-derived neurotrophic factor (BDNF), are responsible for neuronal health and modulation of synaptic plasticity (Byers & Yaffe, 2012). Both individuals with depression and individuals with AD have shown impaired BNGF signalling. Past research has also observed reduced levels of BDNF in the hippocampus of individuals with both depression and AD (Byers & Yaffe, 2012).

In summary, it is unlikely that a single biological mechanism explains the relationship between depressive symptoms and cognitive function. It is more likely that multiple biological mechanisms work in combination (Butters et al., 2008).

2.3.3 Literature Supporting an Association of Depression and Depressive Symptoms with Cognitive Function

There is a large body of evidence on the association between depression and cognitive function, and it can be divided into two subsections based on onset of depression. The first, most well-established evidence, exists for the association between late-life depression and cognitive function. The second subsection is for the association between midlife depression and cognitive function. However, since not all individuals who experience depressive symptoms receive a clinical diagnosis of depression, and depressive symptoms are highly prevalent among older adults, studying the relationship between depressive symptoms and cognitive function also appears to be important. A review of existing literature is discussed in further detail below.

2.3.3.1 Late-life Depression and Cognitive Function

Late-life depression (LLD) is defined as the onset of depression after 65 years of age. The association of LLD and cognitive function is well studied. Past prospective studies show that LLD is associated with a two- to five-fold increased risk for MCI, AD, and other dementias (Barnes et al., 2012; Diniz, Butters, Albert, Dew, & Reynolds, 2013; Geda et al., 2006; Jorm Anthony, 2001; Ownby, Crocco, Acevedo, John, & Loewenstein, 2006). Other studies have only observed an association in specific subgroups (Geerlings et al., 2000), such as those with *APOE-ε4* (Byers & Yaffe, 2012; Geda et al., 2006) or low educational attainment (Byers & Yaffe, 2012; Jungwirth et al., 2011). Two separate meta-analyses showed an association between LLD and dementia in overall pooled findings (Jorm, 2001; Ownby et al., 2006). While some studies did not observe an association, discrepancies may be attributed to differences in methodology (e.g., sampling procedures, operationalization of depression, operationalization of cognitive function), cultural considerations (e.g., study samples from differing countries such as the United

States, Canada, and China), or variations among subpopulations (e.g., veterans, Japanese American men) (Byers & Yaffe, 2012; Diniz et al., 2013).

LLD is also associated with global and domain-specific cognitive deficits. Approximately 20–50% of individuals with LLD have poorer cognitive function than their age- and education-matched comparisons without LLD (Koenig et al., 2015; Osorio, De García Lózar, Ramos, & Agüera, 2009). When compared to those without LLD, individuals with LLD showed a pattern of impairments across cognitive domains similar to older adults with MCI who are not depressed (Tam & Lam, 2012). This included declines in executive function (Cui, Lyness, Tu, King, & Caine, 2007; Klojčnik, Kavcic, & Bakracevic Vukman, 2017; Koenig et al., 2015; Osorio et al., 2009), working memory (Butters et al., 2008), attention (Rapp et al., 2005), and processing speed (Butters et al., 2004). In fact, LLD was commonly associated with significant impairments in executive function in cross-sectional studies (Klojčnik et al., 2017; Osorio et al., 2009), cohort studies (Boyle, Porsteinsson, Cui, King, & Lyness, 2010; Cui et al., 2007; Jungwirth et al., 2011; Koenig et al., 2015), and case-control studies (Ros, Aguilar, Serrano, Ricarte, & Latorre, 2013) studies.

When compared to those with early-onset depression (i.e., depression observed in childhood, adolescence, or young adulthood), those with LLD display larger deficits in executive function. When compared to those without depression, both LLD and early-onset depression were associated with reduced functioning across all cognitive domains. Findings support age as an effect modifier, where LLD is associated with more severe cognitive impairment than depression in younger age (Herrmann, Goodwin, & Ebmeier, 2007). Furthermore, declines in executive function may mediate deficits in other cognitive domains (Alexopoulos, 2005; Butters et al., 2004; Rapp et al., 2005), and this is why cognitive deficits may improve, but do not

completely dissipate after remission of LLD following treatment (Koenig et al., 2015). Overall, these studies provide substantial evidence supporting an association between LLD and cognitive function.

2.3.3.2 Midlife Depression and Cognitive Function

The association between midlife depression and cognitive function is less well established than the association between LLD and cognitive function. Most research has been conducted on populations aged 65 years and older. Therefore, information on middle-aged adults (e.g., 45–64 years) is limited (Bennett & Thomas, 2014; Diniz et al., 2013). As it is widely accepted that dementia develops over decades, it is possible that depression in middle age may be a remote risk factor (i.e., the risk factor hypothesis) or a subclinical feature (i.e., the prodromal hypothesis) of dementia (Bennett & Thomas, 2014; Byers & Yaffe, 2012; Ownby et al., 2006).

Only a few studies have explored the association between midlife depression and cognitive function. In a small case-control study of young and middle-aged adults, depression was associated with deficits in mental flexibility and episodic memory (Airaksinen, Larsson, Lundberg, & Forsell, 2004). In another study, the risk of developing dementia was found to increase with the number of affective episodes in patients with midlife depression. Yet, there were some methodological limitations. Many of these studies relied on hospital data from admitted patients. Therefore, diagnoses were made by different clinicians and were not standardized for research purposes (Kessing & Andersen, 2004). In more recent studies, individuals with midlife depression, compared to those with LLD or no depression, performed worse on measures of executive function and memory (Riddle et al., 2017; Singh-Manoux et al., 2010). Another study showed both midlife depression and LLD were associated with worse

executive function, although the strength of the association was reduced in those with midlife depression compared to LLD (Lugtenburg et al., 2017).

Although additional research is required, emerging findings suggest that cognitive outcomes associated with depression may vary according to age (Lugtenburg et al., 2017; Riddle et al., 2017; Singh-Manoux et al., 2010). In particular, although the general trend of the association is similar across individuals with midlife depression and LLD, the strength of the association with cognitive function may differ according to whether the individual is a middle-aged or older adult.

2.3.3.3 Depressive Symptoms and Cognitive Function

As previously described, there is evidence to support an association between midlife depression and LLD with declines in cognitive function. However, not all middle-aged and older adults who experience depressive symptoms receive a clinical diagnosis of depression. One possible explanation is that their depressive symptoms do not meet criteria for a clinical diagnosis. It is also possible that older adults mistake their depressive symptoms as part of the normal aging process and attribute their symptoms to other conditions or life changes. As a result, studies that rely on participants receiving or reporting a diagnosis of clinical depression may be underestimating prevalence rates of depression (Girling & Huppert, 1995). Nonetheless, depressive symptoms are reported to occur in approximately 8–16% of community-dwelling older adults (Barnes et al., 2012; Blazer et al., 1991; Fiske et al., 2009), and are most frequent among the oldest old (Blazer, 2003).

Depressive symptoms been identified as an independent risk factor for many adverse health outcomes (World Health Organization, 2016). Empirical data have found an association between depressive symptoms and cognitive outcomes, such as cognitive decline, MCI, and

dementia (Bennett & Thomas, 2014; Boyle et al., 2010; Dlugaj et al., 2015; Geda et al., 2006; Goveas, Espeland, Woods, Wassertheil-Smoller, & Kotchen, 2011; Heser et al., 2016; Richard et al., 2013; Spira, Rebok, Stone, Kramer, & Yaffe, 2012; S. Wang & Blazer, 2015). In a cohort study, the hazard of dementia increased by 20% for those with midlife depressive symptoms, 70% for those with late-life depressive symptoms, and 80% for those with both midlife and late-life depressive symptoms (Barnes et al., 2012). As well, a dose-response relationship may exist, where every additional depressive symptom increases the risk for dementia and cognitive disorders not otherwise specified (Boyle et al., 2010; Dotson, Beydoun, & Zonderman, 2010; Geda et al., 2006). This dose-response relationship may also be exacerbated by the synergistic interaction between depressive symptoms and *APOE* genotype (Geda et al., 2006).

When specific types of dementia were examined, having both midlife and late-life depressive symptoms was associated with a greater than three-fold increase in risk for vascular dementia. In contrast, late-life depressive symptoms were associated with a two-fold increase in risk for AD only (Barnes et al., 2012). Findings suggest that late-life depressive symptoms could be an early symptom of AD, whereas a combination of midlife and late-life depressive symptoms are risk factors associated with vascular dementia (Barnes et al., 2012). This is consistent with some studies that suggest the relationship between depressive symptoms with dementia and MCI differs depending on the age of the individual (Dlugaj et al., 2015; Spira et al., 2012; Sundermann, Katz, & Lipton, 2017). However, not all studies agree with this (Geda et al., 2006). In addition, some studies did not observe an association between depressive symptoms and neurocognitive disorders (Dotson et al., 2010; Richard et al., 2013).

In addition to studies examining dementia and MCI as outcomes, there is some evidence supporting an association between depressive symptoms and cognitive function, but it has not

been well explored. Depressive symptoms in older adults have been shown to be associated with poorer cognitive function and longitudinal cognitive decline across multiple cognitive domains (e.g., Dotson, Resnick, & Zonderman, 2008; Freiheit et al., 2012; Royall, Palmer, Chiodo, & Polk, 2012; Sachs-Ericsson, Joiner, Plant, & Blazer, 2005; Zeki Al Hazzouri et al., 2014). Of these studies, some suggest that depressive symptoms temporally preceded cognitive deficits, such that individuals with depressive symptoms that arise and persist before the age of 60 years are at a greater risk for cognitive deficits in later life (Barnes et al., 2012; Bunce et al., 2014; Singh-Manoux et al., 2010). In fact, clinically meaningful and persistently high depressive symptoms are shown to be associated with faster declines in cognitive function and are predictive of future cognitive impairment, even among individuals with the highest levels of cognitive function (Almeida, Hankey, Yeap, Golledge, & Flicker, 2016; Chodosh et al., 2007; Gatz, Tyas, St. John, & Montgomery, 2005; Köhler et al., 2010). There are studies that did not observe an association between depressive symptoms and cognitive function (Almeida et al., 2016), or only observed a cross-sectional, but not longitudinal association (Ganguli, Du, Dodge, Ratcliff, & Chang, 2006). These studies argued that longitudinal cognitive decline cannot be explained by depressive symptoms, but rather, depressive symptoms most likely reflect incipient dementia (Almeida et al., 2016; Ganguli et al., 2006).

In studies that were able to examine specific cognitive domains, depressive symptoms were most commonly associated with executive function (Dotson et al., 2008; Klojčnik et al., 2017; Pantzar et al., 2017; Reppermund et al., 2011; Royall et al., 2012). Multiple studies found that elevated depressive symptoms were associated with lower baseline cognitive scores and greater longitudinal declines in global cognition and/or executive function (Dotson et al., 2008; Freiheit et al., 2012; Goveas et al., 2014). In a study by Brodaty et al. (2012), depressive

symptoms were associated with a two-fold increase in risk for impairments in executive function. Although not consistently observed, co-occurring vascular risk factors and co-morbid cerebrovascular disease with depressive symptoms were also related to worse treatment outcomes and greater declines in global cognition and executive function (Goveas et al., 2014). Older adults with both depressive symptoms and low executive function may also be at greater risk for functional disability (Reppermund et al., 2011; Wilcox et al., 2016), poorer treatment response (Pantzar et al., 2017), and recurrence of depression (Dotson et al., 2010). In addition to executive function, a higher average number of depressive symptoms and longitudinal declines in memory were observed in some (Dotson et al., 2008; Köhler et al., 2010; Panza et al., 2009), but not all studies (Reppermund et al., 2011; Royall et al., 2012). The effects of depressive symptoms on domain-specific cognitive changes may also vary according to age.

Overall, while there is some evidence supporting an association between depressive symptoms and domain-specific cognitive function, a larger and stronger body of evidence supports an association between depressive symptoms and global cognitive impairment (Goveas et al., 2014; Pantzar et al., 2017; Potter et al., 2013). Nonetheless, the studies that focus on depressive symptoms and cognitive function set the foundation for longer cohort studies that can provide clarity regarding the true relationship between depressive symptoms and cognitive function, and whether age is an effect modifier (Byers & Yaffe, 2012; Saczynski et al., 2010).

2.4 Conclusion

The relationship between depressive symptoms and cognitive function is complex. Currently, most of the evidence supports an association between LLD with neurocognitive disorders and global cognitive impairment, although the exact mechanisms underlying the association have yet to be identified. While associations between depressive symptoms and

domains of cognitive function have been identified, the strength and direction of the association appears to differ depending on the age of the individual with depressive symptoms, as well as the domain of cognitive function examined. Furthermore, sex may also be an additional risk factor that modifies the association between depressive symptoms and cognitive function, although past findings are not conclusive.

3.0 Study Rationale and Research Questions

3.1 Study Rationale

The association between depressive symptoms and cognitive function in adulthood is multifaceted. While many studies have observed an association between depressive symptoms and global cognitive impairment, the association with specific cognitive domains is less established. Previous research examining depressive symptoms is generally limited to populations 65 years or older (Bennett & Thomas, 2014). Therefore, these studies are not able to determine whether the association between depressive symptoms and specific cognitive domains differs between middle-aged and older adults. In addition, most study participants are recruited from clinical settings since it is easier to identify individuals with depressive symptoms in the healthcare system rather than among community-dwelling adults (Boyle et al., 2010; Cui et al., 2007; Heser et al., 2016). As such, findings may not be representative of the population at large. Other studies have only been able to recruit participants from one geographical location (e.g., province, city), limiting generalizability. Although age and sex have been mentioned as possible effect modifiers of the association between depressive symptoms and global cognitive impairment, the modifying effects of age and sex are less clear when considering their relationship with the cognitive domain of executive function.

Many studies also depend on a clinical diagnosis of dementia, failing to demonstrate the impact that depressive symptoms may have on early subclinical differences, as well as vulnerabilities in specific cognitive domains (Goveas et al., 2014; Panza et al., 2009). In studies that examined cognitive function, either global cognitive function was assessed or a limited number of tests was used to examine domain-specific cognitive function. For example, executive function is a key domain of cognitive function that is responsible for controlling behaviour,

purposeful decision making, and functional independence. Despite its importance, the relationship between depressive symptoms and executive function has not been well established. As well, past studies have not simultaneously considered a wide variety of covariates. This has prevented the inclusion of certain confounders, such as subjective and objective measures of health, functional and structural measures of social support, and health behaviours.

In summary, there is limited evidence on the association between depressive symptoms and executive function in middle-aged and older adults. There is also limited evidence among population-based samples, studies that measure executive function using more than one cognitive test, and studies that are able to incorporate a variety of confounders. Both age and sex differences have also not been simultaneously studied.

The aim of this study was to examine the association between depressive symptoms and executive function, after controlling for a variety of confounding variables and assessing whether age and sex were effect modifiers. The potential confounders included sociodemographic factors (i.e., age, sex, education, annual household income, province, and urban/rural residence), health factors (i.e., self-rated general health, chronic conditions, and medication for depression), social factors (i.e., marital status and social support availability), and health behaviours (i.e., smoking status and alcohol use). In general, it was hypothesized that the presence of depressive symptoms would be associated with lower executive function, and the strength of the association would increase in older age groups compared to younger age groups, and in females compared to males.

3.2 Research Questions

1. Is the presence of depressive symptoms associated with low executive function, after adjusting for confounders?
2. Does the association between depressive symptoms and low executive function differ across age groups?
3. Does the association between depressive symptoms and low executive function differ in males and females?

4.0 Methods

4.1 Literature Search

A systematic search, using two different databases, was conducted in September 2018 to identify relevant literature on the relationship between depressive symptoms and executive function in older adults. The first database that was searched was PubMed. Initially, search terms related to "depressive symptoms" (e.g., depression, depressive symptoms) and "cognitive function" (e.g., executive function, neuropsychological tests) were used. To narrow the scope of relevant articles, "age" (e.g., middle age, older adult, elderly) and "time" (e.g., aging, prospective cohort study) were added as additional search concepts. The search was further limited to human-based and peer-reviewed articles that were written in English. No date limits were applied to the search strategy (Appendix A, Table A1). The initial search resulted in 399 articles.

The second database that was search was PsycINFO. The same search concepts from the PubMed search strategy were used in PsycINFO. The search was limited to peer-reviewed articles and no date limits were set (Appendix A, Table A2). The initial search resulted in 608 to be further screened. In total, 1,007 articles were retrieved from both PubMed and PsycINFO for screening.

After duplicate articles were removed, the remaining articles were screened in three steps, with assessment for eligibility based on their title, abstract, and then full text. Articles were excluded if the exposure was not related to depression, depressive symptoms, cognitive function, or executive function, if the outcome was not related to depression, depressive symptoms, cognitive function, or executive function, or if the sample only included participants under the age of 45 years. After applying exclusion criteria, 36 articles remained.

In July 2019, the original literature search was updated using the same search concepts (depressive symptoms, cognitive function, age, and time) and databases (i.e., PubMed and PsycINFO) to identify more recently published articles. In total, 1,076 articles were retrieved. After articles that were already screened from the September 2018 search were removed, there were an additional 69 articles to screen for eligibility. In the end, 40 articles were included in the final review (Appendix A, Figure A1). A summary of each of these articles can be found in Appendix B, Table A3.

4.2 Data Source: The CLSA

4.2.1 Background

The CLSA is a large, population-based, ongoing prospective cohort study with the goal of examining the dynamic aging process. The original proposal, submitted by lead investigator Dr. Parminder Raina (McMaster University, Hamilton) and co-principal investigators, Dr. Christina Wolfson (McGill University, Montréal) and Dr. Susan Kirkland (Dalhousie University, Halifax), was part of the Canadian Institutes of Health Research (CIHR) Institute of Aging Request for Applications. The proposal was awarded CIHR funding in 2002 and underwent development and national and international review until 2006. The developed protocol was awarded infrastructure funding from the Canadian Foundation for Innovation and later received full ethics approval in 2010. The CLSA was formally launched in 2011 (Raina et al., 2009).

4.2.2 Overall Study Design

In total, the CLSA sampled 51,338 participants between 45 to 85 years of age at the time of recruitment (Raina et al., 2009). The inclusion of men and women as young as 45 years captures midlife experiences and allows investigators to observe how these experiences are

associated with later-life outcomes. Additionally, the wide age range captures the experiences of those entering older adulthood, retirement, and their final years of life.

All study participants were categorized into one of two study components: the Tracking cohort or the Comprehensive cohort. Participants from both cohorts provided information about the key elements of aging, including biological, physical, social, and psychological functioning, as well as various lifestyle and demographic factors. Both cohorts follow an identical follow-up timeline, with repeated waves of data collection every three years for at least 20 years, or until death. However, each cohort uses a different sampling design and data collection process. This is discussed in further detail below (Raina et al., 2009).

Data for the Tracking cohort were collected using computer-assisted telephone interviews. This method permits the estimation of health and social factors of participants from a geographically representative population across Canada. Recruitment for the Tracking cohort used three different sampling frames: the Canadian Community Health Survey (CCHS) 4.2 on Healthy Aging, provincial healthcare registries, and Random Digit Dialing (RDD). Recruitment occurred in all 10 provinces, yielding a final total of 21,241 participants in the Tracking cohort (Canadian Longitudinal Study on Aging, 2017a; Raina et al., 2009).

Participants in the Comprehensive cohort provided information through physical examinations, biological samples, and in-home and DCS interviews (Main-wave In-home Questionnaire and the Main-wave Data Collection Site Questionnaire). Participants were recruited using provincial healthcare registration databases, RDD sampling frames, and the Quebec Longitudinal Study on Nutrition and Aging (NuAge) study. Participants had to live within 25 to 50 km of a DCS. There were 11 DCS across seven provinces: British Columbia (Victoria, Vancouver, and Surrey), Alberta (Calgary), Manitoba (Winnipeg), Ontario (Hamilton

and Ottawa), Quebec (Montreal and Sherbrooke), Nova Scotia (Halifax), and Newfoundland and Labrador (St. John's). Each DCS was responsible for recruitment of approximately 3,000–6,000 participants. As a result of population size and geographical location, three provinces were not included in the CLSA (New Brunswick, Prince Edward Island, and Saskatchewan). After recruitment, there was a final total of 30,097 participants in the Comprehensive cohort (Canadian Longitudinal Study on Aging, 2017a; Raina et al., 2009).

4.2.3 Sampling Frames

Based on the CLSA protocol, recruitment was initially done exclusively for the Tracking cohort. The initial enrollment platform was the CCHS 4.2 on Healthy Aging. Since the original target population of the CCHS on Healthy Aging included participants 55 years and older, an additional sample of individuals aged 45–54 years was included to capture the age range specified by the CLSA. Provincial healthcare registration databases were used in eight provinces as the second sampling frame. To achieve target sample size numbers and age and sex quotas, RDD was employed (Canadian Longitudinal Study on Aging, 2017a; Raina et al., 2009). RDD was performed only using landline numbers and omitted households that were exclusively mobile-phone users. The Residential Telephone Service Survey by Statistics Canada indicated that the impact of omitting households that only use mobile phones was modest as most households with individuals 45 years and older have landlines (Raina et al., 2009).

The Comprehensive cohort consisted of participants recruited from three sampling frames. Provincial healthcare registration databases were used as the main sampling frame across five provinces (British Columbia, Manitoba, Newfoundland, Nova Scotia, and Ontario). Due to the unique set of administrative and infrastructure regulations set out by each province for the liberation of data, this enrolment platform could not be used in all provinces. RDD was used to

achieve the target sample size and quotas for age and sex. The NuAge study was also used to recruit additional participants between 75 and 85 years of age in Quebec (Canadian Longitudinal Study on Aging, 2017a; Raina et al., 2009).

To ensure accurate estimates for the national and provincial population, 136 sampling strata, based on age group (45–54, 55–64, 65–74, and 75–85), sex (male or female), province, and distance from a DCS catchment area were created for the Tracking cohort. For the Comprehensive cohort, 56 sampling strata, based on age group, sex, and province, were created. Sample weights for each age group, sex, and province stratum were also calculated. Response rates for the Tracking and Comprehensive cohort were 9% and 10%, respectively (Canadian Longitudinal Study on Aging, 2017a). Refer to Appendix D for a breakdown of response rates by province.

In addition to using sampling weights and strata, there were early indications that the proportion of recruited participants with low education levels was less than the proportion in the Canadian population. As such, low education areas were targeted using data from the 2006 Census. The goal was to oversample people with lower educational levels to increase the number of participants with lower education (Canadian Longitudinal Study on Aging, 2017a).

4.2.4 Eligibility Criteria

Since the CCHS on Healthy Aging was used as the initial enrolment platform, eligibility criteria for all participants of the CLSA mirrored the criteria implemented by the CCHS on Healthy Aging. Therefore, individuals living in any one of the three territories; some remote areas or First Nation reserves; residents of long-term care facilities who required 24-hour medical care; full-time workers in the Canadian Armed Forces; and individuals with non-permanent residency, including visa holders or individuals with transitional health care coverage,

were excluded from the study. Individuals in transitional living facilities or senior apartments were included in the study. Other inclusion criteria required participants to be between the ages of 45 to 85 years, speak either English or French, be cognitively able to provide consent and understand the purpose of the study, and be free of cognitive impairment at baseline, as determined by the CLSA interviewer during telephone or in-person interviews (Raina et al., 2009).

4.3 Current Project

4.3.1 Study Sample

Data from the Comprehensive cohort of the CLSA were used for this thesis. The Comprehensive cohort is comprised of participants who completed a Comprehensive Main-wave Disease Symptoms Questionnaire and neuropsychological battery at a DCS. In addition to the DCS visit, the Comprehensive Main-wave In-home Questionnaire was administered during in-home interviews. These methods of data collection allowed for a greater number of measures to be gathered, including measures for depressive symptoms and executive function.

To assess the association between depressive symptoms and executive function, the analytic sample was restricted to participants with completed data available on the exposure and outcome variables, as well as all covariates. This included individuals who completed all tests at the DCS and in-home interviews. Participants without complete data for exposure or outcome variables were excluded first. Next, participants without complete data on all covariates were excluded. The final analytic sample consisted of 23,069 participants. A visual diagram of the sampling process can be found in Appendix E.

4.3.2 Measures

4.3.2.1 Exposure

Depressive symptoms were assessed using the Center for Epidemiological Studies Short Depression Scale (CES-D10), a self-reported questionnaire that screens and measures the affective component of depressive symptoms (i.e., depressed mood). The CES-D10 has good predictive accuracy compared to the original 20-item CES-D, which was first established for the National Institute of Mental Health Studies (Andresen, Malmgren, Carter, & Patrick, 1994). Since its development, the CES-D10 has shown high validity and reliability to detect clinically relevant and significant depressive symptoms among individuals in the general and older population (Björgvinsson, Kertz, Bigda-Peyton, McCoy, & Aderka, 2013; Mohebbi et al., 2018; Radolff, 1977). Additionally, the CES-D10 is a validated measure applicable to heterogeneous groups, such as participants in the CLSA (O'Connell et al., 2018). For a complete list of items on the CES-D and CES-D10, refer to Appendix F.

The CES-D10 measured depressive symptoms based on participants' feelings from the past week. There were four possible responses for each item, scaled from 0–3, for a possible score out of 30. The coding for 8 out of 10 items on the scale was as follows: 0 (rarely or never; less than 1 day), 1 (some of the time; 1–2 days), 2 (occasionally; 3–4 days), or 3 (all of the time; 5–7 days). For two items (i.e., "how often did you feel hopeful about the future?" and "how often did you feel happy?"), the scores were reversed. For example, a score of 0 meant feeling happy all of the time, and a score of 3 indicated rarely or never feeling happy (Radolff, 1977). The overall score was obtained by summing the individual response values from each item on the CES-D10. An overall higher score reflected a greater number of depressive symptoms.

As scores were not normally distributed, the overall CES-D10 score was categorized dichotomously into a variable named *presence of depressive symptoms* based on an established cut-off (Andresen et al., 1994; Canadian Longitudinal Study on Aging, 2017b). A CES-D10 score greater than or equal to 10 indicated the presence of depressive symptoms. In contrast, a score less than 10 indicated the absence of depressive symptoms.

4.3.2.2 Outcome

This thesis used a neuropsychological test battery consisting of all five measures of executive function available in the Comprehensive cohort of the CLSA (Tuokko et al., 2017). These measures assessed the three most common subtypes of executive function: cognitive flexibility, working memory, and inhibition. The Animal Fluency Test, Mental Alternation Test, and Controlled Oral Word Association Test measured cognitive flexibility. The Time-based Prospective Memory Test assessed working memory, and the Victoria Stroop Neurological Screening Test measured inhibition. Details regarding the procedure and scoring of these tests are explained in detail below.

The Animal Fluency Test (AFT) measured verbal fluency by asking participants to recite as many animals as possible in 60 seconds. Responses received a seven-digit code based on the scientific taxonomic classification of the animal. Two coding algorithms were applied to calculate participants' scores. In the first algorithm, repetition of a breed or taxonomic sub-species of an animal (i.e., variation of the same animal) was not counted towards the final score. For example, if a participant recited "bird, parrot, seagull," only bird received a point because it is the broader category that the subsequent responses belong in. In the second algorithm, scores reflected the total number of valid animals listed. This thesis used the scores from the second, less strict, algorithm (Strauss, Sherman, & Spreen, 2006).

The Mental Alternation Test (MAT) is a measure of cognitive flexibility. Participants completed three progressive subtasks: i) counting from one to 20; ii) reciting the letters of the alphabet; and iii) alternating between numbers 1–26 and letters of the alphabet (e.g., 1A, 2B, 3C). Each subtask was allotted a 30-second time limit. Only scores for the third trial were recorded, and points were awarded for each correct alternation. Total scores ranged from 0–51.

The Controlled Oral Word Association Test (COWAT) asked participants to complete three independent subtasks. Each subtask was limited to 60 seconds and participants were asked to name as many words as they could that began with a certain letter. The administered letters were F, A, and S. One point was awarded for each unique word per trial. All homophone words (i.e., words with the same root but different suffixes) were entered into a software to correct scoring. All sister words (i.e., words with the same root but different suffixes) only received one point. Scores from all three one-minute trials were summed to determine an overall COWAT score (Strauss et al., 2006).

The Time-Based Prospective Memory Test (TMT) is a measure of working memory and inhibition (Mioni & Stablum, 2014). At the beginning of the testing period, participants were shown an envelope containing a series of cards and were instructed to provide the interviewer with the card labeled with the number 17. A clock was set to 8:00 and participants were instructed to interrupt whatever was happening at 8:15 to complete the task. Performance was based on three categories: intention to perform, accuracy of response, and need of reminders when the alarm sounds. Possible scores for each category ranged from 0–3. All three scores from each category were summed to get a final score out of 9 (Hernandez Cardenache, Burguera, Acevedo, Curiel, & Loewenstein, 2014).

The Victoria Version of the Stroop Neurological Screening Test (Stroop) is divided into three tasks where participants were asked to state the colour of the ink on the stimulus cards. The three types of stimulus cards corresponding to each task were coloured dots, common words printed in coloured ink, and colour words (e.g., red, blue) printed in non-corresponding colours of ink. Scores were based on the number of errors and the average length of time (in seconds) required to complete the three tasks. An interference score was calculated by dividing the score of the third task (colour words with non-corresponding colours of ink) by the score on the first task (coloured dots) (Graf, Uttl, & Tuokko, 1995). On the first task, scores below seven seconds or above 30 seconds, and on the third task, scores below seven seconds or above 137 seconds, were removed based on pre-established standards (Strauss et al., 2006). These standards were applied to reflect scores that were feasible response times as opposed to measurement errors.

Scores were standardized within each test of executive function using *z*-scores. *Z*-scores were also calculated separately for English and French speakers, and bilingual responses were not included. An overall executive function score was calculated by combining the standardized scores on the AFT, MAT, COWAT, TMT, and Stroop. Since performance on the Stroop is calculated based on time to response, a higher score reflected worse cognitive function. Therefore, the standardized score for the Stroop was reversed and then included in the calculation for overall executive function (Demnitz et al., 2018).

As normed data and cut-offs have not been well established, low executive function was defined by applying a cut-off to the distribution of the overall executive function scores after combining the *z*-scores of each executive function measure. A cut-off of $\geq$ 1.5 SD below the mean was defined as low executive function. This was based on previous work assessing early cognitive decline and MCI (Petersen et al., 1997; Sachdev et al., 2014). The 1.5 SD cut-off was

calculated using the weighted executive function scores of a cognitively healthy sample (n=24,297). The cognitively healthy sample excluded participants who reported a diagnosis of Alzheimer's disease (n=68), multiple sclerosis (n=202), epilepsy (n=322), memory problems (n=519), parkinsonism or Parkinson's disease (n=125), stroke or cerebrovascular accidents (n=522), or ministroke or transient ischemic attack (n=965). In addition, those who screened positive for a traumatic brain injury and reported two or more concussions or any symptoms of a concussion (n=3949) were excluded. These groups were not mutually exclusive. Once the cut-off was determined, it was applied to the overall executive function scores of the analytic sample.

4.3.2.3 Covariates

To examine the association between depressive symptoms and executive function, the following potential confounders were included in final models: sociodemographic factors (i.e., age, sex, province, education, annual household income, and urban/rural residence), health factors (i.e., self-rated general health, chronic conditions, and medication for depression), social factors (i.e., social support availability and marital status), and health behaviours (i.e., smoking status and alcohol use). Each variable is described in further detail below. Refer to Appendix C for a conceptual diagram displaying the relationships between these variables.

Sociodemographic Factors

Age, in years, was determined at the time of the in-home interview and DCS visit. Participants of the CLSA ranged from 45 to 87 years. Age was based on the age groups described in the sampling strategy (divided into four groups: 45–54 years, 55–64 years, 65–74 years, and ≥75 years). Age was included *a priori* as an effect modifier.

Sex was determined by asking participants whether they identified as male or female. Sex was a dichotomous variable and included *a priori* as another effect modifier.

Education was determined based on the highest degree obtained. Responses were categorized as a four-level measure: less than high school, high school graduate, some post-secondary education, and post-secondary degree or diploma.

Annual household income was assessed using a five-level income measure. Possible responses were less than $20,000; $20,000 or more, but less than $50,000; $50,000 or more, but less than $100,000; $100,000 or more, but less than $150,000; and $150,000 or more.

Province of residence was determined at the time of recruitment. Possible responses included Alberta, British Columbia, Manitoba, Newfoundland and Labrador, Nova Scotia, Ontario, and Quebec. *Urban/rural residence* was based on the participant's forward sortation area and was categorized as a dichotomous variable. Participants living in any territory outside of a population centre were classified as rural. Participants living in a core, secondary core, fringe, or population centre located outside of a census metropolitan area (CMA) or census agglomeration (CA) were classified as urban. CMAs had a population over 100,000, with at least 50,000 people living in the core, or population centre. CAs had at least 10,000 people living in the core. Secondary cores had a population of 10,000 people and required the core of a CA to merge with an adjacent CMA. An urban fringe was the core of a CMA or a CA with less than 10,000 persons (Canadian Longitudinal Study on Aging, 2018). Both province and urban/rural residence were included in this study to account for potential geographical differences in the sample.

Health Factors

Self-rated general health was measured by asking participants to rate their general health. Possible responses included excellent, very good, good, fair, and poor.

Medication for depression was measured by asking participants "Are you currently taking medication for depression?" This variable was assessed as a dichotomous measure (i.e., yes versus no).

Chronic conditions were assessed following the methodology used in past CLSA research. A combined measure consisting of 11 self-reported medical conditions, selected based on existing literature describing their impact on cognitive function, was used to determine the presence of *chronic conditions* (O'Connell, personal communication). Conditions included high blood pressure/hypertension; diabetes/borderline diabetes/high blood sugar; 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; cardiac chronic conditions (i.e., heart disease/congestive heart failure; myocardial infarction/heart attack/acute myocardial infarction; angina/chest pain due to heart disease); stroke-related conditions; peripheral vascular disease; and asthma. For each item, participants reported whether they had ever been diagnosed with the condition. For example, a positive screen for high blood pressure was determined by asking participants "Has a doctor ever told you that you have high blood pressure or hypertension?" Chronic conditions were assessed as a dichotomous variable (i.e., at least one chronic condition versus no chronic conditions).

Social Factors

Social support availability (SSA) was measured using the 19-item self-administered Medical Outcomes Study-Social Support Survey (MOS-SSS) (Sherboune & Stewart, 1991). The MOS-SSS can measure four subtypes of SSA (i.e., emotional/informational, tangible, affectionate, and positive social interactions) and overall perceived SSA. One item in the MOS-SSS (someone to do things with to help you get your mind off things) was included for the

calculation of the overall SSA score (RAND Health, 2018). For each item, participants were asked to rate how often the type of support 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), where a higher score indicated greater perceived support levels. For this study, the overall SSA score was used, with low SSA defined as an average score of three or less after responding to all 19 items on the MOS-SSS.

Marital status was treated as a categorical variable with four levels: 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.

Health Behaviours

Smoking status was determined by creating a derived variable classifying participants as current, former, or never smokers. Those who were classified as current smokers responded "yes" to smoking at least 100 cigarettes in their lifetime and "yes" to smoking daily or occasionally within the past 30 days. Those who were classified as former smokers responded "yes" to smoking at least 100 cigarettes in their lifetime, but reported not having smoked in the last 30 days. Never smokers were those who had smoked less than 100 cigarettes in their lifetime and were not smoking at the time of the interview (Government of Canada, 2008).

A*lcohol use* was assessed by creating a derived variable classifying participants into current, former, or never drinkers. Current drinkers were defined as those who responded "yes" to consuming alcohol almost every day, 4–5 times a week, 2–3 times a week, once a week, 2–3 times a month, about once a month, or less than once a month over the past 12 months. Former drinkers were defined as those who responded "yes" to drinking alcohol in the past, but not

within the past 12 months. Never drinkers were those who reported to have never drank (Centers for Disease Control and Prevention, 2018).

4.3.3 Data Analysis

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

4.3.3.1 Descriptive Analyses

Bivariate analyses for the exposure, outcome, and covariates were conducted to provide an overall description of the analytic sample. Frequency tables were computed to gain a better understanding of the characteristics in the analytic sample. Pearson's chi-square tests to test for significant associations between categorical variables were applied. Age group and sex were included as *a priori* effect modifiers. Therefore, analyses were done separately for each age group, and for males and females.

Descriptive analyses were conducted on unweighted and weighted data. Trimmed weights were used for descriptive analyses. The trimmed weights were calculated by the CLSA and were based on inclusion probabilities in the Canadian population (provided by Statistics Canada) and the DCS of the participant (Canadian Longitudinal Study on Aging, 2017a).

4.3.3.2 Multivariable Analyses

Weighted logistic regression analyses were used to address each research question. Odds ratios (OR) and 95% confidence intervals were used to determine the strength and direction of the associations for the low executive function outcome. Covariates were entered into the models in four themed chunks: sociodemographic factors, health factors, social factors, and health behaviors. The variables that comprise each themed chunk are presented in Table 1.

First-order interactions with the exposure variable were assessed. A significance (α) level of 0.20 for main effects and 0.05 for first-order interaction terms was used with backwards elimination variable selection (Tyas et al., 2000). Model fit was assessed using the Mann-Whitney U statistic for the area under the curve of receiver operating characteristic curves. Results for the final models are presented in Appendix G, Table A7. Multicollinearity between depressive symptoms (exposure) and covariates was examined by assessing the variance inflation factor (VIF), where highly correlated variables would identified based on having VIF scores greater than 10 (Kleinbaum, Kupper, Nizam, & Rosenberg, 2013). There were no issues of multicollinearity found among the variables.

Table 1. Analytic plan for assessing the association between depressive symptoms and low executive function

Model	Statistical Approach	Measures and Variables
Model A[1,2,3] (Unadjusted)	Logistic regression	***Exposure***: Depressive symptoms ***Outcome***: Low executive function ***Covariates***: None
Test for interaction terms[1,2,3]	Logistic regression	***Exposure***: Depressive symptoms ***Outcome***: Low executive function ***Covariates***: Sociodemographic: Age, sex, education, annual household income, province, urban/rural residence Health: Self-rated general health, medication for depression, chronic conditions Social: Marital status, social support availability Health behaviours: Smoking status, alcohol use ***Interaction terms***: Depressive symptoms* (Sociodemographic: Age, sex, education, annual household income, province, urban/rural residence Health: Self-rated general health, medication for depression, chronic conditions Social: Marital status, social support availability Health behaviours: Smoking status, alcohol use)
Model B[1,2,3] (Assuming no significant interactions)	Logistic regression	***Exposure***: Depressive symptoms ***Outcome***: Low executive function ***Covariates***: Sociodemographic: Age, sex, education, annual household income, province, urban/rural residence

[1]Reflects the set of models that were used to assess the association between depressive symptoms and low executive function.
[1]Models were run separately for the four different age groups (Research Question 2).
[2]Models were run separately for males and females (Research Question 3).
[3]Backwards elimination was used, with a significance (α) level of 0.05 for first-order interaction terms.

Table 1. Analytic plan for assessing the association between depressive symptoms and low executive function, continued

Model	Statistical Approach	Measures and Variables
Model C[1,2,3] (Assuming no significant interactions)	Logistic regression	***Exposure***: Depressive symptoms ***Outcome***: Low executive function ***Covariates***: Sociodemographic: Age, sex, education, annual household income, province, urban/rural residence Health: Self-rated general health, medication for depression, chronic conditions
Model D[1,2,3]	Logistic regression	***Exposure***: Depressive symptoms ***Outcome***: Low executive function ***Covariates***: Sociodemographic: Age, sex, education, annual household income, province, urban/rural residence Health: Self-rated general health, medication for depression, chronic conditions Social: Marital status, social support availability
Model E[1,2,3] (Final Model)	Logistic regression	***Exposure***: Depressive symptoms ***Outcome***: Low executive function ***Covariates***: Sociodemographic: Age, sex, education, annual household income, province, urban/rural residence Health: Self-rated general health, medication for depression, chronic conditions Social: Marital status, social support availability Health behaviours: Smoking status, alcohol use

[1]Reflects the set of models that were used to assess the association between depressive symptoms and low executive function.
[1]Models were run separately for the four different age groups (Research Question 2).
[2]Models were run separately for males and females (Research Question 3).
[3]Backwards elimination was used, with a significance (α) level of 0.05 for first-order interaction terms.

4.3.4 Ethics and Data Access

The CLSA adheres to the policies and procedures of the CIHR Best Practices for Protecting Privacy in Health Research, Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans. Written, informed consent was obtained by all study participants upon recruitment and all study participants were only identified by a number code, not name. Within the CLSA, the CIHR's Advisory Committee on Ethical, Legal, and Social Issues ensures that ethical practices and confidentiality are maintained for the duration of the study.

This present study is part of the approved Office of Research Ethics (ORE) application at the University of Waterloo, titled "Profiles of Socially and Cognitively Vulnerable Canadians: A Cross-sectional Analysis of the Canadian Longitudinal Study on Aging (CLSA); ORE #21398." In November 2015, the University of Waterloo research team submitted a CLSA data access request, which was granted in December 2015. In April 2016, baseline data for the Tracking cohort was received. A data request update including baseline Comprehensive data (Tracking v3.1, Comprehensive v2.0) was received in February 2017. In April 2017, a modification or amendment form was submitted to the ORE at the University of Waterloo for Emily Ha to be added to the project as a student investigator. In April 2017, Emily Ha was also approved for access by the CLSA. Following approval, three data request updates for Comprehensive data were received. In June 2017, all variables related to cognitive function were updated (Comprehensive v3.1). In January 2018, baseline Comprehensive data for SSA were updated (Comprehensive v3.2). In September 2018, data for the CES-D10 were updated (Comprehensive v4.0) and used in the analyses for this study. All data files stored at the University of Waterloo are password protected and only made available to researchers who have been approved by the CLSA and the University of Waterloo.

5.0 Results

The results of the descriptive and multivariable regression analyses for the three research questions are presented below. An overview of the prevalence of depressive symptoms (Figure 2a) and low executive function (Figure 2b) by age group and sex is presented below. Both age group and sex were significantly associated with depressive symptoms ($p<0.001$). Age group ($p<0.001$), but not sex, was significantly associated with executive function.

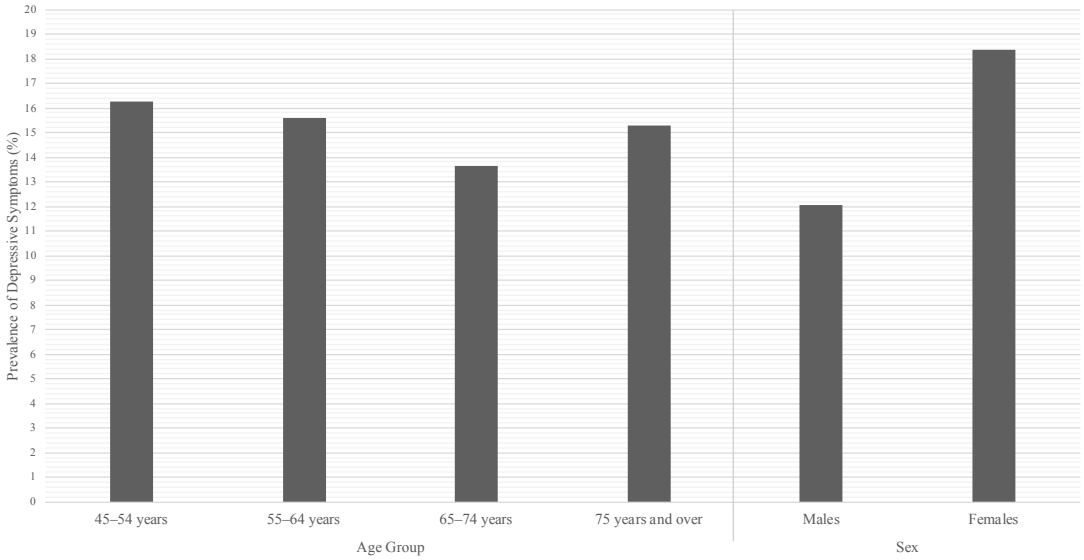

Figure 2a. Prevalence of depressive symptoms by age group and sex

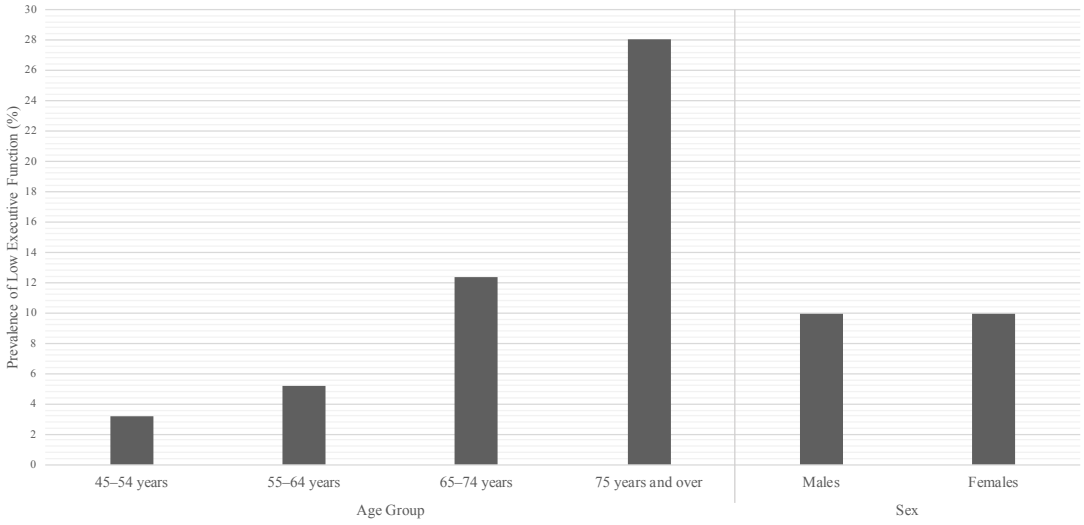

Figure 2b. Prevalence of low executive function by age group and sex

In summary, the prevalence of depressive symptoms was highest among those 45–54 years (16.25%) compared to the other age groups, and in females (18.35%) compared to males (12.08%). The prevalence of low executive function was highest among those 75 years and over (28.06%) compared to other age groups and was approximately equal among males (9.98%) and females (9.97%).

An overview of the multivariable results is presented in Figure 3. Some results were stratified based on significant first-order interactions (e.g., research question 1 was stratified by SSA because SSA was a significant first-order interaction term). In Figure 3, a bolded label indicates a significant association was observed, a positive symbol indicates that a positive association between depressive symptoms and low executive function was found, and a negative symbol indicates that a negative association between depressive symptoms and low executive function was observed.

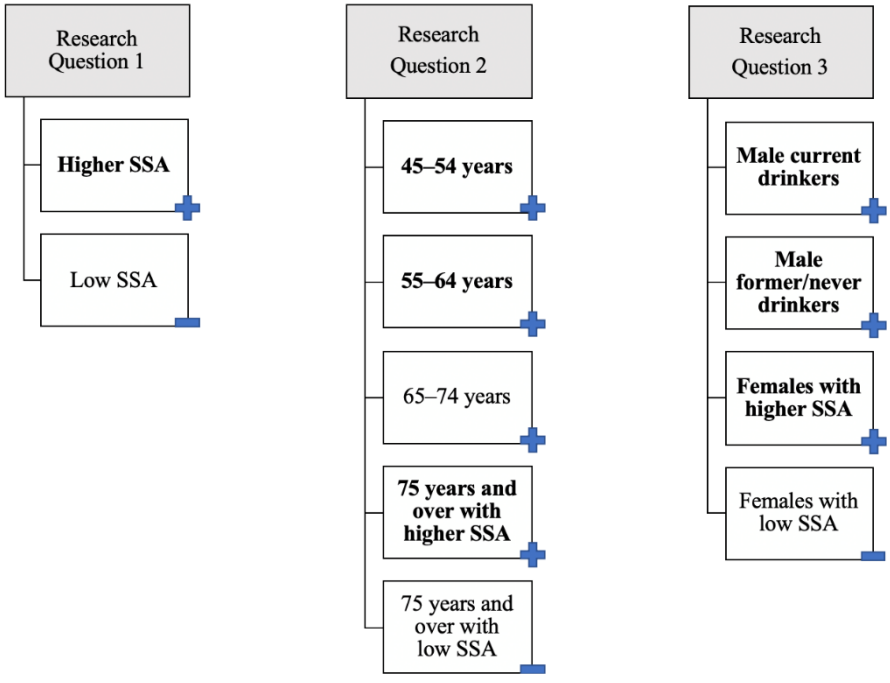

Figure 3. Summary of the results from multivariable regression analyses

5.1 Research question 1: Is the presence of depressive symptoms associated with low executive function, after adjusting for confounders?

5.1.1 Descriptive analyses for the association between depressive symptoms and low executive function

Overall, depressive symptoms were significantly ($p<0.001$) associated with low executive function in both unweighted and weighted descriptive analyses (Table 2). Depressive symptoms were significantly more common in those with versus without low executive function (23.95% versus 14.28%, $p<0.001$).

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

Age was negatively associated with low executive function ($p<0.001$). Among participants with low executive function, depressive symptoms were most prevalent among those 75 years and over (44.59%), yet this age group only accounted for 15.88% of the overall unweighted analytic sample. Both education and income were positively associated with executive function ($p<0.001$). For education, 5.14% of participants obtained less than a high school diploma, yet these individuals accounted for nearly one-fifth of those with low executive function. Considering finances, of those with low executive function, 13.04% had annual household incomes less than $20,000, whereas 5.08% had incomes of $150,000 or more. Province was also significantly associated with low executive function, whereas sex and urban/rural residence were not.

Self-rated general health and reporting a chronic condition were significantly associated with executive function ($p<0.001$), whereas reporting to take medication for depression was only significant in weighted analyses ($p<0.05$). Of those who reported poor or fair self-rated general health, a higher proportion had low executive function (17.21%) than not (7.60%). Participants

who reported at least one chronic health condition were more likely to have low executive function (81.96%) than not (65.31%).

Marital status was significantly associated with executive function ($p<0.001$). The most notable differences were observed among those who reported to be married/common-law or widowed. In those who reported being married/common-law, a lower proportion had low executive function (56.50%) than not (71.61%). For widows, a higher proportion (20.73%) had low executive function compared to the 7.15% who did not. SSA was also significantly associated with low executive function. Among those with low SSA, 11.73% had low executive function, compared to 5.87% who did not. Among the covariates classified as health behaviours, both smoking status and alcohol use were significantly associated with low executive function.

Table 2. Distribution of depressive symptoms and covariates by low executive function status, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=23,069)			Weighted Frequency (n=2,889,798)		
	Executive Function					
	Low (n=2,301)	Not Low (n=20,768)	Total	Low (n=203,154)	Not Low (n=2,686,643)	Total
Depressive symptoms[1] (%)						
Presence	23.95	14.28***	15.25	24.09	14.07***	14.77
Absence	76.05	85.72	84.75	75.91	85.93	85.23
Sociodemographic Factors						
Age, groups (%)						
45–54 years	8.60	28.91***	26.88	18.23	45.62***	43.69
55–64 years	17.47	35.37	33.58	18.86	30.97	30.12
65–74 years	29.34	23.06	23.69	26.06	15.56	16.30
75 years and over	44.59	12.66	15.88	36.85	7.85	9.89
Sex (%)						
Female	50.50	50.51	50.51	51.75	49.89	50.02
Male	49.50	49.49	49.49	48.25	50.11	49.98
Education (%)						
Less than high school	16.99	3.83***	5.14	19.54	3.53***	4.65
High school graduate	14.43	8.47	14.43	14.73	8.08	8.54
Some post-secondary	8.91	7.33	8.91	8.41	6.73	6.85
Post-secondary degree/diploma	59.57	80.37	59.67	57.32	81.67	79.95
Annual household income (%)						
< $20,000	13.04	4.32***	5.19	13.08	3.68***	4.34
≥ $20,000 and < $50,000	42.11	19.68	21.92	42.03	16.30	18.11
≥ $50,000 and < $100,000	31.38	35.74	35.31	29.90	33.50	33.25
≥ $100,000 and < $150,000	8.39	21.33	20.04	8.75	23.65	22.60
≥ $150,000	5.08	18.92	17.54	6.24	22.87	21.70
Province (%)						
Ontario	20.99	21.75***	21.68	13.92	13.45***	13.48
Alberta	7.69	8.69	8.59	8.80	11.25	11.08
British Columbia	16.99	22.38	21.84	24.57	31.99	31.47
Manitoba	11.47	10.59	10.68	10.12	8.50	8.61
NFLD	11.21	7.50	7.87	3.48	2.26	2.34
Nova Scotia	12.30	10.51	10.69	4.68	3.60	3.68
Quebec	19.34	18.58	18.66	34.42	28.96	29.34
Urban/rural residence (%)						
Urban	90.70	90.51	90.53	89.31	90.50	90.41
Rural	9.30	9.49	9.47	10.69	9.50	9.59

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table 2. Distribution of depressive symptoms and covariates by low executive function status, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=23,069)			Weighted Frequency (n=2,889,798)		
	Executive Function					
	Low (n=2,301)	Not Low (n=20,768)	Total	Low (n=203,154)	Not Low (n=2,686,643)	Total
Health Factors						
Self-rated general health (%)						
Poor	3.00	1.20***	1.38	3.21	1.05***	1.20
Fair	14.21	6.40	7.18	14.31	6.37	6.93
Good	36.98	28.45	29.30	39.46	28.95	29.69
Very good	33.12	42.71	41.75	31.29	41.97	41.22
Excellent	12.69	21.24	20.39	11.74	21.65	20.96
Medication for depression (%)						
Yes	8.95	8.08	8.17	78.97	60.25*	61.57
No	91.05	91.92	91.83	21.03	39.75	38.43
Chronic conditions[2] (%)						
Yes	81.96	65.31***	66.97	78.97	60.25***	61.57
No	18.04	34.69	33.03	21.03	39.75	38.43
Social Factors						
Marital status (%)						
Single, never married	8.17	8.51***	8.48	8.17	7.89***	7.91
Married/common-law	56.50	71.61	70.10	62.84	78.23	77.15
Widowed	20.73	7.15	8.50	15.68	4.15	4.96
Divorced/separated	14.60	12.73	12.92	13.30	9.73	9.98
Low SSA (%)						
Yes	11.73	5.87***	6.45	10.51	4.93***	5.32
No	88.27	94.13	93.55	89.49	95.07	94.68
Health Behaviours						
Smoking status (%)						
Current	10.08	8.20**	8.39	10.55	8.61*	8.74
Former	59.41	60.05	59.99	57.77	57.55	57.57
Never	30.51	31.75	31.62	31.68	33.84	33.69
Alcohol use (%)						
Current	77.49	88.12***	87.06	77.51	88.28***	87.53
Former	18.86	10.02	10.90	19.18	9.95	10.60
Never	3.65	1.86	2.04	3.31	1.76	1.87

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
Abbreviations: SSA = social support availability
*p<0.05; **p<0.01; ***p<0.001

5.1.3 Multivariable regression analyses for the association between depressive symptoms and low executive function

As a consequence of significant first-order interactions between depressive symptoms and some covariates, the association between depressive symptoms and low executive function was stratified by SSA (Tables 3a and 3b). In addition, to reduce the number of significant interactions, some levels of multilevel variables (i.e., province, income, self-rated general health) were combined. For province, Alberta and Manitoba, and Newfoundland and Labrador and Nova Scotia were combined. For income, the top two levels (i.e., $100,000 or more, but less than $150,000; and $150,000 or more) were combined. For self-rated general health, fair or poor health were collapsed into one level.

5.1.3.1 Depressive symptoms and low executive function in participants by social support availability

In the higher SSA stratum (Table 3a), depressive symptoms were associated with low executive function. The association was significant in the crude model (Model A) and remained significant with the addition of each chunk of themed covariates (Models B–E), although the strength of the association decreased. In the final model (Model E), which included all covariates, depressive symptoms were significantly associated with 47% greater odds of low executive function (OR=1.47, 95% CI=1.26–1.72).

In those with low SSA, depressive symptoms were positively associated with low executive function in the crude model. Following the addition of sociodemographic covariates, the strength of the association increased, but became protective (Table 3b). In the low SSA stratum, the association between depressive symptoms and low executive function was not significant.

5.1.3.2 Sociodemographic covariates and low executive function in participants by social support availability

Overall, age was significantly associated with low executive function (Tables 3a and 3b). For those with higher SSA, there was a significant and positive dose-response relationship: compared to the youngest age group (45–54 years), there were significantly greater odds of having low executive function for the 55–64 years, 65–74 years, and 75 years and over age groups. This was also observed for those with low SSA, although the relationship was only significant for those 65–74 years and 75 years and over, compared to those 45–54 years.

Sex was also significantly associated with low executive function in both SSA strata. Compared to males, females had lower odds of low executive function (Tables 3a and 3b, Model E). Overall, the association was stronger in the low SSA stratum (OR=0.60, 95% CI=0.43–0.85) than the higher SSA stratum (OR=0.81, 95% CI=0.72–0.92) for females compared to males.

Education and income displayed significant, negative dose-response associations with low executive function in those with higher and low SSA. Although urban/rural residence was not significant in any of the models, geographical distribution across Canada was significant in some models (e.g., those with higher SSA living in British Columbia versus Ontario had significantly lower odds of low executive function).

5.1.3.3 Health covariates and low executive function in participants by social support availability

There was a significant, negative dose-response association between self-rated general health and low executive function in those with higher SSA and low SSA (Tables 3a and 3b). Compared to those who reported their health as ‘poor or fair’, those who had ‘good’, ‘very good’, or ‘excellent’ self-rated health had lower odds of low executive function. Reporting a

chronic condition or current use of medication for depression were not significantly associated with low executive function.

5.1.3.4 Social covariates and low executive function in participants by social support availability

In those with higher SSA, marital status was not significantly associated with low executive function in any final models (Table 3a). However, in the low SSA stratum, compared to those who reported being single or never married, those who reported being married or living with a common-law partner (OR=1.78, 95% CI=1.01–3.12) or who were widowed (OR=2.00, 95% CI=1.14–3.50) had greater odds of low executive function (Table 3b).

5.1.3.5 Health behaviours and low executive function in participants by social support availability

Compared to never smokers, former smokers with higher SSA had significantly lower odds of low executive function (OR=0.84, 95% CI=0.74–0.96). When compared to never drinkers, current drinkers had lower odds of low executive function in both SSA strata, although this was not significant in any model.

Table 3a. Multivariable analysis of the association between depressive symptoms and low executive function in participants with higher social support availability, Canadian Longitudinal Study on Aging, n=21,580

	Low Executive Function[1]				
	Model A OR (95% CI)	**Model B** OR (95% CI)	**Model C** OR (95% CI)	**Model D** OR (95% CI)	**Model E** OR (95% CI)
Presence of depressive symptoms[2]	**2.18 (1.89-2.51)**	**1.74 (1.50-2.02)**	**1.47 (1.26-1.72)**	**1.47 (1.26-1.72)**	**1.47 (1.26-1.72)**
Age, groups (vs. 45–54 years)					
55–64 years		**1.37 (1.12-1.68)**	**1.37 (1.12-1.68)**	**1.36 (1.11-1.67)**	**1.39 (1.13-1.70)**
65–74 years		**3.02 (2.48-3.67)**	**3.05 (2.50-3.73)**	**3.01 (2.46-3.69)**	**3.12 (2.54-3.83)**
75 years and over		**7.62 (6.26-9.29)**	**7.59 (6.19-9.32)**	**7.32 (5.94-9.02)**	**7.56 (6.12-9.35)**
Female vs. male		**0.80 (0.71-0.90)**	**0.83 (0.73-0.93)**	**0.83 (0.73-0.94)**	**0.81 (0.72-0.92)**
Education (vs. less than high school)					
High school graduate		**0.66 (0.52-0.82)**	**0.68 (0.54-0.86)**	**0.69 (0.55-0.87)**	**0.69 (0.55-0.87)**
Some post-secondary		**0.46 (0.36-0.60)**	**0.48 (0.37-0.62)**	**0.49 (0.38-0.63)**	**0.50 (0.38-0.64)**
Post-secondary degree/diploma		**0.37 (0.31-0.45)**	**0.39 (0.33-0.48)**	**0.40 (0.33-0.49)**	**0.41 (0.33-0.49)**
Annual household income (vs. < $20,000)					
≥$20,000 and <$50,000		**0.65 (0.53-0.81)**	**0.70 (0.56-0.86)**	**0.66 (0.53-0.83)**	**0.69 (0.55-0.87)**
≥$50,000 and <$100,000		**0.32 (0.26-0.40)**	**0.36 (0.29-0.45)**	**0.34 (0.27-0.43)**	**0.36 (0.28-0.46)**
≥$100,000		**0.19 (0.15-0.24)**	**0.22 (0.17-0.28)**	**0.20 (0.15-0.26)**	**0.22 (0.17-0.29)**
Province (vs. Ontario)					
Alberta & Manitoba		1.01 (0.84-1.21)	1.00 (0.84-1.20)	1.00 (0.34-1.20)	1.00 (0.83-1.20)
British Columbia		**0.73 (0.61-0.87)**	**0.72 (0.60-0.86)**	**0.72 (0.60-0.86)**	**0.71 (0.59-0.85)**
Newfoundland and Labrador & Nova Scotia		**1.35 (1.14-1.59)**	**1.33 (1.13-1.58)**	**1.33 (1.12-1.57)**	**1.34 (1.13-1.59)**
Quebec		**0.71 (0.61-0.87)**	**0.69 (0.57-0.82)**	**0.69 (0.55-0.87)**	**0.71 (0.60-0.86)**

Table 3a. Multivariable analysis of the association between depressive symptoms and low executive function in participants with higher social support availability, Canadian Longitudinal Study on Aging, n=21,580, 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)	**Model E** OR (95% CI)
Urban residence (vs. rural)		0.85 (0.70-1.03)	0.84 (0.69-1.03)	0.85 (0.70-1.04)	0.84 (0.69-1.03)
Self-rated general health (vs. poor/fair)					
Good			**0.73 (0.61-0.88)**	**0.73 (0.61-0.87)**	**0.74 (0.62-0.88)**
Very good			**0.52 (0.43-0.62)**	**0.51 (0.43-0.62)**	**0.53 (0.44-0.64)**
Excellent			**0.47 (0.37-0.58)**	**0.47 (0.37-0.58)**	**0.48 (0.38-0.60)**
Chronic conditions (yes vs. no)[3]			1.34 (0.98-1.31)	1.13 (0.98-1.31)	1.14 (0.98-1.32)
Medication for depression (yes vs. no)			1.04 (0.85-1.27)	1.05 (0.86-1.28)	1.03 (0.84-1.27)
Marital status (vs. single)					
Married/common-law				1.01 (0.79-1.29)	1.01 (0.79-1.29)
Widowed				1.11 (0.86-1.44)	1.12 (0.86-1.45)
Divorced/separated				**0.76 (0.58-0.98)**	0.77 (0.59-1.00)
Smoking status (vs. never)					
Current					1.04 (0.83-1.30)
Former					**0.84 (0.74-0.96)**
Alcohol use (vs. never)					
Current					0.72 (0.52-1.00)
Former					1.02 (0.71-1.44)

[1]Low executive function was defined as a score ≥ 1.5 SD below the mean of the cognitively healthy sample.
[2]Presence of depressive symptoms was defined as a score ≥ 10 on the CES-D10.
[3]Chronic conditions were defined as the presence of at least 1 of 11 self-reported medical conditions.
Abbreviations: CI = confidence interval; OR = odds ratio
Statistically significant values are **bolded** ($p<0.05$)

Table 3b. Multivariable analysis of the association between depressive symptoms and low executive function in participants with low social support availability, Canadian Longitudinal Study on Aging, n=1,489

	Low Executive Function[1]				
	Model A OR (95% CI)	**Model B** OR (95% CI)	**Model C** OR (95% CI)	**Model D** OR (95% CI)	**Model E** OR (95% CI)
Presence of depressive symptoms[2]	1.10 (0.79-1.52)	0.95 (0.67-1.33)	0.82 (0.57-1.17)	0.80 (0.55-1.15)	0.77 (0.53-1.11)
Age, groups (vs. 45–54 years)					
55–64 years		1.63 (0.95-2.81)	1.55 (0.89-2.68)	1.43 (0.82-2.51)	1.46 (0.84-2.53)
65–74 years		**2.87 (1.65-5.00)**	**2.86 (1.62-5.04)**	**2.49 (1.37-4.52)**	**2.67 (1.48-4.82)**
75 years and over		**5.25 (3.02-9.14)**	**5.24 (2.98-9.23)**	**4.35 (2.39-7.92)**	**4.63 (2.52-8.51)**
Female vs. male		**0.69 (0.49-0.95)**	**0.70 (0.50-0.97)**	**0.66 (0.47-0.92)**	**0.60 (0.43-0.85)**
Education (vs. less than high school)					
High school graduate		**0.41 (0.21-0.78)**	**0.45 (0.23-0.85)**	**0.44 (0.23-0.86)**	**0.46 (0.24-0.88)**
Some post-secondary		**0.37 (0.20-0.69)**	**0.40 (0.22-0.75)**	**0.42 (0.22-0.79)**	0.63 (0.37-1.07)
Post-secondary degree/diploma		**0.32 (0.19-0.51)**	**0.34 (0.21-0.54)**	**0.35 (0.21-0.56)**	**0.21 (0.08-0.50)**
Annual household income (vs. < $20,000)					
≥$20,000 and <$50,000		0.81 (0.54-1.21)	0.87 (0.58-1.31)	0.78 (0.51-1.56)	0.82 (0.54-1.25)
≥$50,000 and <$100,000		**0.57 (0.36-0.89)**	0.65 (0.41-1.03)	**0.55 (0.32-0.92)**	0.63 (0.37-1.07)
≥$100,000		**0.19 (0.09-0.41)**	**0.23 (0.11-0.50)**	**0.17 (0.07-0.42)**	**0.21 (0.08-0.50)**
Province (vs. Ontario)					
Alberta & Manitoba		0.91 (0.57-1.48)	0.92 (0.57-1.49)	0.90 (0.55-1.47)	0.88 (0.53-1.45)
British Columbia		0.64 (0.40-1.01)	0.62 (0.39-1.00)	**0.61 (0.38-0.98)**	**0.58 (0.36-0.93)**
Newfoundland and Labrador & Nova Scotia		1.19 (0.69-2.06)	1.21 (0.70-2.09)	1.22 (0.71-2.12)	1.21 (0.70-2.10)
Quebec		0.64 (0.40-1.04)	0.63 (0.39-1.02)	0.64 (0.39-1.05)	0.67 (0.41-1.09)

Table 3b. Multivariable analysis of the association between depressive symptoms and low executive function in participants with low social support availability, Canadian Longitudinal Study on Aging, n=1,489, 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)	**Model E** OR (95% CI)
Urban residence (vs. rural)		0.66 (0.34-1.29)	0.64 (0.32-1.27)	0.67 (0.34-1.32)	0.64 (0.32-1.26)
Self-rated general health (vs. poor/fair)					
Good			**0.64 (0.43-0.96)**	**0.65 (0.43-0.98)**	**0.66 (0.44-0.99)**
Very good			**0.51 (0.32-0.82)**	**0.51 (0.32-0.81)**	**0.53 (0.33-0.85)**
Excellent			**0.39 (0.20-0.73)**	**0.39 (0.20-0.73)**	**0.43 (0.23-0.81)**
Chronic conditions (yes vs. no)[3]			1.40 (0.88-2.22)	1.36 (0.85-2.18)	1.36 (0.85-2.17)
Medication for depression (yes vs. no)			0.96 (0.58-1.59)	0.99 (0.60-1.65)	1.04 (0.63-1.72)
Marital status (vs. single)					
Married/common-law				**1.83 (1.03-3.25)**	**1.78 (1.01-3.12)**
Widowed				**1.96 (1.13-3.38)**	**2.00 (1.14-3.50)**
Divorced/separated				1.35 (0.84-2.14)	1.39 (0.87-2.23)
Smoking status (vs. never)					
Current					1.09 (0.66-1.79)
Former					0.78 (0.53-1.13)
Alcohol use (vs. never)					
Current					0.44 (0.18-1.08)
Former					0.96 (0.38-2.42)

[1]Low executive function was defined as a score ≥ 1.5 SD below the mean of the cognitively healthy sample.
[2]Presence of depressive symptoms was defined as a score ≥ 10 on the CES-D10.
[3]Chronic conditions were defined as the presence of 1 of 11 self-reported medical conditions.
Abbreviations: CI = confidence interval; OR = odds ratio
Statistically significant values are **bolded** ($p<0.05$)

5.2 Research question 2: Does the association between the presence of depressive symptoms and low executive function differ across age groups?

Descriptive results for age-stratified analyses are presented in Tables 4a–4b. Results for the age-stratified multivariable analyses are presented in Tables 5a–5e.

5.2.1 Descriptive analyses for the association between depressive symptoms and low executive function across age groups

Across age-stratified descriptive results, depressive symptoms were significantly associated with low executive function in both unweighted and weighted data (Tables 4a–4d; $p<0.001$). Overall, there was a significant difference in the frequency of those who reported depressive symptoms versus not. Those with depressive symptoms were more likely to have low executive function in all models.

5.2.2 Descriptive analyses for the association between covariates and low executive function across age groups

Across all age-stratified descriptive analyses, sex was significantly associated with low executive function only in those 65–74 years of age (unweighted: $p<0.05$; weighted: $p<0.001$). Results from other sociodemographic covariates, and health covariates and health behaviours were consistent with unstratified descriptive results presented in Table 2. Across age groups, the influence of social factors was notable. Marital status was significantly associated with low executive function and participants were most likely to report being married or in a common-law relationship for all age groups. The highest proportion of those reporting to be widowed were 75 years and over. In those 75 years and over, 33.53% of widowers had low executive function, but they accounted for 26.94% of the analytic sample. In addition, low SSA was significant in all models. Most notably, those 75 years and over were more likely to report low SSA (9.60%) than any other age group. Of those 75 years and over with low SSA, 11.60% had low executive function.

Table 4a. Distribution of depressive symptoms and covariates by low executive function status in adults 45–54 years of age, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=6,202)			Weighted Frequency (n=1,262,580)		
	Executive Function					
	Low (n=198)	Not Low (n=6,004)	Total	Low (n=37,042)	Not Low (n=1,225,538)	Total
Depressive symptoms[1] (%)						
Presence	33.84	15.67***	16.25	30.03	14.74***	15.19
Absence	66.16	84.33	83.75	69.97	85.26	84.81
Sociodemographic Factors						
Sex (%)						
Female	48.48	51.75	51.64	43.12	48.30	48.15
Male	51.52	48.25	48.36	56.88	51.70	51.70
Education (%)						
Less than high school	13.13	1.83***	2.19	14.69	1.89***	2.26
High school graduate	15.66	6.53	6.82	16.56	6.50	6.79
Some post-secondary	8.08	5.43	5.51	7.51	5.38	5.44
Post-secondary degree/diploma	63.13	86.21	85.47	61.25	86.24	85.50
Annual household income (%)						
< $20,000	12.12	3.16***	3.45	10.99	2.74***	2.98
≥ $20,000 and < $50,000	30.81	9.44	10.13	31.66	8.74	9.41
≥ $50,000 and < $100,000	28.79	28.13	28.15	28.53	27.54	27.57
≥ $100,000 and < $150,000	16.16	28.05	27.67	15.15	29.06	28.65
≥ $150,000	12.12	31.21	30.60	13.66	31.91	31.38
Province (%)						
Ontario	18.69	21.12	21.04	11.59	12.89	12.85
Alberta	8.08	8.53	8.51	13.44	13.12	13.13
British Columbia	19.19	21.94	21.85	24.57	31.46	31.26
Manitoba	11.62	10.58	10.61	8.77	8.50	8.51
NFLD	7.58	8.29	8.27	2.27	2.43	2.42
Nova Scotia	15.15	10.56	10.71	5.90	3.71	3.78
Quebec	19.70	18.99	19.01	33.46	27.88	28.05
Urban/rural residence (%)						
Urban	85.86	89.29	89.18	87.61	90.35	90.27
Rural	14.14	10.71	10.82	12.39	9.65	9.73

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table 4a. Distribution of depressive symptoms and covariates by low executive function status in adults 45–54 years of age, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=6,202)			Weighted Frequency (n=1,262,580)		
	Executive Function					
	Low (n=198)	Not Low (n=6,004)	Total	Low (n=37,042)	Not Low (n=1,225,538)	Total
Health Factors						
Self-rated general health (%)						
Poor	4.04	1.15***	1.24	3.12	0.96***	1.02
Fair	15.66	6.56	6.85	12.94	6.41	6.60
Good	40.91	28.26	28.67	43.64	29.03	29.46
Very good	30.30	43.09	42.68	30.28	42.34	41.99
Excellent	9.09	20.94	20.56	10.02	21.26	20.93
Medication for depression (%)						
Yes	14.14	8.91*	9.08	13.21	8.31*	8.46
No	85.86	91.09	90.92	86.79	91.69	91.54
Chronic conditions[2] (%)						
Yes	63.13	48.85***	49.31	60.65	48.10**	48.47
No	36.87	51.15	50.69	39.35	51.90	51.53
Social Factors						
Marital status (%)						
Single, never married	20.20	10.91***	11.21	16.36	9.22***	9.43
Married/common-law	64.14	76.97	76.56	70.75	81.79	81.47
Widowed	2.02	0.97	1.00	1.94	0.63	0.67
Divorced/separated	13.64	11.16	11.24	10.95	8.36	8.43
Low SSA (%)						
Yes	12.12	4.80***	5.03	9.42	4.25**	4.41
No	87.88	95.20	94.97	90.58	95.75	95.59
Health Behaviours						
Smoking status (%)						
Current	19.70	10.93***	11.21	16.22	10.32	10.49
Former	45.96	52.38	52.18	47.62	51.65	51.53
Never	34.34	36.69	36.62	36.15	38.03	37.98
Alcohol use (%)						
Current	79.80	89.02***	88.73	77.55	88.58***	88.25
Former	17.17	9.14	9.40	19.11	9.70	9.97
Never	3.03	1.83	1.87	3.34	1.72	1.77

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
Abbreviations: SSA = social support availability
*p<0.05; **p<0.01; ***p<0.001

Table 4b. Distribution of depressive symptoms and covariates by low executive function status in adults 55–64 years of age, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=7,747)			Weighted Frequency (n=870,453)		
	Executive Function					
	Low (n=402)	Not Low (n=7,345)	Total	Low (n=38,310)	Not Low (n=832,142)	Total
Depressive symptoms[1] (%)						
Presence	31.34	14.70***	15.57	29.15	14.06***	14.73
Absence	68.66	85.30	84.43	70.85	85.94	85.27
Sociodemographic Factors						
Sex (%)						
Female	49.75	51.49	51.40	46.37	49.95	49.80
Male	50.25	48.51	48.60	53.63	50.05	50.20
Education (%)						
Less than high school	10.45	2.80***	3.20	11.31	3.00***	3.37
High school graduate	15.17	8.51	8.86	14.84	8.77	9.04
Some post-secondary	11.19	7.77	7.95	12.81	7.53	7.76
Post-secondary degree/diploma	63.18	80.91	79.99	61.03	80.70	79.84
Annual household income (%)						
< $20,000	16.92	4.08***	4.75	14.54	3.79***	4.27
≥ $20,000 and < $50,000	34.58	16.83	17.75	32.59	16.05	16.77
≥ $50,000 and < $100,000	29.85	35.74	35.43	33.39	36.07	35.96
≥ $100,000 and < $150,000	10.95	22.63	22.02	10.63	22.67	22.14
≥ $150,000	7.71	20.72	20.05	8.86	21.41	20.86
Province (%)						
Ontario	23.38	22.06***	22.12	16.19	13.54**	13.65
Alberta	5.97	9.19	9.02	8.04	11.16	11.02
British Columbia	16.92	21.80	21.54	28.59	32.81	32.62
Manitoba	12.69	10.80	10.89	11.10	8.44	8.56
NFLD	12.44	7.49	7.74	4.21	2.18	2.27
Nova Scotia	12.19	10.12	10.22	5.30	3.58	3.66
Quebec	16.42	18.56	18.45	26.57	28.29	28.21
Urban/rural residence (%)						
Urban	90.05	89.83	89.84	88.13	89.89	89.81
Rural	9.95	10.17	10.16	11.87	10.11	10.19

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table 4b. Distribution of depressive symptoms and covariates by low executive function status in adults 55–64 years of age, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=7,747)			Weighted Frequency (n=870,453)		
	Executive Function					
	Low (n=402)	Not Low (n=7,345)	Total	Low (n=38,310)	Not Low (n=832,142)	Total
Health Factors						
Self-rated general health (%)						
Poor	5.47	1.27***	1.48	5.21	1.15***	1.33
Fair	17.41	6.63	7.19	16.14	6.78	7.19
Good	36.32	28.41	28.82	36.22	28.10	28.46
Very good	28.11	42.45	41.71	28.75	41.86	41.28
Excellent	12.69	21.24	20.80	13.68	22.11	21.74
Medication for depression (%)						
Yes	16.17	9.45***	9.80	14.95	9.25**	9.50
No	83.83	90.55	90.20	85.05	90.75	90.50
Chronic conditions[2] (%)						
Yes	76.37	64.19***	64.83	74.84	63.58***	64.08
No	23.63	35.81	35.17	25.16	36.42	35.92
Social Factors						
Marital status (%)						
Single, never married	12.94	9.31***	9.50	7.24	5.35***	5.53
Married/common-law	59.20	73.82	73.06	64.85	73.87	72.86
Widowed	6.47	4.02	4.14	13.27	8.15	8.72
Divorced/separated	21.39	12.85	13.30	14.63	12.66	12.88
Low SSA (%)						
Yes	15.17	5.84***	6.33	13.89	5.02***	5.41
No	84.83	94.16	93.67	86.11	94.98	94.59
Health Behaviours						
Smoking status (%)						
Current	17.66	9.42***	9.85	17.36	9.23***	9.59
Former	52.99	60.45	60.06	54.05	60.62	60.33
Never	29.35	30.13	30.09	28.59	30.15	30.08
Alcohol use (%)						
Current	75.93	88.60***	87.93	76.52	88.53***	88.01
Former	20.90	9.67	10.25	20.46	9.66	10.14
Never	3.48	1.73	1.82	3.01	1.80	1.86

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
Abbreviations: SSA = social support availability
*p<0.05; **p<0.01; ***p<0.001

Table 4c. Distribution of depressive symptoms and covariates by low executive function status in adults 65–74 years of age, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=5,464)			Weighted Frequency (n=471,051)		
	Executive Function					
	Low (n=675)	Not Low (n=4,789)	Total	Low (n=52,947)	Not Low (n=418,104)	Total
Depressive symptoms[1] (%)						
Presence	21.19	12.57***	13.63	20.72	12.43***	13.36
Absence	78.81	87.43	86.37	79.28	87.57	86.64
Sociodemographic Factors						
Sex (%)						
Female	53.48	48.74*	49.32	59.58	52.59**	53.38
Male	46.52	51.26	50.68	40.42	47.41	46.62
Education (%)						
Less than high school	17.19	5.26***	6.73	21.98	5.74***	7.56
High school graduate	12.74	9.69	10.07	12.92	9.91	10.24
Some post-secondary	8.00	8.04	8.03	7.55	8.14	8.07
Post-secondary degree/diploma	62.07	77.01	75.16	57.55	76.21	74.12
Annual household income (%)						
< $20,000	13.78	5.16***	6.22	14.20	4.76***	5.82
≥ $20,000 and < $50,000	43.56	28.65	30.49	46.21	28.73	30.69
≥ $50,000 and < $100,000	31.56	42.35	41.01	28.88	42.84	41.27
≥ $100,000 and < $150,000	7.70	15.41	14.46	7.16	15.34	14.42
≥ $150,000	3.41	8.44	7.81	3.53	8.32	7.79
Province (%)						
Ontario	20.15	21.90***	21.69	16.09	15.84***	15.87
Alberta	7.85	8.58	8.49	7.92	8.12	8.10
British Columbia	14.07	22.24	21.23	20.66	31.71	30.47
Manitoba	9.48	10.52	10.40	8.16	8.38	8.36
NFLD	14.07	6.93	7.81	4.94	2.19	2.50
Nova Scotia	12.44	11.51	11.62	4.34	3.55	3.64
Quebec	21.93	18.31	18.76	37.90	30.20	31.07
Urban/rural residence (%)						
Urban	89.48	90.98	90.79	87.42	90.58*	90.22
Rural	10.52	9.02	9.21	12.58	9.42	9.78

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table 4c. Distribution of depressive symptoms and covariates by low executive function status in adults 65–74 years of age, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=5,464)			Weighted Frequency (n=471,051)		
	Executive Function					
	Low (n=675)	Not Low (n=4,789)	Total	Low (n=52,947)	Not Low (n=418,104)	Total
Health Factors						
Self-rated general health (%)						
Poor	2.37	1.27***	1.41	2.52	1.18***	1.33
Fair	13.93	5.35	6.41	15.14	5.31	6.42
Good	34.37	28.15	28.92	36.03	28.88	29.68
Very good	34.81	42.74	41.76	32.57	41.23	40.26
Excellent	14.52	22.49	21.50	13.74	23.40	22.32
Medication for depression (%)						
Yes	9.63	7.16*	7.47	9.95	6.59**	6.97
No	90.37	92.84	92.53	90.05	93.41	93.03
Chronic conditions[2] (%)						
Yes	81.33	76.49**	77.09	80.77	75.88*	76.43
No	18.67	23.51	22.91	19.23	24.12	23.57
Social Factors						
Marital status (%)						
Single, never married	7.26	6.20***	6.33	7.24	5.32***	5.53
Married/common-law	60.89	68.68	67.72	64.85	73.87	72.86
Widowed	15.26	10.23	10.85	13.27	8.15	8.72
Divorced/separated	16.59	14.89	15.10	14.63	12.66	12.88
Low SSA (%)						
Yes	9.78	5.64***	6.15	8.94	5.29***	5.70
No	90.22	94.36	93.85	91.06	94.71	94.30
Health Behaviours						
Smoking status (%)						
Current	10.81	5.70***	6.33	10.40	5.09***	5.69
Former	61.93	65.21	64.81	61.43	64.42	64.09
Never	27.26	29.09	28.86	28.17	30.48	30.22
Alcohol use (%)						
Current	77.19	88.37***	86.99	75.50	88.56***	87.09
Former	19.41	9.92	11.09	20.93	9.87	11.11
Never	3.41	1.71	1.92	3.57	1.57	1.79

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
Abbreviations: SSA = social support availability
*p<0.05; **p<0.01; ***p<0.001

Table 4d. Distribution of depressive symptoms and covariates by low executive function status in adults 75 years and over, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=3,656)			Weighted Frequency (n=285,714)		
	Executive Function					
	Low (n=1,026)	Not Low (n=2,630)	Total	Low (n=74,855)	Not Low (n=210,859)	Total
Depressive symptoms[1] (%)						
Presence	20.96	13.04***	15.26	20.95	13.43***	15.40
Absence	79.04	86.96	84.74	79.05	86.57	84.60
Sociodemographic Factors						
Sex (%)						
Female	49.22	48.17	48.47	53.24	53.49	53.43
Male	50.78	51.83	51.53	46.76	46.51	46.57
Education (%)						
Less than high school	20.18	8.63***	11.87	24.43	10.73***	14.32
High school graduate	15.01	10.57	11.82	15.04	10.88	11.97
Some post-secondary	8.77	9.16	9.05	7.22	8.68	8.30
Post-secondary degree/diploma	56.04	71.63	67.26	53.13	69.71	65.41
Annual household income (%)						
< $20,000	11.21	6.12***	7.55	12.57	6.48***	8.07
≥ $20,000 and < $50,000	46.30	34.17	37.96	49.04	36.64	39.89
≥ $50,000 and < $100,000	32.36	41.10	38.65	29.51	39.49	36.88
≥ $100,000 and < $150,000	6.34	13.12	11.12	5.76	12.49	10.73
≥ $150,000	3.80	4.94	4.62	3.12	4.89	4.43
Province (%)						
Ontario	21.05	22.09***	21.80	12.38	11.64***	11.84
Alberta	8.19	7.87	7.96	7.51	6.92	7.08
British Columbia	18.52	25.29	23.39	25.29	32.34	30.49
Manitoba	12.28	10.15	10.75	11.68	8.94	9.66
NFLD	9.55	6.73	7.52	2.68	1.66	1.92
Nova Scotia	11.70	9.66	10.23	4.00	3.14	3.37
Quebec	18.71	18.21	18.35	36.46	35.35	35.65
Urban/rural residence (%)						
Urban	92.69	94.37	93.90	92.09	93.57	93.18
Rural	7.31	5.63	6.10	7.91	6.43	6.82

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table 4d. Distribution of depressive symptoms and covariates by low executive function status in adults 75 years and over, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=3,656)			Weighted Frequency (n=285,714)		
	Executive Function					
	Low (n=1,026)	Not Low (n=2,630)	Total	Low (n=74,855)	Not Low (n=210,859)	Total
Health Factors						
Self-rated general health (%)						
Poor	2.24	1.03***	1.37	2.71	0.93***	1.40
Fair	12.87	7.30	8.86	13.47	6.66	8.44
Good	38.21	29.51	31.95	41.47	32.01	34.49
Very good	34.50	42.51	40.26	32.17	41.71	39.21
Excellent	12.18	19.66	17.56	10.18	18.69	16.46
Medication for depression (%)						
Yes	4.68	4.03	4.21	4.86	4.30	4.45
No	95.32	95.97	95.79	95.14	95.70	95.55
Chronic conditions[2] (%)						
Yes	88.21	85.67*	86.38	88.87	86.72	87.28
No	11.79	14.33	13.62	11.13	13.28	12.72
Social Factors						
Marital status (%)						
Single, never married	4.58	5.02***	4.90	3.82	4.81***	4.55
Married/common-law	51.07	58.56	56.46	55.73	62.06	60.41
Widowed	33.53	24.37	26.94	29.53	21.86	23.87
Divorced/separated	10.82	12.05	11.71	10.91	11.26	11.17
Low SSA (%)						
Yes	11.60	8.82*	9.60	10.42	7.74*	8.44
No	88.10	91.18	90.40	89.58	92.26	91.56
Health Behaviours						
Smoking status (%)						
Current	4.78	3.16*	3.61	4.36	3.16	3.48
Former	62.87	67.03	65.86	62.11	66.17	65.11
Never	32.36	29.81	30.53	33.53	30.67	31.42
Alcohol use (%)						
Current	77.97	84.26***	82.49	79.41	85.05**	83.57
Former	18.03	13.16	14.52	17.31	12.76	13.95
Never	4.00	2.59	2.98	3.27	2.19	2.48

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
Abbreviations: SSA = social support availability
*p<0.05; **p<0.01; ***p<0.001

5.2.3 Multivariable regression analyses for the association between depressive symptoms and low executive function across age groups younger than 75 years

As a result of significant first-order interactions between the depressive symptoms and some covariates, the 75 years and over age group had to be further stratified by SSA. To reduce the number of significant interactions, some levels of multilevel variables (i.e., province, income, self-rated general health) were combined in these models. For comparison across age groups, attempts to stratify the other age groups by SSA were made. However, this was not possible due to further issues with significant interactions and limited sample sizes within some cells that precluded conducting further stratification.

5.2.3.1 Depressive symptoms and low executive function across age groups younger than 75 years

For those 45–54 years old, depressive symptoms were significantly associated with low executive function in the crude model (Table 5a, OR=2.75, 95% CI=1.99–3.80). The association remained significant after the inclusion of each new chunk of covariates, where, in the final model, depressive symptoms were associated with greater odds of low executive function (OR=1.57, 95% CI=1.08–2.29). This pattern of results was also observed among those 55–64 years (Table 5b, OR=1.39, 95% CI=1.04–1.85). For those 65–74 years, there was a positive association that became nonsignificant following the inclusion of health covariates (Table 5c).

5.2.3.2 Covariates and low executive function across age groups younger than 75 years

Sex was significantly associated with low executive function in those 55–64 years (OR=1.39, 85% CI=1.04–1.85). Although sex was not significant in the 45–54 and 65–74 age groups, all models displayed a similar pattern: compared to males, females had lower odds of low executive function (Tables 5a–5c). Results from other sociodemographic and health covariates were largely similar to what has been already presented.

Although the social covariates were not significant across models, the direction of the association differed across age groups for both marital status and SSA. For example, in those 45–54 years, compared to being single, being widowed was negatively associated with low executive function. In those 55–64 years and 65–74 years, being widowed was positively associated with low executive function. The covariates classified as health behaviours were not significantly associated with low executive function. However, current drinkers, compared to never drinkers, had lower odds of low executive function in the 45–54, 55–64, and 65–74-year age groups.

Table 5a. Multivariable analysis of the association between depressive symptoms and low executive function in 45–54-year olds, Canadian Longitudinal Study on Aging, n=6,202

	Low Executive Function[1]				
	Model A OR (95% CI)	**Model B** OR (95% CI)	**Model C** OR (95% CI)	**Model D** OR (95% CI)	**Model E** OR (95% CI)
Presence of depressive symptoms[2]	**2.75 (1.99-3.80)**	**1.72 (1.20-2.46)**	**1.54 (1.08-2.22)**	**1.56 (1.07-2.28)**	**1.57 (1.08-2.29)**
Female vs. male		**0.72 (0.52-0.98)**	0.74 (0.53-1.02)	0.76 (0.55-1.05)	0.75 (0.54-1.04)
Education (vs. less than high school)					
High school graduate		0.54 (0.28-1.03)	0.56 (0.29-1.09)	0.57 (0.30-1.10)	0.55 (0.29-1.06)
Some post-secondary		**0.31 (0.15-0.66)**	**0.34 (0.16-0.71)**	**0.35 (0.17-0.74)**	**0.34 (0.16-0.72)**
Post-secondary degree/diploma		**0.22 (0.13-0.39)**	**0.24 (0.14-0.42)**	**0.25 (0.14-0.44)**	**0.23 (0.13-0.41)**
Annual household income (vs. < $20,000)					
≥$20,000 and <$50,000		1.10 (0.61-1.98)	1.16 (0.65-2.07)	1.10 (0.59-2.03)	1.12 (0.61-2.07)
≥$50,000 and <$100,000		**0.38 (0.21-0.70)**	**0.42 (0.23-0.76)**	**0.37 (0.19-0.73)**	**0.39 (0.20-0.76)**
≥$100,000		**0.20 (0.11-0.36)**	**0.23 (0.13-0.42)**	**0.20 (0.10-0.40)**	**0.21 (0.10-0.42)**
Province (vs. Ontario)					
Alberta & Manitoba		1.24 (0.74-2.09)	1.24 (0.73-2.09)	1.23 (0.73-2.08)	1.22 (0.72-1.35)
British Columbia		0.85 (0.51-1.42)	0.84 (0.50-1.40)	0.83 (0.50-1.39)	0.80 (0.47-1.35)
Newfoundland and Labrador & Nova Scotia		1.38 (0.85-2.22)	1.41 (0.87-2.28)	1.42 (0.87-2.30)	1.45 (0.89-2.36)
Quebec		0.94 (0.58-1.54)	0.92 (0.56-1.51)	0.92 (0.56-1.51)	0.93 (0.56-1.53)
Urban residence (vs. rural)		0.68 (0.42-1.08)	0.68 (0.43-1.10)	0.71 (0.44-1.15)	0.71 (0.44-1.15)

Table 5a. Multivariable analysis of the association between depressive symptoms and low executive function in 45–54-year olds, Canadian Longitudinal Study on Aging, n=6,202, 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)	**Model E** OR (95% CI)
Self-rated general health (vs. poor/fair)					
Good			0.97 (0.62-1.51)	0.97 (0.62-1.51)	0.97 (0.62-1.51)
Very good			0.69 (0.42-1.12)	0.69 (0.42-1.13)	0.68 (0.42-1.11)
Excellent			**0.52 (0.27-0.99)**	0.53 (0.27-1.01)	0.52 (0.27-1.00)
Chronic conditions (yes vs. no)[3]			1.21 (0.87-1.68)	1.20 (0.87-1.67)	1.19 (0.85-1.66)
Medication for depression (yes vs. no)			0.91 (0.58-1.44)	0.92 (0.58-1.45)	0.91 (0.58-1.44)
Marital status (vs. single)					
Married/common-law				1.14 (0.69-1.89)	1.10 (0.67-1.81)
Widowed				0.89 (0.28-2.84)	0.89 (0.28-2.85)
Divorced/separated				0.72 (0.41-1.26)	0.72 (0.41-1.27)
Low social support availability (yes vs. no)[4]				1.05 (0.58-1.89)	1.03 (0.58-1.84)
Smoking status (vs. never)					
Current					0.76 (0.46-1.23)
Former					0.80 (0.55-1.15)
Alcohol use (vs. never)					
Current					0.80 (0.34-1.84)
Former					1.10 (0.34-1.84)

[1]Low executive function was defined as a score ≥ 1.5 SD below the mean of the cognitively healthy sample.
[2]Presence of depressive symptoms was defined as a score ≥ 10 on the CES-D10.
[3]Chronic conditions were defined as the presence of at least 1 of 11 self-reported medical conditions.
[4]Low social support availability was defined as an average score of ≤ 3 on the MOS-SSS.
Abbreviations: CI = confidence interval; OR = odds ratio
Statistically significant values are **bolded** ($p<0.05$)

Table 5b. Multivariable analysis of the association between depressive symptoms and low executive function in 55–64-year olds, Canadian Longitudinal Study on Aging, n=7,747

	Low Executive Function[1]				
	Model A OR (95% CI)	**Model B** OR (95% CI)	**Model C** OR (95% CI)	**Model D** OR (95% CI)	**Model E** OR (95% CI)
Presence of depressive symptoms[2]	**2.71 (2.15-3.43)**	**1.80 (1.39-2.32)**	**1.44 (1.10-1.91)**	**1.40 (1.07-1.88)**	**1.39 (1.04-1.85)**
Female vs. male		**0.76 (0.60-0.94)**	**0.77 (0.62-0.97)**	**0.77 (0.61-0.98)**	**0.77 (0.61-0.97)**
Education (vs. less than high school)					
High school graduate		0.78 (0.48-1.27)	0.84 (0.52-1.37)	0.85 (0.52-1.39)	0.85 (0.52-1.37)
Some post-secondary		**0.56 (0.34-0.95)**	0.59 (0.35-1.01)	0.60 (0.35-1.01)	0.61 (0.36-1.03)
Post-secondary degree/diploma		**0.38 (0.25-0.58)**	**0.41 (0.27-0.63)**	**0.41 (0.27-0.64)**	**0.42 (0.28-0.64)**
Annual household income (vs. < $20,000)					
≥$20,000 and <$50,000		**0.60 (0.43-0.85)**	**0.67 (0.47-0.95)**	**0.66 (0.46-0.96)**	0.70 (0.48-1.01)
≥$50,000 and <$100,000		**0.26 (0.18-0.37)**	**0.31 (0.21-0.44)**	**0.30 (0.20-0.46)**	**0.35 (0.23-0.53)**
≥$100,000		**0.14 (0.09-0.20)**	**0.17 (0.11-0.26)**	**0.17 (0.10-0.27)**	**0.20 (0.12-0.32)**
Province (vs. Ontario)					
Alberta & Manitoba		0.84 (0.60-1.18)	0.83 (0.59-1.17)	0.83 (0.59-1.18)	0.83 (0.59-1.18)
British Columbia		**0.69 (0.49-0.98)**	**0.69 (0.48-0.97)**	**0.69 (0.48-0.98)**	**0.68 (0.47-0.95)**
Newfoundland and Labrador & Nova Scotia		1.31 (0.96-1.79)	1.31 (0.96-1.80)	1.32 (0.96-1.81)	1.32 (0.96-1.81)
Quebec		**0.51 (0.35-0.73)**	**0.51 (0.35-0.74)**	**0.52 (0.36-0.76)**	**0.55 (0.38-0.80)**
Urban residence (vs. rural)		1.07 (0.73-1.56)	1.04 (0.72-1.52)	1.05 (0.72-1.53)	1.06 (0.73-1.55)

Table 5b. Multivariable analysis of the association between depressive symptoms and low executive function in 55–64-year olds, Canadian Longitudinal Study on Aging, n=7,747, 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)	**Model E** OR (95% CI)
Self-rated general health (vs. poor/fair)					
Good			**0.64 (0.47-0.87)**	**0.65 (0.48-0.88)**	**0.66 (0.49-0.90)**
Very good			**0.45 (0.32-0.64)**	**0.46 (0.32-0.65)**	**0.47 (0.33-0.81)**
Excellent			**0.51 (0.33-0.77)**	**0.51 (0.34-0.78)**	**0.54 (0.35-0.81)**
Chronic conditions (yes vs. no)[3]			**1.31 (1.01-1.71)**	1.31 (1.00-1.70)	1.30 (1.00-1.69)
Medication for depression (yes vs. no)			1.11 (0.81-1.52)	1.11 (0.81-1.52)	1.09 (0.80-1.49)
Marital status (vs. single)					
Married/common-law				1.18 (0.80-1.74)	1.16 (0.79-1.72)
Widowed				1.32 (0.76-2.30)	1.36 (0.78-2.38)
Divorced/separated				1.15 (0.77-1.72)	1.18 (0.79-1.76)
Low social support availability (yes vs. no)[4]				1.20 (0.83-1.73)	1.14 (0.79-1.64)
Smoking status (vs. never)					
Current					1.19 (0.83-1.71)
Former					0.85 (0.65-1.11)
Alcohol use (vs. never)					
Current					0.61 (0.33-1.13)
Former					1.04 (0.55-1.98)

[1]Low executive function was defined as a score ≥ 1.5 SD below the mean of the cognitively healthy sample.
[2]Presence of depressive symptoms was defined as a score ≥ 10 on the CES-D10.
[3]Chronic conditions were defined as the presence of at least 1 of 11 self-reported medical conditions.
[4]Low social support availability was defined as an average score of ≤ 3 on the MOS-SSS.
Abbreviations: CI = confidence interval; OR = odds ratio
Statistically significant values are **bolded** ($p<0.05$)

Table 5c. Multivariable analysis of the association between depressive symptoms and low executive function in 65–74-year olds, Canadian Longitudinal Study on Aging, n=5,464

	Low Executive Function[1]				
	Model A OR (95% CI)	**Model B** OR (95% CI)	**Model C** OR (95% CI)	**Model D** OR (95% CI)	**Model E** OR (95% CI)
Presence of depressive symptoms[2]	**1.63 (1.30-2.04)**	**1.32 (1.03-1.67)**	1.08 (0.83-1.40)	1.05 (0.80-1.38)	1.06 (0.81-1.39)
Female vs. male		0.97 (0.81-1.16)	1.01 (0.84-1.22)	1.04 (0.86-1.26)	1.02 (0.84-1.24)
Education (vs. less than high school)					
High school graduate		**0.46 (0.33-0.65)**	**0.48 (0.34-0.68)**	**0.49 (0.35-0.70)**	**0.50 (0.35-0.71)**
Some post-secondary		**0.39 (0.26-0.57)**	**0.40 (0.27-0.60)**	**0.42 (0.28-0.62)**	**0.43 (0.28-0.62)**
Post-secondary degree/diploma		**0.35 (0.27-0.46)**	**0.37 (0.28-0.49)**	**0.39 (0.30-0.52)**	**0.40 (0.31-0.53)**
Annual household income (vs. < $20,000)					
≥$20,000 and <$50,000		**0.57 (0.43-0.77)**	**0.64 (0.47-0.86)**	**0.57 (0.42-0.79)**	**0.61 (0.44-0.85)**
≥$50,000 and <$100,000		**0.31 (0.23-0.42)**	**0.35 (0.26-0.49)**	**0.30 (0.21-0.43)**	**0.34 (0.23-0.48)**
≥$100,000		**0.21 (0.14-0.30)**	**0.25 (0.17-0.37)**	**0.21 (0.14-0.33)**	**0.24 (0.15-0.37)**
Province (vs. Ontario)					
Alberta & Manitoba		0.95 (0.71-1.26)	0.95 (0.72-1.27)	0.95 (0.71-1.27)	0.92 (0.69-1.23)
British Columbia		**0.65 (0.48-0.88)**	**0.65 (0.48-0.88)**	**0.65 (0.48-0.88)**	**0.63 (0.46-0.85)**
Newfoundland and Labrador & Nova Scotia		**1.52 (1.16-1.98)**	**1.53 (1.17-2.01)**	**1.54 (1.18-2.02)**	**1.54 (1.17-2.02)**
Quebec		0.83 (0.63-1.09)	0.82 (0.62-1.09)	0.83 (0.63-1.10)	0.86 (0.65-1.14)
Urban residence (vs. rural)		0.84 (0.63-1.11)	0.82 (0.62-1.10)	0.85 (0.64-1.13)	0.83 (0.63-1.11)

Table 5c. Multivariable analysis of the association between depressive symptoms and low executive function in 65–74-year olds, Canadian Longitudinal Study on Aging, n=5,464, 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)	**Model E** OR (95% CI)
Self-rated general health (vs. poor/fair)					
Good			**0.59 (0.44-0.80)**	**0.59 (0.44-0.80)**	**0.62 (0.46-0.83)**
Very good			**0.44 (0.33-0.60)**	**0.45 (0.33-0.61)**	**0.49 (0.36-0.66)**
Excellent			**0.40 (0.28-0.57)**	**0.40 (0.28-0.58)**	**0.43 (0.30-0.62)**
Chronic conditions (yes vs. no)[3]			1.00 (0.79-1.26)	0.99 (0.79-1.25)	0.99 (0.78-1.25)
Medication for depression (yes vs. no)			1.08 (0.77-1.51)	1.09 (0.78-1.53)	1.07 (0.77-1.50)
Marital status (vs. single)					
Married/common-law				1.27 (0.87-1.84)	1.31 (0.90-1.92)
Widowed				1.17 (0.77-1.76)	1.20 (0.79-1.83)
Divorced/separated				0.88 (0.59-1.30)	0.90 (0.61-1.34)
Low social support availability (yes vs. no)[4]				1.35 (0.94-1.93)	1.29 (0.90-1.84)
Smoking status (vs. never)					
Current					1.22 (0.86-1.73)
Former					0.90 (0.73-1.11)
Alcohol use (vs. never)					
Current					0.57 (0.34-0.95)
Former					1.01 (0.58-1.74)

[1]Low executive function was defined as a score ≥ 1.5 SD below the mean of the cognitively healthy sample.
[2]Presence of depressive symptoms was defined as a score ≥ 10 on the CES-D10.
[3]Chronic conditions were defined as the presence of at least 1 of 11 self-reported medical conditions.
[4]Low social support availability was defined as an average score of ≤ 3 on the MOS-SSS.
Abbreviations: CI = confidence interval; OR = odds ratio
Statistically significant values are **bolded** ($p<0.05$)

5.2.4 Multivariable regression analyses for the association between depressive symptoms and low executive function in the 75 years and over age group

As previously mentioned, the 75 years and over age group was further stratified by SSA due to significant interactions with SSA. The association between depressive symptoms and low executive function in those 75 years and over with higher SSA was significant in the crude model, and remained significant after the inclusion of all covariates (Table 5d, OR=1.50, 95% CI=1.17–1.93). In those 75 years and over with low SSA, there was a negative association between depressive symptoms and low executive function, although this did not reach significance (Table 5e). This pattern of results was also observed in the models that were stratified by SSA with all age groups combined (Table 3a and Table 3b).

In terms of covariates, for those 75 years and over, the association of sociodemographic and health covariates with low executive function, stratified by SSA (Tables 5d and 5e), were generally consistent with the results observed in the models stratified by SSA across all age groups combined (Tables 3a and 3b). Health behaviours were also consistent with the results from the models stratified by SSA across all age groups, with the exception of alcohol use. Alcohol use in the low SSA stratum showed notable differences from previously observed results. Both current and former drinkers with low SSA, compared to never drinkers, had greater odds of low executive function. Although these associations did not reach statistical significance, greater odds for low executive function in current alcohol drinkers were not observed in any other age-stratified or SSA-stratified models.

Table 5d. Multivariable analysis of the association between depressive symptoms and low executive function in the 75 years and over age group with higher social support availability, Canadian Longitudinal Study on Aging, n=3,305

	Low Executive Function[1]				
	Model A OR (95% CI)	**Model B** OR (95% CI)	**Model C** OR (95% CI)	**Model D** OR (95% CI)	**Model E** OR (95% CI)
Presence of depressive symptoms[2]	**1.94 (1.55-2.43)**	**1.77 (1.39-2.24)**	**1.50 (1.17-1.92)**	**1.48 (1.15-1.90)**	**1.50 (1.17-1.93)**
Female vs. male		0.83 (0.70-1.00)	0.85 (0.71-1.01)	**0.80 (0.65-0.97)**	**0.75 (0.62-0.92)**
Education (vs. less than high school)					
High school graduate		**0.60 (0.44-0.83)**	**0.62 (0.45-0.86)**	**0.63 (0.45-0.87)**	**0.63 (0.45-0.87)**
Some post-secondary		**0.40 (0.28-0.58)**	**0.41 (0.28-0.59)**	**0.42 (0.29-0.60)**	**0.42 (0.29-0.61)**
Post-secondary degree/diploma		**0.41 (0.31-0.53)**	**0.43 (0.33-0.56)**	**0.44 (0.33-0.58)**	**0.44 (0.33-0.57)**
Annual household income (vs. < $20,000)					
≥$20,000 and <$50,000		0.79 (0.57-1.11)	0.81 (0.58-1.12)	0.82 (0.59-1.16)	0.84 (0.59-1.19)
≥$50,000 and <$100,000		**0.49 (0.34-0.69)**	**0.51 (0.36-0.72)**	**0.52 (0.36-0.76)**	**0.54 (0.37-0.79)**
≥$100,000		**0.39 (0.26-0.59)**	**0.42 (0.28-0.63)**	**0.44 (0.28-0.68)**	**0.45 (0.29-0.70)**
Province (vs. Ontario)					
Alberta & Manitoba		1.09 (0.83-1.41)	1.06 (0.81-1.38)	1.07 (0.82-1.39)	1.06 (0.81-1.38)
British Columbia		**0.66 (0.51-0.86)**	**0.64 (0.49-0.83)**	**0.65 (0.50-0.84)**	**0.64 (0.49-0.84)**
Newfoundland and Labrador & Nova Scotia		1.18 (0.91-1.53)	1.11 (0.85-1.44)	1.10 (0.84-1.43)	1.10 (0.84-1.43)
Quebec		**0.66 (0.50-0.87)**	**0.59 (0.45-0.79)**	**0.60 (0.46-0.80)**	**0.61 (0.46-0.81)**
Urban residence (vs. rural)		0.83 (0.59-1.18)	0.82 (0.57-1.17)	0.81 (0.57-1.16)	0.81 (0.56-1.15)

Table 5d. Multivariable analysis of the association between depressive symptoms and low executive function in the 75 years and over age group with higher social support availability, Canadian Longitudinal Study on Aging, n=3,305, 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)	**Model E** OR (95% CI)
Self-rated general health (vs. poor/fair)					
Good			0.77 (0.57-1.17)	0.75 (0.56-1.01)	0.74 (0.55-1.01)
Very good			**0.53 (0.39-0.71)**	**0.51 (0.38-0.69)**	**0.51 (0.38-0.69)**
Excellent			**0.43 (0.30-0.62)**	**0.42 (0.29-0.59)**	**0.42 (0.29-0.60)**
Chronic conditions (yes vs. no)[3]			1.02 (0.79-1.32)	1.01 (0.78-1.30)	1.01 (0.78-1.31)
Medication for depression (yes vs. no)			0.99 (0.64-1.53)	1.02 (0.66-1.58)	1.03 (0.66-1.60)
Marital status (vs. single)					
Married/common-law				1.16 (0.74-1.83)	1.15 (0.73-1.80)
Widowed				1.57 (1.00-2.47)	1.56 (1.00-2.45)
Divorced/separated				0.94 (0.57-1.55)	0.94 (0.57-1.55)
Smoking status (vs. never)					
Current					1.04 (0.63-1.71)
Former					**0.80 (0.66-0.97)**
Alcohol use (vs. never)					
Current					0.76 (0.47-1.24)
Former					0.83 (0.49-1.41)

[1]Low executive function was defined as a score ≥ 1.5 SD below the mean of the cognitively healthy sample.
[2]Presence of depressive symptoms was defined as a score ≥ 10 on the CES-D10.
[3]Chronic conditions were defined as presence of at least 1 of 11 self-reported medical conditions.
Abbreviations: CI = confidence interval; OR = odds ratio
Statistically significant values are **bolded** ($p<0.05$)

Table 5e. Multivariable analysis of the association between depressive symptoms and low executive function in the 75 years and over age group with low social support availability, Canadian Longitudinal Study on Aging, n=351

	Low Executive Function[1]				
	Model A OR (95% CI)	**Model B** OR (95% CI)	**Model C** OR (95% CI)	**Model D** OR (95% CI)	**Model E** OR (95% CI)
Presence of depressive symptoms[2]	0.92 (0.55-1.54)	0.83 (0.48-1.45)	0.75 (0.42-1.34)	0.73 (0.40-1.33)	0.68 (0.36-1.25)
Female vs. male		**0.54 (0.32-0.92)**	**0.55 (0.32-0.95)**	**0.52 (0.30-0.90)**	**0.50 (0.28-0.90)**
Education (vs. less than high school)					
High school graduate		1.85 (0.70-4.84)	1.92 (0.73-5.06)	2.01 (0.73-5.57)	2.06 (0.72-5.89)
Some post-secondary		1.19 (0.46-3.09)	1.16 (0.43-3.15)	1.39 (0.50-3.91)	1.26 (0.44-3.60)
Post-secondary degree/diploma		0.61 (0.31-1.23)	0.60 (0.29-1.21)	0.63 (0.30-1.33)	0.62 (0.29-1.33)
Annual household income (vs. <$20,000)					
≥$20,000 and <$50,000		0.50 (0.25-1.01)	0.52 (0.26-1.06)	**0.44 (0.21-0.92)**	**0.43 (0.20-0.93)**
≥$50,000 and <$100,000		**0.38 (0.17-0.84)**	**0.42 (0.18-0.96)**	**0.32 (0.13-0.78)**	**0.32 (0.20-0.93)**
≥$100,000		**0.08 (0.02-0.31)**	**0.08 (0.02-0.33)**	**0.05 (0.1-0.23)**	**0.06 (0.01-0.25)**
Province (vs. Ontario)					
Alberta & Manitoba		0.78 (0.35-1.71)	0.76 (0.34-1.74)	0.80 (0.35-1.83)	0.87 (0.37-2.05)
British Columbia		0.96 (0.43-2.13)	0.92 (0.40-2.13)	0.98 (0.42-2.29)	1.03 (0.43-2.46)
Newfoundland and Labrador & Nova Scotia		0.76 (0.32-1.82)	0.75 (0.31-1.84)	0.68 (0.28-1.68)	0.80 (0.31-2.03)
Quebec		0.55 (0.24-1.24)	0.52 (0.22-1.21)	0.55 (0.23-1.31)	0.60 (0.25-1.45)
Urban residence (vs. rural)		0.88 (0.27-2.90)	0.82 (0.25-2.72)	0.90 (0.27-2.97)	0.86 (0.28-2.70)

Table 5e. Multivariable analysis of the association between depressive symptoms and low executive function in the 75 years and over age group with low social support availability, Canadian Longitudinal Study on Aging, n=351, 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)	**Model E** OR (95% CI)
Self-rated general health (vs. poor/fair)					
Good			0.72 (0.36-1.46)	0.65 (0.32-1.34)	0.69 (0.33-1.43)
Very good			0.61 (0.28-1.31)	0.55 (0.25-1.20)	0.61 (0.27-1.34)
Excellent			0.42 (0.17-1.04)	0.40 (0.15-1.02)	0.45 (0.17-1.18)
Chronic conditions (yes vs. no)[3]			0.87 (0.35-2.18)	0.98 (0.40-2.40)	0.96 (0.37-2.44)
Medication for depression (yes vs. no)			1.07 (0.33-3.42)	1.27 (0.41-3.88)	1.37 (0.42-4.35)
Marital status (vs. single)					
Married/common-law				1.09 (0.38-3.08)	1.12 (0.39-3.20)
Widowed				1.52 (0.60-3.85)	1.47 (0.18-1.33)
Divorced/separated				0.52 (0.19-1.40)	0.49 (0.18-1.33)
Smoking status (vs. never)					
Current					1.84 (0.58-5.90)
Former					0.77 (0.43-1.38)
Alcohol use (vs. never)					
Current					1.44 (0.39-5.34)
Former					2.35 (0.60-9.21)

[1]Low executive function was defined as a score ≥ 1.5 SD below the mean of the cognitively healthy sample.
[2]Presence of depressive symptoms was defined as a score ≥ 10 on the CES-D10.
[3]Chronic conditions were defined as the presence of at least 1 of 11 self-reported medical conditions.
Abbreviations: CI = confidence interval; OR = odds ratio
Statistically significant values are **bolded** ($p<0.05$)

5.3 Research question 3: Does the association between the presence of depressive symptoms and low executive function differ between males and females?

Descriptive results for sex-stratified analyses are presented in Tables 6a and 6b. Results for the sex-stratified multivariable analyses are presented in Tables 7a and 7b (males), and Tables 8a and 8b (females).

5.3.1 Descriptive analyses for the association between depressive symptoms and low executive function in males and females

Consistent with unstratified and age-stratified analyses, descriptive analyses of the unweighted and weighted data in males (Table 6a) and females (Table 6b) showed a significant difference between those reporting the presence of depressive symptoms versus absence. Overall, in both males and females, there were significant differences in frequency of low executive function in those with depressive symptoms versus not. However, females had a higher prevalence of reporting the prevalence of depressive symptoms (18.35%) than males (12.08%).

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

Overall, the results of the bivariate analyses for males (Table 6a) and females (Table 6b) display the same pattern as the unstratified descriptive analyses: all sociodemographic covariates were significantly associated with low executive function, with the exception of urban/rural residence, and all health covariates were significantly associated with low executive function, except for medication for depression.

Among social factors, males were more likely to report being married or in a common-law relationship than females. Widowed females accounted for 30.12% of the sample with low executive function, although they only contributed to 12.56% of the full analytic sample. Among widowed males, a higher proportion had low executive function (11.15%) than not (3.60%), but only accounted for 4.35% of the analytic sample. For SSA, 9.55% of females with low SSA

reported low executive function, but they only accounted for 6.02% of the full analytic sample. In males, the prevalence of low SSA was 6.89%, with 13.96% of those reporting low SSA having low executive function as well.

Health behaviours followed a similar pattern of results as previously seen in the unstratified analyses. However, health behaviours in males had a stronger significant association with low executive function compared to health behaviours in females. For example, in females, smoking status was not significant in weighted analyses, whereas in males, both smoking status and alcohol use were significant ($p<0.001$).

Table 6a. Distribution of depressive symptoms and covariates by low executive function status in males, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=11,417)			Weighted Frequency (n=1,444,368)		
	Executive Function					
	Low (n=1,139)	Not Low (n=10,278)	Total	Low (n=98,024)	Not Low (n=1,346,345)	Total
Depressive symptoms[1] (%)						
Presence	20.46	11.15***	12.08	21.06	11.50***	12.15
Absence	79.54	88.85	87.92	78.94	88.50	87.85
Sociodemographic Factors						
Age, groups (%)						
45–54 years	8.96	28.19***	26.27	21.49	47.06***	45.33
55–64 years	17.73	34.67	32.98	20.96	30.93	30.26
65–74 years	27.57	23.89	24.25	21.83	14.72	15.20
75 years and over	45.74	13.26	16.50	35.71	7.28	9.21
Education (%)						
Less than high school	15.19	3.39***	4.56	16.78	2.98***	3.92
High school graduate	13.52	7.44	8.05	14.38	6.73	7.25
Some post-secondary	9.39	6.96	7.20	8.61	6.28	6.44
Post-secondary degree/diploma	61.90	82.21	80.19	60.23	84.01	82.39
Annual household income (%)						
< $20,000	8.25	3.12***	3.63	8.96	2.81***	3.23
≥ $20,000 and < $50,000	39.07	15.03	17.43	39.86	12.69	14.53
≥ $50,000 and < $100,000	35.91	35.61	35.64	32.57	31.9	31.98
≥ $100,000 and < $150,000	10.01	24.12	22.71	10.01	26.11	25.02
≥ $150,000	6.76	22.12	20.58	8.60	26.45	25.24
Province (%)						
Ontario	21.07	22.04***	21.94	13.30	13.52***	13.50
Alberta	7.11	8.71	8.55	9.44	12.39	12.19
British Columbia	17.21	22.68	22.13	23.85	31.78	31.24
Manitoba	12.55	10.26	10.49	10.91	8.67	8.83
NFLD	10.27	7.54	7.81	3.10	2.08	2.15
Nova Scotia	12.03	10.81	10.93	4.44	3.24	3.32
Quebec	19.75	17.96	18.14	34.96	28.31	28.76
Urban/rural residence (%)						
Urban	90.52	90.85	90.82	89.41	91.31	91.19
Rural	9.48	9.15	9.18	1059	8.69	8.81

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table 6a. Distribution of depressive symptoms and covariates by low executive function status in males, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=11,417)			Weighted Frequency (n=1,444,368)		
	Executive Function					
	Low (n=1,139)	Not Low (n=10,278)	Total	Low (n=98,024)	Not Low (n=1,346,345)	Total
Health Factors						
Self-rated general health (%)						
Poor	2.90	1.20***	1.37	3.16	1.10***	1.24
Fair	14.40	6.70	7.47	13.27	6.66	7.11
Good	36.08	29.75	30.38	38.78	30.46	31.03
Very good	33.80	41.66	40.88	32.62	41.08	40.51
Excellent	12.82	20.68	19.90	12.17	20.70	20.12
Medication for depression (%)						
Yes	5.71	5.24	5.29	6.62	5.48	5.56
No	94.29	94.76	94.71	93.38	92.52	94.44
Chronic conditions[2] (%)						
Yes	81.39	65.85***	65.60	77.29	57.47***	58.82
No	18.61	36.15	34.40	22.71	42.53	41.18
Social Factors						
Marital status (%)						
Single, never married	8.34	7.67***	7.73	8.72	7.73***	7.80
Married/common-law	69.27	80.24	79.15	74.57	83.71	83.09
Widowed	11.15	3.60	4.35	7.36	1.85	2.23
Divorced/separated	11.24	8.49	8.77	9.38	6.70	6.88
Low SSA (%)						
Yes	13.96	6.11***	6.89	11.85	5.27***	5.71
No	86.04	93.89	93.11	88.15	94.73	94.29
Health Behaviours						
Smoking status (%)						
Current	10.71	8.03***	8.29	11.81	8.59***	8.81
Former	66.11	63.29	63.57	63.50	59.52	59.79
Never	23.18	28.68	28.13	24.69	31.89	31.40
Alcohol use (%)						
Current	79.81	89.26***	88.32	79.95	89.44***	88.80
Former	17.65	9.23	10.07	17.26	9.09	9.64
Never	2.55	1.51	1.61	2.79	1.47	1.56

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
Abbreviations: SSA = social support availability
*p<0.05; **p<0.01; ***p<0.001

Table 6b. Distribution of depressive symptoms and covariates by low executive function status in females, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=11,652)			Weighted Frequency (n=1,445,429)		
	Executive Function					
	Low (n=1,162)	Not Low (n=10,490)	Total	Low (n=105,131)	Not Low (n=1,340,299)	Total
Depressive symptoms[1] (%)						
Presence	27.37	17.35***	18.35	36.92	16.64***	17.39
Absence	72.63	82.65	81.65	73.08	83.36	82.16
Sociodemographic Factors						
Age, groups (%)						
45–54 years	8.26	29.62***	27.49	15.19	44.16***	42.06
55–64 years	17.21	36.05	37.17	16.90	31.02	29.99
65–74 years	31.07	22.25	23.13	30.00	16.41	17.40
75 years and over	43.46	12.08	15.21	37.91	8.42	10.56
Education (%)						
Less than high school	18.76	4.26***	5.71	22.12	4.07***	5.38
High school graduate	15.32	9.48	10.06	15.05	9.43	9.83
Some post-secondary	8.43	7.70	7.78	8.23	7.19	7.27
Post-secondary degree/diploma	57.49	78.56	76.46	54.60	79.31	77.52
Annual household income (%)						
< $20,000	17.73	5.50***	6.72	16.92	4.54***	5.44
≥ $20,000 and < $50,000	45.09	24.24	26.32	44.05	19.93	21.69
≥ $50,000 and < $100,000	26.94	35.87	34.98	27.41	35.08	35.52
≥ $100,000 and < $150,000	6.80	18.59	17.41	7.59	21.17	20.18
≥ $150,000	3.44	15.80	14.56	4.03	19.27	18.16
Province (%)						
Ontario	20.91	21.48***	21.42	14.50	13.38***	13.47
Alberta	8.26	8.67	8.63	8.19	10.10	9.96
British Columbia	16.78	22.09	21.56	25.25	32.19	31.69
Manitoba	10.41	10.91	10.86	9.39	8.33	8.40
NFLD	12.13	7.45	7.92	3.84	2.43	2.53
Nova Scotia	12.56	10.21	10.44	4.91	3.96	4.03
Quebec	18.93	19.19	19.16	33.92	29.61	29.92
Urban/rural residence (%)						
Urban	90.88	90.18	90.25	89.21	89.67	89.64
Rural	9.12	9.82	9.82	10.79	10.33	10.36

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table 6b. Distribution of depressive symptoms and covariates by low executive function status in females, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=11,652)			Weighted Frequency (n=1,445,429)		
	Executive Function					
	Low (n=1,162)	Not Low (n=10,490)	Total	Low (n=105,131)	Not Low (n=1,340,299)	Total
Health Factors						
Self-rated general health (%)						
Poor	3.10	1.21***	1.40	3.25	1.00***	1.17
Fair	14.03	6.10	6.89	15.28	6.09	6.75
Good	37.87	27.17	28.24	40.09	27.44	28.36
Very good	32.44	43.74	42.61	30.05	42.86	41.93
Excellent	12.56	21.78	20.86	11.33	22.61	21.79
Medication for depression (%)						
Yes	12.13	10.86	10.99	12.40	10.58	10.71
No	87.87	89.14	89.01	87.60	89.42	89.29
Chronic conditions[2] (%)						
Yes	82.53	66.75***	68.32	80.52	63.04***	64.31
No	17.47	33.25	31.68	19.48	36.96	35.69
Social Factors						
Marital status (%)						
Single, never married	8.00	9.34***	9.21	7.66	8.04***	8.01
Married/common-law	43.98	63.16	61.24	51.94	72.73	71.22
Widowed	30.12	10.62	12.56	23.44	6.45	7.69
Divorced/separated	17.90	16.88	16.98	16.96	12.78	13.08
Low SSA (%)						
Yes	9.55	5.63***	6.02	9.25	4.59***	4.93
No	90.45	94.37	93.98	90.75	95.41	95.07
Health Behaviours						
Smoking status (%)						
Current	9.47	8.38*	8.49	9.37	8.62	8.68
Former	52.84	56.87	56.47	52.43	55.58	55.35
Never	37.69	34.75	35.04	38.20	35.80	35.97
Alcohol use (%)						
Current	75.22	87.01***	85.83	75.24	87.12***	86.26
Former	20.05	10.78	11.71	20.97	10.82	11.56
Never	4.73	2.21	2.46	3.80	2.06	2.18

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
Abbreviations: SSA = social support availability
*p<0.05; **p<0.01; ***p<0.001

5.3.3 Multivariable regression analyses for the association between depressive symptoms and low executive function in males and females

As a result of significant first-order interactions, models for males had to be further stratified by alcohol use and models for females had to be further stratified by SSA. Attempts were made to stratify the opposite sex by the significant interaction term (i.e., females by alcohol use and males by SSA). This was not possible due to issues with further significant interactions and limited sample sizes within some cells that precluded conducting further stratification. To address other significant first-order interactions, some levels of multilevel variables were combined (i.e., province, income, self-rated general health).

5.3.3.1 Regression analyses for the associations in males by alcohol use

Multivariable analyses for the models for males by alcohol use are presented in Table 7a and 7b. In these models, alcohol use was stratified into two levels: current drinkers versus former/never drinkers. Depressive symptoms were significantly associated with low executive function in males who were current or former/never drinkers (Tables 7a and 7b). Overall, the strength of the association between depressive symptoms and low executive function was stronger in male former/never drinkers (OR=1.70, 95% CI=1.07–2.70), although male current drinkers also had increased odds of low executive function (OR=1.49, 95% CI=1.14–1.93).

The associations between sociodemographic and health covariates with low executive function followed the same general pattern observed in previous analyses. For social covariates, only certain levels of marital status were significantly associated with low executive function among males. In male former/never drinkers, those who reported being married or in a common-law relationship, widowed, or divorced/separated had greater odds of low executive function compared to single males. Low SSA was associated with greater odds of low executive function in all models for male former/never drinkers.

Table 7a. Multivariable analysis of the association between depressive symptoms and low executive function in male former/never drinkers, Canadian Longitudinal Study on Aging, n=1,334

	Low Executive Function[1]				
	Model A OR (95% CI)	**Model B** OR (95% CI)	**Model C** OR (95% CI)	**Model D** OR (95% CI)	**Model E** OR (95% CI)
Presence of depressive symptoms[2]	**2.87 (1.86-4.41)**	**2.05 (1.29-3.27)**	**1.74 (1.10-2.75)**	**1.72 (1.08-2.73)**	**1.70 (1.07-2.70)**
Age, groups (vs. 45–54 years)					
55–64 years		1.44 (0.82-2.55)	1.35 (0.76-2.41)	1.30 (0.73-2.34)	1.29 (0.72-2.33)
65–74 years		**2.54 (1.42-4.55)**	**2.56 (1.42-4.63)**	**2.52 (1.39-4.54)**	**2.48 (1.37-4.52)**
75 years and over		**5.34 (2.96-9.64)**	**5.20 (2.83-9.55)**	**4.79 (2.59-8.86)**	**4.67 (2.47-8.86)**
Education (vs. less than high school)					
High school graduate		0.78 (0.35-1.76)	0.83 (0.36-1.89)	0.84 (0.3-1.89)	0.84 (0.37-1.91)
Some post-secondary		**0.41 (0.18-0.96)**	0.45 (0.19-1.03)	0.44 (0.19-1.01)	**0.44 (0.19-0.74)**
Post-secondary degree/diploma		**0.34 (0.17-0.67)**	**0.36 (0.18-0.72)**	**0.36 (0.18-0.71)**	**0.22 (0.19-0.74)**
Annual household income (vs. < $20,000)					
≥$20,000 and <$50,000		0.87 (0.46-1.67)	1.00 (0.52-1.91)	0.91 (0.44-1.86)	0.89 (0.43-1.83)
≥$50,000 and <$100,000		**0.29 (0.15-0.55)**	**0.33 (0.17-0.64)**	**0.29 (0.14-0.63)**	**0.29 (0.13-0.62)**
≥$100,000		**0.21 (0.10-0.46)**	**0.25 (0.12-0.55)**	**0.22 (0.09-0.54)**	**0.22 (0.09-0.53)**
Province (vs. Ontario)					
Alberta & Manitoba		0.86 (0.45-1.65)	0.86 (0.44-1.67)	0.85 (0.44-1.66)	0.85 (0.47-1.64)
British Columbia		0.62 (0.36-1.07)	0.61 (0.35-1.07)	0.63 (0.36-1.10)	0.63 (0.36-1.11)
Newfoundland and Labrador & Nova Scotia		1.11 (0.65-1.90)	1.12 (0.65-1.91)	1.13 (0.66-1.95)	1.12 (0.64-1.95)
Quebec		0.98 (0.54-1.78)	0.99 (0.54-1.83)	1.01 (0.54-1.87)	1.01 (0.54-1.88)
Urban residence (vs. rural)		0.94 (0.47-1.87)	0.96 (0.48-1.92)	0.96 (0.48-1.92)	0.96 (0.48-1.94)

Table 7a. Multivariable analysis of the association between depressive symptoms and low executive function in male former/never drinkers, Canadian Longitudinal Study on Aging, n=1,334, 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)	**Model E** OR (95% CI)
Self-rated general health (vs. poor/fair)					
Good			**0.59 (0.35-0.98)**	0.61 (0.37-1.03)	0.62 (0.37-1.04)
Very good			**0.53 (0.32-0.90)**	**0.55 (0.32-0.92)**	**0.55 (0.32-0.93)**
Excellent			**0.45 (0.21-0.94)**	**0.45 (0.21-0.94)**	**0.45 (0.21-0.96)**
Chronic conditions (yes vs. no)[3]			1.38 (0.82-2.33)	1.30 (0.76-2.20)	1.30 (0.77-2.20)
Medication for depression (yes vs. no)			1.20 (0.66-2.17)	1.27 (0.70-2.32)	1.25 (0.69-2.29)
Marital status (vs. single)					
Married/living with a common-law partner				**2.17 (1.04-4.53)**	**2.15 (1.02-4.50)**
Widowed				**2.74 (1.13-6.34)**	**2.70 (1.11-6.55)**
Divorced/separated				1.81 (0.85-3.84)	1.78 (0.83-3.77)
Low social support availability (yes vs. no)[4]				1.56 (0.92-2.65)	1.58 (0.93-2.68)
Smoking status (vs. never)					
Current					1.06 (0.56-2.00)
Former					1.17 (0.75-1.81)

[1]Low executive function was defined as a score ≥ 1.5 SD below the mean of the cognitively healthy sample.
[2]Presence of depressive symptoms was defined as a score ≥ 10 on the CES-D10.
[3]Chronic conditions were defined as the presence of at least 1 of 11 self-reported medical conditions.
[4]Low social support availability was defined as an average score of ≤ 3 on the MOS-SSS.
Abbreviations: CI = confidence interval; OR = odds ratio
Statistically significant values are **bolded** ($p<0.05$)

Table 7b. Multivariable analysis of the association between depressive symptoms and low executive function in male current drinkers, Canadian Longitudinal Study on Aging, n=10,083

	Low Executive Function[1]				
	Model A OR (95% CI)	**Model B** OR (95% CI)	**Model C** OR (95% CI)	**Model D** OR (95% CI)	**Model E** OR (95% CI)
Presence of depressive symptoms[2]	**2.30 (1.83-2.89)**	**1.73 (1.35-2.20)**	**1.54 (1.19-1.99)**	**1.50 (1.15-1.94)**	**1.49 (1.14-1.93)**
Age, groups (vs. 45–54 years)					
55–64 years		1.30 (0.96-1.75)	1.28 (0.95-1.73)	1.30 (0.96-1.75)	1.32 (0.98-1.78)
65–74 years		**2.60 (1.94-3.47)**	**2.57 (1.91-3.46)**	**2.61 (1.93-3.53)**	**2.72 (2.01-3.68)**
75 years and over		**7.75 (5.83-10.31)**	**7.58 (2.63-10.21)**	**7.57 (5.59-10.25)**	**8.03 (5.90-10.93)**
Education (vs. less than high school)					
High school graduate		**0.65 (0.44-0.94)**	0.69 (0.47-1.00)	0.69 (0.47-1.00)	0.71 (0.49-1.03)
Some post-secondary		**0.53 (0.36-0.77)**	**0.55 (0.37-0.81)**	**0.55 (0.37-0.81)**	**0.57 (0.38-0.84)**
Post-secondary degree/diploma		**0.34 (0.25-0.45)**	**0.36 (0.27-0.48)**	**0.36 (0.27-0.48)**	**0.37 (0.28-0.50)**
Annual household income (vs. < $20,000)					
≥$20,000 and <$50,000		0.81 (0.54-1.20)	0.85 (0.58-1.26)	0.91 (0.59-1.40)	0.93 (0.60-1.43)
≥$50,000 and <$100,000		**0.42 (0.28-0.62)**	**0.46 (0.31-0.67)**	**0.49 (0.31-0.77)**	**0.50 (0.32-0.79)**
≥$100,000		**0.21 (0.14-0.32)**	**0.24 (0.16-0.36)**	**0.26 (0.16-0.42)**	**0.27 (0.16-0.44)**
Province (vs. Ontario)					
Alberta & Manitoba		1.04 (0.80-1.36)	1.04 (0.80-1.36)	1.03 (0.79-1.34)	1.03 (0.79-1.35)
British Columbia		**0.69 (0.52-0.92)**	**0.69 (0.52-0.91)**	**0.69 (0.52-0.91)**	**0.69 (0.52-0.92)**
Newfoundland and Labrador & Nova Scotia		1.26 (0.98-1.63)	1.23 (0.95-1.59)	1.23 (0.95-1.59)	1.23 (0.95-1.59)
Quebec		0.77 (0.59-1.01)	**0.76 (0.58-0.99)**	**0.75 (0.57-0.99)**	**0.76 (0.58-0.99)**
Urban residence (vs. rural)		0.84 (0.62-1.15)	0.84 (0.62-1.16)	0.83 (0.61-1.14)	0.83 (0.61-1.14)

Table 7b. Multivariable analysis of the association between depressive symptoms and low executive function in male current drinkers, Canadian Longitudinal Study on Aging, n=10,083, 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)	**Model E** OR (95% CI)
Self-rated general health (vs. poor/fair)					
Good			0.76 (0.58-1.01)	0.76 (0.58-1.01)	0.77 (0.58-1.02)
Very good			**0.62 (0.46-0.82)**	**0.62 (0.46-0.83)**	**0.63 (0.47-0.84)**
Excellent			**0.51 (0.36-0.72)**	**0.51 (0.36-0.72)**	**0.52 (0.37-0.74)**
Chronic conditions (yes vs. no)[3]			1.14 (0.91-1.42)	0.85 (0.57-1.28)	1.15 (0.92-1.44)
Medication for depression (yes vs. no)			0.84 (0.56-1.26)	0.85 (0.57-1.28)	0.85 (0.82-1.27)
Marital status (vs. single)					
Married/living with a common-law partner				0.82 (0.55-1.22)	0.84 (0.57-1.25)
Widowed				1.04 (0.67-1.62)	1.07 (0.68-1.66)
Divorced/separated				**0.64 (0.42-0.97)**	**0.64 (0.43-0.97)**
Low social support availability (yes vs. no)				1.16 (0.84-1.59)	1.13 (0.82-1.55)
Smoking status (vs. never)					
Current					1.21 (0.86-1.69)
Former					0.85 (0.69-1.05)

[1]Low executive function was defined as a score ≥ 1.5 SD below the mean of the cognitively healthy sample.
[2]Presence of depressive symptoms was defined as a score ≥ 10 on the CES-D10.
[3]Chronic conditions were defined as the presence of at least 1 of 11 self-reported medical conditions.
[4]Low social support availability was defined as an average score of ≤ 3 on the MOS-SSS.
Abbreviations: CI = confidence interval; OR = odds ratio
Statistically significant values are **bolded** ($p<0.05$)

5.3.3.2 Regression analyses for the associations in females by social support availability

Models for females stratified by SSA are presented in Tables 8a and 8b. Depressive symptoms were significantly associated with greater odds of low executive function in females who reported higher SSA (OR=1.33, 95% CI=1.09–1.62). In females with low SSA, depressive symptoms were associated with lower odds of low executive function, although this association was not significant (Table 8b).

Sociodemographic and health variables displayed the same associations that have been previously observed models only stratified by SSA. For females who reported low SSA, the associations between marital status and low executive function were similar to those observed in the models for males and females combined and stratified by only SSA: those with low SSA have greater odds of low executive function when reporting to be married or in a common-law relationship, widowed, or divorced/separated. When considering health behaviours, among females with higher SSA, former smoking associated with lower odds of low executive function (OR=0.77, 95% CI=0.65–0.91).

Table 8a. Multivariable analysis of the association between depressive symptoms and low executive function in females with higher social support availability, Canadian Longitudinal Study on Aging, n=10,950

	Low Executive Function[1]				
	Model A OR (95% CI)	**Model B** OR (95% CI)	**Model C** OR (95% CI)	**Model D** OR (95% CI)	**Model E** OR (95% CI)
Presence of depressive symptoms[2]	**1.92 (1.66-2.37)**	**1.63 (1.35-1.96)**	**1.32 (1.09-1.61)**	**1.32 (1.09-1.61)**	**1.33 (1.09-1.62)**
Age, groups (vs. 45–54 years)					
55–64 years		**1.58 (1.19-2.10)**	**1.60 (1.20-2.13)**	**1.58 (1.19-2.11)**	**1.61 (1.21-2.15)**
65–74 years		**3.77 (2.86-4.97)**	**3.92 (2.95-5.21)**	**3.80 (2.85-5.06)**	**3.88 (2.89-5.19)**
75 years and over		**8.78 (6.63-11.63)**	**8.98 (6.71-12.02)**	**8.38 (6.22-11.31)**	**8.43 (6.20-11.46)**
Education (vs. less than high school)					
High school graduate		**0.58 (0.27-0.54)**	**0.60 (0.45-0.80)**	**0.61 (0.45-0.81)**	**0.60 (0.45-0.81)**
Some post-secondary		**0.38 (0.27-0.54)**	**0.39 (0.28-0.56)**	**0.41 (0.29-0.58)**	**0.41 (0.29-0.59)**
Post-secondary degree/diploma		**0.38 (0.30-0.54)**	**0.40 (0.31-0.51)**	**0.41 (0.32-0.53)**	**0.41 (0.32-0.53)**
Annual household income (vs. < $20,000)					
≥$20,000 and <$50,000		**0.63 (0.49-0.80)**	**0.68 (0.53-0.87)**	**0.65 (0.50-0.83)**	**0.67 (0.52-0.87)**
≥$50,000 and <$100,000		**0.35 (0.27-0.45)**	**0.39 (0.30-0.51)**	**0.37 (0.28-0.49)**	**0.39 (0.29-0.52)**
≥$100,000		**0.22 (0.16-0.31)**	**0.27 (0.20-0.37)**	**0.24 (0.17-0.35)**	**0.26 (0.19-0.38)**
Province (vs. Ontario)					
Alberta & Manitoba		**0.95 (0.57-0.92)**	0.96 (0.75-1.24)	0.96 (0.75-1.23)	0.95 (0.74-1.22)
British Columbia		**0.72 (0.57-0.92)**	**0.72 (0.56-0.91)**	**0.72 (0.75-1.23)**	**0.70 (0.55-0.89)**
Newfoundland and Labrador & Nova Scotia		**1.40 (1.12-1.76)**	**1.41 (1.12-1.77)**	**1.40 (1.11-1.77)**	**1.42 (1.13-1.79)**
Quebec		**0.64 (0.50-0.82)**	**0.61 (0.48-0.78)**	**0.61 (0.48-0.79)**	**0.63 (0.49-0.80)**
Urban residence (vs. rural)		0.83 (0.64-1.08)	0.82 (0.63-1.06)	0.83 (0.34-1.09)	0.83 (0.63-1.08)

Table 8a. Multivariable analysis of the association between depressive symptoms and low executive function in females with higher social support availability, Canadian Longitudinal Study on Aging, n=10,950, 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)	**Model E** OR (95% CI)
Self-rated general health (vs. poor/fair)					
Good			**0.71 (0.56-0.91)**	**0.71 (0.56-0.90)**	**0.72 (0.56-0.92)**
Very good			**0.43 (0.33-0.55)**	**0.43 (0.33-0.55)**	**0.44 (0.34-0.56)**
Excellent			**0.41 (0.30-0.55)**	**0.40 (0.30-0.55)**	**0.41 (0.31-0.56)**
Chronic conditions (yes vs. no)[3]			1.11 (0.91-1.36)	1.11 (0.91-1.36)	1.11 (0.91-1.36)
Medication for depression (yes vs. no)			1.05 (0.82-1.34)	1.06 (0.83-1.36)	1.06 (0.83-1.35)
Marital status (vs. single)					
Married/living with a common-law partner				1.16 (0.86-1.56)	1.16 (0.86-1.56)
Widowed				1.29 (0.94-1.77)	1.31 (0.96-1.80)
Divorced/separated				0.93 (0.67-1.29)	0.95 (0.68-1.32)
Smoking status (vs. never)					
Current					0.94 (0.70-1.27)
Former					**0.77 (0.65-0.91)**
Alcohol use (vs. never)					
Current					0.92 (0.62-1.36)
Former					1.23 (0.81-1.88)

[1]Low executive function was defined as a score ≥ 1.5 SD below the mean of the cognitively healthy sample.
[2]Presence of depressive symptoms was defined as a score ≥ 10 on the CES-D10.
[3]Chronic conditions were defined as the presence of at least 1 of 11 self-reported medical conditions.
Abbreviations: CI = confidence interval; OR = odds ratio
Statistically significant values are **bolded** ($p<0.05$)

Table 8b. Multivariable analysis of the association between depressive symptoms and low executive function in females with low social support availability, Canadian Longitudinal Study on Aging, n=702

	Low Executive Function[1]				
	Model A OR (95% CI)	**Model B** OR (95% CI)	**Model C** OR (95% CI)	**Model D** OR (95% CI)	**Model E** OR (95% CI)
Presence of depressive symptoms[2]	0.84 (0.53-1.34)	0.76 (0.47-1.23)	0.66 (0.39-1.10)	0.63 (0.37-1.08)	0.59 (0.34-1.03)
Age, groups (vs. 45–54 years)					
55–64 years		0.98 (0.42-2.31)	0.90 (0.38-2.13)	0.91 (0.38-2.19)	1.02 (0.43-2.41)
65–74 years		2.13 (0.92-4.93)	2.12 (0.91-4.96)	1.98 (0.81-4.86)	2.33 (0.95-5.75)
75 years and over		**3.52 (1.55-8.00)**	**3.65 (1.61-8.27)**	**3.45 (1.43-8.31)**	**3.94 (1.57-9.88)**
Education (vs. less than high school)					
High school graduate		0.47 (0.20-1.14)	0.52 (0.21-1.24)	0.58 (0.23-1.44)	0.70 (0.28-1.77)
Some post-secondary		0.42 (0.16-1.08)	0.44 (0.17-1.14)	0.50 (0.19-1.31)	0.55 (0.21-1.44)
Post-secondary degree/diploma		**0.40 (0.20-0.77)**	**0.41 (0.21-0.79)**	**0.49 (0.23-0.91)**	**0.50 (0.25-0.99)**
Annual household income (vs. <$20,000)					
≥$20,000 and <$50,000		**0.53 (0.30-0.93)**	0.56 (0.31-1.01)	**0.46 (0.26-0.82)**	**0.49 (0.27-0.89)**
≥$50,000 and <$100,000		**0.32 (0.16-0.62)**	**0.36 (0.18-0.71)**	**0.27 (0.14-0.53)**	**0.33 (0.16-0.68)**
≥$100,000		**0.14 (0.03-0.62)**	**0.15 (0.03-0.67)**	**0.09 (0.08-0.47)**	**0.12 (0.02-0.63)**
Province (vs. Ontario)					
Alberta & Manitoba		1.50 (0.75-3.00)	1.42 (0.69-2.92)	1.38 (0.67-2.87)	1.41 (0.68-2.96)
British Columbia		0.92 (0.46-1.84)	0.87 (0.43-1.75)	0.81 (0.40-1.63)	0.82 (0.40-1.68)
Newfoundland and Labrador & Nova Scotia		1.22 (0.52-2.86)	1.24 (0.54-2.88)	1.18 (0.51-2.72)	1.14 (0.50-2.62)
Quebec		0.72 (0.34-1.53)	0.68 (0.31-1.49)	0.70 (0.31-1.54)	0.82 (0.38-1.78)
Urban residence (vs. rural)		0.65 (0.22-1.93)	0.65 (0.21-1.96)	0.73 (0.24-2.20)	0.65 (0.22-1.95)

Table 8b. Multivariable analysis of the association between depressive symptoms and low executive function in females with low social support availability, Canadian Longitudinal Study on Aging, n=702, 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)	**Model E** OR (95% CI)
Self-rated general health (vs. poor/fair)					
Good			0.75 (0.41-1.37)	0.76 (0.41-1.39)	0.72 (0.40-1.32)
Very good			0.61 (0.30-1.25)	0.61 (0.30-1.26)	0.61 (0.29-1.30)
Excellent			0.52 (0.20-1.38)	0.54 (0.21-1.43)	0.60 (0.23-1.56)
Chronic conditions (yes vs. no)[3]			1.16 (0.57-2.35)	1.18 (0.59-2.37)	1.14 (0.56-2.32)
Medication for depression (yes vs. no)			1.28 (0.65-2.49)	1.31 (0.56-2.26)	1.38 (0.70-2.70)
Marital status (vs. single)					
Married/living with a common-law partner				2.14 (0.94-4.86)	2.00 (0.90-4.45)
Widowed				1.80 (0.80-4.04)	1.76 (0.77-4.03)
Divorced/separated				1.13 (0.56-2.26)	1.19 (0.59-2.40)
Smoking status (vs. never)					
Current					1.23 (0.59-2.57)
Former					0.93 (0.53-1.63)
Alcohol use (vs. never)					
Current					0.28 (0.10-0.80)
Former					0.59 (0.19-1.88)

[1]Low executive function was defined as a score ≥ 1.5 SD below the mean of the cognitively healthy sample.
[2]Presence of depressive symptoms was defined as a score ≥ 10 on the CES-D10.
[3]Chronic conditions were defined as the presence of at least 1 of 11 self-reported medical conditions.
Abbreviations: CI = confidence interval; OR = odds ratio
Statistically significant values are **bolded** ($p<0.05$)

6.0 Discussion

6.1 Study Findings

This study investigated the association between depressive symptoms and executive function, a key domain of cognitive function. A number of sociodemographic, health, and social factors, as well as health behaviours, were included in the investigation to assess whether they affect the association. This study used both descriptive analyses and multivariable logistic regression.

In summary, more than one-sixth of the analytic sample reported the presence of depressive symptoms. Across age groups, the prevalence of depressive symptoms was highest among those 45–54 years and lowest among those 64–75 years. Between sexes, the prevalence of depressive symptoms was higher among females compared to males. Across age groups, the prevalence of low executive function was highest among those 75 years and over and lowest among those 45–54 years, which is expected as cognitive function has been found to decline in older age. The prevalence of low executive function did not differ by sex. In bivariate analyses, depressive symptoms were significantly associated with low executive function in the overall association, and when stratified by age group and sex. A consistent pattern was observed, where the prevalence of depressive symptoms was higher among those who had low executive function compared to those who did not have low executive function.

Overall, this study found that the presence of depressive symptoms was associated with low executive function, after adjusting for confounders. Age, sex, and SSA showed effect modification of the association between depressive symptoms and low executive function. When stratified by age, those who reported depressive symptoms had greater odds of low executive function compared to those who did not report depressive symptoms in the 45–54 year, 55–64

year, 65–74 year age groups and in those 75 years and over with higher SSA. The strength of the association between depressive symptoms and low executive function increased in the oldest age group (i.e., 75 years and over), which is supported by past literature that found that depressive symptoms are associated with poorer cognitive outcomes in older adults compared to younger age groups.

When stratified by sex, those who reported depressive symptoms had significantly greater odds of low executive function compared to those who did not report depressive symptoms in males and in females with higher SSA. The strength of the association between depressive symptoms and low executive function differed when comparing males and females. Findings are consistent with past literature that depressive symptoms may influence later-life health outcomes for males and females differently.

When stratified by SSA, consistent patterns were observed across all research questions: in the higher SSA stratum, those who reported depressive symptoms had significantly greater odds of low executive function compared to those who did not report depressive symptoms, whereas the association was not significant in the low SSA stratum. As expected, reporting depressive symptoms was associated with poorer cognitive outcomes.

6.1.1 Discussion of the results stratified by social support availability

Following the inclusion of all covariates, depressive symptoms were positively associated with low executive function in those with higher SSA. The positive association observed between depressive symptoms and low executive function in this study is consistent with past literature that also showed positive cross-sectional associations of depressive symptoms with cognitive function, and more specifically, executive function (Klojčnik et al., 2017). Some longitudinal studies also support a positive association between depressive symptoms with

executive function and global cognitive function (Dotson et al., 2008; Freiheit et al., 2012; Pantzar et al., 2017; Royall et al., 2012). Given that most of the studies on depression and executive function are limited to smaller clinical populations or older adults (Cui et al., 2007; de Paula et al., 2016; Klojčnik et al., 2017; Tam & Lam, 2012), findings from this study may be more generalizable to the middle-aged and older Canadian population.

However, the significant and positive association between depressive symptoms and low executive function in the higher SSA stratum, and the negative, although not significant, association in the low SSA stratum appear to be surprising, given evidence that social support has been shown to be a protective factor for depression and cognition separately, and it might be expected that higher levels of social support might mitigate the detrimental effects of depressive symptoms on cognition (Dickinson, Potter, Hybels, Mcquoid, & Steffens, 2011; Ellwardt, Aartsen, Deeg, & Steverink, 2013; Harasemiw, Newall, Shooshtari, Mackenzie, & Menec, 2018; Kim, Kwak, Kim, Youm, & Chey, 2019; Rutter, 2019; Seeman, Lusignolo, Albert, & Berkman, 2001). As this was not observed in this study, the modifying effect of SSA on the association between depressive symptoms and executive function may be explained by the reciprocity theory or differences in the operationalization of variables between this study and others.

The reciprocity theory states that receiving support that cannot be returned can be distressing for the recipient (Uehara, 1995). The recipient of the support may start to question their usefulness and social functioning. As well, undesired feelings of dependence may arise (Uehara, 1995). While most studies that reference the reciprocity theory refer to populations of individuals with disabilities, other studies have reported the burden of social support among healthy adults and those with depression (Gleason, Iida, Shrout, & Bolger, 2008; Sims et al., 2014). Therefore, it may not be that higher SSA has direct negative effects on cognitive function,

but rather higher SSA may be perceived differently by individuals with depressive symptoms. For example, it has been shown that some individuals, particularly those living with depression, chronic conditions, illnesses or disabilities, perceive higher social support as a stressor (Reinhardt, Boerner, & Horowitz, 2006; Sims et al., 2014). In addition, depressive symptoms have been shown to increase risk of executive dysfunction (Klojčnik et al., 2017), so it is possible that the association is driven by the presence of depressive symptoms, rather than SSA.

In addition, perceived social support may not be aligned with the needs of the individual and may manifest in poorer cognitive function (Sims et al., 2014). As seen in this thesis, depressive symptoms in those with higher SSA were associated with greater odds of low executive function. This may be a result of misalignment, where the perceived SSA was not helpful for those with depressive symptoms, resulting in greater odds of low executive function. However, the effects of SSA subtypes were not assessed in this study. Although subtypes of SSA have not been explicitly differentiated in the past, some studies suggest that emotional and tangible social support affect depressive symptoms differently (Sims et al., 2014). Therefore, in addition to overall SSA, subtypes of SSA may modify the association between depressive symptoms and executive function differently. Previous unpublished work with CLSA Comprehensive data has shown that subtypes of SSA modified the association between depressive symptoms and executive function differently (Iacono, 2018). As such, future work with the CLSA may be able to further address the role of SSA on the relationship between depressive symptoms and executive function by assessing SSA subtypes.

Other possible explanations for the results stratified by SSA in this study may be attributed to the variables studied. Past research has focused on the association between social support and cognitive function, rather than on social support as a modifier for the association

between depressive symptoms and cognitive function. For example, while there is a longitudinal study that found that higher levels of overall social support and its subtypes (e.g., affection and positive social interactions) were associated with increased risk of incident cognitive impairment, this study did not account for the presence of depressive symptoms (Pillemer, Ayers, & Holtzer, 2018). In addition, the baseline risk for low executive function has been shown to be higher in those with low SSA, before consideration of depressive symptoms (Ellwardt et al., 2013; Pillemer & Holtzer, 2016). Therefore, this may be why nonsignificant results were found for the association between depressive symptoms and low executive function in the low SSA stratum: it may be difficult to detect increases with depressive symptoms beyond the elevated baseline risk of low executive function in those with low SSA.

This study also focused on a larger age range (45–85 years) that included participants who reported cognitive conditions, whereas other studies focused on younger adults (e.g., university students) or those 65 years and over with no history of cognitive conditions (Seeman et al., 2001). The sample size of this study was also relatively large. Therefore, there may have been sufficient power to detect a range of significant results that may not have previously been detectable. Furthermore, both marital status and SSA were included as covariates. Given that social support is not consistently defined across literature, it may not have been identified as a separate form of support that differs from marital status. However, this study did not find that marital status affected the association between depressive symptoms and low executive function. As this is a cross-sectional study, the temporality between depressive symptoms and level of SSA cannot be determined. While some studies have shown that higher SSA increases negative affect (i.e., depressed mood), it possible that depressive symptoms cause lower SSA, which has been suggested by the literature (Gleason et al., 2008; Riddle, McQuoid, Potter, Steffens, &

Taylor, 2015). More severe depressive symptoms may also require higher levels of social support. Therefore, while there appears to be a positive association between higher SSA and depressive symptoms with low executive function, depressive symptoms, rather than social support, may drive the relationship with executive function. Future work should examine depressive symptoms as a continuous measure to determine whether severity of depressive symptoms is an important determinant in this relationship.

6.1.2 Discussion of the results stratified by age group

In analyses stratified by age, depressive symptoms were positively associated with low executive function across all age groups, with the exception of those 75 years and over with low SSA. This is generally consistent with previous studies, which found significant and positive dose-response associations between depressive symptoms with cognitive function and executive function by age (Barnes et al., 2012; Byers et al., 2012; Chui et al., 2015). There are a few studies that have compared depressive symptoms with cognitive function in both middle and later life, and observed stronger associations between depressive symptoms and dementia in later life (Barnes et al., 2012). In this present study, the 65–74-year age group showed a strong association between depressive symptoms and low executive function in the crude model, but not in the final model. While it was expected that there would be significant and positive associations in the older age groups, a possible explanation for the nonsignificant result may be attributed to older adults commonly mistaking their depressive symptoms as part of the normal aging process. As such, while those in the 65–74 age group may be feeling clinically relevant depressive symptoms, they may be more likely than younger individuals to dismiss their depressive symptoms. Older adults have been shown to mistake depressive symptoms as part of the normal aging process, or attribute them to changes in societal roles, such as transitioning into

retirement. Under-reporting depressive symptoms may also be apparent in this study, as those 65–74 years had the lowest prevalence of depressive symptoms although the prevalence of depressive symptoms is known to increase with age (Blazer, 2003; Minicuci et al., 2002).

In addition to age, SSA was an effect modifier for the association in the 75 years and over age group. This is consistent with some studies that found that depressive symptoms were negatively associated with social isolation, and that the strength of the association increased with age (Blazer et al., 1991). In addition, compared to other age groups, those 75 years and over with depressive symptoms were more likely to report being widowed, and both older age and widowhood have been shown to have a negative influence on perceived social support and cognitive function (Alexopoulos, 2005). It is also possible that the severity of depressive symptoms in the older age groups is greater than in younger age groups, and therefore drives the association towards greater risk of low executive function in the older age groups.

6.1.3 Discussion of the results stratified by sex

In sex-stratified descriptive analyses, females reported a higher prevalence of depressive symptoms than males, although the prevalence of low executive function was approximately equal between males and females. In bivariate analyses, depressive symptoms were significantly associated with executive function in both males and females.

In multivariable analyses of males, alcohol use was identified as an effect modifier. For both male current drinkers, and male former or never drinkers, reporting depressive symptoms was associated with greater odds of low executive function compared to not reporting. This is expected as the risk for low executive function has been shown to be higher in those with depressive symptoms compared to those without depressive symptoms (Dotson et al., 2008; Klojčnik et al., 2017; Pantzar et al., 2017; Reppermund et al., 2011; Royall et al., 2012).

Therefore, alcohol use in combination with depressive symptoms may result in additional risk for low executive function.

In this study, compared to males who were current drinkers, males who were former or never drinkers showed a stronger positive association between depressive symptoms and greater odds for low executive function. A possible explanation for the stronger association observed in male former or never drinkers can be described by referencing the J-shaped curve, where those who engage in minimal to no drinking are at greater risk for declines in cognitive function than current drinkers who consume moderate amounts of alcohol (Alzheimer's Society of Canada, 2019; Andreasson, 1998; Tyas, 2001). As such, there may greater risk of low executive function in those who report depressive symptoms and former or never drinking, compared to those who report depressive symptoms and current drinking. The J-shape curve can also be applied to the association between alcohol use and mortality. In Canada, alcohol consumption is a normative behaviour. As such, former drinkers may disproportionately include those who stopped drinking because of alcoholism, as well as those with health issues with contraindications that include alcohol. For example, individuals taking many of the common antidepressants should not consume alcohol (Ruitenberg et al., 2002). Also, those taking antidepressants may have more severe depressive symptoms. Therefore, those who are former drinkers may be at increased risk of mortality and cognitive decline due to other health and medical conditions that caused them to stop drinking, including severe depressive symptoms. In turn, this may be why the association is stronger in former or never drinkers than current drinkers, although there is still greater odds of low executive function observed in both groups.

In analyses of females by SSA, females with higher SSA who reported depressive symptoms had greater odds of low executive function compared to those who did not report

depressive symptoms. In contrast, females with low SSA who reported depressive symptoms had lower odds of low executive function, compared to those who did not report depressive symptoms. Past studies have found that greater levels of social strain and negative interactions were associated with higher global cognitive function (Hughes, Andel, Small, Borenstein, & Mortimer, 2008). Therefore, it is possible that the negative relationships females experience, and the potential of associated depressive symptoms that arise from these negative relationships, can result in more efficient and widespread cognitive functioning through cognitive stimulation (Hughes et al., 2008), possibly explaining why females with low SSA who reported depressive symptoms had lower odds of low executive function.

Females are also more likely to report receiving social support from their children and family, whereas males report receiving the majority of their social support from their spouses. Over time, females also do not see an increase in support, whereas males observe increases in support from their spouses with age (Gurung, Taylor, & Seeman, 2003). Therefore, it is possible that with increasing age and depressive symptoms, women are more likely to increase their independence due to emotional and social distancing from their spouse. As a result, women with depressive symptoms may be less likely to be dependent on social supports and feel more motivated to accomplish tasks on their own. In turn, this results in cognitive stimulation and possibly explains why those with depressive symptoms but with low SSA have lower odds of low executive function. In contrast, females with higher SSA may grow to be dependent on their social supports and therefore the effects of depressive symptoms on cognitive function are greater. This is similar to the reciprocity theory, as previously described (Uehara, 1995).

In conclusion, depressive symptoms were associated with low executive function, and results supported age group and sex as effect modifiers. While significant associations were

observed among descriptive and multivariable results, it is likely that the strength of the associations (i.e., the odds ratios) based off of the analytic sample are an underestimate of the Canadian population at large. This is because of possible selection bias. It has been shown that individuals who have depression, or are experiencing depressive symptoms, as well as individuals with cognitive impairments or chronic conditions, are less likely to volunteer and participate in epidemiological studies (Li & Ferraro, 2005; Montgomery et al., 2010; R. O. Roberts et al., 2008). As such, the participants in the CLSA, and therefore the analytic sample, are likely to be healthier, with higher cognitive functioning and less depressive symptoms than the age- and sex-matched Canadian population at large.

6.2 Strengths

One of the most prominent strengths is the CLSA's large population-based sample. Alongside targeted recruitment of low education areas to reduce possible selection bias for more highly educated participants, the CLSA used sampling strata based on age, sex, and province during recruitment to yield a more nationally representative sample. In addition, the inclusion of a wide age range, capturing adults between 45 to 85 years, allowed for the association between depressive symptoms and executive function to be explored across different age groups. Such an investigation has not been previously explored in a Canadian sample and will be valuable in extending previous findings to middle-aged and older community-dwelling adults. Overall, the large and population-based nature of the sample allows results to be more generalizable to the community-dwelling aging population in Canada.

Another strength of this study is the extensive amount of information about demographic, health, social, and psychological factors included in the CLSA. Unlike previously published cross-sectional and longitudinal studies, this allowed for the association between depressive

symptoms and executive function to be explored while controlling for many covariates in the regression models. In turn, the ability to include many covariates simultaneously in logistic regression models may provide future studies with insights on the types of variables that influence the association between depressive symptoms and executive function. For example, these covariates included both subjective and objective measures of health; self-rated general health has not been previously investigated, although the perspectives of aging adults play an important role in health outcomes. Moreover, both structural and functional social factors, such as marital status and SSA, have not been considered simultaneously in a single study. As such, this study is able to include variables that are more reflective of both objective measures of health and subjective perceptions and experiences of aging adults.

In addition to the consideration of many covariates in a single study, this study was able to use a neuropsychological battery to measure executive function. Previous studies have only considered measures of global cognitive function or used a single test to represent executive function. By using several tests to measure executive function in this study, a more representative and accurate assessment of a key cognitive domain was conducted.

6.3 Limitations

Although there are many strengths associated with this study, there were also some limitations. One limitation is that the heterogeneous sample may increase the risk of confounding by variables not accounted for in this study. Moreover, participants in the Comprehensive cohort had to live within 25–50 km of a DCS, thereby excluding individuals who lived further away. Also, recruitment excluded those living in New Brunswick, Prince Edward Island, Saskatchewan, any of the territories, indigenous reserves, long-term care facilities, and military

bases. Therefore, findings from the CLSA are not completely generalizable to the Canadian aging population.

There was also the possibility of participation bias, as the overall response rate was 10%, with 97% identifying as Caucasian. As such, the sample may not be fully representative of all middle-aged and older adults in Canada. In Canada, 21% of Canadians identify as a visible minority, and among those 65 years and over, 12% identify as a visible minority (Statistics Canada, 2017, 2018). With regards to the exposure, the CES-D10 captures self-reported depressive symptoms experienced in the past week. As such, it does not reflect symptoms experienced over longer durations and CES-D10 results are not the same as receiving a clinical diagnosis of depression. Therefore, scores from the CES-D10 should be communicated with caution and may not be generalizable to individuals with clinical depression.

At the time of analysis, only baseline cross-sectional data on the exposure, outcome, and covariates were available. As such, the temporality of the association cannot be determined and there is the possibility for reverse causation in the association between depressive symptoms and executive function. There may also be a cyclical relationship between depressive symptoms and executive function, where over time, the impact of one condition may influence the occurrence of the other.

6.4 Implications and Future Directions

Results from this study support an association between depressive symptoms and low executive function. Findings suggest that depressive symptoms are prevalent among middle-aged and older adults and present as a potentially amenable factor involved in pathways implicated in poorer cognitive outcomes. These findings support previous research indicating that awareness of, and access to mental health resources are important. In particular, mental health resources and interventions for depressive symptoms may help buffer the effects of the cognitive decline, and the domain-specific cognitive decline that occur with age.

This investigation addressed existing gaps in literature by extending evidence of an association between depressive symptoms and low executive function to middle-aged and older community-dwelling adults. In addition, the association was examined across age groups and between sexes, with the strongest associations observed in older age groups and in females. As such, it is possible that intervention programs that target females and males differently in older age may have the strongest impact on reducing cognitive decline. Some examples of ways these study findings can be used include targeting psychological barriers, such as stigma against mental health, or providing different avenues of support for individuals experiencing depressive symptoms as ways to reduce cognitive decline. In addition, by using a neuropsychological battery, a more comprehensive assessment of the association between depressive symptoms and domain-specific cognitive function was completed while adjusting for a variety of previously identified and new covariates.

Future research should use longitudinal CLSA data, when it becomes available, to determine whether depressive symptoms are associated with cognitive decline across age groups and between sexes. Longitudinal analysis will help address the issue of reverse causality, and

help to determine the exact nature of the association (i.e., are depressive symptoms a risk factor or preclinical symptom of cognitive decline?). Research directed at elucidating the temporal association will inform the search for possible treatment opportunities that may vary depending on the age and sex of the individual or population in need.

In addition, as social support presented as a significant effect modifier in many of the models, further, in-depth analyses of how different subtypes of SSA affect the association between depressive symptoms and executive function, as well as determining the temporal association between social support and depressive symptoms, would help inform new and existing social support interventions. Since the exact nature of the beneficial impact of social support in relation to depressive symptoms and cognitive function has yet to be established, investigating how social support is perceived at different points across the lifespan may provide further explanation for the differences in the direction of the association between depressive symptoms and low executive function in the higher SSA stratum versus low SSA stratum. It is also likely that SSA affects males and females differently, and therefore will moderate the association of depressive symptoms with low executive function differently between sexes.

6.5 Conclusions

Overall, as the population continues to age, having better awareness about the effects of depressive symptoms on cognitive outcomes may contribute to better health outcomes for middle-aged and older adults. Research into factors associated with age-related cognitive decline is essential for social and health services that aim to help adults maintain their functional independence and health into older age. By investigating the association between depressive symptoms and executive function, findings from this study extended evidence to areas not previously researched. The results indicate that depressive symptoms are likely detrimental to

executive function, but the nature of the association differs with age and sex. As well, social support was shown to be another important factor closely linked with depressive symptoms and cognitive function. Findings from this study will serve as a foundation for further investigation using longitudinal data from the CLSA, once these data become available. Future work should include allocating resources to examine the longitudinal association between depressive symptoms and executive function, and examining whether this longitudinal association differs by age, sex, and SSA.

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8.0 Appendix

Appendix A: Literature Search Strategies

Table A1. Literature search strategy for PubMed

	Search Terms			
Database	**Depressive Symptoms**	**Cognitive Function**	**Age**	**Time**
PubMed	Depression[MeSH] OR Depression[tiab] OR Depressive Symptom*[tiab]	Executive Function[MeSH] OR Executive Function[tiab] OR Neuropsychological Tests[MeSH]	Aged[MeSH] OR Elderly[tiab] OR Older Adult*[tiab] 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 strategy: #1 AND #2 AND #3 AND #4

#1 Depression[MeSH] OR Depression[tiab] OR Depressive Symptom*[tiab]
#2 Executive Function[MeSH] OR Executive Function[tiab] OR Neuropsychological Tests[MeSH]
#3 Aged[MeSH] OR Elderly[tiab] OR Older Adult*[tiab] OR Middle Age* OR Middle Aged
#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]

Search performed on September 15, 2018 and retrieved 399 records.

Updated search performed July 3, 2019 and retrieved 435 records.

Table A2. Literature search strategy for PsycINFO

	Search Terms			
Database	**Depressive symptoms**	**Cognitive Function**	**Age**	**Time**
PsycINFO	"Depression" OR "Depressive Symptom*"	"Executive Function" OR "Neuropsychological Tests" OR Cognitive Function" OR "Cognitive Impairment"	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 strategy: #1 AND #2 AND #3 AND #4 AND Peer-Reviewed Journals Only

#1 (Keywords: Depression OR Keywords: Depressive Symptom*)
#2 (Keywords: Executive Function OR Keywords: Neuropsychological Tests OR Keywords: Cognitive Function OR Keywords: Cognitive Impairment)
#3 (Keywords: Elderly OR Keywords: Older Adult OR Keywords: Senior* OR Keywords: Aged (65 yrs & older) OR Keywords: Very Old (85 yrs & older) OR Keywords: Middle Age (40-64 yrs) 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))
#4 (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: 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)

Search performed on September 16th, 2018 and retrieved 608 records.

Updated search performed July 4, 2019 and retrieved 641 records.

Literature Search
July 2019

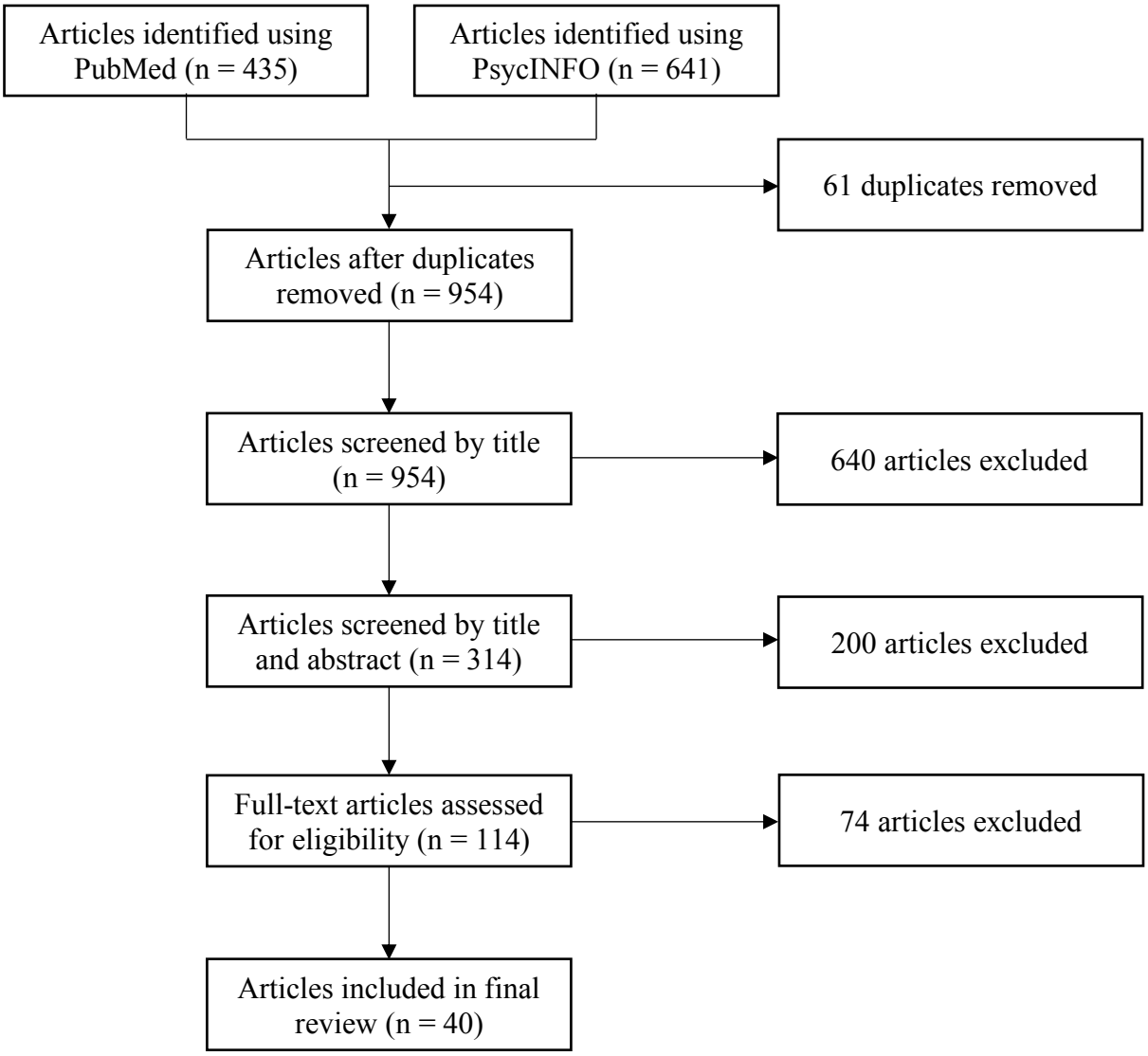


Figure A1. Flowchart of systematic literature search strategy

Articles excluded if:

1) Exposure is not depression, depressive symptoms, cognitive function or executive function
2) Outcome is not depression, depressive symptoms, cognitive function or executive function
3) Sample only included participants under the age of 45 years

Appendix B: Literature Search Summary Tables

Table A3. Summary table for findings on the association between depressive symptoms and executive function

Study	Study population, characteristics, and design	Exposure and covariates	Outcome	Analysis	Results
Almeida et al., 2016 Depression as a risk factor for cognitive impairment in late life: The Health in Men cohort study	The original Health in Men Study (HIMS) is an ongoing cohort study that began in 1996 and recruited men between the ages of 65 to 83 years. This present study includes 4,568 community-derived men with a history of, or current depression at the start of the second wave. Participants were followed until the third wave of HIMS (2004-2008).	*Exposure:* History of, or current depression determined by medical records, a "yes" response to the question "Have you ever been treated for an emotional or nervous illness such as depression?", and current use of antidepressant. Clinically significant depressive symptoms were determined using the Geriatric Depression Scale (GDS-15). *Covariates:* Age, birth place, education, smoking status, hypertension, diabetes, and coronary heart disease.	Incident cognitive impairment, assessed using the 2008 modified Telephone Interview for Cognitive Status (TICS). Men were classified as i) normal cognitive function (TICS >31), ii) mild cognitive impairment (MCI; 27<TICS≤ 31), and iii) cognitive impairment (TICS ≤27).	Count and proportions (%) of categorical data and means, ranges, and standard deviations of continuous data were determined. χ^2 tests were used to determine the probability that the distribution of men in groups of current, past, and no history of depression was due to change. Risk rate ratios were obtained using multinomial logistic regression and 95% confidence intervals.	Current, not history, of depression increased the risk of future cognitive impairment (2.07, 95% CI: 1.24-3.45). There was no dose effect between severity of depression and future development of cognitive decline. Findings suggest that depressive symptoms are a prodromal characteristic of cognitive impairment.

Barnes et al., 2006 Depressive symptoms, vascular disease, and mild cognitive impairment. Findings from the Cardiovascular Health Study	This study includes 2,220 participants who were enrolled in the Cardiovascular Health Study (CHS) at baseline and completed the CHS Cognition Study in 1998-1999. All participants were over the age of 65 years at enrollment and had Modified Mini-Mental State (3MS) scores ≥ 90 in 1992-1993, and normal cognition or MCI in 1998-1999. Follow-up assessments occurred annually for 6 years.	*Exposures*: Depressive symptoms were determined using the 10-item Center for Epidemiological Studies Depression Scale (CES-D10). Classifications include moderate or high depressive symptom (CES-D-10 score ≥8 in 1998-1999), low (3≤ CES-D-10 score ≤7), and none (0≤ CES-D-10 score ≤2). Vascular events, (e.g., stroke and transient ischemic attack (TIA)), were identified at baseline in the CHS and hospitalizations and outpatient cardiovascular events during follow-up. *Covariates:* Antidepressant use and type, carotid artery atherosclerosis status, ankle-arm blood pressure, diabetes mellitus status, and cerebral MRI.	Diagnosis of mild cognitive impairment (MCI) at follow-up. This was determined using the 3MS, Digit Symbol Test, Benton Visual Retention Test, Telephone Interview for Cognitive Status, Telephone Interview for Cognitive Status and Dementia Questionnaire, medical histories, activities of daily living (ADL) and instrumental ADL impairment, and medication use. All MCI decisions were then reviewed by a committee with neurologists and psychiatrists.	A Lowess Smoothing Curve was used to graphically display the association. Linear regression was used to determine ordinal arrangement for continuous variables. Non-parametric tests were applied to determine arrangement for categorical variables. Backwards stepwise logistic regression was used to determine if presence of depressive symptoms and/or presence of vascular disease increased odds of developing MCI during the 6-year follow-up.	Depressive symptoms and vascular disease measures were independently associated with greater odds of MCI. Risk of MCI increases with number of depressive symptoms in older adults with normal cognition. The odds of developing MCI doubles in those with moderate or high depressive symptoms (CES-D-10 score ≥8) at baseline. This finding is independent of vascular disease.

Bennett & Thomas, 2014 (Review) Depression and dementia: Cause, consequence or coincidence?	Various study populations and sample characteristics were mentioned through the literature review.	Depression or depressive were used as search terms for MEDLINE(R) and EMBASE electronic databases. Covariates were not considered in this literature review.	Dementia, cognitive disorders, vascular, multi-infarct, and Alzheimer's disease were used as search terms.	N/A	Dementia and depression are common in the elderly and have a complex relationship. Depression has been reported to be both a risk factor and causative agent of Alzheimer's disease and other dementias.
Boyle et al., 2010 Depression predicts cognitive disorder in primary care patients	This prospective cohort study included 470 participants, with annual assessments occurring between March 2003 December 2005 (i.e., 3 years). At baseline, participants were cognitively normal, ≥65 years of age, and recruited from primary care offices in the	*Exposures:* A diagnosis of depression was determined using the Structured Clinical Interview for DSM-IV (SCID). Patients were categorized as: i) current major depressive disorder (MDD); ii) current minor depression (MinD) based on DSM-IV criteria; and iii) non-depressed. The 24-item Hamilton Depression Rating Scale (HDRS) and the HDRS -psychological/	Dementia or cognitive disorder not otherwise specified (NOS) status was determined by performance on the Mini-Mental State Examination, Mattis Dementia Rating Scale-initiation/ perseveration subscale, Trail Making Test Part B, and Trails A. These tests measured four cognitive domains: global cognition, executive function, sustained attention	Cox proportional hazard models were used to determine time-dependent effect of depression on the occurrence of dementia or cognitive disorder NOS. Sensitivity analysis was performed to determine if use of antidepressants affected risk of outcomes after a 3-year period. Attrition was analyzed using a	The hazard ratio (HR) for cognitive disorders per unit increase in HDRS-P was 1.11 (95% CI: 1.02-1.21). The HR per unit increase in HDRS scores was 1.07 (95% CI: 1.02-1.12). No significant changes in the findings were observed in sensitivity analysis. Depression was found to be predictive of dementia or

	greater Rochester area.	affective (HDRS-P) was used to assess depressive symptoms. *Covariates:* Age, gender, and education.	and sequencing, and information processing/ psychomotor speed DSM-IV criteria were used to inform diagnoses.	χ^2 test for categorical variables and a nonparametric Wilcoxon test for continuous variables. All tests were two-tailed with $\alpha = 0.05$.	cognitive disorder NOS, controlling for covariates. MDD, MinD, HDRS, and HDRS-P are predictive of dementia or cognitive disorder NOS after a 3-year follow-up period.
Brodaty et al., 2012 Neuropsychiatric symptoms in older people with and without cognitive impairment	This study includes 799 community-dwelling adults enrolled in the prospective Sydney Memory and Ageing Study. Participants were 70-90 years of age upon enrollment and were followed for 2 years.	*Exposure:* Presence or absence of neuropsychological symptoms (NPS) at baseline. Informants were used to determine frequency (scale 0-4) and severity (scale 0-3) of NPS in the following domains: delusions, hallucinations, agitation, depression, anxiety, elation, apathy, disinhibition, irritability, aberrant motor behaviour, sleep disturbance, and appetite disturbance.	At baseline, cognitive impairment was defined by a diagnosis of mild cognitive impairment or performing 1.5 SD below the mean for the group on neuropsychological tests measuring memory, language, attention/processing speed, executive function, and visuospatial abilities. At follow-up, the main outcome was cognitive status, categorized as: no	Group differences were determined using *t*-tests for continuous variables and χ^2 tests for categorical variables. Logistic regression was used to determine associations between predictors and outcomes at baseline and follow-up.	At baseline, NPS were more frequent in participants with impairments in executive function, attention/ processing speed and global cognition. Depression was significantly associated with executive function (OR = 2.41, 95% CI: 1.5-3.9, p = 0.001). At follow-up, depression was found to predict dementia (OR = 2.67, 95% CI: 1.1-

		Covariates: Age, gender, and education.	cognitive impairment (NCI), mild cognitive impairment (MCI) or dementia, and cognitive decline.		12.5, $p = 0.038$), but did not predict MCI (OR = 0.87; 95% CI: 0.5-1.5, $p = 0.63$).
Bunce et al., 2014 Causal associations between depression symptoms and cognition in a community-based cohort of older adults	This study includes 896 community-dwelling adults, who are aged 70-97 and enrolled in the Canberra Longitudinal Study. Participants completed annual assessments for over the course of 4 years. Assessments were completed between 1990 and 2002.	*Exposure:* Depression symptoms were measured using the Goldberg Depression Scale at baseline and follow-up. Scores ranged from 0-9, based on number of "yes" responses. A higher score suggests a greater severity of depression. *Covariates:* Age, gender, years of highest educational attainment, potential presence of preclinical dementia (indicated by a score <24 of 30 on any of the assessments). Additional covariates were considered in cross-lagged analysis, including visual impairment, hearing	Performance in specific cognitive domains, measured using on a range of cognitive tests: i) processing speed, measured with the Symbol-Letters Modalities Test and the Wecsher's Digit-Symbol Substitution; ii) verbal fluency, measured using the animal fluency task; iii) face and word recognition, measured using the Rivermead Behavioural Memory Test; iv) episodic memory, measured with four memory tasks testing word, face, name, and address recall and figure reproduction; and v)	Descriptive statistics were performed by standardizing scores to a common metric (mean = 100, SD = 10) at baseline. Participants were categorized as i) having 2≤ depression symptoms, or ii) <2 depression symptoms. A cross-lagged structural equation model was constructed to assess the effects of baseline depression symptoms on follow-up cognition and baseline cognition,	Initial depression symptoms had significant effects on subsequent cognitive performance in multiple domains, including processing speed, mean simple RT, and mean choice RT. Overall, depression symptoms predict cognitive deficits in certain cognitive domains after a 4-year follow-up period. Results suggest that depression precedes cognitive impairment.

		impairment, disease count, activities of daily living score, and locus of control.	simple and choice reaction time (RT), measured with 20s task trials.	and follow-up depression symptoms.	
Byers & Yaffe, 2012 (Review) Depression and risk of developing dementia	Various study populations and sample characteristics were mentioned through the literature review.	Depression or depressive symptoms in early life, midlife, and older age. Covariates were not considered in this literature review.	Dementia and related cognitive functions.	N/A	Earlier-life depression is associated with a 2-fold increase in risk for dementia. Late-life depression showed more conflicting results but there appears to be an association. However, the nature of the association between depression in late-life and dementia is unclear.
Chodosh et al., 2007 Depression symptoms as a predictor of cognitive decline: MacArthur Studies of Successful Aging	This study includes 711 high physical and cognitive functioning adults enrolled in the longitudinal MacArthur Study of Successful Aging. Participants were	*Exposure:* Self-reported depression symptoms measured at baseline using the Hopkins Symptom Check List (SCL) depression subscale. The scale has 11 questions with a 1-4 set response (1 = not at all, 2 = a little, 3 =	Cognitive function was determined using: i) an 18-item version of the Boston Naming Test, ii) construction, iii) a spatial version of the Delayed Spatial Recognition Span Test, iv) a subtest of	A linear regression model was used to assess the association between depression symptoms and longitudinal cognitive decline. 95% confidence intervals and effect	For every quartile increase in baseline depressive symptoms, the summary of cognitive performance score at follow-up, on average, declined. In those who developed

	between 70-79 years of age at baseline and followed for a period of 7-years. Baseline data were collected between May 1988 and December 1989, with all follow-up visits completed in 1995 to reassess cognitive performance.	quite a bit, and 4 = extremely) based the week preceding assessment. SCL depression subscale reflects DSM-IV criteria for major depressive disorders. Scores could range from 11-44. *Covariates:* Age, gender, education, income, disease burden variable (composite score based on status of diabetes mellitus, previous heart attacks, strokes, and other chronic diseases, cancer, hypertension, hip fracture and any fracture), blood pressure, and glycosylated hemoglobin.	the Revised Wechsler adult intelligence scale, and v) a delayed incidental recall after 10 minutes of the 18-item Boston Naming Test. Longitudinal cognitive decline observing the difference between the baseline and follow-up assessment. Incident cognitive impairment was assessed using the nine-item version of the SPMSQ. Inclusion criteria was a score $6 \leq$ at baseline. Scores < 7 at follow-up indicate incident cognitive impairment.	sizes were determined using bootstrapping. Model was fitted to 1,000 bootstrap samples and a [2.5%, 97.5%] distribution of primary effect. Logistic regression was used to assess the association between depression symptoms and incident cognitive impairment. Sensitivity analysis was performed to assess whether a stricter definition of cognitive impairment changed the primary findings and to assess if using a different instrument to measure depression yielded different results.	cognitive impairment, their mean decline in summary cognitive score was higher than those who did not develop cognitive impairment. For every quartile increase in baseline depressive symptoms, there was 20% increased odds of developing cognitive impairment. After bootstrapping and adjusting for covariates, the odds increased per quartile increase in depressive Overall, higher depressive symptoms at baseline are associated with a larger decline in cognitive function over a 7-year follow-up period.

Cui et al., 2007 Does depression precede or follow executive dysfunction? Outcomes from older primary care patients	Prospective cohort study consisting of 284 participants, who were recruited from private practices and university-affiliated clinics that offered general internal medicine, geriatrics and family medicine expertise in Monroe County, New York. All participants were 65 years of age and older and completed year 1 and year 2 follow-up interviews.	*Exposure:* Executive function, measured by the initiation-perseveration subscale of the Mattis Dementia Rating Scale and the Trails Making Tests A and B. *Covariates:* Systolic blood pressure, antihypertensive therapy, cardiovascular disease, diabetes mellitus, smoking, atrial fibrillation, and left ventricular hypertrophy. The cumulative severity of these cerebrovascular risk factors represents the American Heart Association Stroke Risk-Factor Prediction Chart. Other covariates were age, gender, education, MMSE score, and Cumulative Illness Rating Scale score.	Depression diagnosis at 1-year lagged and at each subsequent follow-up point. Diagnosis based on consensus conference, SCID criteria, and patient interview and medical record. Depression diagnosis categorized as: 1) current or partially remitted major depression; 2) current or partially remitted minor depression (based on DSM-IV criteria); and 3) no depression. Depression symptom severity determined with the 24-item Hamilton Depression Rating Scale (HAM-D).	Baseline data was analyzed using χ^2 test for categorical variables and the nonparametric Wilcoxon test for continuous variables. Simple and multiple regression models were used to analyze longitudinal data.	Antecedent depression independently predicted executive functioning in Trials A and B, but not initiation-perseveration. Older persons with depression are at risk for specific aspects of executive dysfunction.

Dlugaj et al., 2015 Depression and mild cognitive impairment in the general population: Results of the Heinz Nixdorf Recall Study	This study used cross-sectional data from follow-up time one (i.e., five years after baseline) from the Heinz Nixdorf Recall (Risk Factors, Evaluation of Coronary Calcium and Lifestyle; HNR) study. 583 participants with mild cognitive impairment (MCI) and 1,446 cognitively normal participants between the ages of 50-80 years of age were included.	*Exposure:* A German version of the Centre for Epidemiological Studies 15-item short form Depression Scale (CES-D). A higher score suggested greater levels of depressive symptoms. *Covariates:* Age, gender, education, apolipoprotein E epsilon 4 (*APOE-e4*) status, body mass index (BMI; kg/m^2), prevalence of diabetes mellitus, blood pressure (mmHg), prevalence of hypertension, history of coronary heart disease, history of stroke, smoking status, and use of antidepressants.	Cognitive performance based on the following tests: i) eight-word list testing immediate and delayed verbal memory; ii) labyrinth test for testing processing speed; iii) semantic category animals test and word recall test for verbal fluency; iv) abstraction for executive function; and v) clock-drawing for visualospatial organization. Diagnosis of MCI followed International Working Group on MCI criteria and required cognitive impairment insufficient to fulfill criteria for dementia.	Raw cognitive performance scores were adjusted by stratifying age and education. Mann-Whitney U test was used to compare differences in continuous variables between cognitive normal and MCI participants. A Pearson's χ^2test was used to compare differences in categorical variables. Log-Poisson regression models were used to determine prevalence rate ratios (PRR) of MCI versus cognitively normal participants.	Currently elevated depressive symptoms and higher CES-D scores were more often observed in participants with MCI than cognitively normal participants. After adjusting for covariates, a significant association was found between currently elevated depressive symptoms and increased PRR for overall MCI, non-amnestic MCI, and amnestic MCI. Results suggest that the relationship between depression and MCI differs based on the subtype of MCI and time of onset of depressive symptoms.

Dotson et al., 2010 Recurrent depressive symptoms and the incidence of dementia and mild cognitive impairment	This study used data from the Baltimore Longitudinal Study on Aging, which consists of community-dwelling adults over the age of 50 years without a history of central nervous system disease, cardiac disease, or metastatic cancer at baseline. 1,239 participants with a Blessed Information Memory Concentration score ≥3, subjective Clinical Dementia Rating score ≥0.5, or abnormal Dementia Questionnaire results were included.	*Exposure:* Depressive symptoms were measured using the 20-item Center for Epidemiological Studies Depression Scape (CES-D). An elevated CES-D score was considered ≥16. *Covariates:* Age, sex, race/ethnicity, education, smoking status, self-reported history of diabetes mellitus, hypertension, cardiovascular disease, dyslipidemia, body mass index, and systolic blood pressure.	Incident MCI or dementia. A diagnosis of MCI was determined by cognitive impairment in a single domain or cognitive impairment in multiple domains but not meeting the criteria for significant functional loss. A diagnosis of dementia was defined by DSM-III-R criteria.	*t*-tests and ANOVAs and χ^2 tests were used to analyze differences across continuous and categorical variables, respectively. Kaplan-Meier survival curves and log-rank tests were computed and compared against time-dependent occurrence of elevated depressive symptoms. Cox proportional hazards models were used to determine whether dementia and MCI and elevated depressive symptoms were associated. Sensitivity analysis was performed using Alzheimer's disease as an outcome. For all tests, $\alpha = 0.05$.	A dose-response relationship between incident all-cause dementia and recurrent depressive symptoms was observed ($p<0.001$). Overall, only the first episode of depressive symptoms is associated with incidence of dementia. Findings also show that severity of depressive symptoms show a dose-response relationship to cognitive decline. Therefore, depression may be a risk factor and prodrome.

Dotson et al., 2008 Differential association of concurrent, baseline, and average depressive symptoms with cognitive decline in older adults	Using data from the Baltimore Longitudinal Study on Aging (BLSA), 1,589 community-dwelling adults over the age of 50 years and who were considered dementia-free at baseline were included. The study began in 1958, with follow-up assessments every two years. In 2000, participants over the age of 80 years started annual assessments. In total, there are 19 repeated assessments over a 26-year follow-up period.	*Exposure:* Depressive symptoms were determined using the 20-item Center for Epidemiological Studies Depression Scale (CES-D). A cut-off of 16 points was used to determine two depression categories (low versus high). *Covariates:* Sex, self-reported race, education, and scores on the Primary Mental Abilities vocabulary test.	Performance in five cognitive domains: learning and memory, attention and executive function, verbal and language abilities, visuospatial functioning, and general cognitive status. The neuro-psychological tests included the California Verbal Learning Test, the Benton Visual Retention Test, a subtest of the Wechsler Adult Intelligence Scale-Revised for digit span, the Trail Making Test parts A and B, the FAS and semantic fluency test, the Boston Naming Test, the verbal fluency test, the Card Rotations Test and the Mini-Mental State Exam and BIMCS.	Linear mixed models were used to determine fixed and random effects. Mixed-effect models were used to account for longitudinal analyses. Baseline age, time interval (i.e., years since baseline testing), and interval were considered in two- and three-way interactions. Models included fixed effects of all independent variables and their interactions, and random effects of intercept and interval. Backwards elimination was used to identify significant covariates. Effect sizes were measured using Cohen's *d*.	Executive dysfunction and longitudinal decline in memory, attention, and general cognitive status were observed in individuals with a higher average of depressive symptoms. Prolonged depressive symptoms, compared to transient, showed a greater effect on cognitive functioning. This is emphasized in the age by depressive symptoms interaction, where older individuals, compared to younger, are more vulnerable if they have depressive symptoms.

Freiheit et al., 2012 A dynamic view of depressive symptoms and neurocognitive change among patients with coronary artery disease	Data from an urban tertiary care hospital in Alberta were obtained for 350 participants 60 years and older from the Calgary Cardiac and Cognition (3C) Study. All participants underwent coronary angiopathy without prior revascularization. Follow-up occurred at 6, 12, and 30 months.	*Exposure:* Depressive symptoms, measured using the Geriatric Depression Scale. Scores ≥5 indicated depressive symptoms. *Covariates:* Self-reported education, current or past smoking, drinking, living arrangements, self-reported health, stroke-free status, anxiety, and various health characteristics. Blood samples, or buccal samples when neccssary, were also collected at time of vascularization.	Performance in three domains and global cognitive function were considered. Learning and memory were assessed using the Brief Visuospatial Memory Test-Revised and the Consortium to Establish a Registry for Alzheimer's Disease Test of Verbal Learning and Memory. Verbal fluency was measured using the Controlled Oral Word Association Test. Attention and executive function were assessed using the Trail Making Test, parts A and B. Global cognitive function was assessed using raw scores obtained from the Mini-Mental State Examination.	Linear mixed models with an unstructured correlation matrix were used. Depressive symptoms were modelled as a categorical measure to allow for nonlinear associations. Linear regression models were also used to compare the four depressive symptom categories with cognitive change. An *APOE-ε4* interaction term was used to calculate mean differences in cognitive scores.	Relative to other depressive symptom groups, those with persistent depressive symptoms had lower average cognitive domain scores. In longitudinal models, those with persistent depressive symptoms had significantly greater decline in attention/executive function, learning/memory, verbal fluency, and global cognitive function. Persistent depressive symptoms within the first year were associated with subsequent cognitive decline. Global cognitive decline was greater in *APOE-ε4* carriers.

Ganguli et al., 2006 Depressive symptoms and cognitive decline in late life	Data for 1,256 community-dwelling adults, 65 years and older, and dementia-free at baseline were obtained from the Monongahela Valley Independent Elders Survey (MoVIES), which is a 12-year prospective cohort study with assessments every two years. The initial assessment (wave one) occurred between 1988-1989. Depressive symptoms were first measured in wave two (1989-1991).	*Exposure:* Depressive symptoms were measured using the modified Center for Epidemiological Studies Depression Scale (mCES-D). Items were coded in a yes/no format, for a maximum score of 20. Researchers used percentile-based cut-off points derived from the cohort norms. The cut-off point was at the 90th percentile (i.e., score of 5). Participants who scored ≥5 points were classified as depressed. *Covariates:* Age, sex, education, and recruitment status (present or absence of depression at baseline, time since baseline, presence or absence of incident dementia).	Performance on a neuropsychological battery from the Consortium to Establish a Registry for Alzheimer's Disease (CERAD). Cognitive tests included: the Mini-Mental State Examination (MMSE), 10-item CERAD word list, 18-item story for immediate and delayed retell, P and S letter fluency, animals and fruits category fluency, 15-item CERAD version of the Boston Naming Test, the 4-item CERAD Constructional Praxis Task, the Clock Drawing Test and Trails Making Test A and B. Dementia diagnosis was based on CERAD criteria.	Descriptive statistics were computed using *t*-tests and χ^2 tests. Single random effects modelling was applied to all composite cognitive scores and the MMSE. Models were adjusted for covariates and included interaction terms. Post hoc analysis was performed for antidepressant use, persistent vs. transient depression (mCESD score ≥5 at wave 2 = transient; mCESD score ≥5 at waves 2 and 3 = persistent), and the random effect of age.	Depressive symptoms were significantly associated with baseline scores in all cognitive domains and in the MMSE, even after adjustment, in the dementia-free group. Depressive symptoms are also associated with baseline composite scores, regardless of whether they are transient or persistent. Depressive symptoms are not associated with subsequent decline in cognitive performance (longitudinal) or the rate of decline. Therefore, depression is not a part of incipient dementia.

Geda et al., 2006 Depression, apolipoprotein E genotype, and the incidence of mild cognitive impairment	Data for 840 participants were obtained from the Mayo Alzheimer Disease Patient Registry for Longitudinal Studies of Cognitive Aging. The cohort started in 1986 with subsequent follow-up every 12-18 months. At baseline, all participants were cognitively normal (established by Mayo's Older American Normative Studies, MOANS) and without depression.	*Exposures:* Depression was measured using the 15-item Geriatric Depression Scale (GDS). A score ≥6 was classified as depressed. Participants who scored <6 were considered the reference group. Individuals who scored ≥ 6 on at least one follow-up assessment were considered depressed. History of depression (i.e., depressive episodes prior to enrollment in study) was also obtained using medical record-linkage systems from the Rochester Epidemiology Project. *APOE* genotype was gathered from blood samples. *Covariates:* Sex and education.	The primary outcome was incidence of mild cognitive impairment (MCI). Diagnosis was according to the Petersen et al., criteria. The secondary outcome was incidence of MCI or dementia (composite). A composite outcome was measured because participants could develop dementia without any indication of MCI since follow-up occurred every 12-18 months. Criteria for diagnosis of dementia followed DSM-III-R criteria.	Cox proportional hazards models were computed. Age was also used as the time scale for a more stringent survival analysis. Stratified analysis for gender (men vs. women) and by level of depression severity (GDS scores of 6, 7-15 vs. 0-5) was performed. Multivariate models were developed to assess multiplicative and additive interaction effects of *APOE* genotype, newly developed depression and history of depression preceding baseline. All tests were two-tailed and set to $\alpha = 0.05$.	Depression increased the risk of MCI and dementia. This association was stronger in men (HR = 4.5, 95% CI: 1.8-11.3) than women (HR = 1.5, 95% CI: 0.7-3.6). Severity of symptoms is not associated with risk of MCI. Participants with no history of depression, but developed depression during the study, had a greater risk of MCI than those who were positive for current and history of depression. Having both *APOE-e4* and depression significantly increased the independent effects of each factor on risk of MCI.

Goveas et al., 2014 Depressive symptoms and longitudinal changes in cognition: Women's Health Initiative Study of Cognitive Aging	Data was obtained from the Women's Health Initiative Study of Cognitive Aging (WHIMS), which included women between the ages of 65-79 years and free of mild cognitive impairment (MCI) or probable dementia upon enrollment. This prospective cohort study includes 2,221 women who participated in baseline and at least one follow-up assessment (out of seven) for cognitive performance.	*Exposures:* Depressive symptoms (DS) were measured using the 15-item Geriatric Depression Scale (GDS). Elevated DS were considered a GDS score ≥5. A composite cardiovascular risk factor (CVRF) score and history of cardiovascular disease (CVD) was ascertained. *Covariates:* Age, race-ethnicity, education, marital status), medical history (hysterectomy, antidepressant use, prior hormone therapy use, smoking, use of cholesterol-lowering medication, BMI, hypertension, diabetes, prior CVD, and physical activity), and lifestyle habits (smoking and alcohol use).	Battery of cognitive measures to determine domain-specific performance. Domains included verbal knowledge (Primary Mental Abilities Vocabulary test), verbal fluency (letter and semantic tests), short-term figural memory (Benton Visual Retention Test (BVRT), verbal memory (California Verbal Learning Test), attention and working memory (Digit Span Forward and Backward Test), spatial ability (Card Rotations Test), fine motor speed (Finger Trapping Test), and global cognition (Mini-Mental State Examination; MMSE).	Descriptive statistics were performed using *t*-tests and χ^2 tests. Cognitive domains were standardized using baseline mean and standard deviation of scores. Cross-sectional analyses were achieved using ANCOVA. Mixed-model repeated measures for within-person correlation were used. Interaction terms (DS by prior CVD, and DS and CVRF score) were used to determine moderation effects. Models were adjusted for all covariates. $p<0.01$ was defined as significant.	Persistently high DS in women were associated with significant declines in global cognition, verbal knowledge, and verbal fluency ($P<0.01$), and figural memory ($P<0.05$). In women with fluctuating DS, there were no significant longitudinal changes. Women with both DS and CVD performed worse on figural memory and fine motor speed ($P<0.01$), showing a significant interaction effect. History of CVD and CVRF score did not moderate longitudinal relationships.

Goveas et al., 2011 Depressive symptoms and incidence of mild cognitive impairment and probable dementia in elderly women: The Women's Health Initiative Memory Study	Data from the Women's Health Initiative Memory Study (WHIMS), which includes women between the ages of 65 to 79 and free of MCI at enrollment, was used. This study included 6,376 community-dwelling post-menopausal women who completed the Center for Epidemiologic Studies Depression Scale (CES-D) and the two-item National Institute of Mental Health's Diagnostic Interview Schedule (DIS) and attended at least one follow-up visit.	*Exposures:* Current depression was measured using the Burnam screening algorithm. Cut off scores of 0.06 and 0.009 indicate current depressive disorders. A CES-D score ≥5 (out of a possible 18) also defined current depressive symptoms. History of depressive symptoms was ascertained using the two-item DIS. Responding "yes" to both questions was defined as having a positive history of depressive symptoms. *Covariates:* Body mass index (BMI; kg/m^2), physical exercise, hormone treatment, history of cardiovascular disease (self-reported myocardial infarction, coronary bypass surgery, angioplasty,	Incidence of MCI and probable dementia, measured in four phases. First, all women completed the 3MS at baseline and all annual follow-up visits. Women who were deemed cognitively healthy went on to complete Phase 2 and 3 within three months of Phase 1. Phase 2 involved the administration of the modified Consortium to Establish a Registry for Alzheimer's Disease (CERAD) neuropsychological battery. Within a month of completing Phase 2, Phase 3 was administered, where a local physician their medical history and performed a physical and	Descriptive statistics were performed using Kruskal-Wallis and χ^2 tests. Cox proportional hazards regression was used to compute survival analyses. Single predictor (unadjusted) and multiple predictors (adjusted) models were used. Distribution of incidence was shown by plotting the cumulative hazard functions. Time-dependent models were fitted to MCI, probable dementia and MCI or probable dementia. Significance was assessed using asymptotic Wald tests.	Overall, compared to those not depressed, women with depressive disorder had a greater risk of subsequent MCI and incidence of dementia. after full model adjustment, findings remained significant. Findings support a causal factor.

		congestive heart failure, angina pectoris, carotid endarterectomy or angioplasty, cardiac catherization, aortic aneurysm, atrial fibrillation, or cardiac arrest), cerebrovascular disease (self-reported transient ischemic attack or stroke), level of vascular disease risk (number of risk factors and comorbid vascular conditions), cognitive function (measure using the Modified Mini-Mental State Examination (3MS) at baseline and annual follow-up's), and history of antidepressant and other medication use.	neuropsychiatric examination. DSM-IV criteria were used for classifying participants as i) probable dementia, ii) MCI, or iii) no dementia. MCI was based on the baseline performance at the time WHIMS was initiated. Women classified as having probable dementia continued to Phase 4, which consisted of a noncontract computed tomography brain scan and blood tests to exclude possibility of alternative explanations for symptoms, other than dementia.	All multivariable models included all confounders, regardless of significance. Stepwise variable selection was used for models for probable dementia, MCI, and MCI or probable dementia.	
Heser et al., 2016 Late-life depressive symptoms and history of major	Using data from the German Study on Aging, Cognition, and Dementia in	*Exposure:* Depressive symptoms at follow-up one, measured using the 15-item Geriatric Depression Scale. Cut-	Cognitive performance measured using the Mini-Mental State Examination	ANCOVA was used to analyze mean cognitive test performance scores of the four	Groups with depressive symptoms at the last follow-up performed worse

depression: Cognitive deficits are largely due to incipient dementia rather than depression	Primary Care Patients (AgeCoDe). At baseline, all participants were 75 years of age and older. This study uses data from 1, 332 participants who completed follow-up one to follow-up six. Follow-up data after baseline in 2003/2004 occurred every 18 months.	off score ≥6 indicated clinically relevant scores. This cut-off was used to create the two study groups: 1) with elevated depressive symptoms; and 2) without elevated depressive symptoms. Lifetime prevalence of major depression diagnosed according to DSM-IV criteria. *Covariates:* Age at follow-up one, sex, and education level.	(MMSE), the verbal fluency test, the Consortium to Establish a Registry for Alzheimer's Disease (CERAD) immediate recall, delayed recall and recognition measures, and the Structured Interview for Diagnosis of Dementia of Alzheimer type, Multi-infarct Dementia, and Dementia of other Aetiology according to DSM-IV and ICD-10 criteria (SIDAM) cognitive section (SISCO) that measures orientation, memory and higher cortical functions.	participant groups (with and without depression), adjusting for covariates. Effect sizes of group differences analyzed using logistic regression. Backwards elimination was applied. Significance was sent to α=0.05. The "healthy" control group included individuals without depression and without subsequent dementia at follow-up six.	significantly worse all cognitive tests. Participants with a lifetime history of depression but no subsequent dementia showed no difference from control group. Participants without lifetime history of depression and subsequent dementia performed significantly worse on all cognitive tests compared to the control group. Participants with a lifetime history of depression and subsequent dementia performed statistically significantly worse on all cognitive tests, other than verbal fluency and intellectual function.

					Results are in accordance with hypothesis that executive dysfunction is a consequence of LLD, but indicates incipient dementia in non-depressed participants. Individuals with LLD but no subsequent dementia will have minor cognitive deficits, whereas individuals with LLD and subsequent dementia will have large cognitive deficits.
Jungwirth et al., 2011 The influence of depression on processing speed and executive function in nondemented subjects aged 75	This study uses data the 287 of participants who did not develop dementia from the Vienna Transdanube Aging (VITA) study. The VITA study included participants who	*Exposures*: Current depressive episode, diagnosed using a questionnaire based on DSM-IV criteria. All symptoms were evaluated using a clinical interview (SCID).	Performance on cognitive tests measuring processing speed and executive function. Processing speed was measured using the Trails Making Test-A (TMT-A). Executive function was based	Univariate ANOVA and *t*-tests for binary variables were performed for all covariates and depression variables. Any statistically significant findings were incorporated	Participants with depression performed significantly slower than non-depressed participants on TMT-A. Depressed participants performance significantly lower

	were 75-years of age and born between May 1925 and June 1826. Baseline investigation started between May 2000 and November 2002, with two follow-up points at 30- and 60-months after baseline assessment.	The Hamilton Rating Scale for Depression and the 15-item Short Geriatric Depression Scale were used as depression rating scales. *Covariates:* Sex, education, intake of antidepressants, intake of benzodiazepines, history of depressive disorder, and cerebral comorbidity (summation of 10 possible conditions at baseline: stoke, Parkinson's disease, cerebral trauma, epileptic seizures, resuscitation, brain surgery, brain tumour, meningioma, lacunae, and/or infarcts, and occurrence of the highest rating of periventricular hyperintensities).	on set formation and set shifting, measured using the Trail Making Test-B (TMT-B) (set shifting) and the verbal fluency test (animal) (set formation).	into a multiple regression analysis of variance. Comparisons across groups were accomplished using t-tests, Mann-Whitney U-test (for education), or χ^2 tests (for sex). p <0.05 was considered statistically significant.	on verbal fluency and had a slower performance time on TMT-B than non-depressed participants. Overall, depression has a minor influence on performance of cognitive tests measuring processing speed and executive function.

Klojčnik et al., 2017 Relationship of depression with executive functions and visuospatial memory in elderly	This study included 71 participants who were between the ages of 69 and 85 years and residents of a retirement home. Participants with depressive symptoms were intentionally recruited to increase variability in the depression variable.	*Exposure:* Depression status, as outlined by the Beck Depression Inventory (BDI), categorized by: non-depressed (BDI<10 points), mild depression (BDI 10-15 points), borderline clinical depression (BDI 16-19 points), moderate depression (BDI 20-29 points), and severe depression (30-36 points). *Covariates:* Age, current health problems, current overall well-being, possible head injuries, potential history of psychiatric treatment, and current medical treatment.	Performance on the Montréal Cognitive Assessment (MoCA) Scale, Trail Making Test A and B (TMT-A and TMT-B, respectively), the Stroop colour and word test, the digit span task, the verbal fluency task and the Rey-Osterrich complex figure test (ROCF).	Kolmogorov-Smirnov test assessed normality of distribution. A Pearson partial correlation coefficient, *r*, value was computed for all associations between depression and cognitive test performance. Forward regression models were applied to assess if specific neuropsychological tests predicted depression in any test that was statistically significantly associated with depression. Once the coefficient of determination (R^2) stops significantly changing ($\alpha = 0.05$), entry stops.	Higher BDI scores are correlated with lower performance scores on the neuropsychological tests. The Rey-Osterreich recall test and the Stroop test independently significantly predicted performance on the BDI and explained 70% of the variance ($F(2,69) = 82.14$, $p < 0.0005$, $R^2_{Adj} = 0.70$). The strongest predictor was the ROCT ($\beta = -0.67$, $p < 0.0005$), then the Stroop test ($\beta = -0.23$, $p = 0.15$). Findings show that older persons with depression have difficulty with set switching function compared to a control group.

Koenig et al., 2015 Neuro-psychological functioning in the acute and remitted states of late-life depression	Using baseline data from the *Pathways* study, which is part of the University of Pittsburgh's NIMH-funded Advanced Center for Intervention Research for Late-Life Mood Disorders. Participants were recruited between 1996 and 2002 and participated in *Pathways.* This present study includes 438 participants.	*Exposure:* Depression diagnosis was established using the Structured Clinical Interview for Axis I DSM-IV Disorders (SCID-IV). Severity was measured using the Hamilton Rating Scale for Depression (HRSD-17). Participants were categorized as: i) no previous or current history of MDD (ND); ii) having met criteria for DSM-IV diagnosis at any point in history but euthymic, and iii) met criteria for DSM-IV diagnosis of MDD and depressed at time of baseline cognitive assessment, defined by HRSD-17≥12 (MDD-depressed, MDD-D). *Covariates:* Age, gender, education, race, and medical burden.	Performance on 22 validated cognitive scales or tasks, that measure the following cognitive domains: global cognition, premorbid intellectual ability, episodic memory, executive function, attention and processing speed, verbal ability, and visuospatial ability.	ANOVA and χ^2 tests were performed. Pairwise comparisons with Bonferroni adjustment were used to look at overall group differences. η^2 and ϕ coefficient were computed to determine effect sizes. All raw scores were converted to Z-scores based on distribution of ND participants. ANACOVA was used to compare ND, MDD-E, and MDD-D. Overall group differences were determined using Hochberg's adjusted overall p-value for multiple comparisons.	Participants with a history of depression performed worse than participants who were ND. Overall, participants with LLD showed impairments in episodic memory, speed of information processing, executive functioning, and visuospatial ability. However, no differences were observed between depressed groups, suggesting trait deficits are associated with LLD.

Köhler et al., 2010 Depressive symptoms and cognitive decline in community-dwelling older adults	598 community-dwelling older adults who were enrolled in the Maastricht Ageing Study (MAAS). Participants without major neurological conditions or psychiatric disorders and over the age of 60 years were recruited from family practices in the Netherlands between 1993 and 1995. Follow-up assessments occurred at 3-years (F1) and 6-years (F2).	*Exposures:* Depressive symptoms were measured using a revised 90-item version of the Symptom Checklist (SCL-90). For the purposes of this study, only 16-tems assessing depression were administered at baseline, F1 and F2. Symptoms were ranked on a Likert scale (1 = not at all to 5=extremely), with possible scores ranging from 16-80. *APOE* genotyping was determined by genomic deoxyribonucleic acid extracted from blood samples using polymerase chain reaction. *Covariates:* Age, sex, education, baseline cognition, and baseline depression.	Neuropsychological assessment measuring performance in the following domains: episodic verbal memory, selective attention, information processing speed, global cognition, and global intelligence. Cognitive impairment no dementia (CIND) was defined as significant cognitive impairment. CIND was then subdivided into amnestic CIND (CIND+) and without amnestic CIND (CIND-).	*t*-tests and linear regression analysis were performed. All neuro-psychological tests were standardized to z-scores using mean and SD of baseline scores. Composite memory z-scores were computed Cross-sectional analysis of baseline associations were conducted. Linear mixed models were used to determine longitudinal associations. A depression-by-time interaction term was used to assess change in cognitive score. Effect modification of *APOE-e4* genotype was considered.	There is a statistically significant association between depressive symptoms and subsequent cognitive decline. Faster cognitive decline and development of CIND could be predicted by clinically significant depressive symptoms and persistently high depressive symptoms. The presence of one *APOE-e4 allele* was associated with higher risk of CIND, although it did not show a moderating effect. This suggests that *APOE-e4* works independently.

Lugtenburg et al., 2017 The relationship between depression and executive function and the impact of vascular disease	This study uses baseline data of 83, 613 participants from the Lifelines Study. All participants were recruited from the general population and 18 years of age and older.	*Exposure:* Depression status was determined by the Mini International Neuropsychiatric Interview (MINI), which is based on DSM-IV criteria for a current major or minor depressive episode. *Covariates*: Age, gender, educational level, Framingham Risk Score (FRS), and the presence of vascular disease.	Executive function, measured using the Ruff Figural Fluency Test (RFFT). Score was based on total number of unique designs.	Multivariable linear regression models were built to assess association between minor- and major depression with RFFT scores between younger and older adults. Young adults were defined as participants younger than 60 years of age. Older adults were defined as participants 60 years of age and older.	Younger adults with major or minor depressive disorder were performed significantly worse on the RFFT. Adding vascular disease burden attenuated the association by 5.9%. Older adults with major depression performed significantly worse on the RFFT. Adding vascular disease burden attenuated the association by 5.0%. An association between and executive function was observed for both young and older adults. Vascular disease burden affects younger and older adults.

Osorio et al., 2009 Executive function in patients with late onset depression	Case-control study (20 cases, 10 controls) consisting of participants who were 60 years and older. Cases were recruited from psychiatric clinics of the Mental Health Centers of Madrid and Catilla y Leon communities. Controls were volunteers recruited from primary care out-patient clinics who did not have a history of affective disorders upon enrollment.	*Exposure:* Late-onset depression (LOD) according to DSM-IV criteria and the Yesavage Geriatric Depression Scale (GDS). It is a 150-item scale and depression is defined as a GDS score ≥7. *Covariates:* Age, gender, marital status, education, personal psychiatric and family history.	MEC (Spanish version of the Mini Mental State Exam) performance, which measures time and space orientation, mnesic registry, attention and calculation, recall, speech and constructive praxis. An Executive Interview Scale (EXIT-S) was also used. Scores ranged from 0-50, with higher score indicating greater impairment in executive function.	ANOVA was used to compare group differences between LOD and non-LOD. ANCOVA, adjusted for GDS scale, was used to assess the association between depressive symptoms and neuro-psychological tests. Significance was set to $p<0.05$.	Compared to individuals with no history of depression or affective disorders, participants with personal history of LOD and GSD scores < 7 had higher scores on the EXIT-S.
Pantzar et al., 2017 Cognitive performance in unipolar older-age depression: A longitudinal study	Data was obtained from the population-based Swedish National Study on Aging and Care in Kungsholmen	*Exposure:* Unipolar depression diagnosis was determined using the International Classification of Mental and Behavioural Disorders, ICD-10 criteria. The	A cognitive test battery was applied to measure different domains of cognitive function. The following domains were assessed: processing speed,	ANOVAs and χ^2 tests were used to conduct descriptive statistics. Mixed repeated measure ANCOVAs were	The differential pattern of deficits support depression as state-, rather than trait- related. Persons transitioning from non-depressed to

	(SNAC-K). Participants between 60-72 years undergo assessments every 6 years and participants 78 years and older undergo assessments every 3 years. This study includes 212 participants who were 60 years and older at baseline (T1). Both 3-year and 6-year follow-ups were used (T2), with the maximum follow-up time capped at 6-years.	Comprehensive Psychopathological Rating Scale was used to determine level and severity of depressive symptoms. Status of unipolar depression and/or depressive symptoms was gathered at T1 and T2. *Covariates:* Age and gender.	short-term memory, attention, executive function, verbal fluency, episodic memory, semantic memory, and spatial ability.	used to examine group- and time-effects on cognitive performance, adjusting for covariates. These cross-sectional ANCOVAs were performed at T1 and T2 to examine main effects. Within each group, cognitive changes were determined using paired samples *t*-tests, and all effect sizes (Cohen's *d*) were also determined.	depressed will see the largest change in cognitive decline. Findings suggest that depression severity determines extent of cognitive deficits. Importantly, executive dysfunction was only seen in groups with depressed status, whereas general cognitive decline in processing speed, executive function, category fluency, and episodic and semantic memory was observed, suggesting them to be a normal part of cognitive aging.
Panza et al., 2009 Temporal relationship between depressive symptoms and	Participants were enrolled in the Italian Longitudinal Study on Aging (ILSA), between	*Exposure:* Depressive symptoms, measured using the 30-item Geriatric Depression Scale (GDS-30). GDS score <10 indicates an	Cognitive function was measured using the Mini-Mental State Examination (MMSE) for global functions and the	Spearman and Kendall nonparametric correlations were performed for categorical	Depressive symptoms at baseline were associated with a faster rate of decline in global

cognitive impairment: The Italian Longitudinal Study on Aging	the ages of 65-84 years at enrollment, and living independently or institutionalized. This present study stratified a random sample of the ILSA by age and gender. There are 2,963 participants included in the present study. Baseline data was collected between March 1992 and June 1993. Follow-up assessment occurred in September 1995-October 1996 (F2).	absence of depression, 10≤ GDS score ≤19 indicates mild depression, and a 20≤ GDS score ≤30 indicates severe depression. *Covariates*: Age, sex, and education.	Babcock Story Recall Test (BSRT) for episodic memory. Mild cognitive impairment was defined according to Petersen and colleagues' criteria. Dementia was diagnosed based on DSM-III-R criteria. Probable Alzheimer's disease followed the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association criteria. Vascular diseases followed the International Statistical Classification of Diseases and related health problems 10th revision criteria.	variables to assess the relationship between depressive symptoms, sex, education and cognitive function at baseline. A maximum likelihood in separate random-effects regression model was used. Random-effects regression model computed subject-specific trajectories using only random intercepts. Time (at baseline and follow-up) was included as an interaction term. All models were adjusted for covariates.	cognitive function and episodic memory relayed recall. Depressive symptoms were significantly correlated with lower scores for global cognitive function (p <0.01), immediate recall (p <0.01), and delayed recall (p <0.01).

Potter et al., 2013 Neuropsychological predictors of dementia in late-life major depressive disorder	Participants were part of the Neurocognitive Outcomes of Depression in the Elderly study. Participants met criteria for a current episode of unipolar major depression, over the age of 60 years, and did not have other psychiatric or cognitive illnesses.	*Exposure*: Number and severity of depressive symptoms using the Montgomery-Asberg Depression Rating Scale. *Covariates*: Age.	Neuropsychological assessment was based on the Consortium to Establish a Registry for Alzheimer's Disease neuropsychological battery. Chose 15 individuals measures from the battery to use as independent variables. A yearly consensus panel reviewed each incident case of AD, vascular dementia, and Lewy body dementia Criteria for diagnosis was based on DSM-IV.	Prior to analyses, Markov chain Monte Carlo imputation procedures were used for missing values. For discriminant analysis, a data-reduction technique was used to derive a specified number of reduced models based on χ^2tests. After, bivariate and logistic regression models were used.	Older adults with depression exhibited lower cognitive performance prior to developing dementia. Bivariate analysis for conversion to dementia indicated that the largest effect size was observed on tests for memory and executive function.
Reppermund et al., 2011 The relationship of current depressive symptoms and past depression with cognitive impairment and instrumental activities of daily	This study uses baseline data of 800 participants from the Sydney Memory and Aging Study (MAS), which recruited participants using the electoral roll in Sydney,	*Exposures:* Current depressive symptoms were measured using the 15-item short form of the Geriatric Depression Scale (GDS). A GDS score ≥6 indicates clinical relevancy. History and treatment of depressive episodes	Neuropsychological performance of different tests measuring the following cognitive domains: memory and learning, attention and processing speed, language, visuospatial ability,	All raw cognitive test scores were standardized. Descriptive statistics were performed using independent t-tests and χ^2 tests. ANCOVA was applied to identify	Overall, depressive symptoms and sub-syndromal symptoms pose an adverse health risk in late-life cognitive outcomes. Current episodes of depressive symptoms are

living in an elderly population: The Sydney Memory and Ageing Study	Australia to investigate mild cognitive impairment (MCI) in older, dementia-free community-dwelling adults. Participants were between the ages of 70-90 years upon recruitment.	were self-reported. Other psychiatric conditions were measured using the 9-item Goldberg Anxiety Scale (GAS), the K-10 questionnaire, and the Satisfaction with Life Scale (SWLS). Cardiovascular risk factor index (CVR) was determined using a regression model based off of the Framingham Stroke Study. *Covariates:* Age, gender, education, use of antidepressants, CVR, K-10, and SWLS.	and executive function.	differences between participants with and without clinically significant depression or depressive symptoms to performance in each cognitive domain, controlling for age, sex and education. Antidepressant use, CVR, K-10, SWLS and GAS were also used as covariates. Level of significance was set at $p<0.05$.	associated with poorer memory and executive function performance. History of depression is associated with lower executive function performance.
Richard et al., 2013 Late-life depression, mild cognitive impairment, and dementia	This present study uses data from 2, 160 community-dwelling Medicare recipients who are aged 65 years and older and	*Exposure:* Depression was measured using the Boston form (short version) of the Center for Epidemiological Studies Depression (CES-D) scale. This scale consisted of 10-items with yes (1	MCI diagnosis was based on Petersen criteria and further categorized as amnestic MCI and naMCI. A diagnosis of dementia met DSM-III-R criteria. A diagnosis of	Descriptive statistics were performed using *t*-tests and χ^2 tests. Logistic regression models were used to assess the cross-sectional	Depression at baseline was associated with a higher risk of dementia, even after adjustment in all models. The risk was higher for AD than VaD.

	part of a larger cohort study called the Washington Heights-Inwood Columbia Aging Project (WHICAP). Participants were recruited between 1999 to 2001 and completed baseline assessment upon enrollment. Follow-up assessments were completed at 18- to 24-month intervals.	point)/no (0 points) answers for a total rating out of 10. A CES-D score ≥4 was used to ascertain positive depression status. *Covariates:* Age, ethnic group, education levels, *APOE* genotype, and vascular risk factors (diabetes mellitus, hypertension, current smoking, low high-density lipoprotein levels, and high waist to hip ratio, with low ranges from 0 to 18).	Alzheimer's disease (AD) met the National Institute of Neurological Disorders and Stroke (NINDS)-Alzheimer's Disease and Related Disorders Association criteria. Vascular dementia (VaD) used the NINDS-Association Internationale pour la Recherché et l'Enseignement en Neuroschiences (NINDS-AIREN) criteria.	association between depression and MCI or dementia. Proportional hazards models were used to determine longitudinal analyses. Hazard ratios represented time to event (i.e., incidence of dementia or MCI). Those who did not develop MCI or dementia were censored at the time of their last visits.	Overall, depression was related to a higher odds of prevalent MCI and dementia, incident dementia, and progression from MCI to dementia. The association was stronger for VaD than AD. Depression is also associated with vascular risk factors and cerebrovascular lesions.
Riddle et al., 2017 Longitudinal cognitive outcomes of clinical phenotypes of late-life depression	This study consists of 273 depressed and 164 never-depressed community-dwelling adults from the Duke University Neurocognitive Outcomes of Depression in the	*Exposure:* Age and time of onset of the first (initial) depressive episode was determined using a structured interview. Clinicians rated severity of depression according to the Montgomery-Asberg Depression Rating Scale (MADRS). The	Performance on baseline neuropsychological measures. Domains included: episodic memory, executive function, verbal fluency, and attention-working memory.	Cognitive domain scores were standardized. For each domain, a Cronbach's coefficient alpha was computed, as well. General linear models were used to assess baseline	Overall, depressed participants performed worse in episodic memory, attention-working memory, verbal fluency and executive function domains over time, compared to non-depressed participants.

	Elderly study. Participants were 60 years of age and older, diagnosed with major depressive disorder according to DSM-IV, and scored ≤15 on the Center for Epidemiological Studies on Depression Scale (CES-D). Diagnosis was confirmed by a clinical interview and the National Institute of Mental Health Diagnostic Interview Schedule.	MADRS was not applied to non-depressed participants. Comorbid medical problems (diabetes, hypertension, and heart disease) were determined using self-reported questions from the National Institute of Mental Health and Epidemiological Catchment Area program. *Covariates:* Age, sex, education, race, study time, and baseline neuropsychological domain z-score.		differences in z-scores, controlling for covariates. Differences were assessed across the group variables: depression diagnosis, age at onset, or remission status. Mixed model longitudinal analyses tested for interaction terms between time and vascular risk factor morbidity to determine differences in the effects of time across groups.	
Ros et al., 2013 Depression affects specifically executive functioning: New evidence from older population	This case-control study (26 participants with depression and 26 matched controls without depression) matched participants on	*Exposure:* Presence of major depression (MD), diagnosed by the Mini-International Neuropsychiatric Interview (MINI).	Performance on the Verbal Fluency task, as a measure for executive function.	*t*-tests, χ^2 tests, ANCOVAs, and hierarchical regressions were applied to examine data.	Compared to the non-depressed group, the depressed group performed more poorly on the verbal fluency task Consistent with the aforementioned

	age, gender, education level, performance on memory tasks, and Mini-Mental State Examination (MMSE) score. All participants were over the age of 60 years, currently using antidepressants, and not cognitively impaired.	*Covariates:* Age, gender, and education level.			result, ANCOVA revealed that non-depressed participants perform better on the verbal fluency task compared to the depressed group. Hierarchical regression confirmed that presence of MD significantly predicted poorer verbal fluency scores.Age, gender, and education level were not significant.
Royall et al., 2011 Depressive symptoms predict longitudinal change in executive control but not memory	Data from the Freedom House Study (FHS), which recruited participants from a list of non-institutionalized residents living within a single San Antonio comprehensive care retirement community	*Exposures:* Depressive symptoms were measured using the short Geriatric Depression Sale (GDS). Information regarding functional status and comorbid conditions were assessed using the Older Adults	Performance in executive function and memory measures. Executive function was measured using the Executive Interview (EXIT25) and Trail Making Test A and B (TMT-A and TMT-B). Higher scores on the EXIT25 indicate	Latent Growth Curve modelling was used to estimate the trajectory of change, determining both fixed and random effects. A goodness of fit χ^2 test validated the structure of the models. A root	Depressive symptoms are associated with the longitudinal change in attention and executive function, but not memory. This finding may also only be true for subsets of executive function.

	(CCRC), was used. The present study included 547 older retirees who were 70 years or older, retirees and evaluated at three separate time points over three years.	Resources Scale (OARS). *Covariates:* Age, gender, education, baseline test scores, and level of care.	greater impairment. Scores ≥15/50 suggest impairment. Higher time elapsed on TMT-A and TMT-B suggest impairment. Memory was measured using The California Verbal Learning Task (CVLT).	means square error approximation (RMSEA) was used to assess if data was acceptable (RMSEA ≤0.05 indicates a better fit). A comparative fit index (CFI) was used to compare models to one without change. CFI >0.95 suggests adequate fit.	
Sachs-Ericsson et al., 2005 The influence of depression on cognitive decline in community-dwelling elderly persons	Participants were 65 years and older upon enrollment into the Established Populations for Epidemiologic Studies of the Elderly (EPESE). This present study uses data from 3, 094 participants from the North Carolina cohort with baseline (1986-1987) and	*Exposure:* Depression, which was measured using the modified Center for Epidemiologic Studies Depression (CES-D) scale. The scale was administered at baseline (Cronbach's $\alpha = 0.82$). Participants could score between the range of 0-20, with higher scores indicating more depressive symptoms.	Global cognitive function was measured using the Short Probable Mental Status Questionnaire (SPMSQ). The questionnaire was administered at baseline (Cronbach's $\alpha = 0.74$) and follow-up (Cronbach's $\alpha = 0.74$). Participants errors were summed to	Descriptive statistics were used to define group characteristics. Paired-sample *t*-test were used to compare baseline and follow-up SPMSQ scores. Linear regression analysis was used to predict cognitive decline from baseline, based on follow-up CES-D score.	Overall, an association between depressive symptoms and subsequent cognitive decline was shown. Higher CES-D scores were associated with cognitive errors 3-years later, after controlling for covariates and baseline cognitive performance.

	second-wave (follow-up; 1989-1990) interviews.	*Covariates:* Age, race, gender, family income, education, and physical functioning. Also controlled for baseline cognitive functioning score in the linear regression models.	form a continuous range between 0-10 errors. The higher scores reflect more difficulties completing the questionnaire.		
Singh-Manoux et al., 2010 Persistent depressive symptoms and cognitive function in late midlife: The Whitehall II Study	Data was obtained from the Whitehall II study that surveyed London-based office staff. 4,271 participants between the ages of 35-55 years were included. Baseline screening occurred between 1986-1988, with six subsequent questionnaire assessments occurred during: 1989-1990, 1995-1996, 2001, and 2006. Questionnaire	*Exposures*: Depressive symptoms were measured using the 4-item depression subscale on the 30-item General Health Questionnaire (GHQ). Non-cases were defined as GHQ score ≤3; depression cases were defined as GHQ scores ≥4. Distal depressive symptoms were defined as GHQ depression in the first 3 assessments. Proximal depressive symptoms were defined as GHQ depression in the last 2 assessments of the six-year follow-up. Any case of GHQ depression classified	Cognitive function was measured the last follow-up assessment (phase 7) using a battery that consisted of six standard tasks for the following five cognitive domains: memory, reasoning, vocabulary, phonemic and semantic verbal fluency, and global cognition. Cognitive deficit was defined as scores in the lowest quantile for each cognitive test.	Logistic regression was used to determine i) the association between GHQ depression (any history of depression) and cognitive deficits, ii) cross-sectional associations between GHQ depression and cognitive performance at Phase 7, only, iii) longitudinal association between frequency of depressive symptoms over the 18-year follow-up and cognitive deficits at Phase 7,	Compared to those with no depressive symptoms at any assessment, frequent depressive symptoms were associated with poorer performance on all cognitive measures. There is some evidence for association between frequent and distal depressive symptoms and poorer performance. Frequent proximal depressive symptoms were

	and clinical assessment occurred at 1991-1993, 1997-1999, and 2002-2004.	participants as history of GHQ depression. *Covariates:* Age, sex, highest qualification of education, marital status, diabetes, clinically validated coronary heart disease, stroke, hypertension, and antidepressant use.		and iv) the association between distal and proximal symptoms and cognitive performance.	associated with poor performance on all tests.
Spira et al., 2012 Depressive symptoms in oldest-old women: Risk of mild cognitive impairment and dementia	This present study uses data from the ancillary Study of Osteoporotic Fractures (SOF) study, called the Women, Cognitive Impairment Study of Exceptional Aging (WISE). WISE recruited women who were 85 years or older and community-dwelling between 2002 and 2004. The 2002-2004 assessment is	*Exposure:* Depressive symptoms, measured at baseline using the 15-item Geriatric Depression Score (GDS). Responses were scored and a GDS score ≥6 suggested probable depression. *Covariates:* age, race, educational attainment, medical conditions (hypertension, myocardial infarction, diabetes, stroke, and dementia), coronary heart disease (history of angina or myocardial infarction),	Cognitive function was determined by the performance on a cognitive test battery that measured: global cognition, attention, working memory, verbal learning and memory, verbal fluency, executive function and psychomotor speed. At the five-year follow-up assessment, participants were screened to determine if they had a positive clinically relevant	Descriptive statistics were determined using *t*-tests, Mann-Whitney or Kruskal-Wallis test, and χ^2 tests or Fisher's exact tests. Multivariable models were used to find associations between depressive symptoms and cognitive function, MCI or dementia. and covariates were adjusted for. Regression analyses were performed to	Participants with elevated depressive symptoms at baseline performed poorly on a majority of the cognitive tests at the 5-year follow-up assessment. Depression remains an important risk factor for subsequent cognitive impairment in the oldest old women. However, the exact nature of the relationship remains unknown.

	baseline. The 5-year follow-up is the year 20 visit of the SOF. The present study had a sample size of 1, 534 participants.	height, weight, medications, and Informant Questionnaire of Cognitive Decline in the Elderly score.	cognitive status, including a positive status for mild cognitive impairment (MCI) or dementia. MCI diagnosis was based on Petersen and colleagues criteria and dementia diagnosis was based on DSM-IV criteria.	examine the causal pathway linking stroke. Model diagnoses, including calculation of Pregibon Delta-Beta statistic were performed.	
Sundermann, Katz & Lipton, 2017 Sex differences in the relationship between depressive symptoms and risk of amnestic mild cognitive impairment	Data was obtained from the community-based Einstein Aging Study (EAS), where baseline assessment began in 1993 and included men and women 70 years of age and older. The present study included 572 women and 345 men.	*Exposure:* Depressive symptoms were measured using the 15-item Geriatric Depression scale. GDS-15 scores ranged from 0 to 15, with higher scores indicating a greater number of symptoms. *Covariates:* Age, education, self-reported history of clinical depression, self-reported antidepressant use, and a comorbidity index (based on	A diagnosis of mild cognitive impairment (MCI) or dementia. A diagnosis of MCI was defined by meeting the following criteria: objective memory impairment on the Free and Cued Selective Reminding Test-Free Recall and/or the Logical Memory Subtest of the Wechsler Memory Scale-Revised and subjective memory	Descriptive statistics were determined using ANOVA and χ^2 tests. Cox proportional hazards models were used to determine hazard ratios for incidence of MCI. Nested Cox models with follow-up time as the scale were computed. Models were used to determine the main effect of depressive	Overall, the depressive symptoms by sex interaction was significant. In sex-stratified analyses, mild symptoms were associated with a two-fold increased risk of MCI in men (compared to those with no/low DS), although this test was underpowered. Among women, moderate/severe depressive symptoms were

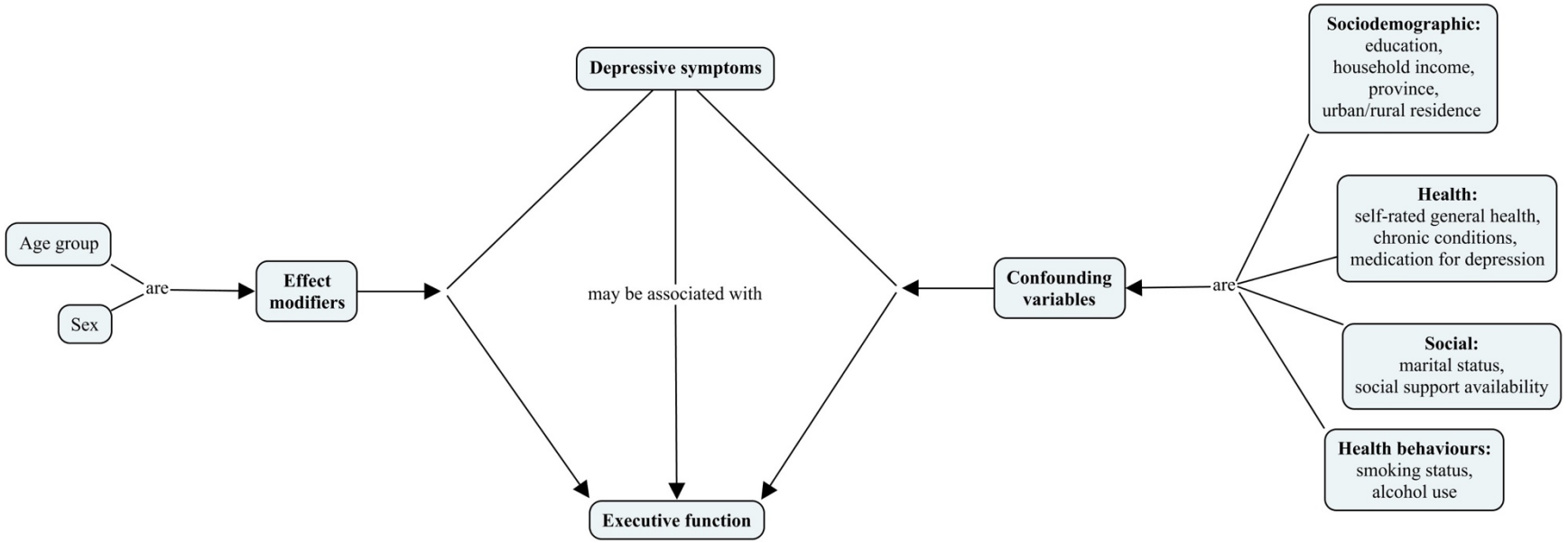
		cardiovascular disease(s), diabetes, hypertension, heart failure, angina, myocardial infarction, or strokes).	complaints without impaired functional ability (determined using self-or informant responses to the Consortium to Establish a Registry for Alzheimer's Disease and the EAS Health Assessment questionnaire). A diagnosis of dementia was made according to the DSM-IV criteria.	symptoms on incidence of MCI or dementia. Models were sex-stratified to compare results between men and women. All tests were two-sided and $\alpha = 0.05$.	significantly associated with incidence of MCI (compared to no/low DS women). The same trend was not applicable for mild symptoms.
Tam & Lam, 2012 Cognitive and functional impairment in Chinese elderly with late-onset depression	This case study included 105 participants recruited from psychiatric outpatient clinics who were ≥60 years at baseline, ≥50 years when they experienced their first depressive episode, and fulfilled DSM-IV criteria for diagnosis of major or minor depression.	*Exposure:* Clinical diagnosis of depression, following DSM-IV criteria and symptom severity according to the Montgomery-Asberg Depression Rating Scale (MADRS) and the Hamilton Depression rating Scale (HDRS).	Performance on a variety of cognitive tests measuring the following cognitive domains: global cognition, episodic memory, attention and working memory, and executive function.	ANOVA with Bonferroni correction was used to determine demographic, cognitive, and functional score differences between groups. Significance was set to $p < 0.05$. χ^2 test was used to compare frequencies of categorical data. Z-scores were computed to	Compared to the healthy control group, participants with a clinical diagnosis of depression at baseline had significant cognitive decline in tests for global cognition, episodic memory, working memory, and executive function. Depression affected multiple cognitive domains.

	Controls were recruited from a population-based cohort study of cognitive impairment. Controls were ≥60 years and had a Clinical Dementia Rating (CDR) scale score of 0.			compare group means.	Most consistently, depressed patients had slowed processing speed and deficits in executive function and memory
Wang & Blazer, 2015 (Review) Depression and cognition in the elderly	Various study populations and sample characteristics were mentioned through the literature review.	Late-life depression (LLD), broadly defined as unipolar depressive symptoms without psychotic features (e.g., major depressive disorder without psychotic features, pre-clinicall depression, or depression with insufficient symptoms) in adults 65 years of age and older. Covariates were not considered in this literature review.	Cognitive symptoms consistent with mild cognitive disorder or mild cognitive impairment (MCI).	N/A	There is a complex interplay between biological and environmental factors that contribute to the development of LLD and comorbid cognitive impairment(s). Despite LLD and comorbid cognitive impairment being one of the most prevalent psychiatric syndromes in older adults, effective treatments remain sparse.

Wei et al., 2019 Late-life depression and cognitive function among older adults in the U.S.: The National Health and Nutrition Examination Survey (NHANES), 2011-2014	Cross-sectional data from the 2011–2012 and 2013–2014 NHANS study of non-institutionalized Americans. Data were combined and consisted of 3180 participants 60 years and over.	*Exposure:* Depressive symptoms were assessed using the 9-item Patient Health Questionnaires (PHS-9). Scores range from 0 (not at all) to 3 (every day), adding up to range from 0–27. Depression status was validated using cut-offs of the PHS-9, with total scores of 5–19 indicating clinically relevant depression (mild to moderate) and total scores of ≥15 indicating clinically significant depression (moderate to severe). *Covariates*: Age, sex, race, marital status, education, smoking, physical activity, co-morbidities (hypertension, diabetes, coronary heart disease, and stroke), body height, and weight	Cognitive function was measured using the Delayed Word Recall Test, the Animal Fluency Test, and the Digit Symbol Substitution Test. These measured immediate verbal memory, language ability, executive function and processing speed.	Cognitive tests were normalized by *z*-scores. Multivariable linear regression models were used to examine the association of depression and depressive symptoms with domain-specific and global cognitive function. Estimated effect sizes (β) and 95% confidence intervals were estimated for final models. Effect sizes for depression only, and depression and diabetes were determined.	A robust association between depressive symptoms and cognitive function, including executive function and overall cognition was observed. Effect sizes increased with severity of depressive symptoms. Depression and diabetes showed a synergistic relationship with cognitive function.

Zeki Al Hazzouri et al., 2014 Long-term cumulative depressive symptom burden and risk of cognitive decline and dementia among very old women	Participants were enrolled in the ongoing prospective cohort Study of Osteoporotic Fractures (SOF). Participants were recruited between September 1986 and October 1988 and were 65 years of age or older upon recruitment. The present study uses data from 7, 240 participants who were followed for 20-years.	*Exposure:* Depressive symptoms (DS) were measured using the 15-item Geriatric Depression Scale (GDS-15). A higher score indicated more depressive symptoms. The GDS was administered in Year 2 of the SOF, which is considered baseline in the present study. Follow-up assessments occurred at years 6, 10, 15, and 20. *Covariates:* Age, education, race, marital status, smoking status, current alcohol consumption, physical activity, height, weight, body mass index, self-reported medical conditions (hypertension, heart attack, stroke, and diabetes), and current use of medications, including antidepressants.	Cognitive function was determined using tests that reflect performance in global cognitive function and executive function. At year 20, additional measurements for immediate and delayed recall and verbal fluency were included. A diagnosis of dementia or mild cognitive impairment (MCI) was determined using a two-step process that followed DSM criteria for diagnosis of dementia and a modified Petersen and colleagues' criteria for diagnosis of MCI.	Linear mixed models with random intercepts and slopes were used to estimate the association between quartile of depressive symptom burden (AUCs) as a time-dependent covariate.	Worse performance on the delayed California Verbal Learning Test, forward Digit Span test, the 3MS, and the verbal fluency tests at year-20 assessment was significantly associated with the higher quartile of long-term DS burden. Higher DS burden was associated with worse performance on everything except the backward Digit Span test. A higher quartile of long-term DS burden was associated with greater odds of developing dementia or MCI.

Appendix C: Conceptual Diagram of the Association Between Depressive Symptoms and Executive Function



Exposure variable
- Depressive symptoms

Outcome variable
- Executive function

Effect modifiers
- Age group
- Sex

Confounding variables

Sociodemographic:
- Education
- Annual household income
- Province
- Urban/rural residence

Health:
- Self-rated general health
- Chronic conditions
- Medication for depression

Social:
- Marital status
- Social support availability

Health behaviours:
- Smoking status
- Alcohol use

Figure A2. Conceptual diagram of the association between depressive symptoms and executive function with covariates

Appendix D: Provincial and Overall Response Rates in the Canadian Longitudinal Study on Aging

Table A4. Provincial and overall response rates for the Tracking Cohort[1]

	AB	BC	MB	NB	NL	NS	ON	PE	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
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
TS	0.07	0.10	0.09	0.10	0.08	0.02	0.09	0.13	0.13	0.07	0.10
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
HR	--	0.02	0.07	0.05	0.05	0.10	0.04	0.05	--	0.09	0.06
Overall	**0.08**	**0.09**	**0.09**	**0.08**	**0.07**	**0.10**	**0.08**	**0.09**	**0.13**	**0.08**	**0.09**

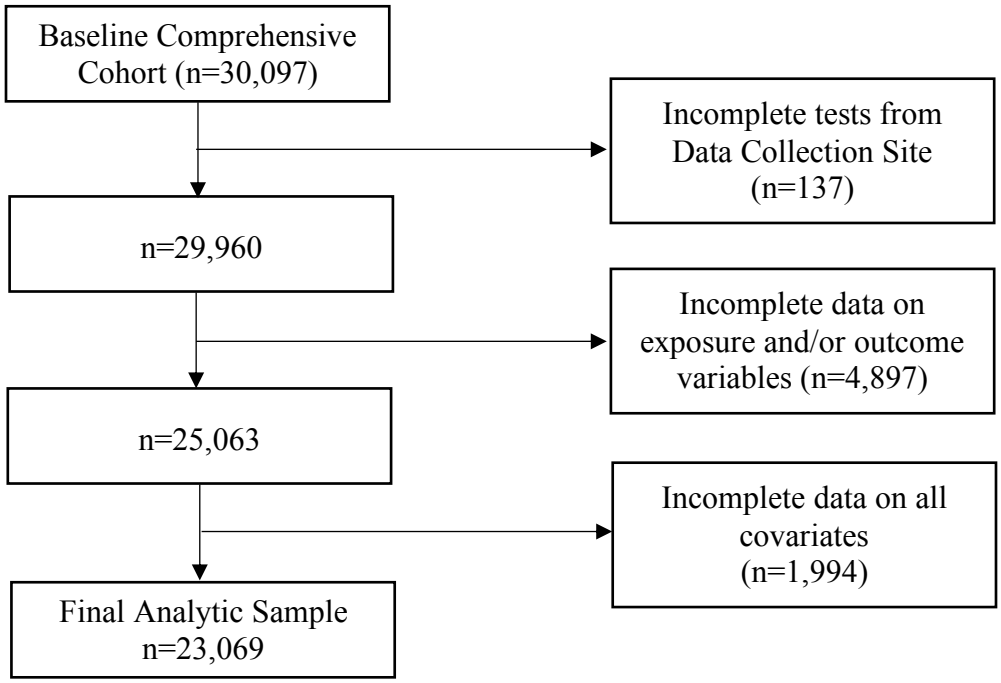
CCHS: Canadian Community Health Survey
RDD: Random Digit Dialing
RTS: Random (Telephone) Sampling from listed telephone numbers
TS: Telephone Sampling
HRI: Initial Health Registry mail-outs
HR2: Health Registry mail-outs targeting lower-educated areas
HR: Health Registry mail-outs (estimates based on number of eligible people who were sent letters)
[1](Canadian Longitudinal Study on Aging, 2017a)

Table A5. Provincial and overall response rates for the Comprehensive Cohort[1]

	AB	BC	MB	NL	NS	ON	QC	Canada
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
TS	0.11	0.10	0.10	0.15	0.12	0.09	0.10	0.10
HR1	--	0.02	0.09	0.06	0.16	0.09	--	0.09
HR2	--	--	--	--	0.08	--	--	0.08
HR	--	0.02	0.09	0.06	0.14	0.09	--	0.09
Overall	**0.11**	**0.09**	**0.10**	**0.12**	**0.13**	**0.09**	**0.10**	**0.10**

CCHS: Canadian Community Health Survey
RDD: Random Digit Dialing
RTS: Random (Telephone) Sampling from listed telephone numbers
TS: Telephone Sampling
HRI: Initial Health Registry mail-outs
HR2: Health Registry mail-outs targeting lower-educated areas
HR: Health Registry mail-outs (estimates based on number of eligible people who were sent letters)
[1](Canadian Longitudinal Study on Aging, 2017a)

Appendix E: Flowchart of the Analytic Sample



Appendix F: Center for Epidemiological Studies Depression Scale

Table A6. Center for Epidemiological Studies Depression (CES-D) Scale[1]

(A)	I was bothered by things that usually don't bother me?[a]
(B)	I did not feel like eating; my appetite was poor.
(C)	I felt I could not shake off the blues even with help from my family or friends.
(D)	I felt that I was just as good as other people.
(E)	I had trouble keeping my mind on what I was doing.[a]
(F)	I felt depressed.[a]
(G)	I felt that everything I did was an effort.[a]
(H)	I felt hopeful about the future.[a]
(I)	I thought my life had been a failure.
(J)	I felt fearful.[a]
(K)	My sleep was restless.[a]
(L)	I was happy.[a]
(M)	I talked less than usual.
(N)	I felt lonely.[a]
(O)	People were unfriendly.
(P)	I enjoyed life.
(Q)	I had crying spells.
(R)	I felt sad.
(S)	I felt that people dislike me.
(T)	I could not get "going."[a]

[1]All questions refer to how participants have felt in the *past week*, that is, from [DATE ONE WEEK AGO] to yesterday. Participants were asked "How often were you…"
[a]Indicates items on the 10-item version of the Center for Epidemiological Studies Depression Scale (CES-D10). There are four possible responses for each item: rarely or never (less than 1 day), some of the time (1–2 days), occasionally (3–4 days), or all of the time (5–7 days). (Kohout, Berkman, Evans, & Cornoni-Huntley, 1993; Radolff, 1977)

Appendix G: Model Fit

Table A7. Diagnostics of model fit in all weighted logistic regression models for analyses

Final Model*	Mann-Whitney			
	Area**	Standard Error	95% Wald Confidence Limits	
Depressive symptoms and executive function				
Research Question 1 (Stratified by social support availability)				
Higher social support availability	0.81	0.005	0.80	0.82
Low social support availability	0.79	0.015	0.74	0.80
Research Question 2 (Stratified by age group)				
45–54-year age group	0.76	0.019	0.72	0.79
55–64-year age group	0.75	0.013	0.73	0.78
65–74-year age group	0.70	0.011	0.69	0.73
75 years and over (Higher social support availability)	0.70	0.010	0.66	0.73
75 years and over (Low social support availability)	0.72	0.028	0.67	0.78
Research Question 3 (Stratified by sex)				
Males (Former/never drinkers)	0.79	0.015	0.76	0.82
Males (Current drinkers)	0.80	0.007	0.79	0.82
Females (Higher social support availability)	0.81	0.007	0.80	0.83
Females (Low social support availability)	0.78	0.023	0.73	0.82

*Diagnostics reflect results from the final model (Model E) that includes all covariates

**Area under the receiver operating characteristic curve

Appendix H: Supplementary Results Tables for Stratified Analyses

A. Analyses for the association of depressive symptoms and covariates with low executive function by social support availability

In research question 1, the association was stratified by SSA. Descriptive results for each stratum of social support (i.e., higher SSA versus low SSA) are presented in Tables A8 and A9. These descriptive results correspond to the multivariable results presented in Section 5.1.3, Tables 3a and 3b of the main body.

Notably, the prevalence of depressive symptoms in those with low SSA (44.46%) is more than three times greater than the prevalence of depressive symptoms in those with higher SSA (13.23%). Of those who reported depressive symptoms in the low SSA stratum, 43.70% have low executive function. Of those who reported depressive symptoms in the higher SSA stratum, 21.32% have low executive function. Those who report low SSA and depressive symptoms are more likely to have low executive function.

Table A8. Distribution of depressive symptoms and covariates by low executive function status in participants with higher social support availability, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=21,580)			Weighted Frequency (n=2,736,065)		
	Executive Function					
	Low (n=2,031)	Not Low (n=19,549)	Total	Low (n=181,812)	Not Low (n=2,554,253)	Total
Depressive symptoms[1] (%)						
Presence	21.32	12.39***	13.23	21.84	12.32***	12.95
Absence	78.68	87.61	86.77	78.16	87.68	87.05
Sociodemographic Factors						
Age, groups (%)						
45–54 years	8.57	29.24***	27.29	18.45	45.94***	44.11
55–64 years	16.79	35.38	33.63	18.14	30.94	30.09
65–74 years	29.99	23.12	23.76	26.52	15.50	16.23
75 years and over	44.66	12.27	15.32	36.88	7.62	9.56
Sex (%)						
Female	51.75	50.64	50.74	52.48	50.07	50.23
Male	48.25	49.36	49.26	47.52	49.93	49.77
Education (%)						
Less than high school	16.00	3.61***	4.78	18.70	3.30***	4.33
High school graduate	15.02	8.49	9.11	15.31	8.09	8.57
Some post-secondary	8.62	7.18	7.32	8.19	6.59	6.70
Post-secondary degree/diploma	60.36	80.72	78.80	57.80	82.02	80.41
Annual household income (%)						
< $20,000	11.03	3.39***	4.11	10.98	2.87***	3.41
≥ $20,000 and < $50,000	41.70	18.67	20.84	42.04	15.44	17.21
≥ $50,000 and < $100,000	32.55	36.12	35.79	30.62	33.69	33.49
≥ $100,000 and < $150,000	9.11	22.02	20.81	9.46	24.25	23.26
≥ $150,000	5.61	19.79	18.46	6.90	23.75	22.63
Province (%)						
Ontario	20.63	21.80***	21.69	13.79	13.48***	13.50
Alberta	7.98	8.62	8.56	9.28	11.27	11.13
British Columbia	16.64	22.33	21.79	24.63	31.98	31.49
Manitoba	10.88	10.52	10.55	9.53	8.44	8.51
NFLD	12.06	7.60	8.02	3.72	2.29	2.38
Nova Scotia	12.65	`0.72	10.90	4.69	3.65	3.72
Quebec	19.15	18.41	18.48	34.36	28.89	29.26
Urban/rural residence (%)						
Urban	90.35	90.30	90.30	89.04	90.33	90.25
Rural	9.65	9.70	9.70	10.96	9.67	9.75

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table A8. Distribution of depressive symptoms and covariates by low executive function status in participants with higher social support availability, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=21,580)			Weighted Frequency (n=2,736,065)		
	Executive Function					
	Low (n=2,031)	Not Low (n=19,549)	Total	Low (n=181,812)	Not Low (n=2,554,253)	Total
Health Factors						
Self-rated general health (%)						
Poor	2.61	1.04***	1.19	2.93	0.88***	1.02
Fair	12.90	5.82	6.48	12.92	5.85	6.32
Good	36.63	27.82	48.65	39.59	28.39	29.13
Very good	34.61	43.50	42.66	32.35	42.64	41.95
Excellent	13.24	21.83	21.02	12.22	22.24	21.57
Medication for depression (%)						
Yes	8.67	7.73	7.82	9.34	7.74	7.85
No	91.33	92.27	92.18	90.66	92.26	92.15
Chronic conditions[2] (%)						
Yes	81.29	64.90***	66.45	78.02	59.88***	61.08
No	18.71	35.10	33.55	21.98	40.12	38.92
Social Factors						
Marital status (%)						
Single, never married	6.99	7.30***	7.27	7.17	6.78***	6.80
Married/common-law	60.91	74.37	73.10	66.79	80.44	79.54
Widowed	19.89	6.76	8.00	15.02	3.91	4.65
Divorced/separated	12.21	11.57	11.63	11.02	8.87	9.01
Health Behaviours						
Smoking status (%)						
Current	8.62	7.62	7.72	9.33	8.05	8.14
Former	60.71	60.45	60.47	58.83	57.92	57.98
Never	30.67	31.93	31.81	31.84	34.03	33.88
Alcohol use (%)						
Current	79.03	88.64***	87.74	79.18	88.72***	88.08
Former	17.53	9.55	10.30	17.59	9.60	10.13
Never	3.45	1.81	1.96	3.23	1.69	1.79

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
*p<0.05; **p<0.01; ***p<0.001

Table A9. Distribution of depressive symptoms and covariates by low executive function status in participants with low social support availability, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=1,489)			Weighted Frequency (n=153,733)		
	Executive Function					
	Low (n=270)	Not Low (n=1,219)	Total	Low (n=21,342)	Not Low (n=132,390)	Total
Depressive symptoms[1] (%)						
Presence	43.70	44.63	44.46	43.29	47.75	47.13
Absence	56.30	55.37	55.54	56.71	52.35	52.87
Sociodemographic Factors						
Age, groups (%)						
45–54 years	8.89	23.63***	20.95	16.35	39.38***	36.19
55–64 years	22.59	35.19	32.91	24.94	31.57	30.65
65–74 years	24.44	22.15	22.57	22.17	16.72	17.48
75 years and over	44.07	19.03	23.57	36.55	12.32	15.69
Sex (%)						
Female	41.11	48.48*	47.15	45.56	46.45	46.33
Male	58.89	51.52	52.85	54.44	53.55	53.67
Education (%)						
Less than high school	24.44	7.30***	10.41	26.70	7.82***	10.44
High school graduate	10.00	8.12	8.46	9.75	7.78	8.05
Some post-secondary	11.11	9.76	10.01	10.33	9.49	9.61
Post-secondary degree/diploma	54.44	74.82	71.12	53.22	74.92	71.90
Annual household income (%)						
< $20,000	28.15	19.28***	20.89	30.99	19.26***	20.88
≥ $20,000 and < $50,000	45.19	35.93	37.61	41.94	32.93	34.18
≥ $50,000 and < $100,000	22.59	29.61	28.34	23.73	29.91	29.05
≥ $100,000 and < $150,000	2.96	10.17	8.87	2.72	12.12	10.82
≥ $150,000	1.11	5.00	4.30	0.63	5.78	5.07
Province (%)						
Ontario	23.70	21.00	21.49	15.08	12.84***	13.15
Alberta	5.56	9.76	9.00	4.67	10.88	10.02
British Columbia	19.63	23.22	22.57	24.08	32.12	31.01
Manitoba	15.93	11.73	12.49	15.19	9.61	10.39
NFLD	4.81	5.82	5.64	1.42	1.68	1.64
Nova Scotia	9.63	7.05	7.52	4.59	2.69	2.96
Quebec	20.74	21.41	21.29	34.97	30.17	30.84
Urban/rural residence (%)						
Urban	93.33	6.67	93.89	91.54	8.46	93.33
Rural	94.01	5.99	6.11	93.62	6.38	6.67

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05, **p<0.01, ***p<0.001

Table A9. Distribution of depressive symptoms and covariates by low executive function status in participants with low social support availability, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=1,489)			Weighted Frequency (n=153,733)		
	Executive Function					
	Low (n=270)	Not Low (n=1,219)	Total	Low (n=21,342)	Not Low (n=132,390)	Total
Health Factors						
Self-rated general health (%)						
Poor	5.93	3.77***	4.16	5.61	4.29*	4.47
Fair	24.07	15.75	17.26	26.18	16.40	17.76
Good	39.63	38.56	38.75	38.31	39.87	39.66
Very good	21.85	30.11	28.61	22.23	29.09	28.14
Excellent	8.52	11.81	11.22	7.67	10.35	9.98
Medication for depression (%)						
Yes	11.11	13.62	13.16	11.91	13.39	13.18
No	88.89	86.38	86.84	88.09	86.61	86.82
Chronic conditions[2] (%)						
Yes	87.04	71.86***	74.61	86.99	67.48***	70.19
No	12.96	28.14	25.39	13.01	32.52	29.81
Social Factors						
Marital status (%)						
Single, never married	25.99	27.97***	25.99	16.65	29.30***	27.54
Married/common-law	26.66	27.40	26.66	29.22	35.60	34.71
Widowed	15.78	13.29	15.78	21.33	8.70	10.46
Divorced/separated	31.56	31.34	31.56	32.80	26.40	27.29
Health Behaviours						
Smoking status (%)						
Current	21.11	17.56	18.20	20.94	19.36	19.58
Former	49.63	53.65	52.92	48.78	50.48	50.25
Never	29.26	28.79	28.88	30.28	30.16	30.18
Alcohol use (%)						
Current	65.93	79.74***	77.23	63.32	79.95***	77.64
Former	28.89	17.47	19.54	32.70	16.87	19.07
Never	5.19	2.79	3.22	3.98	3.18	3.29

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
*p<0.05; **p<0.01; ***p<0.001

B. Analyses for the association of depressive symptoms and covariates with low executive function in those 75 years and over by social support availability

In research question 2, the association between depressive symptoms and low executive function in those 75 years and over was stratified by SSA. Descriptive results for each stratum of social support (i.e., higher SSA versus low SSA) are presented in Tables A10 and A11 of Appendix H. These descriptive results correspond to the multivariable results presented in Section 5.2.4, Tables 5d and 5e of the main body.

Table A10. Distribution of depressive symptoms and covariates by low executive function status in adults 75 years and over with higher social support availability, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=3,305)			Weighted Frequency (n=261,601)		
	Executive Function					
	Low (n=907)	Not Low (n=2,398)	Total	Low (n=67,055)	Not Low (n=194,546)	Total
Depressive symptoms[1] (%)						
Presence	19.40	11.18***	13.43	19.40	11.52***	13.54
Absence	80.60	88.82	86.57	80.60	88.48	86.46
Sociodemographic Factors						
Sex (%)						
Female	50.17	47.87	48.50	53.71	53.08	53.24
Male	49.83	52.13	51.50	46.29	46.92	46.76
Education (%)						
Less than high school	19.74	8.09***	11.29	24.63	10.18***	13.88
High school graduate	14.99	10.84	11.98	14.74	11.00	11.96
Some post-secondary	8.16	9.22	8.93	6.58	8.73	8.18
Post-secondary degree/diploma	57.11	71.85	67.81	54.05	70.09	65.98
Annual household income (%)						
< $20,000	9,70	5.42***	6.60	11.05	5.87***	7.19
≥ $20,000 and < $50,000	45.76	33.69	37.00	49.35	35.85	39.31
≥ $50,000 and < $100,000	33.41	42.24	39.82	29.92	40.40	37.71
≥ $100,000 and < $150,000	7.06	13.51	11.74	6.35	12.78	11.13
≥ $150,000	4.08	5.13	4.84	3.32	5.11	4.65
Province (%)						
Ontario	21.28	22.31***	22.03	12.59	11.69	11.91
Alberta	8.27	7.51	7.72	7.69	6.76	7.00
British Columbia	17.53	25.69	23.45	24.46	32.84	30.69
Manitoba	12.02	9.80	10.41	11.35	8.59	9.30
NFLD	10.03	6.84	7.72	2.79	1.67	1.96
Nova Scotia	12.13	9.80	10.44	4.10	3.15	3.39
Quebec	18.74	18.06	18.25	37.03	35.30	35.75
Urban/rural residence (%)						
Urban	92.50	94.29	93.80	91.92	93.34	92.97
Rural	7.50	5.71	6.20	8.08	6.66	7.03

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table A10. Distribution of depressive symptoms and covariates by low executive function status in adults 75 years and over with higher social support availability, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=3,305)			Weighted Frequency (n=261,601)		
	Executive Function					
	Low (n=907)	Not Low (n=2,398)	Total	Low (n=67,055)	Not Low (n=194,546)	Total
Health Factors						
Self-rated general health (%)						
Poor	2.21	0.92***	1.27	2.70	0.82***	1.30
Fair	12.02	6.88	8.29	12.89	6.25	7.95
Good	37.82	28.61	31.13	41.35	31.33	33.81
Very good	35.83	43.83	41.63	33.12	42.86	40.36
Excellent	12.13	19.77	17.67	9.94	18.86	16.58
Medication for depression (%)						
Yes	4.63	3.92	4.11	4.98	4.23	4.42
No	95.37	96.08	95.89	95.02	95.77	95.58
Chronic conditions[2] (%)						
Yes	87.76	85.36	86.02	88.70	86.24	86.87
No	12.24	14.64	13.98	11.30	13.76	13.13
Social Factors						
Marital status (%)						
Single, never married	3.75	4.25***	4.11	3.10	4.17**	3.90
Married/common-law	55.02	61.97	60.06	59.54	64.94	63.56
Widowed	32.08	23.48	25.84	28.19	21.18	22.98
Divorced/separated	9.15	10.30	9.98	9.17	9.71	9.57
Health Behaviours						
Smoking status (%)						
Current	3.97	2.96	3.24	3.83	3.01	3.22
Former	63.84	67.39	66.41	63.22	66.34	65.54
Never	32.19	29.65	30.35	32.95	30.65	31.23
Alcohol use (%)						
Current	79.38	84.86***	83.36	80.79	85.55*	84.33
Former	16.65	12.76	13.83	15.91	12.37	13.28
Never	3.97	2.38	2.81	3.30	2.08	2.39

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
*p<0.05; **p<0.01; ***p<0.001

Table A11. Distribution of depressive symptoms and covariates by low executive function status in adults 75 years and over with low social support availability, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=351)			Weighted Frequency (n=24,113)		
	Executive Function					
	Low (n=119)	Not Low (n=232)	Total	Low (n=7,800)	Not Low (n=16,313)	Total
Depressive symptoms[1] (%)						
Presence	32.77	32.33	32.48	34.29	36.26	35.62
Absence	67.23	67.67	67.52	65.71	63.74	64.38
Sociodemographic Factors						
Sex (%)						
Female	42.04	51.29	48.15	49.13	58.41	55.41
Male	57.98	48.71	51.85	50.87	41.59	44.59
Education (%)						
Less than high school	23.52	14.22**	17.38	22.70	17.31*	19.05
High school graduate	15.13	7.76	10.26	17.67	9.49	12.14
Some post-secondary	13.45	8.62	10.26	12.73	8.09	9.59
Post-secondary degree/diploma	47.90	69.40	62.11	46.90	65.11	59.22
Annual household income (%)						
< $20,000	22.69	13.36**	16.52	25.62	13.80**	17.62
≥ $20,000 and < $50,000	50.42	45.26	47.01	46.38	46.13	46.21
≥ $50,000 and < $100,000	24.37	29.31	27.64	26.00	28.70	27.83
≥ $100,000 and < $150,000	0.84	9.05	6.27	0.68	9.04	6.34
≥ $150,000	1.68	3.02	2.56	1.33	2.33	2.00
Province (%)						
Ontario	19.33	19.83	19.66	10.64	11.07	10.93
Alberta	7.56	11.64	10.26	5.97	8.87	7.93
British Columbia	26.05	21.12	22.79	32.43	26.46	28.39
Manitoba	14.29	13.79	13.96	14.46	13.12	13.56
NFLD	5.88	5.60	5.70	1.72	1.49	1.56
Nova Scotia	8.40	8.19	8.26	3.19	3.03	3.09
Quebec	18.49	19.83	19.37	31.59	35.96	34.55
Urban/rural residence (%)						
Urban	94.12	95.26	94.87	93.51	96.40	95.47
Rural	5.88	4.74	5.13	6.49	3.60	4.53

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table A11. Distribution of depressive symptoms and covariates by low executive function status in adults 75 years and over with low social support availability, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=351)			Weighted Frequency (n=24,113)		
	Executive Function					
	Low (n=119)	Not Low (n=232)	Total	Low (n=7,800)	Not Low (n=16,313)	Total
Health Factors						
Self-rated general health (%)						
Poor	2.52	2.16	2.28	2.82	2.29	2.46
Fair	19.33	11.64	14.25	18.44	11.55	13.78
Good	41.18	38.79	39.60	42.51	41.53	41.85
Very good	24.37	28.88	27.35	24.05	28.02	26.74
Excellent	12.61	18.53	16.52	12.18	16.62	15.18
Medication for depression (%)						
Yes	5.04	5.17	5.13	3.88	5.22	4.78
No	94.96	94.83	94.87	96.12	94.78	95.22
Chronic conditions[2] (%)						
Yes	91.60	88.79	89.74	90.27	92.37	91.69
No	8.40	11.21	10.26	9.73	7.63	8.31
Social Factors						
Marital status (%)						
Single, never married	10.92	12.93	12.25	10.00	12.46**	11.66
Married/common-law	21.01	23.28	22.51	23.04	27.76	26.23
Widowed	44.54	33.62	37.32	41.08	29.97	33.56
Divorced/separated	23.53	30.17	27.92	25.88	29.81	28.54
Health Behaviours						
Smoking status (%)						
Current	10.92	5.17	7.12	8.90	4.97	6.24
Former	55.46	63.36	60.68	52.55	64.09	60.36
Never	33.61	31.47	32.19	38.56	30.94	33.41
Alcohol use (%)						
Current	67.23	78.02*	74.36	67.64	78.98*	75.31
Former	28.57	17.24	21.08	29.36	17.44	21.30
Never	4.20	4.74	4.56	3.00	3.58	3.40

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
*p<0.05; **p<0.01; ***p<0.001

C. Analyses for the association of depressive symptoms and covariates with low executive function by sex and alcohol use

In research question 3, alcohol use was a significant first-order interaction among males. Therefore, models for males were stratified by alcohol use (i.e., current drinkers versus former/never drinkers).

Descriptive results for each stratum of alcohol use (i.e., current drinkers versus former/never drinkers) for males are presented in Tables A12 and A13 of Appendix H. The descriptive results for each stratum of alcohol use for females are presented in Tables A14 and A15.

Table A12. Distribution of depressive symptoms and covariates by low executive function status in male former/never drinkers, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=1,334)			Weighted Frequency (n=161,783)		
	Executive Function					
	Low (n=230)	Not Low (n=1,104)	Total	Low (n=19,654)	Not Low (n=142,129)	Total
Depressive symptoms[1] (%)						
Presence	28.26	15.49***	17.69	30.27	15.58***	17.37
Absence	71.74	84.51	82.31	69.73	84.42	82.63
Sociodemographic Factors						
Age, groups (%)						
45–54 years	9.13	26.99***	23.91	25.66	47.35***	44.72
55–64 years	21.30	34.87	32.53	24.27	31.61	30.72
65–74 years	26.96	21.83	22.71	21.15	13.22	14.19
75 years and over	42.61	16.30	20.84	28.92	7.82	10.38
Education (%)						
Less than high school	15.22	4.80***	6.60	17.65	3.58***	5.29
High school graduate	17.39	9.42	10.79	18.59	8.67	9.87
Some post-secondary	10.43	7.70	8.17	7.73	6.83	6.94
Post-secondary degree/diploma	56.96	78.08	74.44	56.04	80.92	77.90
Annual household income (%)						
< $20,000	11.74	6.70***	7.57	15.62	5.76***	6.96
≥ $20,000 and < $50,000	50.43	23.82	28.41	51.88	19.98	23.86
≥ $50,000 and < $100,000	25.65	35.51	33.81	19.49	34.21	32.42
≥ $100,000 and < $150,000	8.26	19.66	17.69	8.79	22.30	20.65
≥ $150,000	3.91	14.31	12.52	4.22	17.76	16.11
Province (%)						
Ontario	22.17	20.65*	20.91	14.34	12.72***	12.91
Alberta	6.96	8.97	8.62	9.83	12.99	12.60
British Columbia	21.74	31.25	29.61	29.88	44.74	42.94
Manitoba	10.00	10.60	10.49	9.87	8.54	8.70
NFLD	10.87	5.98	6.82	2.90	1.72	1.87
Nova Scotia	13.04	11.41	11.69	4.78	3.42	3.58
Quebec	15.22	11.14	11.84	28.41	15.87	17.39
Urban/rural residence (%)						
Urban	90.87	92.75	7.57	92.58	94.84	94.57
Rural	9.13	7.25	92.43	7.42	5.16	5.43

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table A12. Distribution of depressive symptoms and covariates by low executive function status in male former/never drinkers, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=1,334)			Weighted Frequency (n=161,783)		
	Executive Function					
	Low (n=230)	Not Low (n=1,104)	Total	Low (n=19,654)	Not Low (n=142,129)	Total
Health Factors						
Self-rated general health (%)						
Poor	3.91	2.99***	3.15	4.48	3.07**	3.24
Fair	21.30	9.78	11.77	21.18	10.12	11.46
Good	32.17	31.34	31.48	34.27	30.39	30.87
Very good	30.87	38.22	36.96	29.71	38.87	37.76
Excellent	11.74	17.66	16.64	10.35	17.54	16.67
Medication for depression (%)						
Yes	9.57	9.33	9.37	11.55	9.73	9.95
No	90.43	90.67	90.63	88.45	90.27	90.05
Chronic conditions[2] (%)						
Yes	84.78	67.93***	70.84	81.22	61.57***	63.96
No	15.22	32.07	29.16	18.78	38.43	36.04
Social Factors						
Marital status (%)						
Single, never married	8.70	10.69***	10.34	7.72	10.51***	10.17
Married/common-law	63.91	76.45	74.29	72.82	81.55	80.49
Widowed	11.30	3.26	4.65	6.35	1.43	2.03
Divorced/separated	16.09	9.60	10.72	13.11	6.51	7.31
Low SSA (%)						
Yes	20.43	10.05***	11.84	19.67	8.50***	9.86
No	79.57	89.95	88.16	80.33	91.50	90.14
Health Behaviours						
Smoking status (%)						
Current	11.74	9.33**	9.75	11.53	9.81**	10.02
Former	61.74	52.81	54.35	62.10	47.12	48.94
Never	26.52	37.86	35.91	26.37	43.07	41.04

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
Abbreviations: SSA = social support availability
*p<0.05; **p<0.01; ***p<0.001

Table A13. Distribution of depressive symptoms and covariates by low executive function status in male current drinkers, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=10,083)			Weighted Frequency (n=1,282,585)		
	Executive Function					
	Low (n=909)	Not Low (n=9,174)	Total	Low (n=78,369)	Not Low (n=1,204,216)	Total
Depressive symptoms[1] (%)						
Presence	18.48	10.63***	11.34	18.75	11.02***	11.49
Absence	81.52	89.37	88.66	81.25	88.98	88.51
Sociodemographic Factors						
Age, groups (%)						
45–54 years	8.91	28.33***	26.58	20.45	47.03***	45.40
55–64 years	16.83	34.64	33.04	20.13	30.85	30.20
65–74 years	27.72	24.13	24.46	22.01	14.90	15.33
75 years and over	46.53	12.90	15.93	37.42	7.22	9.07
Education (%)						
Less than high school	15.18	3.22***	4.29	16.56	2.91***	3.75
High school graduate	12.54	7.21	7.69	13.33	6.50	6.92
Some post-secondary	9.13	6.87	7.07	8.83	6.21	6.37
Post-secondary degree/diploma	63.15	82.71	80.95	61.29	84.37	82.96
Annual household income (%)						
< $20,000	7.37	2.69***	3.11	7.29	2.46***	2.76
≥ $20,000 and < $50,000	36.19	13.97	15.98	36.85	11.83	13.36
≥ $50,000 and < $100,000	38.50	35.62	35.88	35.85	31.66	31.92
≥ $100,000 and < $150,000	10.75	24.66	23.38	10.31	26.56	25.57
≥ $150,000	7.48	23.05	21.65	9.70	27.48	26.39
Province (%)						
Ontario	20.79	22.20***	22.08	13.04	13.61***	13.58
Alberta	7.15	8.68	8.54	9.35	12.32	12.14
British Columbia	16.06	21.65	21.14	22.33	30.25	29.77
Manitoba	13.20	10.22	10.49	11.18	8.69	8.84
NFLD	10.12	7.73	7.94	3.15	2.12	2.19
Nova Scotia	11.77	10.74	10.83	4.35	3.22	3.29
Quebec	20.90	18.78	18.97	36.61	29.78	30.19
Urban/rural residence (%)						
Urban	90.43	90.63	90.61	88.61	90.90	90.76
Rural	9.57	9.37	9.39	11.39	9.10	9.24

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table A13. Distribution of depressive symptoms and covariates by low executive function status in male current drinkers, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=10,083)			Weighted Frequency (n=1,282,585)		
	Executive Function					
	Low (n=909)	Not Low (n=9,174)	Total	Low (n=78,369)	Not Low (n=1,204,216)	Total
Health Factors						
Self-rated general health (%)						
Poor	2.64	0.98***	1.13	2.83	0.86***	0.98
Fair	12.65	6.33	6.90	11.28	6.25	6.56
Good	37.07	29.56	30.24	39.91	30.47	31.05
Very good	34.54	42.08	41.40	33.35	41.34	40.85
Excellent	13.09	21.05	20.33	12.63	21.07	20.55
Medication for depression (%)						
Yes	4.73	4.75	4.75	5.39	4.98	95.00
No	95.27	95.25	95.27	94.61	95.02	5.00
Chronic conditions[2] (%)						
Yes	80.53	63.35***	64.90	76.31	56.99***	58.17
No	19.47	36.65	35.10	23.69	43.01	41.83
Social Factors						
Marital status (%)						
Single, never married	8.25	7.30***	7.39	8.97	7.41***	7.50
Married/common-law	70.63	80.70	79.79	74.98	83.97	83.42
Widowed	11.11	3.64	4.31	7.61	1.90	2.25
Divorced/separated	10.01	8.36	8.51	8.45	6.73	6.83
Low SSA (%)						
Yes	12.32	5.64***	6.24	9.89	4.88***	5.19
No	87.68	94.36	93.76	90.11	95.12	94.81
Health Behaviours						
Smoking status (%)						
Current	22.33	27.58***	27.11	11.88	8.45**	8.66
Former	67.22	64.55	64.79	63.86	60.98	61.16
Never	10.45	7.87	8.10	24.27	30.57	30.18

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
Abbreviations: SSA = social support availability
*p<0.05; **p<0.01; ***p<0.001

Table A14. Distribution of depressive symptoms and covariates by low executive function status in female former/never drinkers, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=1,651)			Weighted Frequency (n=198,671)		
	Executive Function					
	Low (n=288)	Not Low (n=1,363)	Total	Low (n=26,034)	Not Low (n=172,637)	Total
Depressive symptoms[1] (%)						
Presence	34.03	23.55***	25.38	31.37	22.16**	23.37
Absence	65.97	76.45	74.62	68.63	77.84	76.63
Sociodemographic Factors						
Age, groups (%)						
45–54 years	6.60	26.49***	23.02	12.57	42.10***	38.23
55–64 years	17.01	33.16	30.35	16.22	29.25	27.54
65–74 years	31.94	23.18	24.71	33.85	16.83	19.06
75 years and over	44.44	17.17	21.93	37.36	11.83	15.17
Education (%)						
Less than high school	25.00	6.75***	9.93	27.97	6.71***	9.49
High school graduate	15.28	11.59	12.24	13.33	11.11	11.40
Some post-secondary	8.68	8.73	8.72	7.83	8.20	8.15
Post-secondary degree/diploma	51.04	72.93	69.11	50.87	73.98	70.95
Annual household income (%)						
< $20,000	22.22	12.03***	13.81	21.60	10.42***	11.89
≥ $20,000 and < $50,000	52.78	31.33	35.07	50.29	26.25	29.40
≥ $50,000 and < $100,000	20.83	32.94	30.83	22.75	32.78	31.46
≥ $100,000 and < $150,000	3.47	14.01	12.17	3.25	17.69	15.80
≥ $150,000	0.69	9.68	8.12	2.11	12.87	11.46
Province (%)						
Ontario	23.61	19.00	19.81	15.80	11.79	12.31
Alberta	7.29	7.26	7.26	6.71	7.97	7.81
British Columbia	23.26	30.96	30.96	36.73	45.66	44.49
Manitoba	11.81	13.21	13.21	10.44	9.85	9.93
NFLD	9.38	6.31	6.31	2.85	1.98	2.10
Nova Scotia	11.11	9.98	9.98	4.36	3.74	3.82
Quebec	13.54	13.28	13.28	23.11	19.01	19.55
Urban/rural residence (%)						
Urban	92.71	92.59	92.61	93.30	92.35	92.47
Rural	7.29	7.41	7.39	6.70	7.65	7.53

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table A14. Distribution of depressive symptoms and covariates by low executive function status in female former/never drinkers, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=1,651)			Weighted Frequency (n=198,671)		
	Executive Function					
	Low (n=288)	Not Low (n=1,363)	Total	Low (n=26,034)	Not Low (n=172,637)	Total
Health Factors						
Self-rated general health (%)						
Poor	5.90	2.93***	3.45	5.99	2.36***	2.84
Fair	19.44	10.71	12.24	22.37	10.62	12.16
Good	37.85	33.60	34.34	37.39	32.09	32.79
Very good	29.51	36.02	34.89	29.37	36.25	35.35
Excellent	7.29	16.73	15.08	4.88	18.67	16.86
Medication for depression (%)						
Yes	15.28	13.06	13.45	16.57	11.86	12.48
No	84.72	86.94	86.55	83.43	88.14	87.52
Chronic conditions[2] (%)						
Yes	88.89	70.65***	73.83	86.81	65.85***	68.59
No	11.11	29.35	26.17	13.19	34.15	31.41
Social Factors						
Marital status (%)						
Single, never married	11.46	10.49***	10.66	11.79	8.47***	8.91
Married/common-law	36.81	58.18	54.45	43.57	69.00	65.66
Widowed	32.29	13.28	16.60	24.98	8.11	10.32
Divorced/separated	19.44	18.05	18.29	19.66	14.42	15.11
Low SSA (%)						
Yes	15.63	9.98**	10.96	15.22	8.38**	9.27
No	84.38	90.02	89.04	84.78	91.62	90.73
Health Behaviours						
Smoking status (%)						
Current	7.64	8.36	8.24	7.57	8.68	8.54
Former	43.75	42.85	43.00	42.40	41.40	41.53
Never	48.61	48.79	48.76	50.03	49.92	49.93

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
Abbreviations: SSA = social support availability
*p<0.05; **p<0.01; ***p<0.001

Table A15. Distribution of depressive symptoms and covariates by low executive function status in female current drinkers, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=10,001)			Weighted Frequency (n=1,246,759)		
	Executive Function					
	Low (n=874)	Not Low (n=9,127)	Total	Low (n=79,096)	Not Low (n=1,167,662)	Total
Depressive symptoms[1] (%)						
Presence	25.17	16.42***	17.19	25.46	15.83***	16.44
Absence	74.83	83.58	82.81	74.54	84.17	83.56
Sociodemographic Factors						
Age, groups (%)						
45–54 years	8.81	30.09***	28.23	16.06	44.47***	42.67
55–64 years	17.28	36.49	34.81	17.12	32.28	30.38
65–74 years	30.78	22.11	22.87	28.74	16.34	17.13
75 years and over	43.14	11.32	14.10	38.09	7.91	9.83
Education (%)						
Less than high school	16.70	3.89***	5.01	20.19	3.68***	4.73
High school graduate	15.33	9.16	9.70	15.62	9.18	9.59
Some post-secondary	8.35	7.55	7.62	8.37	7.04	7.12
Post-secondary degree/diploma	59.61	79.40	77.67	55.83	80.10	78.56
Annual household income (%)						
< $20,000	16.25	4.53***	5.55	15.37	3.67***	4.42
≥ $20,000 and < $50,000	42.56	23.18	24.88	42.00	19.00	20.46
≥ $50,000 and < $100,000	28.95	36.31	35.67	28.94	35.42	35.01
≥ $100,000 and < $150,000	7.89	19.27	18.28	9.01	21.69	20.88
≥ $150,000	4.35	16.71	15.63	4.67	20.22	19.23
Province (%)						
Ontario	20.02	21.85***	21.69	14.07	13.62***	13.65
Alberta	8.58	8.89	8.86	8.68	10.41	10.30
British Columbia	14.65	20.76	20.23	21.47	30.20	29.65
Manitoba	9.95	10.56	10.51	9.04	8.10	8.16
NFLD	13.04	7.63	8.10	4.16	2.50	2.60
Nova Scotia	13.04	10.24	10.49	5.09	4.00	4.07
Quebec	20.71	20.07	20.13	37.48	31.18	31.58
Urban/rural residence (%)						
Urban	90.27	89.82	89.86	87.86	89.28	89.19
Rural	9.73	10.18	10.14	12.14	10.72	10.81

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table A15. Distribution of depressive symptoms and covariates by low executive function status in female current drinkers, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=10,001)			Weighted Frequency (n=1,246,759)		
	Executive Function					
	Low (n=874)	Not Low (n=9,127)	Total	Low (n=79,096)	Not Low (n=1,167,662)	Total
Health Factors						
Self-rated general health (%)						
Poor	2.17	0.95***	1.06	2.35	0.80***	0.90
Fair	12.24	5.41	6.01	12.95	5.42	5.89
Good	37.87	26.21	27.23	40.98	26.75	27.65
Very good	33.41	44.89	43.89	30.27	43.84	42.98
Excellent	14.30	22.54	21.82	13.45	23.20	22.58
Medication for depression (%)						
Yes	11.10	10.53	10.58	11.03	10.39	10.43
No	88.90	89.47	89.42	88.97	89.61	89.57
Chronic conditions[2] (%)						
Yes	80.43	66.17***	67.41	78.46	62.63***	63.63
No	19.57	33.83	32.59	21.54	37.37	36.37
Social Factors						
Marital status (%)						
Single, never married	6.86	9.17***	8.97	6.30	7.98***	7.87
Married/common-law	46.34	63.90	62.36	54.69	73.28	72.10
Widowed	29.41	10.22	11.90	22.93	6.21	7.27
Divorced/separated	17.39	16.71	16.77	16.08	12.53	12.76
Low SSA (%)						
Yes	7.55	4.99**	5.21	7.28	4.03***	4.23
No	92.45	95.01	94.79	92.72	95.97	95.77
Health Behaviours						
Smoking status (%)						
Current	10.07	8.38	8.53	9.97	8.61	8.70
Former	55.84	58.97	58.69	55.73	57.68	57.56
Never	34.10	32.65	32.78	34.31	33.71	33.75

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
Abbreviations: SSA = social support availability
*p<0.05; **p<0.01; ***p<0.001

D. Analyses for the association of depressive symptoms and covariates with low executive function by sex and social support availability

In research question 3, SSA was a significant first-order interaction term among females. Therefore, female models were stratified by SSA (i.e., higher SSA versus low SSA) and are presented in the main body of text (Section 5.3.3.2).

For males and females, separately, descriptive results for each stratum of social support are presented in Tables A16 and A17, and Tables A18 and A19, respectively.

Table A16. Distribution of depressive symptoms and covariates by low executive function status in males with higher social support availability, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=10,630)			Weighted Frequency (n=1,361,858)		
	Executive Function					
	Low (n=980)	Not Low (n=9,650)	Total	Low (n=86,405)	Not Low (n=1,275,452)	Total
Depressive symptoms[1] (%)						
Presence	17.04	9.43***	10.13	18.48	9.85***	10.40
Absence	82.96	90.57	89.87	81.52	90.15	89.60
Sociodemographic Factors						
Age, groups (%)						
45–54 years	9.08	28.38***	26.60	22.23	47.18***	45.60
55–64 years	16.63	34.66	33.00	19.70	30.89	30.18
65–74 years	28.16	24.00	24.38	22.15	14.77	15.24
75 years and over	46.12	12.95	16.01	35.92	7.16	8.98
Education (%)						
Less than high school	13.47	3.14***	4.09	14.93	2.72***	3.49
High school graduate	14.08	7.38	8.00	15.21	6.66	7.21
Some post-secondary	9.18	6.75	6.97	8.39	6.09	6.24
Post-secondary degree/diploma	63.27	82.74	80.94	61.47	84.53	83.07
Annual household income (%)						
< $20,000	6.22	2.06***	2.45	7.23	1.92***	2.26
≥ $20,000 and < $50,000	37.76	14.01	16.20	38.97	11.79	13.51
≥ $50,000 and < $100,000	37.45	35.94	36.08	33.29	32.07	32.14
≥ $100,000 and < $150,000	11.02	24.85	23.57	10.90	26.73	25.72
≥ $150,000	7.55	23.14	21.70	9.60	27.50	26.36
Province (%)						
Ontario	20.31	22.17***	21.99	12.81	13.62***	13.57
Alberta	7.45	8.55	8.45	10.01	12.37	12.22
British Columbia	17.04	22.61	22.10	24.29	31.37	31.26
Manitoba	12.45	10.15	10.36	10.62	8.60	8.73
NFLD	11.22	7.68	8.01	3.35	2.13	2.21
Nova Scotia	12.14	11.13	11.22	4.33	3.30	3.37
Quebec	19.39	17.72	17.87	34.60	28.25	28.65
Urban/rural residence (%)						
Urban	90.20	90.65	90.61	89.23	91.18	91.05
Rural	9.80	9.35	9.39	10.77	8.82	8.95

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table A16. Distribution of depressive symptoms and covariates by low executive function status in males with higher social support availability, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=10,630)			Weighted Frequency (n=1,361,858)		
	Executive Function					
	Low (n=980)	Not Low (n=9,650)	Total	Low (n=86,405)	Not Low (n=1,275,452)	Total
Health Factors						
Self-rated general health (%)						
Poor	2.65	0.98***	1.14	3.02	0.88***	1.02
Fair	12.45	6.23	6.80	11.05	6.24	6.54
Good	35.51	29.13	29.72	39.09	29.89	30.47
Very good	35.71	42.39	41.78	33.88	41.74	41.24
Excellent	13.67	21.26	20.56	12.96	21.26	20.73
Medication for depression (%)						
Yes	5.61	5.04	5.09	6.65	5.29	5.38
No	94.39	94.96	94.91	93.35	94.71	94.62
Chronic conditions[2] (%)						
Yes	80.31	63.55***	65.10	75.80	57.23***	58.41
No	19.69	36.45	34.90	24.20	42.77	41.59
Social Factors						
Marital status (%)						
Single, never married	6.63	6.08***	6.13	7.32	6.21***	6.28
Married/common-law	76.53	83.54	82.90	80.40	86.36	85.98
Widowed	8.98	3.14	3.68	5.90	1.63	1.90
Divorced/separated	7.86	7.23	7.29	6.38	5.80	5.84
Health Behaviours						
Smoking status (%)						
Current	8.67	7.36***	7.48	10.24	7.94**	8.09
Former	68.37	63.68	64.11	65.07	59.91	60.24
Never	22.96	28.96	28.41	24.69	32.15	31.67
Alcohol use (%)						
Current	81.33	89.71***	88.94	81.73	89.80***	89.29
Former	15.92	8.82	9.47	15.24	8.77	9.18
Never	2.76	1.47	1.59	3.04	1.43	1.53

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
*p<0.05; **p<0.01; ***p<0.001

Table A17. Distribution of depressive symptoms and covariates by low executive function status in males with low social support availability, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=787)			Weighted Frequency (n=82,510)		
	Executive Function					
	Low (n=159)	Not Low (n=628)	Total	Low (n=11,618)	Not Low (n=70,892)	Total
Depressive symptoms[1] (%)						
Presence	41.51	37.58	38.37	40.26	41.25*	41.11
Absence	58.49	62.42	61.63	59.74	58.75	58.89
Sociodemographic Factors						
Age, groups (%)						
45–54 years	8.18	25.16***	31.73	16.04	44.88***	40.82
55–64 years	24.53	34.71	32.66	30.34	31.73	31.53
65–74 years	23.90	22.13	22.49	19.47	13.82	14.62
75 years and over	43.40	17.99	23.13	34.15	9.57	13.03
Education (%)						
Less than high school	25.79	7.17***	10.93	30.47	7.78***	10.97
High school graduate	10.06	8.44	8.77	8.23	7.95	7.99
Some post-secondary	10.69	10.19	10.29	10.23	9.65	9.74
Post-secondary degree/diploma	53.46	74.20	70.01	51.07	74.62	71.30
Annual household income (%)						
< $20,000	20.75	19.43***	19.70	22.07	18.84***	19.29
≥ $20,000 and < $50,000	47.17	30.73	34.05	47.00	28.91	31.43
≥ $50,000 and < $100,000	26.42	30.57	29.73	27.54	29.50	29.22
≥ $100,000 and < $150,000	3.77	12.90	11.05	3.39	15.10	13.47
≥ $150,000	1.89	6.37	5.46	0.00	7.66	6.59
Province (%)						
Ontario	25.79	20.06*	21.22	16.90	11.67**	12.41
Alberta	5.03	11.15	9.91	5.27	12.79	11.73
British Columbia	18.24	23.73	22.62	20.55	32.67	30.97
Manitoba	13.21	12.10	12.33	13.12	10.04	10.47
NFLD	4.40	5.41	5.21	1.27	1.24	1.24
Nova Scotia	11.32	5.89	6.99	5.21	2.19	2.62
Quebec	22.01	21.66	21.73	37.67	29.40	30.56
Urban/rural residence (%)						
Urban	92.45	93.95	93.65	90.70	93.80	93.37
Rural	7.55	6.05	6.35	9.30	6.20	6.63

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table A17. Distribution of depressive symptoms and covariates by low executive function status in males with low social support availability, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=787)			Weighted Frequency (n=82,510)		
	Executive Function					
	Low (n=159)	Not Low (n=628)	Total	Low (n=11,618)	Not Low (n=70,892)	Total
Health Factors						
Self-rated general health (%)						
Poor	4.40	4.46**	4.45	4.23	4.94**	4.84
Fair	26.42	14.01	16.52	29.76	14.31	16.49
Good	39.62	39.33	39.39	36.42	40.85	40.22
Very good	22.01	30.41	28.72	23.26	29.27	28.43
Excellent	7.55	11.78	10.93	6.33	10.63	10.03
Medication for depression (%)						
Yes	6.29	8.44	8.01	6.41	8.80	8.47
No	93.71	91.56	91.99	93.59	91.20	91.53
Chronic conditions[2] (%)						
Yes	88.05	68.31***	72.30	88.41	61.78***	65.53
No	11.95	31.69	27.70	11.59	38.22	34.47
Social Factors						
Marital status (%)						
Single, never married	18.87	32.01***	29.35	19.14	35.23***	32.97
Married/common-law	24.53	29.46	28.46	30.97	36.06	35.34
Widowed	24.53	10.67	13.47	18.21	5.80	7.55
Divorced/separated	32.08	27.87	28.72	31.68	22.90	21.14
Health Behaviours						
Smoking status (%)						
Current	23.27	18.31	19.31	23.51	20.29	20.75
Former	52.20	57.32	56.29	51.85	52.50	52.41
Never	24.53	24.36	24.40	24.64	27.21	26.85
Alcohol use (%)						
Current	70.44	82.32***	79.92	66.72	82.95***	80.67
Former	28.30	15.61	18.17	32.30	14.87	17.33
Never	1.26	2.07	1.91	0.97	2.17	2.00

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
*p<0.05; **p<0.01; ***p<0.001

Table A18. Distribution of depressive symptoms and covariates by low executive function status in females with higher social support availability, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=10,950)			Weighted Frequency (n=1,374,207)		
	Executive Function					
	Low (n=1,051)	Not Low (n=9,899)	Total	Low (n=95,406)	Not Low (n=1,278,801)	Total
Depressive symptoms[1] (%)						
Presence	25.31	84.73***	16.24	24.88	14.79***	15.49
Absence	74.69	15.27	83.76	75.12	85.21	84.51
Sociodemographic Factors						
Age, groups (%)						
45–54 years	8.09	30.07***	27.96	15.04	44.70***	42.64
55–64 years	16.94	36.07	34.24	16.74	31.00	30.01
65–74 years	31.68	22.25	23.16	30.48	16.23	17.22
75 years and over	43.29	11.60	14.64	37.75	8.08	10.14
Education (%)						
Less than high school	18.36	4.07***	5.44	22.11	3.89***	5.15
High school graduate	15.89	9.58	10.18	15.40	9.51	9.92
Some post-secondary	8.09	7.61	7.65	8.01	7.09	7.15
Post-secondary degree/diploma	57.66	78.75	76.72	54.48	79.51	77.77
Annual household income (%)						
< $20,000	15.51	4.69***	5.73	14.36	3.81***	4.54
≥ $20,000 and < $50,000	45.39	23.21	25.34	44.82	19.09	20.87
≥ $50,000 and < $100,000	27.97	36.31	35.51	28.21	35.31	34.82
≥ $100,000 and < $150,000	7.33	19.26	18.12	8.16	21.77	20.83
≥ $150,000	3.81	16.53	15.31	4.44	20.02	18.94
Province (%)						
Ontario	20.93	21.45***	21.40	14.67	13.35***	13.44
Alberta	8.47	8.70	8.68	8.63	10.16	10.06
British Columbia	16.2	22.05	21.50	24.94	32.22	31.72
Manitoba	9.42	10.88	10.74	8.54	8.29	8.30
NFLD	12.84	7.53	8.04	4.06	2.44	2.56
Nova Scotia	13.13	10.32	10.59	5.02	4.00	4.07
Quebec	18.93	19.07	19.06	34.14	29.54	29.86
Urban/rural residence (%)						
Urban	90.49	89.95	90.00	88.87	89.49	89.45
Rural	9.51	10.05	10.00	11.13	10.51	10.55

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table A18. Distribution of depressive symptoms and covariates by low executive function status in females with higher social support availability, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=10,950)			Weighted Frequency (n=1,374,207)		
	Executive Function					
	Low (n=1,051)	Not Low (n=9,899)	Total	Low (n=95,406)	Not Low (n=1,278,801)	Total
Health Factors						
Self-rated general health (%)						
Poor	2.57	1.10***	1.24	2.84	0.88***	1.02
Fair	13.32	5.41	6.17	14.61	5.47	6.11
Good	37.68	26.54	27.61	40.04	26.89	27.80
Very good	33.59	44.57	43.52	30.97	43.54	42.66
Excellent	12.84	22.38	21.46	11.54	23.22	22.41
Medication for depression (%)						
Yes	11.51	10.36	10.47	11.78	10.19	10.30
No	88.49	89.64	89.53	88.22	89.81	89.70
Chronic conditions[2] (%)						
Yes	82.21	66.22***	67.75	80.04	62.51***	63.73
No	17.79	33.78	32.25	19.96	37.49	36.27
Social Factors						
Marital status (%)						
Single, never married	7.33	8.49***	8.37	7.05	7.35***	7.33
Married/common-law	46.34	65.42	63.59	54.47	74.54	73.15
Widowed	30.07	10.29	12.19	23.28	6.18	7.37
Divorced/separated	16.27	15.80	15.84	15.21	11.93	12.16
Health Behaviours						
Smoking status (%)						
Current	8.56	7.88	7.95	8.51	8.16	8.18
Former	53.57	57.30	56.94	53.17	55.94	55.75
Never	37.87	34.82	35.11	38.32	35.90	36.07
Alcohol use (%)						
Current	76.88	87.60***	86.58	17.86	18.28***	18.22
Former	19.03	10.26	11.11	45.12	48.16	47.75
Never	4.09	2.13	2.32	37.02	33.56	34.03

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
*p<0.05; **p<0.01; ***p<0.001

Table A19. Distribution of depressive symptoms and covariates by low executive function status in females with low social support availability, Canadian Longitudinal Study on Aging

Characteristics	Frequency (n=702)			Weighted Frequency (n=71,222)		
	Executive Function					
	Low (n=111)	Not Low (n=591)	Total	Low (n=9,724)	Not Low (n=61,498)	Total
Depressive symptoms[1] (%)						
Presence	46.85	52.12	51.28	46.92	55.23	54.06
Absence	53.15	47.88	48.72	53.08	44.77	45.91
Sociodemographic Factors						
Age, groups (%)						
45–54 years	9.91	22.00***	20.09	16.72	33.05***	30.82
55–64 years	19.82	35.70	33.19	18.48	31.40	29.63
65–74 years	25.23	22.17	22.65	23.39	20.06	20.79
75 years and over	45.05	20.14	24.07	39.41	15.49	18.76
Education (%)						
Less than high school	22.52	7.45***	9.83	22.18	7.87***	9.82
High school graduate	9.91	7.78	8.12	11.57	7.57	8.12
Some post-secondary	11.71	9.31	9.69	10.45	9.30	9.46
Post-secondary degree/diploma	55.86	75.47	72.36	55.80	75.26	72.60
Annual household income (%)						
< $20,000	38.74	19.12***	22.22	41.95	19.74***	22.77
≥ $20,000 and < $50,000	42.34	41.46	41.60	36.53	37.57	37.43
≥ $50,000 and < $100,000	17.12	28.60	26.78	19.55	30.38	28.90
≥ $100,000 and < $150,000	1.80	7.28	6.41	1.97	8.69	7.77
≥ $150,000	0.00	3.55	2.99	0.00	3.62	3.12
Province (%)						
Ontario	20.72	22.00	21.79	12.90	14.19	14.01
Alberta	6.31	8.29	7.98	3.96	8.68	8.03
British Columbia	21.62	22.67	22.51	28.30	31.49	31.06
Manitoba	19.82	11.34	12.68	17.67	9.13	10.29
NFLD	5.41	6.26	6.13	1.60	2.18	2.10
Nova Scotia	7.21	8.29	8.12	3.84	3.27	3.35
Quebec	18.92	21.15	20.80	31.74	31.06	31.15
Urban/rural residence (%)						
Urban	94.59	94.08	94.16	92.54	93.40	93.29
Rural	5.41	5.92	5.84	7.46	6.60	6.71

[1]Presence of depressive symptoms: CES-D10 score ≥10;
Absence of depressive symptoms: CES-D10 score <10
Abbreviations: NFLD = Newfoundland and Labrador
*p<0.05; **p<0.01; ***p<0.001

Table A19. Distribution of depressive symptoms and covariates by low executive function status in females with low social support availability, Canadian Longitudinal Study on Aging, continued

Characteristics	Frequency (n=702)			Weighted Frequency (n=71,222)		
	Executive Function					
	Low (n=111)	Not Low (n=591)	Total	Low (n=9,724)	Not Low (n=61,498)	Total
Health Factors						
Self-rated general health (%)						
Poor	8.11	3.05	3.85	7.26	3.53	4.04
Fair	20.72	17.60	18.09	21.90	18.81	19.23
Good	3964	37.73	38.03	40.57	38.76	39.00
Very good	21.62	29.78	28.49	21.01	28.88	27.80
Excellent	9.91	11.84	11.54	9.26	10.02	9.92
Medication for depression (%)						
Yes	18.02	19.12	18.95	18.47	18.67	18.64
No	81.98	80.88	81.05	81.53	81.33	81.36
Chronic conditions[2] (%)						
Yes	85.59	75.63*	77.21	85.29	74.05*	75.58
No	14.41	24.37	22.79	14.71	25.95	24.42
Social Factors						
Marital status (%)						
Single, never married	14.41	23.69**	22.22	13.69	22.46**	21.26
Married/common-law	21.92	25.21	24.64	27.13	35.06	33.98
Widowed	30.63	16.07	18.38	25.05	12.04	13.82
Divorced/separated	33.33	35.03	34.76	34.14	30.44	30.94
Health Behaviours						
Smoking status (%)						
Current	18.02	16.75	16.95	17.86	18.28	18.22
Former	45.95	49.75	49.15	45.12	48.16	47.75
Never	36.04	33.50	33.90	37.02	33.56	34.03
Alcohol use (%)						
Current	59.46	76.99***	74.22	59.24	76.49**	74.13
Former	29.73	19.46	21.08	33.18	19.17	21.08
Never	10.81	3.55	4.70	7.57	4.34	4.79

[2]Chronic conditions: presence of at least 1 of 11 self-reported medical conditions
*p<0.05; **p<0.01; ***p<0.001