Personality Traits and Depressive Symptoms in Informal Caregivers in Canada: a longitudinal

study of the Canadian Longitudinal Study on Aging data

by

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**Author's Declaration**

      I, Grace Herring, 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. I understand that my thesis may be made electronically available to the public.

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**List of Abbreviations**

CES-D: Center for Epidemiological Studies Depression

CLSA: Canadian Longitudinal Study on Aging

MDD: Major Depressive Disorder

TIPI: Ten Item Personality Inventory

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**Abstract**

In 2018, approximately one out of four Canadians, aged 15 and older, provided informal care to a family member or a friend. Caregivers are at an increased risk for depression and depressive symptoms because of the psychological, emotional, social and financial problems that they might endure due to their caregiving roles. Demographic factors such as age, sex, race, education, income, marital status and retirement status have been associated with depressive symptoms in the literature. As has physical health, and a number of caregiving characteristics such as the relationship with the care recipient, the intensity of caregiving including the hours of caregiving per week, the duration of caregiving, the relationship with the care recipient and the type of caregiving task. There is a large body of literature that links Neuroticism and Extraversion to depressive symptoms. However, to date the link between the personality traits and depressive symptoms in the caregiver population remains unclear.

The overall topic of this thesis, personality and depressive symptoms, was addressed in two research phases. The first objective was to determine factors associated with depressive symptoms in informal caregivers. This question was approached using an exploratory, cross-sectional design to analyze baseline data and explore associations using the independent variables age, sex, education, household income, race, marital status, retirement status, self-rated health, Neuroticism, Extraversion, relationship with care recipient, hours per week caregiving, number of weeks of providing informal care, type and number of caregiver duties and the dependent variable, depressive symptoms. Data from the Canadian Longitudinal Study on Aging (CLSA), comprehensive assessment group were used to address this objective.

The second objective of this study was to determine the association between two of the Big Five personality traits - Neuroticism and Extraversion, and depressive symptoms, in informal

caregivers, 45 years and older, in Canada. We used an explanatory design to address this question. This analysis used baseline and three-year follow-up data in a prospective cohort design, on the comprehensive group in the CLSA. The main predictors were Neuroticism and Extraversion at baseline, which were measured using the Ten-Item Personality Inventory (TIPI). The outcome, depressive symptoms, was measured using the Center for Epidemiologic Studies Depression 10 item Scale, at three-year follow up. Covariates included age, sex, education, household income, race, marital status, retirement status, self-rated health, relationship with care recipient, hours per week caregiving, number of weeks of providing informal care, and type and number of caregiver duties. This study was approved by members of the Canadian Longitudinal Study on Aging (CLSA) and an ethics board exemption from Lakehead University was provided.

The analyses began with the cross-sectional study. We used a multivariable linear regression model to identify the factors associated with depressive symptoms in informal caregivers at baseline. Age, hours per week caregiving, the two personality variables, sex, income, race, relationship with care recipient, marital status and providing medical care all showed a significant association with depressive symptoms. Next, generalized linear model analyses were performed to understand the relationship between Extraversion, Neuroticism and depressive symptoms. We ran models examining each of the personality traits as the primary exposure variables separately. Findings from this study confirmed previous findings on the effect of Neuroticism and depressive disorders. It also provides some evidence for the influence of Extraversion on depressive symptoms, depending on age, and these findings should be considered when targeting interventions to support informal caregivers.

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## Chapter 2: Background

### 2.1 Caregivers in Canada

Informal caregivers are individuals who provide a broad range of unpaid and ongoing assistance for an older adult or a person with a chronic or disabling condition (Family Caregiver Alliance, 2014; Roth et al., 2015). They are usually a relative, partner, friend or neighbour to the care recipient. Over nine million individuals provide informal care in Canada (Statistics Canada, 2020) and in 2018, approximately 1 out of 4 of Canadians, aged 15 and older, provided informal care to a family member or a friend (Statistics Canada, 2020). Ageing needs were the most commonly reported reason for providing informal care (28%), followed by needs associated with cancer (11%), cardio-vascular disease (9%), mental illness (7%) and Alzheimer's disease and dementia (6%) (Sinha, 2013). The majority of caregivers (66%) provided less than 7 hours of caregiving per week, 21% provided 7-21 hours per week, 7% provided 21-48, 2.9% provided 48-96 hours per week and 3.1% of caregivers provided more than 96 hours of caregiving per week (Ysseldyk, Kuran, Powell & Villeneuve, 2019). Approximately 6 million informal caregivers provide care to seniors in Canada (Canadian Association for Retired Persons, 2014). In fact, informal caregivers provide 70%-80% of senior care (CARP, 2014; Sinha, 2013). More than half of informal caregivers in Canada are women. Approximately half of caregivers reported their parents or parents-in-law as the care recipient, although caregivers were 2.5 times more likely to be caring for their own mother than their father (Sinha, 2013). Other relationships with care recipients, in order of their frequency, include friends or neighbours, grandparents, siblings and extended family members, spouses and sons or daughters (Sinha, 2013). The majority of caregivers were over the age of 50 and half to three quarters are between the ages of 45-64 (Turner & Findlay, 2012; Sinha, 2013). The age distribution of informal caregivers in Canada,

according to the General Social Survey is as follows: 15-34 years old (15%), 35-49 years old

(25%), 50-64 years old (40%), 65-74% (14%) and 75+ (6%) (Ysseldyk et al., 2019).

As the baby boomers age, the number of individuals who need care and support will

grow, as will the need for informal caregivers (Khayatzadeh-Mahani & Leslie, 2018). Canadians

are living longer than ever before, and the current life expectancy is 82.25 years (Macrotrends,

2020). This represents an increase in life expectancy of about 10 years over the last five decades

(Macrotrends, 2020). Older age increases the prevalence of chronic disorders, such as cancers,

cardiovascular disease and dementia (Fernandes et al., 2016), which in turn, require more

support and care. Furthermore, 93% of seniors have indicated that they would prefer to stay at

home as long as possible (Health Council of Canada, 2012). Home and community health care

services are often not covered by provincial health care systems and so care recipients must

either purchase private service or rely on unpaid care from family and friends (Lilly, Laporte &

Coyte, 2010). From the Statistics Canada's General Social Survey, Cycle 21, Fast et al (2013)

estimated that Canadian informal caregivers communally spent 12.6 million dollars in one year

in expenses relating to their caregiving role (Fast et al., 2013). These expenses include

transportation costs, purchasing items, housing or food costs and paying for services (Health

Council of Canada, 2012). It was estimated that informal caregivers contributed $25 billion per

year economically and from time commitments, to Canada (Hollander, Liu, & Chappell, 2009);

this is an older estimate because newer comparable estimates were not found. There was an

increase of over a million caregivers in Canada between 2012-2018 (Sinha, 2013; Statistics

Canada, 2020). This means if the contributions were to be calculated today with the same

criteria, they would likely be larger than $25 billion. This number might be inflated; however,

because it does not account for money lost from informal caregivers reducing their employment

hours or exiting the labour force completely. Of the caregivers that are balancing work and caregiving duties, the CCHS Healthy Aging component revealed that 13% of informal caregivers in Canada have had their work impacted by caregiving duties, and 50% of those people reported that they had to reduce or modify work hours to accommodate caregiving schedule (Health Council of Canada, 2012).

**2.2.1 Caregiver Health**

Informal caregivers might be at risk for poorer physical health than non-caregivers (Pinquart & Sörensen, 2003; Vitaliano, Zhang, & Scanlon, 2003; de Zwart, Bakx & van Doorslaer, 2017). However, as pointed out by Roth, Fredman and Haley, most of these studies have used convenience or clinical samples for the caregivers, and different recruitment methods for the comparison caregiving or non-caregiving groups (2015). Physical health is likely poorer in clinical samples rather than population-based samples, and the results are probably biased towards caregivers reporting lower physical health. Furthermore, in a systematic review using only high-quality studies, the authors suggest the way physical health is measured influences whether caregivers have better, poorer or similar physical health, compared to non-caregivers (Bom, Bakx, Schut & van Doorslaer, 2019). When physical health is self-assessed, the effects of caregiving are positive but when health is measured through prescription drug intake or reported pain to act as a proxy of physical health, assuming the more pain someone is in or more prescription drug one takes represents worsening health, the effects of caregiving is negative (Bom et al., 2019). The effect of caregiving might also depend on sex/gender, relationship with caregiver, intensity of caregiving, as well as how long the person has been providing care (Bom et al., 2019). The mental health of caregivers might also be at stake (Pinquart & Sörensen, 2003; Vitaliano et al, 2003). They experience extra stress, physical strain and fatigue (Bom et al., 2019)

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and are at an increased risk of developing depression or depressive symptoms (Bernabeu-Mora et al., 2016; Hajek & Konig, 2017; Pinquart et Sörensen, 2003; Rabia & Miri, 2016; Schulz & Sherwood, 2008; Smith et al., 2011; Van der Lee et al., 2014).

**2.2 Depressive Symptoms**

**2.2.1 Definition**

Depression is a common mental illness that negatively impacts thoughts and feelings (The National Institute of Mental Health Information, 2019). The core diagnostic feature of depression is sadness most of the day, every day and a loss of interest in activities enjoyed, for at least two weeks (The National Institute of Mental Health Information, 2019; APA, p.160-161, 2013; Mckeever, Agius & Mohr, 2017). It can also cause sleep disturbances and decreased energy, weight gain or loss, fatigue, feelings of worthlessness and/or guilt, difficulty in concentration, restlessness, physiological symptoms such as aches and pains, headaches, cramps, digestive problems and suicidal ideation (American Psychiatric Association, p. 160-161, 2013; The National Institute of Mental Health Information, 2019; Mckeever et al., 2017).

Depression is a serious illness that can contribute to many negative outcomes. It is associated with poor health-related behaviours such as low-quality diet, sedentary life-style, smoking and heavy alcohol use (Appelhans et al., 2012, Kingsbury et al., 2016, Roshanaei-Moghaddam, Katon & Russo, 2009) and depression is a risk factor for shortened life expectancy (Cuijpers et al., 2014; Gilman, Sucha, Kingsbury, Horton, Murphy & Colman, 2017, Walker, McGee & Druss, 2015). It is therefore a serious health outcome that needs to be thoroughly understood and prevented, not only for the caregiver, but for the care recipient and society as a whole, because of the magnitude of the caregiver's contribution to the health care system.

**2.2.2 Epidemiology**

According to the Institute for Health Metrics and Evaluation, depressive disorders were the fourth most common health problem to cause disability in Canada (Institute for Health Metrics and Evaluation, 2019). Using data obtained from the information from the longitudinal National Public Health Survey and a series of cross-sectional surveys from Canadian Community Health Survey, between 2001 and 2013, Pattern et al., (2016) estimated the incidence rates of major depressive episodes in Canada. The National Public Health Survey (NPHS) was a Canadian Health Survey by Statistics Canada that followed a representative sample of Canadians (n=15, 254) who were followed between 1994 and 2010, and were interviewed every two years (Pattern et al., 2016). The Canadian Community Health Survey is a series of individual surveys that have been distributed every one to two years since 2001 (Pattern et al., 2016), and have sample sizes between 21,000 to 128,000, across Canada. The incidence rate of major depressive episode, between 1994-2010, was 3.5% every two years (Pattern et al., 2016) and the annual incidence rate of major depressive episodes was calculated to be 1.8% (Pattern et al., 2016). The authors state the actual incidence rate would probably be higher, as the Composite International Diagnostics Interview – Short Form, the instrument used to assess depression, covers the past year whereas the interviews were often conducted two years apart (Pattern et al., 2016). Using the National Public Health Survey data, Meng & D'Arcy calculated the 16-year cumulative incidence rate for major depressive episode in Canada to be 12.07% (2014). In another Canadian cohort study, 5318 people in the Montreal area were followed and the two-year cumulative incidence rate of depressive episodes was 4.8% (4.2% for males and 5.4% for females) (Meng et al., 2017). The four-year follow-up in the same study reported a cumulative incidence rate of 6.6% (5.9% for males and 7.3% for females) (Meng et al., 2017). The lifetime prevalence of

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major depressive episode in Canada was 12.2% in 2003 (Pattern et al., 2006), the annual

prevalence was 4.8% (Pattern et al., 2006) and the 30-day point prevalence was 1.8% (Pattern et

al., 2006). The prevalence rate of major depressive episode in Canada has remained stable since

2003 (Pattern et al., 2016). These findings report on the incidence and prevalence of depressive

disorders, not depressive symptoms. The number of symptoms is often used to diagnose

depressive disorders and there is a minimum threshold that a person must experience before they

are diagnosed with depression (APA, p.160-161, 2013). As such, these numbers underestimate

the incidence and prevalence of depressive symptoms.

There are reported differences between age categories in the incidence and prevalence of

depression (Kessler et al., 2010, Pattern et al, 2006, Regan, Kearney, Savva, Cronin & Kenny,

2013). Most studies have found that older people are less likely to report major depressive

episodes than younger people (Kessler et al., 2010, Pattern et al, 2006, Regan et al., 2013).

Pattern et al., (2006) reported an increase in lifetime prevalence of major depressive disorder

from 15-25 years old (8.8%) to 26-45 old (12.2%). The lifetime prevalence then remained stable

to the 46-64 age group (12.4%) and decreased in the 65 and older age group (6.4%). The annual

prevalence for major depressive disorder revealed a downward trend with age (Pattern et al.,

2006). The reported annual prevalence for those 15-25 years of age was 5%, 26-45 years of age

was 4.5%, 46-64 years of age was 3.7% and those aged 65 and older had a reported annual

prevalence of 1.9% (Pattern et al., 2006). The decrease in depression with age trend has been

shown to reverse through the late-life stages where there is an increase in depression scores after

the age of 65 (Yang, 2007). The increase in depression in late-life adults was explained when

including social risk factors into the model, such as education, income, race, marital status,

health status, life events, social support and integration (Yang, 2007). The finding that

depression may increase in later years is still important because aging often comes with deteriorating health and change in marital and economic status, meaning there is the potential for older adults to be at an increased risk of depression. It should be noted the epidemiological information presented is on depressive disorders, not on depressive symptoms. While related, the two are not synonymous. Not everyone who exhibits depressive symptoms has a depressive disorder, but everyone who has a depressive disorder exhibits depressive symptoms. Therefore, the information presented above represents the absolute minimum incidence/prevalence of depressive symptoms, and the real numbers are likely much higher.

**2.2.3 Risk Factors for Depressive Disorders**

There are and have been many theories for the etiology and risk factors for depression (Friedman & Anderson, p.5-7, 2009). Models that integrate biological, psychological and social factors are the prominent frameworks for understanding depression today (Friedman & Anderson, p.5, 2009). Genes and the environment both play a role in the development of depression and can be understood as life stressors interacting with certain genes that make the individual predisposed to depression (Friedman & Anderson, p.5, 2009). The genes do not necessarily have to be inherited but can also be a product of prolonged exposure to stress that can disrupt chemical messaging systems in the brain (Friedman & Anderson, p.6, 2009).

Known risk factors for depression include being female (APA, p.166, 2013; Meng & D'Arcy, 2014; Meng et al., 2017; Pattern et al., 2006), younger age (Meng et al, 2014; Meng et al., 2017; Regan et al., 2013), temperament, such as Neuroticism (APA, p.166, 2013), environment including negative childhood experiences and stressful life events (APA, p.166, 2013), genetic and physiological factors such as relatives with major depressive disorder (APA,

p.166, 2013; Meng et al., 2017),  and all other major disorders (APA, p.158, 2013; Meng & D'Arcy, 2014; Pattern et al., 2006). Other risk factors include relationship status such as being widowed, separated or divorce (Meng et al., 2017, Pattern et al., 2006, Yang, 2007), being white (Bailey, Mokonogho & Kumar, 2019; Meng & D'Arcy, 2014; Meng et al., 2017) and lower socioeconomic status (Meng & D'Arcy, 2014; Meng et al., 2017; Pattern et al., 2006; Yang, 2007).

Informal caregiving has an enormous reach and affects many Canadians. While providing support and care to a loved one can bring a sense of accomplishment and giving back, it can also bring tremendous strain to the caregiver (Van der Lee, Bakker, Duivenvoorden, & Dröes, 2014). They often pay expenses out of pocket, including transportations cost and care aids (Health Council of Canada, 2012). Furthermore, balancing employment and caregiving responsibilities can be a difficult task (Health Council of Canada, 2012; Sinha, 2013). It becomes increasingly difficult to balance work and caregiving as the duties increase in intensity and time commitments, and those who are unsuccessful at managing both are more likely to leave work altogether instead of reducing the number of labour force hours or limit informal care responsibilities (Canadian Association for Retireed Persons, 2014).  Caregivers are at an increased risk of reduced exercise, unhealthy eating habits and increased alcohol consumption (Ysseldyk et al., 2019).

Caregivers are under additional stress than non-carers because of the physical, psychological, emotional, social and financial problems that they endure as a result of caregiving responsibilities (Vitaliano et al, 2003). Vulnerability to the adverse effects of caregiving depends on many factors. Females are more likely to have a higher sense of distress (Adelman, Tmanova, Delgado, Dion & Lachs, 2014; Hirdes, Freeman, Smith & Stolee, 2012; Hirst, 2005; Metzelthin,

Verbakel, Veenstra, Exel, Ambergen & Kempen, 2017). Caring for a spouse or parent (Bernabeu et al, 2016; Hirdes et al, 2012), lower education (Adelman et al, 2014) poor caregiver health (Fekete, Tough, Siegrist & Brinkhof, 2017) as well as the number of caregiving hours (Hirdes et al, 2012; Mitchell, Hirdes, Poss, Slegers-Boyd, Caldarelli & Martin, 2015, Adelman et al, 2014, Pinquart & Sorensen, 2003, Hirst, 2005) and the care recipient's physical and mental health (Hirdes et al, 2012, Mitchell et al 2015) may all increase distress in the caregiver.

Compared to non-carers, caregivers report more distress (Pinquart et al, 2003, Vitaliano et al, 2003) and are at an increased risk for depression and depressive symptoms (Bernabeu-Mora, Garcia-Gullamon, Montilla-Herrador, Escolar-Reina, Garcia-Vidal & Medina-Mirapeix, 2016, Hajek & Konig, 2017, Pinquart et al, 2003, Rabia & Miri, 2016, Schulz & Sherwood, 2008, Smith et al., 2011, Van der Lee et al., 2014) and for overall decline in mental health status Canadian Association for Retireed Persons, 2014).

## 2.3 Personality and Depression

### 2.3.1 Personality

The American Psychological Association defines personality as "individual differences in characteristic patterns of thinking, feeling and behaving" (American Psychological Association, 2019). Personality psychology generally uses the trait approach to understand and research personality. The trait approach was developed from the lexical hypothesis (John, Naumann & Soto, p.117, 2008), which suggests that all relevant personality characteristics are already embedded in language (John et al., p.117, 2008). Beginning in the early 20th century, personality researchers, such as Klages (1932), Baumgarten (1933), Allport and Odbert (1936) extracted terms from dictionaries to describe human personalities (John et al., p.117, 2008). Allport and Odbert extracted 18,000 words from the dictionary that described human personality, which they

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reduced to approximately 4,500 words that they considered personality traits. In 1943, Cattell

used Allport and Odbert's list of 4,500 words, and through factor analysis, reduced the list to 16

factors, which became part of his 16 Personality Factors (John et al., p.118, 2008). Cattell's work

was criticized because other researchers failed to replicate the 16 separate factors and they argue

that personality can be represented by fewer individual traits, (Larsen & Buss, p.73-74, 2014),

however he can be credited with applying an empirical approach to studying personality

psychology (Larsen & Buss, p.73, 2014).

Following Cattell's work, many researchers set out to examine the structure of

personality traits using factor analysis. Investigators such as Fiske (1949), Tupus and Christal

(1961), Norman (1963), Borgatta (1964), and Digman and Takemoto-Chock (1981) all

developed personality structures that resemble the five-factor model that is prominent in

personality psychology today (John et al., p.118, 119, 2008). Norman replicated the five-factor

model of Tupas and Christal (1961) and labelled the factors Extraversion or Surgency,

Agreeableness, Conscientiousness, Emotional Stability and Culture (John et al, p.118, 2008). In

the 1980's and 1990's Goldberg set out to replicate Norman's five categories across different

data sources and methodologies and found that they were consistently replicable across different

studies (John et al., p.118, 2008).

In 1983, Costa and McCrae, developed a theory with three personality traits

(Extraversion, Neuroticism and Openness to Experience), and noted that they closely resembled

three of Norman's five factors; Agreeableness and Conscientiousness were not encompassed in

their theory (John et al., p.125, 2008). They extended their theory, and in a series of papers in the

1980s and 1990s, demonstrated that these five personality factors could be captured in various

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personality questionnaires (John et al., p.125, 2008). Their Five Factor model is one of the most widely used theories in personality psychology.

In line with the trait approach, each of the five traits is on a continuum with polar ends. Individuals fall somewhere between the poles for each of the traits and there are a vast number of combinations of Big Five personality profiles. Individuals high in Neuroticism tend to worry, be temperamental, emotional, self-conscious, vulnerable and experience high levels of self-pity (McCrae & Costa, p. 27, 2003). In contrast, those with low levels of Neuroticism, are calm, even-tempered, self-satisfied, emotionally stable, and comfortable in most situations (McCrae & Costa, 2003). People who are high in Agreeableness are softhearted, trusting, generous and good-natured in daily situations (McCrae & Costa, p. 27, 2003). Those low in Agreeableness are ruthless, suspicious, critical and irritable in various contexts (McCrae & Costa, p. 27, 2003). People high in Extraversion are out-going, passionate, fun-loving, talkative and active, while those low in the trait are reserved, tend to spend more time alone, are quiet and passive in most situations (McCrae & Costa, p. 27, 2003). People who are high in Conscientiousness are organized, hardworking, punctual, ambitious and preserving (McCrae & Costa, p. 27, 2003). Those who are low in Conscientiousness tend to quit easily, are disorganized and are often late in daily situations (McCrae & Costa, p. 27, 2003). Finally, people who have high levels of Openness to experience are more liberal, creative, imaginative and curious in their lives, while those low in Openness to experience conventional, conservative and down-to-earth (McCrae & Costa, p. 27, 2003). Traits are considered to be continuous and consistent overtime (Nettle & Nettle, 2009). This does not mean, for example, that a person high in Extraversion is always outgoing; rather, it is a pattern of behaviour, and a person high in Extraversion will be more

outgoing more often and in a wider range of circumstances than someone who is lower in

Extraversion (Barenbaum & Winter, p.11, 2008).

The Big Five approach uses descriptive words to explain behavioural patterns in humans, but how do individuals develop their unique personality profiles? Like many areas in the human sciences, the debate between nature and nurture has been a topic of interest among personality psychologists. Some of the most compelling arguments for a biological component in personality comes from the Minnesota Twin Study (Bouchard & McGue, 1990; Tellegen et al., 1988), where researchers studied 46 pairs of identical twins and 26 pairs of fraternal twins who were reared apart. As identical twins share 100% of their DNA while fraternal twins share 50%, a correlation in personality traits between identical twins would be compelling evidence for heritability of traits (Larsen & Buss, p. 161, 2014). Studies have reported a correlation of 0.70 in Neuroticism between identical twins (Bouchard & McGue, 1990; Tellegen et al., 1988). The average heritability between all traits measured was 0.54 (Bouchard & McGue, 1990; Tellegen et al., 1988). This means over half an individual's personality is attributable to their genes. Other twin studies found similar results and supported the argument of around 50% heritability of personality traits (Floderus-Myred, Pedersen, & Rasmuson, 1980; Loehlin, 2012; Henderson, 1982; Moore, Schermer, Paunonen & Vernon, 2010).

There are differences in personality traits between men and women. A large cross-cultural study found that women scored higher on traits such as Neuroticism, Agreeableness, Extraversion and Conscientiousness, compared to men (Schmitt, Realo, Voracek, & Allik, 2009). The biggest difference was found in Neuroticism, where women in 49 out of 55 nations had significantly higher scores than men (Schmitt et al., 2009). In 34 nations, women scored significantly higher in Agreeableness; it was higher for men in one nation only (South Korea)

(Schmitt et al., 2009). In 25 and 23 nations, respectively, women scored significantly higher than men in Extraversion and Conscientiousness, with only two countries reporting significantly higher Extraversion or Conscientiousness in men (Schmitt et al., 2009). The results were mixed for Openness; most countries found no significant differences between the genders, eight countries reported statistically higher levels of Openness in men and four countries found significantly higher levels of the trait in women (Schmitt et al., 2009). In Canada in particular, women scored higher than men in all traits except for Openness, with the largest effect size found in Neuroticism (0.49) (Schmitt et al., 2009).

Personality is generally thought as stable throughout the lifespan. There seems to be moderate to high levels of rank-order stability throughout adulthood (Costa & McCrae, 1994, McCrae & Costa, 2008), meaning that those who rank higher in a trait in their early life, will likely remain higher in that trait throughout the lifespan. However, the literature suggests that there is mean-level change in traits as the individual ages (i.e., as a group, as people age, the average personality trait score changes). For example, Openness, Extraversion and Neuroticism show a gradual decline in mean between the age of 30 and 50, while the mean for Agreeableness tends to increase (Costa & McCrae, 1994). Alleman, Zimprich and Hertzog found that Neuroticism declines more still between middle and older age (2007).

### 2.3.2 Personality and Depression

Kotov et al. (2010) reviewed 175 studies on the relationship between personality traits and a range of mental illnesses, including Major Depressive Disorder (MDD), Unipolar Depression and Dysthymic Disorder (Kotov et al., 2010). Specifically, 94 of the included studies reported results on the effects of Neuroticism and one of the three disorders mentioned above, 79 on Extraversion, 34 on Conscientiousness, 35 for Agreeableness and 38 for Openness. Only

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studies where a referent group was available from either the article or authors, in order to

calculate effect size between control and diagnostics groups were included. This meta-analysis

synthesizes 851 effect sizes from 175 articles to give a comprehensive review of personality

traits and psychopathology (Kotov et al., 2010).

The largest effect size between those diagnosed with depressive disorders and controls

was found in Neuroticism (mean d=1.60). All associations were positive, and all effect sizes

were equal to or greater than 0.92. Those diagnostic with MDD, Unipolar or Dysthymic Disorder

are consistently higher in Neuroticism, compared to controls (Kotov et al., 2010). Those

diagnosed with a depressive disorder were overall lower in Extraversion compared to the

controls, with an average Cohen's d effect size of -1.00, however the effect size was non-

significant in articles that reported on MDD (Kotov et al., 2010). Lower levels of

Conscientiousness were found in those diagnosed with depressive disorders compared to controls

(mean d = -1.09) (Kotov et al., 2010). In both Agreeableness (mean d = -0.03) and Openness to

new experiences (mean d= -0.32), the effect sizes between the diagnostic groups and control

groups were ambiguous (Kotov et al., 2010).

More recent studies have reiterated the positive relationship between Neuroticism and

depressive disorders (Hayward, Taylor, Smoski, Steffens & Payne, 2013; Khoo & Simms, 2018;

Luan et al., 2018; Koorevaar et al., 2013, Sadeq & Molinari, 2018) and the negative relationship

between Extraversion and depression (Khoo & Simms, 2018; Luan et al., 2018; Koorevaar et al.,

2013, Sadeq & Molinari, 2018). The literature surrounding Openness to new experience is mixed

with some studies indicating a null relationship between the trait and depression (Kotov et al.,

2010; Markon, Kruger & Watson, 2005; Sadeq & Molinari, 2018). Studies have also found that

age of onset of depression is positively associated with Openness to new experience, in

particular, higher levels of Openness are associated with earlier age of depression onset

(Koorevaar et a., 2013), while other studies have shown a negative association (Khoo & Simms,

2018; Weber et al., 2012). Low Conscientiousness is linked to higher levels of depressive

disorders in adults, although it is not a strong as Neuroticism and Extraversion (Hayward et al.,

2013; Sadeq & Molinari, 2018; Weber et al., 2012). Studies have reported mixed results on the

association between Agreeableness and depressive disorders. A meta-analysis reported low

Agreeableness associated with depressive disorders in adults (Malouff, Thorsteinsson & Schutte,

2005); however, individual studies reported no association between Agreeableness and

depressive disorders (Hayward et al., 2013; Sadeq & Molinari, 2018; Weber et al., 2012). As,

most research has used a cross-sectional design; prospective longitudinal studies are needed to

clarify causality between mental illness and personality traits (Kotov et al., 2010).

## 2.4 Personality traits and depression among informal caregivers

Given that the most robust evidence appears to exist for the relationship between

depression, Neuroticism, and Extraversion, these were examined more closely in the context of

informal caregiving. The results of the identified studies are summarized based on their design

(i.e., reviews, longitudinal studies, and cross-sectional studies).

## 2.4.1 Reviews

One review was identified that investigated personality traits and depression within

informal caregivers in seventeen cross-sectional and longitudinal studies (Lautenschlager, Kurz,

Loi, & Cramer, 2013). Findings suggested that Neuroticism was significantly associated with

negative psychological well-being and had a greater impact on caregiver well-being than

diagnosis, symptoms and limitations of patients, and was positively associated with depression.

The review did not offer any results on Extraversion and it did not mention any critical appraisal

of included studies and therefore the results on depression and caregivers should be interpreted

cautiously. It highlights the fact that only a limited number of quality studies have been

conducted examining personality traits, especially any trait aside from Neuroticism, and

depression in family carers. Only two of the studies (Melo & de Mendonca, 2011; Nordtug,

Krokstad & Homen, 2011) included in this review were relevant for the current study.

### 2.4.2 Longitudinal Studies

Only two studies were identified, so the search was extended to include adverse mental

health outcomes; this search resulted in the identification of two additional longitudinal studies.

Of the two studies specifically related to depression, one was an 18-month longitudinal

study that followed 97 caregiver spouses (Ruiz, Matthews, Scheier, & Schulz, 2006). This study

found that higher Neuroticism is associated with higher depressive symptoms in caregivers. The

second longitudinal study followed 52 family caregivers over one year, the results were

reiterated that Neuroticism is positively associated with depression (Trujillo, Perrin, Doser, &

Norup, 2016). Furthermore, these authors found that depression decreased more quickly in

caregivers low in Neuroticism. There were no longitudinal studies identified that examined the

relationship between Extraversion and depressive symptoms or diagnosis of depression.

The other two longitudinal looked at the association between subjective and objective

caregiving burden Möller-Leimkühler, 2006; Möller-Leimkühler & Mädger, 2011 and

psychological well-being (Möller-Leimkühler & Mädger, 2011) and personality. Both studies

found a significant association between Neuroticism and the mental health outcomes. The

relationship between Extraversion and adverse mental health outcomes showed null results (Möller-Leimkühler, 2006; Möller-Leimkühler & Mädger, 2011).

These four longitudinal studies all had small sample sizes, with the largest sample having 97 participants (Ruiz et al., 2006). This means they are limited in their generalizability and threatens internal validity because it increases the possibility that their results were due to chance. The four studies identified all used very specific family caregiver populations again limiting their generalizable usefulness. Larger, population-based studies are needed to extend the results to a wider range of informal caregivers. Möller-Leimkühler & Mädger (2011) investigated the effect of personality on psychological well-being, subjective and objective caregiver burden and Möller-Leimkühler (2006) looked at objective and subjective caregiver burden. While related, these are different constructs than depressive symptoms however they are all concerned with mental health. Caregiver burden has been associated with depression among caregivers (Brown, Ruggiano & Meadows, 2018; Pinquart & Sörensen, 2007). Of course their results can not be directly infered to depressive symtpoms but it gives a clearer picture on the effects of Neuroticism on mental health.  More longitudinal studies examining depressive disorders or symptoms in larger sample sizes of informal caregivers are needed (Kim et al., 2014; Kim et al., 2005; Lautenschlager et al., 2013; Melo et al., 2011; Möller-Leimkühler & Mädger, 2011; Nordtug et al., 2011; Ruiz et al., 2006; Trujillo et al., 2016; Weaving, Orgeta, Orrell, & Petrides, 2014).

## 2.4.3 Cross-Sectional Studies

Similar to the findings of the longitudinal studies, there appears to be a consistent positive relationship between Neuroticism and depressive symptoms in cross-sectional studies

(Carter & Acton, 2006; Kim, Duberstein, Sörensen, & Larson, 2005; Melo et al., 2011; Nordtug, Krokstad, & Holen, 2011; Tew, Naismith, Pereira, & Lewis, 2013). There does seem to be some evidence that Extraversion is associated with lower levels of depressive symptoms (Kim et al., 2017; Melo et al., 2011); however, other studies did not find an association (Kim et al., 2005). As with all cross-sectional studies, the six articles included in this review lack the ability to make assumptions about the direction of the relationship. Furthermore, depression could have predated participants' caregiving role. The studies identified provide evidence to the importance of the association between personality traits and depressive symptoms in informal caregivers, but they are limited in sample size and study design.

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A LONGITUDINAL STUDY OF THE CLSA DATA

## Chapter 3: Study Rationale

### 3.1 Summary of justification for the study

Informal caregivers play an important role in Canada's health system. They aid millions of Canadians each year who need help in a broad range of daily activities (Canadian Association for Retired Persons, 2014; Sinha, 2013; Statistics Canada, 2020). As the baby boomers age, the number of individuals who need care and support will grow, as will the need for informal caregivers (Khayatzadeh-Mahani & Leslie, 2018). Furthermore, most seniors have reported they preferred to stay in their home as long as possible (Health Council of Canada, 2012).

That informal caregivers are at increased risk for depression is well-established. While being a caregiver can offer the individual a sense of giving back it can also come with additional strain (Van der Lee, Bakker, Duivenvoorden, & Dröes, 2014). They often pay expenses out of pocket, including transportations cost and care aids (Health Council of Canada, 2012). Furthermore, balancing employment and caregiving responsibilities can be a difficult task (Health Council of Canada, 2012; Sinha, 2013). Because of the additional stress they experience due to their caregiving responsibilities, they are at risk of emotional and mental health decline (Canadian Association for Retired Persons, 2014) and they report more distress than non-carers (Pinquart et al., 2003, Vitaliano et al., 2003). Numerous studies have concluded that they are at an increased risk for depression and depressive symptoms compared to non-caregivers (Bernabeu-Mora, Garcia-Gullamon, Montilla-Herrador, Escolar-Reina, Garcia-Vidal & Medina-Mirapeix, 2016, Hajek & Konig, 2017, Pinquart et al, 2003, Rabia & Miri, 2016, Schulz & Sherwood, 2008, Smith et al., 2011, Van der Lee et al., 2014). As the number of caregivers is expected to grow, it is essential that we try to understand all aspects of their well-being.

Personality research can be used to identify those at risk of developing depression, and to tailor efforts to prevent and treat depression. Neuroticism and Extraversion, in particular, have consistently shown to be associated with depressive symptoms (Kotov et al., 2010), however their role in the informal caregiving population is not yet well understood. Further, to date, the studies on this topic have mainly used convenience samples (Möller-Leimkühler, 2006; Möller-Leimkühler & Mädger, 2011; Ruiz, Matthews, Scheier, & Schulz, 2006; Trujillo, Perrin, Doser, & Norup, 2016), had small sample sizes (e.g., the largest was n=97, see Ruiz et al., 2006), and cross-sectional in design, limiting the inferences (Carter & Acton, 2006; Ferrario, Zotti, Massara, & Nuvolone, 2003; Kim, Duberstein, Sörensen, & Larson, 2005; Melo et al., 2011; Nordtug, Krokstad, & Holen, 2011; Tew, Naismith, Pereira, & Lewis, 2013).

## 3.2 Conceptual Framework

The vulnerability model will act as the conceptual framework guiding the current work. The vulnerability model was introduced by Zubin and Spring (1977) to try to understand the etiology of episodes of schizophrenia. The authors combined previous etiological approaches to understanding psychopathology including ecological, development, learning, genetic internal environment and neurophysiological models to create the vulnerability model. It explains why certain individuals can handle a crisis while other might develop an episode of schizophrenia under the same circumstances (Zubin & Spring, 1977). The model proposes that each of us has a certain degree of vulnerability and under the right circumstances, can develop into a psychopathology (Zubin & Spring, 1977). The vulnerability can come from number of origins including genetic, biological, environmental, developmental or learning and can be from a combination these origins (Zubin & Spring, 1977). The two major components are the biological components which include vulnerabilities the individual is born with and the acquired

component, which are vulnerabilities which we acquire throughout or lives (Zubin & Spring, 1977). This model also proposes that the vulnerabilities can be captured empirically so they can be predicted. For the example related to schizophrenia, a highly vulnerable person is someone who might be induced into an episode because of numerous daily stresses (Zubin & Spring, 1977). In contrast, someone who has low vulnerability would rarely have a crisis and would only have episodes because of catastrophic events (Zubin & Spring, 1977).

The vulnerability model can be extended outside of schizophrenia to etiological explanations of any psychopathology, including depression and depressive symptoms and it has also been used to explain the relationship between personality traits and psychopathologies (Krueger & Tackett, 2003; Kotov et al., 2010). In the context of personality traits, this model hypothesizes that certain personality traits will influence whether a person develops a psychopathology or not (Kotov et al., 2010). For caregivers, individuals who are predisposed to depressive disorder because of their personality traits; for example, high in Neuroticism, are potentially more vulnerable to the negative effects of the added stress of caregiving and this vulnerability could lead to depressive symptoms.

## 3.3 Research Objectives

To address gaps in the literature, the current study uses a large, population-based sample and a longitudinal design (3 years of follow-up data) to study the relationship between Neuroticism, Extraversion, and depression among Canadian informal caregivers aged 45 years or older. More specifically, this study will:

1) Identify factors associated with depressive symptoms at baseline; including sociodemographic factors (i.e., age, sex, education, marital status, household income, retirement status and race), self-rated health, personality (Neuroticism and

Extraversion) and factors related to caregiving (i.e., types of care provided, number of different types of care provided, amount of time spent on caregiving responsibilities, duration of caregiving and relationship with care recipient).

2) Determine the association between Extraversion and Neuroticism at baseline and depressive symptoms at three-year follow-up.

> Hypothesis 1: Neuroticism at baseline will be positively associated with depressive symptoms at follow-up.

> Hypothesis 2: Extraversion at baseline will show a negative association with depressive symptoms at 3-year follow-up.

This thesis uses a manuscript-style format to present the research and results of the two research questions. We hope that the information in this thesis can be disseminated through journal publications. As such, the most appropriate format to present the finding is in the style of an academic manuscript. Chapter four will address the first research objective, to identify factors that are associated with depressive symptoms in informal caregivers, 45 years and older, in Canada, using the CLSA baseline data. Chapter five will address the second objective, to determine the association between Extraversion and Neuroticism at baseline and depressive symptoms at three-year follow-up in informal caregivers, 45 years and older, in Canada. Each paper will include its own background, methods, results and discussions section, relating to the particular research question it aims to answer.

Chapter six provides an overall discussion for both research objectives as well as epidemiological considerations for both manuscripts. Chapter seven goes over the ethical considerations and Chapter eight speaks to the strengths and limitations of this thesis.

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**Chapter 4: Factors associated with depressive symptoms in informal caregivers**

**4.1 Abstract**

**Background:** Over nine million Canadians provided informal care to a person in need of assistance, in 2018. The additional role of caregiving can put the carer at risk of developing adverse mental health outcomes, such as depressive symptoms. The objective of this study was to identify factors that are associated with depressive symptoms in informal caregivers, 45 years and older, in Canada.

**Methods:** The study employed a cross-sectional design, and used baseline data from the Canadian Longitudinal Study on Aging. Cross-tabulations of demographic (i.e., age, sex, race, education, total household income, marital status and retirement status), caregiver characteristics (i.e., self-reported health, personality traits (Neuroticism, Extraversion)), and caregiving characteristics (i.e., caregiving tasks, number of tasks, number of hours caregiving per week, duration of caregiving, and relationship with care recipient) by presence of depression (i.e., determined by a score of 10+ on the Center for Epidemiologic Studies - Depression 10 scale). Bivariable and multivariable linear regressions were performed to determine the association between the demographic, caregiver characteristics and depressive symptomatology. A backwards stepwise method was used to decide which confounders should remain in the multivariable model.

**Results:** Age, Sex, race, household income, marital status, perceived general health, Neuroticism, Extraversion, provision of medical care, hours per week caregiving and relationship with care recipient were all associated with depressive symptomatology in informal caregivers in a multivariable model. Education, duration of caregiving, the number of tasks and all caregiving

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task beside medical care did not show a significant relationship with depressive

symptomatology.

**Conclusions:** This study provides a description of informal caregivers in Canada, aged 45 years

and older, and highlights factors (i.e., Extraversion, Neuroticism, age, sex, hours per week

caregiving, household income, white versus non-white, relationship with care recipient, general

health, marital status and providing medical care) that are associated with prevalent depressive

symptomatology in informal caregivers. The significant associations from this study reiterate

previous findings and extend them into the informal caregiving population. Future studies should

investigate the longitudinal effects of the independent variables on depressive symptoms.

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**4.2 Introduction**

Informal caregivers are individuals who provide a broad range of unpaid and ongoing assistance for an older adult or a person with a chronic or disabling condition (Family Caregiver Alliance, 2014; Roth et al., 2015). In 2018, approximately one in four Canadians, aged 15 and older, provided informal care to a family member or a friend (Canadian Association for Retired Persons, 2014; Sinha, 2013; Statistics Canada, 2020; Statistics Canada, 2020).

Ageing needs were the most reported reason for informal caregiving (Sinha, 2013), and 93% of seniors have indicated that they would prefer to stay at home as long as possible (Health Council of Canada, 2012). Home and community health care services are often not covered by provincial health care systems, and so care recipients must either purchase private service or rely on unpaid care from family and friends (Lilly, Laporte & Coyte, 2010). As the baby boomers age, the number of individuals who need care and support will grow, as will the need for informal caregivers (Khayatzadeh-Mahani & Leslie, 2018).

It is estimated that Canadian informal caregivers communally spend 12.6 million dollars per year in expenses relating to their caregiving role (Fast, Dosman, Lero & Lucas, 2013), for example, transportation costs, purchasing items, housing or food costs, and paying for services (Health Council of Canada, 2012). Furthermore, it is estimated that informal caregivers contribute $25 billion per year to the Canadian economy, when including the value of their time commitments (Hollander, Liu, & Chappell, 2009).

Informal caregiving has an enormous reach and affects many Canadians. While providing support and care to a loved one can bring a sense of accomplishment and giving back, it can also bring tremendous strain (Van der Lee, Bakker, Duivenvoorden, & Dröes, 2014). Caregivers are under additional stress than non-carers because of the physical, psychological, emotional, social

and financial issues that carers might encounter as a result of caregiving responsibilities

(Vitaliano, Zhang & Scanlan, 2003). As such, they are at an increased risk for depression and

depressive-symptoms (Bernabeu-Mora, Garcia-Gullamon, Montilla-Herrador, Escolar-Reina,

Garcia-Vidal & Medina-Mirapeix, 2016; Hajek & Konig, 2017; Pinquart & Sörensen, 2003;

Rabia & Miri, 2016; Schulz & Sherwood, 2008; Smith et al., 2011; Van der Lee et al., 2014).

Depression is a common and serious illness that can contribute to many negative

outcomes. Depressive symptoms include sadness most of the day, every day for a period of at

least two weeks, with loss of interest in activities enjoyed, sleep disturbances and decreased

energy, weight gain or loss, fatigue, feelings of worthlessness and/or guilt, difficulty in

concentration, restlessness, physiological symptoms such as aches and pains, headaches, cramps,

digestive problems and suicidal ideation (American Psychiatric Association, p.160-161, 2013;

Mckeever, Agius & Mohr, 2017; The National Institute of Mental Health Information, 2019). It

is associated with poor health-related behaviours such as low-quality diet, sedentary life-style,

smoking and heavy alcohol use (Appelhans et al., 2012; Kingsbury et al., 2016; Roshanaei-

Moghaddam, Katon & Russo, 2009), as well as shortened life expectancy (Cuijpers, Vogelzangs,

Twisk, Kleiboer, Li, & Pennix, 2014; Gilman, Sucha, Kingsbury, Horton, Murphy & Colman,

2017; Walker, McGee & Druss, 2015).

Depressive symptoms have been found to be associated with several demographic

variables including age, with most studies finding those who are younger report higher levels of

depressive symptoms (Kessler et al., 2010, Pattern et al, 2006, Regan, Kearney, Savva, Cronin &

Kenny, 2013), although there is evidence that depressive symptoms increase after 65 (Yang,

2007). Being female and poor, self-rated physical health are also risk factors for depressive

symptoms (APA, p.166, 2013; Fekete, Tough, Siegrist & Brinkhof, 2017; Meng et al, 2014;

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Meng et al., 2017). Other risk factors include relationship status such as being widowed, separated or divorced, compared to being married (Meng et al., 2017, Pattern et al., 2006, Yang, 2007) and lower socioeconomic status (Meng & D'Arcy, 2014; Meng et al., 2017; Pattern et al., 2006; Yang, 2007). There are reported racial and ethnic differences in the prevalence of depressive disorders with white individuals having a higher incidence of depression (Meng & D'Arcy, 2014; Meng et al., 2017) although this difference may be inflated by the underdiagnoses of the health care provider for Black Americans compared to white Americans (Bailey, Mokonogho & Kumar, 2019). Depressive symptoms have demonstrated a relationship with lower education (Chang-Quan, Zheng-Rong, Yong-Hong, Yi-Zhou & Qing-Xiu, 2010; Meng et al., 2017) and depression and depressive symptoms has shown to have a significant relationship with retirement status (Doshi, Cen & Polsky, 2008). Retirement status has shown to predict depression in spousal caregivers, although its relationship might be partly explained by the older age and poorer health of retirees compared to those still working (de Zwart, Bakx & van Doorslaer, 2017).

Personality refers to the thoughts, feelings and behavioural patterns that are characteristic to the individual. Extraversion describes those who are out-going, fun-loving, social individuals (McCrae & Costa, p.27, 2003) while people who are high in Neuroticism tend to worry and be temperamental (McCrae & Costa, p.27, 2003). Extraversion has been shown to have a negative relationship with depressive symptoms (Khoo & Simms, 2018; Koorevaar et al., 2013; Kotov et al., 2010; Luan et al., 2018; Sadeq & Molinari, 2018) and Neuroticism has shown the inverse relationship (Hayward, Taylor, Smoski, Steffens & Payne, 2013; Khoo & Simms, 2018; Kotov et al., 2010; Koorevaar et al., 2013, Luan et al., 2018; Sadeq & Molinari, 2018).

Certain caregiving characteristics may also be associated with depressive symptoms. As the number of hours per week caregiving increases so does the strain on the carer (CARP, 2014). Research has shown that caregiving intensity, or the number of hours per week of caregiving and duration of caregiving can impact depression amongst informal caregivers (Papastavrou, Charalambous, Tsangari, & Karaylannis, 2012; Pinquart & Sörensen, 2011). Studies have also reported an increased risk of subjective caregiver burden depending on the relationship with the care recipient. In particular, spousal and child caregivers have been associated with higher subject caregiver burden (Bernabeu et al, 2016, Hirdes et al, 2012). The type of care provided (i.e., financial, transportation etc.) may also impact the caregivers' mental health. For example, if a caregiver is providing personal care, they are likely aiding a recipient in worse health than someone who only provides transportation, and the care recipient's health has been associated with more caregiving distress (Hirdes et al, 2012, Mitchell et al 2015). It possible that the more tasks a caregiver provides the care recipient could be an indicator of recipient's health and caregiving intensity as well, as those who offer many tasks are likely to providing more caregiving hours.

Any at risk group for depression or depressive symptoms should be understood so that all precautions can be made to prevent this illness. This includes identifying characteristics that may make the individual more vulnerable to the adverse effects of informal caregiving. As such, this study aimed to identify factors associated with depressive symptoms in Canadian informal caregivers.

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**4.3 Methods**

This study used a predictive model in a cross-sectional design with anonymized secondary data. An ethics waiver was obtained from the Lakehead University Research Ethics Board (see appendix A).

**4.3.1 Study Population**

The goal of the CLSA is to help us live longer, healthier lives and uncover reasons why some individuals age more successfully than others (Raina et al., 2008).

The CLSA is a twenty-year prospective cohort national study of more than 50,000 men and women between the ages of 45 and 85 (at baseline) (Raina, Wolfson, & Kirkland, 2008; Raina et al., 2019). The participants will be followed until at least 2033, or until death (Raina et al., 2008; Raina et al., 2019). Recruitment began in 2010 and baseline assessments were completed in 2015 (Raina et al., 2019). The CLSA is comprised of two groups; the tracking assessment group (n=21,000) who provide information over telephone interviews, and the comprehensive assessment group (n=30,000) who provide in-home and telephone interviews, as well as  information at data collection sites every three years (Raina et al., 2008). To be included in the CLSA comprehensive group, participants must live within 25 to 50 km radius of one of the 11 major academic, data collection sites because of physical assessments that they provide to the CLSA (Raina et al., 2008; Raina et al., 2019)

The CLSA collects information on social and demographic measures, health status, functioning measures, psychological measures, lifestyles and behavioural measures and health care utilization. In addition, the comprehensive group also complete cognitive measures, provide physical assessments (including physical function assessments, vision and hearing tests, blood

and urine samples), Main Wave Disease Symptoms Questionnaire, neuropsychological battery

(including personality inventory) (Raina et al., 2008; Raina et al., 2019).

The study population for the present study included individuals from the comprehensive

assessment group from the CLSA 2015 baseline data (as they have the most comprehensive

data).  As such, it includes 13,043 informal caregivers, representing 43.3% of the total sample of

30,097 individuals in the comprehensive group.

**4.3.2 Measures**

**4.3.2.1 Outcome**

The outcome variable for the bivariable and multivariable analyses was the participants'

score on the Center for Epidemiologic Studies - Depression 10 (CES-D 10) scale. The CES-D 10

is designed to assess depressive symptomatology in the general population; it measures current

(in the past week) depressive symptoms, with an emphasis on affect and depressed mood

(Andreson et al., 1994). The components include: depressed mood, feelings of guilt and

worthlessness, feeling of helplessness and hopelessness, psychomotor retardation, loss of

appetite and sleep disturbances (Andreson et al., 1994). The overall scores range from 0-30 and

higher scores indicate more depressive symptoms (Andreson et al., 1994). The recommended

cutoff score for significant depressive symptoms is ten or more (Andreson et al., 1994). The

CES-D has been validated in older adult populations (Andreson et al., 1994; Irwin, Artin &

Oxman, 1999) and has shown good internal consistency ($\alpha$=0.92) (Irwin et al., 1999); it has been

used in caregiving populations (Pinquart & Sörensen , 2003).

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**4.3.2.2 Independent Variables**

CLSA variables (CLSA, 2018) known to have significant associations with depressive symptoms were included in this study. Socio-demographic characteristics included age, sex, marital status, race, household income, education, and retirement status.

*Age* was measured in years and sex was measured by asking the participant if they were male or female. To measure *race*, we originally used the variable "SDC_DCGT_COM" which refers to participants cultural and racial background. There were 14 possible responses; however, because of the overwhelming majority of people who indicated they were white, the other cells were very small. Instead of looking at race for the bivariable and multivariable analyses, it was decided it would be more statistically appropriate to investigate white vs non-white for the bivariable and multivariable analyses. Three *education* variables from the CLSA data ("ED_ELHS_COM", "ED_HSGR_COM" and "ED_HIGH_COM") were combined to create the education variable used in the present study. The CLSA questionnaire asks participants what the highest grade of elementary or high school they had completed ("ED_ELHS_COM"). They then asked if the participant had received any other education that could be counted towards a degree ("ED_HSGR_COM"). If the participant answered "yes", they would be asked the highest degree, certificate or diploma they had obtained ("ED_HIGH_COM"). If they answered "no", the highest degree/certificate/diploma question was skipped. These three items were combined to include all educational information in one variable and avoid missing data because of the CLSA skip pattern. *Total household income* was measured by the CLSA variable "INC_TOT_COM" and the possible responses were 1) less than 20,000$ 2) 20,000-49,999$ 3) 50,000-99,999$ 4) 100,000-149,999$ or 5) 150,000$ or greater. *Marital status* was obtained from the variable "SDC_MRTL_COM" and the possible responses were 1) Single, never married or never lived

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with a partner 2) Married/Living with a partner in a common-law relationship 3) Widowed 4)

Divorced 5) Separated (CLSA, 2018). For *retirement status*, the variable "RET_RTRD_COM"

(CLSA, 2018) was used and there were three possible answers: 1) Completely Retired 2) Partly

Retired and 3) Not retired.

Characteristics of the caregiver were also included. *Perceived general health* was

measured by the variable "GEN_HLTH_COM", which asked, "in general, would you say your

health is… 1) Excellent 2) Very good 3) Good 4) Fair or 5) Poor".

*Neuroticism* and *Extraversion* were measured using the Ten-Item Personality Inventory

(TIPI) to measure personality following the Five Factor framework. The TIPI was created by

Gosling, Rentfrow and Swann (2003) as a brief alternative to the traditional measures of the Five

Factor model. The TIPI scale has shown acceptable test-retest reliability (Gosling et al., 2003)

and construct validity through convergent validity with BFI (Gosling et al., 2003). Scores for

each personality trait are the average of two items and range from 1-7. Personality traits are

conceptualized as a spectrum with two opposite ends. For Neuroticism, the TIPI measures its

counterpart: Emotional Stability (Gosling et al, 2003). For the sake of consistency throughout

this study, the scores of Emotional Stability were reversed to represent Neuroticism.

Finally, caregiving variables were also included. *Hours of caregiving per week* was based

on the CLSA variable "CAG_HRWK_NB_COM". There were seven *types of caregiving tasks*,

including personal care, medical care, managing care such as making appointments, household

care such as home maintenance, transportation, meal preparation and other. Responses to these

seven variables was yes/no. *Total number of tasks* was created by adding the number of yes

responses to the caregiving duties variables and responses range from 0-7. The *duration of*

*caregiving* was measured by the number of weeks in the past 12 months they provided assistance

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"CAG_WEEK_NB_COM" (CLSA, 2018). *Relationship with care recipient* was measured by

"CAG_RELN_COM" and the possible answers included husband/wife, common-low partner,

parent, child, sibling, grandchild, father-in-law/mother-in-law, son-in-law/daughter-in-law,

brother-in-law/sister-in-law, other relative and friend/neighbour/other (CLSA, 2018).

### 4.3.3 Statistical Analyses

All data were analyzed using STATA software, version 16.

A univariate analysis was run first. Means and standard deviations were obtained for age,

hours of caregiving per week, number of weeks providing care, Neuroticism, Extraversion, the

CES-D score and the quantity of tasks a caregiver provides for the recipient. For the categorical

variables, percentage and total counts were calculated.

Next, cross-tabulations were used with Pearson's chi-square to attain the distribution of

people over the CES-D cut-off of ten or more for significant depressive symptoms, at each level

for all the categorical variables (Andreson et al., 1994). A simple linear regression was run for

each of the variables on the CES-D score. An incremental F-test compares the sum of squares of

error of the full model and nested model. To produce the final model, incremental f-tests were

used for each of the non-significant predictors to see if their contribution was important for the

fit of model. If inclusion of the variable increases the prediction error by a large amount, then

removing that variable from the full model is the better decision (Lu & Zhang, 2010). Finally, a

multivariable model was run to determine which variables were associated with depressive

symptoms in our study population.

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**4.4 Results**

**4.4.1 Baseline Caregiver Characteristics**

There were 13,043 participants who indicated that they had provided informal care in the last 12 months at baseline; tables 1 and 2 provide a detailed description of the characteristics of the informal caregivers and caregiving.

The average age for the study population was 62.19 (9.85) and a little over half were female (55.32%). The vast majority of participants indicated that they were white (91.60%) and they were well educated with over half (50.52%) indicating that they had a University certificate and above. The most commonly reported household income bracket was $50,000-99,999 (33.99%), followed by $20,000-49,999 (20.29%) and $100,000-149,999 (19.21%). Most of the participants were married (69.88%), and a similar percent were completely and not retired (43.10%, 44.89% respectively) with 11.67% indicating they were partially retired. Overall, the participants perceived their health positively as 91.28% of the study population reported good, very good or excellent general health. On average they were low in Neuroticism and high in Extraversion. The most common relationship with care recipient was parent (31.82%) followed by friend, neighbour, other (25.43%). On average the informal caregivers provided 2.64 different tasks for the care recipients and the most common tasks being transportation (74.32%), assistance with activities (54.55%) and meal preparation (43.28%). The caregivers provided 13.83 hours per week of caregiving and they had been caregiving on average for 25.83 weeks prior to data collection. Their mean CES-D 10 score was 5.46 out of 30, with 2,148 participants scoring over the cut-off for significant depressive symptoms of ten and more.

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Table 1. *Characteristics measured continuously for informal caregivers in the CLSA 2015 baseline comprehensive assessment group*

| Variables | Sample size | Min/Max | Mean (SD) | Don't Know | Refused |
|---|---|---|---|---|---|
| Age | 13,043 | 45/86 | 62.19 (9.85) | - | - |
| Neuroticism | 12,498 | 1/7 | 2.19 (1.39) | - | 84 (0.67%) |
| Extraversion | 12,448 | 1/7 | 4.45 (1.80) | - | 134 (1.07%) |
| Hours of caregiving per week | 13,043 | 1/168 | 13.83 (25.56) | - | - |
| Number of weeks providing care | 12,901 | 1/52 | 25.83 (21.14) | 139 (1.07%) | 3 (0.02%) |
| Quantity of Task | 13, 043 | 0/7 | 2.64 (1.67) | - | - |
| CES-D score | 12, 984 | 0/30 | 5.46 (4.74) | 35 (0.12%) | 126 (0.42%) |

Table 2. *Characteristics measured categorically for informal caregivers in the CLSA 2015 baseline comprehensive group*

| Variable | N (%) |
|---|---|
| Sex | |
| Female | 7,215 (55.32%) |
| Male | 5,828 (44.68%) |
| Race | |
| white | 11, 947 (91.60%) |
| Non-white | 993 (7.61%) |
| Education | |
| No High School | 599 (4.59%) |
| No post-secondary degree, certificate or diploma | 2,151 (16.50%) |
| Trade certificate or diploma from a vocational school or apprenticeship training | 1,363 (10.45%) |
| Non-university certificate or diploma from community college, CEGEP, school of nursing etc. | 2,340 (17.94%) |
| University certificate below bachelor's level | 564 (4.33%) |
| Bachelor's degree | 3,230 (24.77%) |
| University degree or certificate above bachelor's degree | 2,793 (21.42%) |
| Don't Know | 1 (0.01%) |
| Total Household income | |
| <20,000$ | 629 (4.82%) |

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| | |
|---|---|
| 20,000-49,999 | 2,646 (20.29%) |
| 50,000-99,999 | 4,433 (33.99%) |
| 100,000-149,999 | 2,506 (19.21%) |
| >150,000 | 2,094 (16.05%) |
| Don't Know | 280 (2.15%) |

Marital Status

| | |
|---|---|
| Single, never married or never lived with a partner | 1,144 (8.77%) |
| Married/Living with a partner in common-law relationship | 9,114 (69.88%) |
| Widowed | 1,091 (8.36%) |
| Divorced | 1,358 (10.41%) |
| Separated | 333 (2.55%) |
| Refused | 3 (0.02%) |

Retirement Status

| | |
|---|---|
| Completely Retired | 5,621 (43.10%) |
| Partially Retired | 1,522 (11.67%) |
| Not Retired | 5,855 (44.89%) |
| Don't Know | 44 (0.34%) |

General Health

| | |
|---|---|
| Excellent | 2,613 (20.03%) |
| Very Good | 5,425 (41.59%) |
| Good | 3,869 (29.66%) |
| Fair | 958 (7.34%) |
| Poor | 171 (1.31%) |
| Don't Know | 7 (0.05%) |

Relationship with Care Recipient

| | |
|---|---|
| Husband/Wife | 2, 040 (15.64%) |
| Common-Law Partner | 143 (1.10%) |
| Parent | 4,150 (31.82%) |
| Child | 809 (6.20%) |
| Sibling | 690 (5.29%) |
| Grandchild | 61 (0.47%) |
| Father-in-law/mother in law | 1,048 (8.03%) |
| Son-in-law/daughter-in-law | 46 (0.35%) |
| Brother-in-law/sister-in-law | 219 (1.68%) |
| Other relative | 502 (3.85%) |
| Friend, neighbor, other | 3,317 (25.43%) |
| Don't Know | 17 (0.13%) |
| Refused | 1 (0.01%) |

Care giving task

| | |
|---|---|
| Provided personal care | 3,733 (28.62%) |
| Medical Care | 3,383 (25.94%) |
| Managing Care | 4,695 (36.00%) |
| Assistance with Activities | 7,115 (54.55%) |
| Transportation | 9, 693 (74.32%) |
| Meal Preparation | 5,645 (43.28%) |

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Other   200 (1.53%)

## 4.4.2 Distribution of Caregivers by CES-D 10 Cutoff Score

The baseline data were stratified by CES-D less than or equal to 10, the clinical cut-off for significant depressive symptoms (Andreson et al., 1994)  (see table 3). At baseline, 83.43% reported a CES-D score less than 10, under the clinical cut-off, meaning that approximately 16.57% showed signs of depression (n=2,153). Females represented 65.27% of those in the depressive symptom group while only representing 55.26% of the entire sample ($x^2$=104.92, p<0.001). Those who were white compared to non-white were more likely to be above the clinical cut-off ($x^2$=40.04, p<.001). Depressive symptoms appeared less frequent as educational attainment increased and was associated with depressive symptoms ($x^2$=115.78, p<.001). There was a significant difference between the income levels in those that were above and below the CES-D cut-off ($x^2$=392.91, p<.001). Being married appeared to have a protective factor against depressive symptoms. Those who were married were underrepresented in the depressive group. Those widowed, divorced or single were overrepresented in the depressive group compared to the total sample ($x^2$=192.82, p<.001). Retirement status ($x^2$=13.52, p<.009) and general health was associated with significant depressive symptoms ($x^2$=970.84, p<.001). For the caregiving characteristics, relationship with recipient ($x^2$=39.72, p<.001), providing personal care ($x^2$=39.33, p<.001), managing care ($x^2$=23.15, p<.001) and meal preparation ($x^2$=10.27, p<.001) were significantly associated with significant depressive symptoms.

Table 3. *Cross tabulations showing the percentage of those above and below recommended cut-off for significant depressive symptoms, in each level of categorical variables of informal caregivers in the CLSA 2015 baseline comprehensive assessment group*

| Variable | CESD-10 score below cutoff (n=10,819) | CESD-10 score above cutoff (n=2,148) |
|---|---|---|
| Total Study Population | 83.43% | 16.57% |
| **Age Group** | | |
| 45-54 | 25.80% | 27.56% |
| 55-64 | 36.42% | 36.29% |
| 65-74 | 23.06% | 21.30% |
| 75+ | 14.72% | 14.85% |
| **Sex** | | |
| Female | 53.28% | 65.27% |
| Male | 46.72% | 34.73% |
| **Race** | | |
| white | 92.12% | 89.15% |
| Non-white | 7.88% | 10.85% |
| **Education** | | |
| No High School | 4.02% | 7.31% |
| No post-secondary degree, certificate or diploma | 15.97% | 19.14% |
| Trade certificate or diploma from a vocational school or apprenticeship training | 10.13% | 12.06% |
| Non-university certificate or diploma from community college, CEGEP, school of nursing etc. | 17.63% | 19.42% |
| University certificate below bachelor's level | 4.22% | 4.80% |
| Bachelor's degree | 25.52% | 21.29% |
| University degree or certificate above bachelor's degree | 22.50% | 15.98% |
| **Total Household income** | | |
| <20,000$ | 3.88% | 11.07% |
| 20,000-49,999 | 19.64% | 30.43% |
| 50,000-99,999 | 36.48% | 34.00% |
| 100,000-149,999 | 21.51% | 14.79% |
| >150,000 | 18.49% | 9.71% |
| **Marital Status** | | |
| Single, never married or never lived with a partner | 8.03% | 12.57% |
| Married/Living with a partner in common-law relationship | 72.49% | 57.73% |
| Widowed | 7.70% | 10.99% |
| Divorced | 9.52% | 14.71% |
| Separated | 2.27% | 4.00% |
| **General Health** | | |
| Excellent | 22.54% | 7.78% |

|  | | | |
|---|---|---:|---:|
|  | Very Good | 44.21% | 28.70% |
|  | Good | 27.24% | 41.75% |
|  | Fair | 5.31% | 17.43% |
|  | Poor | 0.70% | 4.33% |
| **Retirement Status** | | | |
|  | Completely Retired | 42.90% | 44.56% |
|  | Partially Retired | 11.99% | 10.26% |
|  | Not Retired | 45.11% | 45.17% |
| **Relationship with care recipient** | | | |
|  | Husband/Wife | 15.35% | 17.14% |
|  | Common-Law Partner | 1.02% | 1.54% |
|  | Parent | 32.23% | 30.27% |
|  | Child | 5.93% | 7.55% |
|  | Sibling | 5.21% | 5.78% |
|  | Grandchild | 0.44% | 0.61% |
|  | Father-in-law/mother in law | 8.52% | 5.87% |
|  | Son-in-law/daughter-in-law | 0.36% | 0.33% |
|  | Brother-in-law/sister-in-law | 1.73% | 1.49% |
|  | Other relative | 3.96% | 3.31% |
|  | Friend, neighbor, other | 25.24% | 26.04% |
| **Care giving task** | | | |
|  | **Provided personal care** | | |
|  | No | 72.22% | 67.13% |
|  | Yes | 27.78% | 32.87% |
|  | **Medical Care** | | |
|  | No | 75.15% | 68.72% |
|  | Yes | 24.85% | 31.28% |
|  | **Managing Care** | | |
|  | No | 64.84% | 59.31% |
|  | Yes | 35.16% | 40.69% |
|  | **Assistance with Activities** | | |
|  | No | 45.47% | 45.07% |
|  | Yes | 54.53% | 54.93% |
|  | **Transportation** | | |
|  | No | 25.55% | 25.98% |
|  | Yes | 74.45% | 74.02% |
|  | **Meal Preparation** | | |
|  | No | 57.30% | 53.58% |
|  | Yes | 42.70% | 46.42% |
|  | **Other** | | |
|  | No | 98.49% | 98.42% |
|  | Yes | 1.51% | 1.58% |

Bold indicates Pearson's chi-square was significant at p=.05

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### 4.4.3 Association Between Independent Variables and CES-D 10 Score Using Simple Linear Regression

A bivariate analysis was run with each of the variables on the CES-D 10 score. Age was not associated with depressive symptoms. Being male was associated with higher CES-D scores and all income levels higher than the reference (<$20,000) were associated with lower CES-D scores compared to <$20,000. Non-white compared to white was associated with higher levels of depressive symptoms. Being married was associated with lower depressive symptoms, compared to being single, while being widowed was associated with higher CES-D 10 scores in informal caregivers, compared to being single. Higher educational attainment was associated with less depressive symptoms with the highest level, university degree or certificate above a Bachelor's, having the strongest negative association with the CES-D score than the other educational levels. Partially retired showed a negative relationship with depressive symptoms compared to completely retired while self-perceived general health showing a strong relationship with depressive symptoms. As general health worsened, depressive symptoms worsened. Both the personality traits showed a significant relationship with depressive symptoms; Neuroticism showed a negative relationship and Extraversion showed a positive association. Parent, parent-in-law and sibling-in-law all were associated with lower CES-D scores compared to taking care of one's spouse. The number of different tasks a caregiver provides showed a positive relationship with the CES-D score and those who provided personal care, medical care and managing care were all associated with higher depressive symptoms compared to not providing those types of caring. Not surprisingly, as caregiver hours increase, so do depressive symptoms as does the number of weeks as a caregiver. See table 4 for full results.

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Table 4. *Bivariable results of simple linear regression of independent variables on CES-D score of informal caregivers in CLSA comprehensive assessment group at 2015 baseline*

| Variables | Coefficient | Std. Err | P>[t] | 95% CI |
|---|---|---|---|---|
| Age | -.01 | .00 | .09 | -.01, .02 |
| Sex | | | | |
| Female | 0.0 | - | - | - |
| Male | **-1.14** | **.13** | **<.05** | **-1.40, -.88** |
| Total Household Income | | | | |
| <20,000 | 0.0 | - | - | - |
| 20,000-49,999 | **-1.73** | **.33** | **<.05** | **-2.39, -1.08** |
| 50,000-99,999 | **-3.41** | **.32** | **<.05** | **-4.04, -2.79** |
| 100,000-149,999 | **-4.07** | **.33** | **<.05** | **-4.73, -3.42** |
| >150,000 | **-4.37** | **.34** | **<.05** | **-5.04, -3.70** |
| Race | | | | |
| white | 0.0 | - | - | - |
| Non-white | **.99** | **.25** | **<.05** | **.50, 1.47** |
| Marital Status | | | | |
| Single | 0.0 | - | - | - |
| Married/Living with a partner in common-law relationship | **-1.69** | **.23** | **<.05** | **-2.14, -1.23** |
| Widowed | **.97** | **.32** | **<.05** | **.35, 1.59** |
| Divorced | .09 | .30 | .76 | -.50, .68 |
| Separated | -.03 | .47 | .95 | -.94, .89 |
| Education | | | | |
| No High School | 0.0 | - | - | - |
| High school | **-1.09** | **.35** | **<.05** | **-1.77, -.40** |
| Trade School | **-1.10** | **.37** | **<.05** | **-1.83, -.38** |
| Non-university diploma or certificate | **-1.32** | **.35** | **<.05** | **-1.98, -.63** |
| University certificate below bachelor's | **-.95** | **.44** | **<.05** | **-1.82, -.09** |
| Bachelor's degree | **-2.11** | **.36** | **<.05** | **-2.77, -1.45** |
| University degree or certificate above bachelor's degree | **-2.25** | **.34** | **<.05** | **-2.92, -1.59** |
| Retirement Status | | | | |
| Completely Retired | 0.0 | - | - | - |
| Partially Retired | **-.51** | **.22** | **<.05** | **-.93, -.08** |
| Not Retired | -.17 | .14 | .22 | -.45, .10 |
| General Health | **1.82** | **.07** | **<.05** | **1.68, 1.96** |
| Neuroticism | **1.32** | **.05** | **<.05** | **1.23, 1.40** |
| Extraversion | **-.41** | **.04** | **<.05** | **-.47, -.34** |
| Relationship with care recipient | | | | |
| Husband/Wife | 0.0 | - | - | - |
| Common-Law Partner | .11 | .65 | .86 | -1.16, 1.39 |

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| | | | | |
|---|---|---|---|---|
| Parent | **-.44** | **.20** | **.03** | **-.84, -.04** |
| Child | .13 | .31 | .68 | -.48, .74 |
| Sibling | -.10 | .33 | .77 | -.75, .55 |
| Grandchild | -.33 | .98 | .74 | -2.25, 1.59 |
| Father-in-law/Mother-in-law | **-1.37** | **.29** | **<.05** | **-1.93, -.81** |
| Son-in-law/Daughter-in-law | -.70 | 1.12 | .53 | -2.89, 1.48 |
| Brother-in-law/sister-in-law | **-1.36** | **.54** | **<.05** | **-2.41, -.31** |
| Other Relative | -.59 | .37 | .12 | -1.32, .14 |
| Friend, neighbor, other | .06 | .21 | .76 | -.35, .48 |
| Quantity of Tasks | **.11** | **.04** | **<.05** | **.04, 19** |
| Provided Personal Care | **.51** | **.15** | **<.05** | **.22, 79** |
| Provided Medical Care | **.78** | **.15** | **<.05** | **.49, 1.07** |
| Provided Managing Care | **.31** | **.14** | **<.05** | **.04, .58** |
| Provided Assistance with Activities | -.02 | .13 | .87 | -.28, .24 |
| Provided Transportation | -.29 | .15 | .05 | -.59, .00 |
| Provided Meal Preparation | .16 | .13 | .22 | -.10, .42 |
| Provided Other types of care | .74 | .54 | .17 | -.31, 1.80 |
| Hours per week caregiving | | | | |
| < 7 | 0.0 | - | - | - |
| 8-21 | **.36** | **.17** | **<.05** | **.16, .58** |
| 22.48 | **.93** | **.26** | **<.05** | **.42, 1.45** |
| 49-96 | **1.25** | **.35** | **<.05** | **.57, 1.93** |
| 96+ | **1.70** | **.34** | **<.05** | **1.03, 2.38** |
| Number of weeks caregiving | **.01** | **.00** | **<.05** | **.01, .02** |

Bold indicated significance at p=.05

### 4.4.4 Association Between Independent Variables and CES-D 10 Score using Multivariable Linear Regression

Compared to the bivariate analysis, two of the hours per week category, numbers of weeks caregiving, being married compared to single, education, being partially retired and several caregiving tasks no longer showed significant associations with the CES-D 10 score in the multivariable model. See table 5 for full results.

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Table 5. *Coefficients of independent variables in full multivariable linear regression results with participants' CES-D 10 score as outcome for informal caregivers in CLSA comprehensive assessment group at 2015 baseline*

| Variables | Coefficient | Std. Err | P>[t] | 95% CI |
|---|---|---|---|---|
| Age | -.01 | .01 | .23 | -.03, .01 |
| Sex | | | | |
| Female | 0.0 | - | - | - |
| Male | **-.56** | **.14** | **<.05** | **-.82, -.29** |
| Total Household Income | | | | |
| <20,000 | 0.0 | - | - | - |
| 20,000-49,999 | **-.80** | **.33** | **<.05** | **-1.44, -.16** |
| 50,000-99,999 | **-1.62** | **.33** | **<.05** | **-2.27, -.96** |
| 100,000-149,999 | **-1.81** | **.36** | **<.05** | **-2.52, -1.01** |
| >150,000 | **-1.92** | **.38** | **<.05** | **-2.66, -1.18** |
| Race | | | | |
| white | 0.0 | - | - | - |
| Non-white | **.53** | **.24** | **<.05** | **.07, 1.00** |
| Marital Status | | | | |
| Single | 0.0 | - | - | - |
| Married/Living with a partner in common-law relationship | -.22 | .25 | .38 | -.70, .27 |
| Widowed | **1.32** | **.32** | **<.05** | **.68, 1.95** |
| Divorced | .37 | .29 | .21 | -.20, .94 |
| Separated | .85 | .45 | .06 | -.03, 1.73 |
| Education | | | | |
| No High School Leaving | 0.0 | - | - | - |
| High school | -.05 | .35 | .89 | -.73, .64 |
| Trade School | .01 | .37 | .98 | -.71, .73 |
| Non-university diploma or certificate | .03 | .35 | .92 | -.65, .72 |
| University certificate below bachelor's | -.12 | .43 | .78 | -.96, .73 |
| Bachelor's degree | -.21 | .43 | .54 | -.89, .47 |
| University degree or certificate above bachelor's degree | -.12 | .35 | .73 | -.81, .57 |
| Retirement Status | | | | |
| Completely Retired | 0.0 | - | - | - |
| Partially Retired | .14 | .21 | .50 | -.27, .55 |
| Not Retired | .26 | .18 | .15 | -.10, .62 |
| General Health | **1.29** | **.07** | **<.05** | **1.14, 1.43** |
| Neuroticism | **1.01** | **.05** | **<.05** | **.99, 1.10** |
| Extraversion | **-.27** | **.04** | **<.05** | **-.34, -.20** |
| Relationship with care recipient | | | | |
| Husband/Wife | 0.0 | - | - | - |
| Common-Law Partner | 0.80 | .61 | .19 | -1.99, .40 |

| Variables | Coefficient | Std. Err | P>[t] | 95% CI |
|---|---|---|---|---|
| Parent | **-.54** | **.22** | **.01** | **-.97, -.11** |
| Child | -.32 | .31 | .30 | -.92, .28 |
| Sibling | -.50 | .33 | .12 | -1.15, .14 |
| Grandchild | -.99 | .95 | .30 | -2.85, .86 |
| Father-in-law/Mother-in-law | **-.61** | **.28** | **.03** | **-1.16, -.06** |
| Son-in-law/Daughter-in-law | **-.23** | 1.03 | .82 | -2.25, 1.79 |
| Brother-in-law/sister-in-law | -.95 | .51 | .06 | -1.95, .06 |
| Other Relative | **-1.01** | **.36** | **.01** | **-1.72, -.29** |
| Friend, neighbor, other | -.24 | .23 | .29 | -.69, .21 |
| Quantity of Tasks | -.21 | .15 | .16 | -.50, .08 |
| Provided Personal Care | .31 | .22 | .15 | -.11, .74 |
| Provided Medical Care | **.57** | **.23** | **<.05** | **.12, 1.03** |
| Provided Managing Care | .32 | .23 | .16 | -.13, .77 |
| Provided Assistance with Activities | .23 | .20 | .21 | -.14, .64 |
| Provided Meal Preparation | .14 | .22 | .51 | -.28, .57 |
| Provided Other types of care | .45 | .53 | .39 | -.59, 1.49 |
| Hours per week caregiving | | | | |
| <7 | 0.0 | - | - | - |
| 8-21 | .21 | .17 | .23 | -.13, .54 |
| 22-48 | **.60** | **.27** | **.03** | **.07, 1.13** |
| 49-96 | .35 | .35 | .32 | -34, 1.04 |
| 96+ | **.91** | **.38** | **.02** | **.17, 1.65** |
| Number of weeks caregiving | .00 | .00 | .23 | -.00, .01 |

Retirement status, weeks caregiving, quantity of tasks and all the caregiving tasked besides providing medical care were removed based on the non-significant incremental F-test. Education was kept in the final model, because removing it significantly increased the prediction error. See table 6 for variables that were included in the final model. The adjusted $R^2$ was 0.26, which means the final model explains 26% of the variance of depressive symptoms.

Table 6. *Coefficients of independent variables in final multivariable linear regression results with participants' baseline CES-D 10 score as outcome, in informal caregivers in CLSA comprehensive assessment group at 2015 baseline*

| Variables | Coefficient | Std. Err | P>[t] | 95% CI |
|---|---|---|---|---|
| Age | **-.02** | **.01** | **<.05** | **-.04, -.00** |
| Sex | | | | |
| Female | 0.0 | - | - | - |
| Male | **-.53** | **.13** | **<.05** | **-.79, -.27** |

| | | | | |
|---|---|---|---|---|
| **Total Household Income** | | | | |
| <20,000 | 0.0 | - | - | - |
| 20,000-49,999 | **-.75** | **.32** | **<.05** | **-1.39, -.12** |
| 50,000-99,999 | **-1.61** | **.33** | **<.05** | **-2.26, -.96** |
| 100,000-149,999 | **-1.76** | **.36** | **<.05** | **-2.46, -1.06** |
| >150,000 | **-1.89** | **.37** | **<.05** | **-2.61, -1.15** |
| **Race** | | | | |
| white | 0.0 | - | - | - |
| Non-white | **.53** | **.24** | **<.05** | **.06, .99** |
| **Marital Status** | | | | |
| Single | 0.0 | - | - | - |
| Married/Living with a partner in common-law relationship | -.26 | .25 | .30 | -.74, .22 |
| Widowed | **1.36** | **.33** | **<.05** | **.72, 1.99** |
| Divorced | .36 | .29 | .22 | -.21, .93 |
| Separated | .87 | .45 | .05 | -.01, 1.76 |
| **Education** | | | | |
| No High School | | | | |
| High school | .01 | .35 | .97 | -.67, .70 |
| Trade School | -.01 | .37 | .98 | -.73, .72 |
| Non-university diploma or certificate | .03 | .35 | .92 | -.65, .72 |
| University certificate below bachelor's | -.10 | .43 | .81 | -.95, .75 |
| Bachelor's degree | -.22 | .34 | .53 | -.89, 46 |
| University degree or certificate above bachelor's degree | .12 | .35 | .74 | -.81, .57 |
| General Health | **1.28** | **.04** | **<.05** | **1.20, 1.37** |
| Neuroticism | **1.01** | **.05** | **<.05** | **.92, 1.10** |
| Extraversion | **-.26** | **.04** | **<.05** | **-.33, -.19** |
| **Relationship with care recipient** | | | | |
| Husband/Wife | 0.0 | - | - | - |
| Common-Law Partner | -.72 | .61 | .24 | -1.91, .47 |
| Parent | -.53 | **.21** | **<.05** | **-.95, -.11** |
| Child | -.35 | .30 | .25 | -.94, .24 |
| Sibling | -.56 | .33 | .09 | -1.20, .08 |
| Grandchild | -1.00 | .95 | .29 | -2.86, .86 |
| Father-in-law/Mother-in-law | **-.65** | **.28** | **<.05** | **-1.20, -.10** |
| Son-in-law/Daughter-in-law | -.32 | 1.03 | .76 | -2.34, 1.71 |
| Brother-in-law/sister-in-law | **-1.08** | **.51** | **<.05** | **-2.08, -.09** |
| Other Relative | **-1.00** | **.36** | **<.05** | **-.1.71, -.29** |
| Friend, neighbor, other | -.33 | .22 | .41 | -.77, .11 |
| Provided Medical Care | **.42** | **.16** | **<.05** | **.11, 72** |
| **Hours per week caregiving** | | | | |
| <7 | 0.0 | - | - | - |
| 8-21 | .18 | .17 | .28 | -.15, .51 |
| 22-48 | **.59** | **.26** | **<.05** | **.08, 1.11** |

| | | | | |
|---|---|---|---|---|
| 49-96 | .32 | .34 | .36 | -.36, .99 |
| 96+ | **.90** | **.34** | **<.05** | **.23, 1.57** |

**4.5 Discussion**

The purpose of the present study was to identify factors associated with depressive symptoms in informal caregivers in Canada. Using data from the 2015 CLSA baseline, this study presented the baseline characteristics of all those who had indicated they had provided informal care, within the last 12 months. Next, cross-tabulations were estimated to understand the distribution of participants above and below the cut-off for significant depressive symptoms, across the levels of each of the categorical variables. Bivariable and multivariable linear regression analyses were run to identify factors significantly related to the CES-D 10 score. We found that 16% of caregivers exhibited depressive symptoms overall, and that several socio-demographic, caregiver, and caregiving variables were associated with depression.

In the multivariable model that controlled for other factors, total household income showed a strong relationship with depressive symptoms. Each level additional of total household income was associated with a lower depressive score, compared to <20, 000$. As the amount of income increased, it had stronger negative association with depressive symptoms, with 150,000$ or more being associated with a decrease in participants CES-D score by 1.92 compared to <20,000$. This relationship declined in a linear fashion. This finding is in line with previous literature that suggests lower socioeconomic status is a risk factor for depressive disorders (Meng & D'Arcy, 2014; Meng et al., 2017; Pattern et al., 2006; Yang, 2007). There is a possibility that the effect of income on depressive disorders is more pronounced in informal caregivers as they might have to pay out of pocket expenses related to caregiving (Fast et al., 2013) or maybe the caregivers who exhibited more depressive symptoms were less able to earn a higher income.

There is also evidence that informal caregivers have had their work impacted because of their caregiving roles (Health Council of Canada, 2012) which in turn would impact their finances.

Another important factor associated with depressive symptoms was perceived general health. As the CES-D 10 score increased, we saw a co-occurring decrease in general health scores. This finding has been documented in the literature (APA, p.158, 2013; Meng & D'Arcy, 2014; Meng et al., 2017, Pattern et al., 2006; Regan et al., 2013) and caregivers' health has been shown to influence the level of distress on the caregiver (Fekete, Tough, Siegrist & Brinkhof, 2017). In the study population, aiding someone else would become increasingly difficult as the caregivers' own health deteriorates. The added stress of managing one's own health while balancing caregiving roles as well as other responsibilities might push an individual to develop depressive symptoms. Conversely, those who have more depressive symptoms might perceive their health to be worse.

An increase in Neuroticism increased the CES-D score in informal caregivers, whereas increasing Extraversion was associated with a decrease in the CES-D score. These findings follow previous results on personality and depression (Hayward, Taylor, Smoski, Steffens & Payne, 2013; Koorevaar et al., 2013; Kotov, Gamez, Schmidt & Watson, 2010; Luan et al., 2018; Sadeq & Molinari, 2018). Neuroticism has shown the strongest personality link to depressive disorders in the literature. In a large meta-analysis, all studies included found an association between depressive disorders and Neuroticism, with all effect sizes equal to or greater than 0.92 (Kotov et al., 2010). In the present study, for each additional one-point increase in the Neuroticism TIPI score, participants' score on the CES-D increased by more than one, on average. This study confirms the strong association between Neuroticism and depressive symptoms. Extraversion consistently decreases the risk of depressive disorders; however, the

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impact of Extraversion on depressive disorders is less notable than Neuroticism (Kotov et al.,

2010). When the Extraversion score increased by one-unit, the CES-D score decreased, on

average, by -.26. The findings of the current study reiterate the findings of previous research:

Extraversion has an inverse relationship to depressive symptoms than Neuroticism, although the

link is not as strong.

Female sex was associated with depressive symptoms. These findings align with previous

literature (APA, p.158, 2013; Meng & D'Arcy, 2014; Meng et al., 2017, Pattern et al., 2006;

Regan et al., 2013). We also found that informal caregivers are more likely to be female

(Adelman, Tmanova, Delgado, Dion & Lachs, 2014; Hirst, 2005; Hirdes, et al., 2012;

Metzelthin, Verbakel, Veenstra, Exel, Ambergen & Kempen, 2017). Being non-white compared

to white was associated with a higher CES-D score. This finding was opposite to previous

studies that report a higher prevalence of depressive disorders in Caucasian individuals (Bailey et

al., 2019; Meng & D'Arcy, 2014; Meng et al., 2017), however our study grouped many cultural

and ethnic backgrounds into one category because the study population was predominately

white. Because of this, no inferences can be made about the relationship between depressive

symptoms and racial or ethnic background aside from being white was associated with lower

levels of depressive symptoms. Marital status and depressive symptoms had a statically

significant relationship. Specifically, those who indicated they were widowed were associated

with higher the CES-D scores, compared to being single. Marital status has been shown to be a

predictive factor for depressive symptoms (Meng et al., 2017, Pattern et al., 2006, Yang, 2007).

The dataset did not include a measure of the care recipient's health which has shown to

increase caregiver distress (Hirdes et al, 2012; Mitchell, Hirdes, Poss, Slegers-Boyd, Caldarelli

& Martin, 2015). The lack of this variable might have attributed to the low $R^2$ of the model. The

dataset did include types of care that the caregivers provided the recipients. Presumably, if a caregiver was responsible for providing personal care (such as bathing, clothing, etc.), the recipient would be in worse health then if the caregiver provided tasks such as transportation. Similarly, providing medical care might indicate that the care recipient was in worse health than helping with activities. In the multivariable model, providing medical care was associated with higher scores on the CES-D, and this was statistically significant, compared to not providing medical care. None of the other caregiving tasks were significant. One might assume that providing transportation or help with activities might be associated with lower depressive scores because those who provided solely transportation in contrast to providing personal care are taking care of recipients in worse health; however, the items were asked individually, and therefore those who provided medical care and were above the cut-off could also respond yes to providing transportation (for example), meaning no difference would be found in the CES-D score between those who did or did not provide transportation. All seven of the caregiver tasks were merged into one variable to represent the quantity of tasks. The thought behind this was that the more tasks the caregiver performs, the higher the intensity of caregiving, which, if intensity of caregiving is conceptualized as number of hours per week, has been associated with caregiver distress (Adelman et al., 2014; Hirdes et al, 2012; Hirst, 2005; Mitchell et al., 2015; Pinquart & Sorensen, 2003). In the present study, however, the relationship was non-significant. Those who provided 5-7 caregiving tasks were overrepresented in the above 9 CES-D 10 group compared to the overall study population; however, the coefficient was still non-significant. This could be explained by the small sample sizes for those who provided five to seven tasks.

The number of hours spent caregiving per week was associated with depressive symptoms. Those who indicated they spent 22-48 or 96+ hours per week on their caregiving

duties, were more likely to have a higher CES-D score than those who spent 7 hours or less hours caregiving per week. Other studies have found that as the caregiving hours increase, the caregiver is more vulnerable to caregiver distress (Adelman et al., 2014; Hirdes et al, 2012; Hirst, 2005; Mitchell et al., 2015; Pinquart & Sorensen, 2003) and depression (Papastavrou et al., 2012; Pinquart & Sorensen, 2003). This of course makes sense as it would be increasingly difficult to juggle all responsibilities as the hours taking care of someone else push past the hours of a full-time job.

Taking care of one's parent, parent-in-law, child-in-law or other relative related to lower CES-D scores, compared to taking care of one's spouse. This finding is supported by previous studies that have suggested taking care of one's spouse is a risk factor for caregiver distress (Bernabeu et al, 2016; Hirdes et al, 2012). There could be several explanations for this. Firstly, if an informal caregiver is taking care of their spouse, they likely live in the same residence as the care recipient. It would be difficult for them to leave their caregiver role, as they are constantly around their spouse. If the recipient's spouse needs caregiving due to deteriorating health or disability that has developed with age, it would be hard for the caregiver to watch their spouse's health decline, especially with a lifetime of healthy memories. In fact, all relationships with care recipients had lower depressive symptoms means, except for common-law, compared to spouse, although not all were statistically significant. We found a null result for the number of weeks caregiving which was in contradiction to the literature (Papastavrou, et al., 2012; Pinquart & Sörensen, 2011). The question about the duration of caregiving askes participants about the past year. It could be that in order to see the association between depressive symptoms and duration of caregiving, we must look beyond one year.

Surprisingly, we found a null result for education. Other studies have shown that lower education is associated with depressive disorders in older adults (Chang-Quan et al., 2010; Meng et al., 2017) and caregiver distress (Adelman et al, 2014). One explanation for the null findings could be the effect of income. Education was significant at every level in the bivariable analysis, but once included in this model with income, the association disappeared. It could be that low socioeconomic status is associated with depressive symptoms, and income better explains the variation in depressive symptoms than education does. Retirement status was excluded from the final model because it did not show a significant relationship with depressive symptoms. It may be that retirement status does not itself have a relationship with depressive symptoms, rather health that tends to decrease as people age and therefore retire, that has a relationship with depressive symptoms (de Zwart et al., 2017).

In the full model, age was non-significant, but after removing other non-significant variables it was significant in the final model. In the present study, as age increased, the CES-D score decreased, however the coefficient was very small. The large sample size probably played an important role to push the relationship between age and depressive symptoms past statistical significance. For example, a one-year increase in age was associated with a -.02 decrease in the CES-D score. This means that a 40-year increase in age would be associated with a -0.8 decrease in the depressive symptoms score, all other variables held constant. If two caregivers were the same, except one was 45 with a CES-D score of 7 and the other was 55, we'd expect to see the 55-year old's depressive symptoms score at 6.8. The statistical significance of this small difference is likely due to the large sample size rather than a meaningful association. The literature does suggest that depressive disorders are associated with younger age (Meng & D'Arcy, 2014, Meng et al., 2017, Pattern et al., 2006, Regan et al., 2013) although some studies

have found an increase in depression after age 65 (Yang, 2007). Yang explained their positive association between age and depression by deteriorating health that is associated with ageing (2007). The population of the present study reported excellent general health, with 91.28% reporting "good" or better. Any incline in depressive symptoms seen in older populations was not present in the current study. This is reiterated in the cross-tabulations where the distribution above and below the cut-off are almost parallel across age groups.

### 4.6 Strengths and Limitations

The limitations of this study start with the cross-sectional design. The results indicate which factors are associated with depressive symptoms at baseline, but they cannot explain the relationship further; as such no claim to causality has been made. Future work should include using baseline characteristics to predict depressive symptoms later on in informal caregivers.

Another limitation is that participants were part of the comprehensive group in the CLSA, and as such had to live within a 25- to 50-kilometer radius of one of the 11 major academic data collection sites (Raina et al., 2008; Raina et al., 2019). Therefore, the results of this study are not generalizable to those caregivers living in more remote areas of Canada.

The ability of the full model to explain depression scores was relatively low, suggesting that important variables that are associated with depressive symptoms are missing from the model. As mentioned, we were restricted to the variables used by the CLSA. Variables such as care recipient health was not available, and this is possibly a strong predictor of depressive symptoms, because it has been shown to be associated with caregiver distress (Hirdes et al, 2012, Mitchell et al 2015). This could be a key missing component because seeing a loved one with deteriorating health would likely take a larger toll on the caregiver's mental health and would demand more in terms of responsibilities from the caregiver. However, humans are complex as

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are depressive symptoms and cannot be completely accounted for by statistical models which would partially explain the low $r^2$. Depression is known to have a heritability component and having blood relatives with a history with depression or suicide is a known risk factor (APA, p.166, 2013). While this might be difficult information, it may help to better understand depression.

One major strength of this study is the size of the CLSA, both in sample and the number of constructs that were measured. It allowed the current study to include many factors that had previously been found to be important. It also gave the study statistical power to discover any real effects that exist and not leave the researchers wondering if the null results are due to a small sample or because of a real lack of association.

**4.7 Conclusions**

This study provided a detailed description of informal caregivers in Canada, 45 years and older. It also identified factors that were associated with depressive symptoms within the same study population. Over 16% of the participants were above the clinical cut-off for significant depressive disorders. Demographic characteristics such as sex, income, marital status and white versus non-white were associated with depressive symptoms. The caregiver characteristics, hours per week spent caregiving, relationship with care recipient and if the caregiver provided medical care, all were found to be associated with depressive symptoms. The personality traits Extraversion and Neuroticism also were found to have a relationship with depressive symptoms.

These findings highlight characteristics of those with depressive symptoms, which could potentially put an informal caregiver at risk for developing depressive symptoms. Because of the cross-sectional design, it's impossible to distinguish the direction of the relationships. This information should be used as a starting point for further research into causal pathways and

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intervention studies to prevent adverse depressive outcomes in the large important cohort of

informal caregivers.

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**Chapter 5: The relationship between Extraversion, Neuroticism and depressive symptoms**
**5.1 Abstract**

**Background:** Over nine million Canadians provided informal care to a person who needed assistance in 2018. The additional role of caregiving can put the carer at risk of developing adverse mental health outcomes, such as depressive symptoms. Extraversion, a personality trait possessed by people who are typically more outgoing, and Neuroticism, a trait marked by frequent worry, have shown to be important predictors for depressive symptoms although this association is not clear in the informal caregiving population. The objective of this study was to determine the association between Extraversion and Neuroticism at baseline and depressive symptoms at three-year follow-up in informal caregivers, 45 years and older, in Canada.

**Methods:** A prospective cohort study using data from the Canadian Longitudinal Study on Aging was conducted to determine the association between Extraversion and depressive symptoms and Neuroticism and depressive symptoms. Confounding factors were controlled in a multivariable model (age, sex, race, education, total household income, marital status, retirement status, self-perceived general health, caregiver tasks, relationship with care recipient, hours of caregiving per week, number of weeks providing care and the number of caregiver tasks) and were identified based on a change in mean square error between full and reduced model. A Gaussian log link generalized linear model was used for the final analyses.

**Results:** There were 6,812 informal caregivers included in this study. Six hundred caregivers had CES-D 10 score of ten or more at follow-up. High levels of Neuroticism predicted higher levels of depressive symptoms ($\exp^{\beta}$=.018, p=.001). There was significant effect modification by age on the Extraversion and depressive symptoms association, so data were stratified into four

age groups. There was no effect of Extraversion on depressive symptoms in caregivers aged 45-54. In caregivers 55+, Extraversion was a protective factor in the development of depressive symptoms. The effect of Extraversion strengthened at each age increase (55-64: $\exp^\beta$=-.007, p=.014, 65-74: $\exp^\beta$=-.017, p=<.001, 75+: $\exp^\beta$=-.018, p=.001) .

**Conclusion:** The link between Neuroticism and depressive symptomatology has been well established in the general population as well as a variety of subpopulations, including now, informal caregivers. This knowledge should be now translated into support program or intervention studies for informal caregivers. The link between Extraversion and depressive symptoms depends on age and future studies address the age interaction when investigating personality and depressive symptoms in informal caregivers. This finding might explain the mixed results from previous studies.

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**5.2 Introduction**

Over nine million individuals provide informal care to a person who needs assistance in Canada (Canadian Association for Retired Persons, 2014; Sinha, 2013; Statistics Canada, 2020). In 2018, approximately one in four Canadians, aged 15 and older, provided informal care to a family member or a friend (Statistics Canada, 2020). Approximately six million informal caregivers provide care to seniors (CARP, 2014). In fact, informal caregivers provide 70%-80% of senior care in Canada (CARP, 2014; Sinha, 2013). More than half of informal caregivers in Canada are women, and half to three quarters are between the ages of 45-64 (Turner & Findlay, 2012; Sinha, 2013). Approximately half of caregivers reported their parents or parents-in-law as the care recipient, although caregivers were 2.5 times more likely to be caring for their own mother than their father (Sinha, 2013).

Canadians are living longer than ever before, and the current life expectancy is 82.25 years old (Macrotrends, 2020). This represents an increase in life expectancy of about 10 years over the last five decades (Macrotrends, 2020). Older age increases the prevalence of chronic disorders; such as cancers, cardiovascular disease and dementia (Fernandes et al., 2016); which in turn, increase the need for more support and care. Furthermore, 93% of seniors have indicated that they would prefer to stay at home as long as possible (Health Council of Canada, 2012). Home and community health care services are often not covered by provincial health care systems and so care recipients must either purchase private service or rely on unpaid care from family and friends (Lilly, Laporte & Coyte, 2010). As such, the number of individuals who need care and support will grow, as will the need for informal caregivers (Khayatzadeh-Mahani & Leslie, 2018).

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Depression is a common mental illness that negatively impacts thoughts and feelings (The National Institute of Mental Health Information, 2019). According to the Institute for Health Metrics and Evaluation, depressive disorders were the fourth most common health problem to cause disability in Canada (Institute for Health Metrics and Evaluation, 2019). The core diagnostic feature of depression is sadness most of the day or every day and a loss of interest in activities enjoyed (American Psychiatric Association, p.160-161, 2013; Mckeever, Agius & Mohr, 2017; The National Institute of Mental Health Information, 2019). It can also cause sleep disturbances and decreased energy, weight gain or loss, fatigue, feelings of worthlessness and/or guilt, difficulty in concentration, restlessness, physiological symptoms such as aches and pains, headaches, cramps, digestive problems and suicidal ideation (APA, p. 160-161, 2013; Mckeever et al., 2017; The National Institute of Mental Health Information, 2019).

A number of sociodemographic factors have a well-documented relationship with depression. In particular, being female and younger age are risk factors for depression (Meng & D'Arcy, 2014; Meng et al., 2017, Pattern et al., 2006) however there is evidence to suggest older age is a risk factor for depressive symptoms after the age of 65 (Yang, 2007). Environment including negative childhood experiences and stressful life events (APA, p.166, 2013), genetic and physiological factors (such as relatives with major depressive disorder and all other major disorders) (APA, p.166, 2013; Meng et al., 2017) and chronic conditions (Meng & D'Arcy, 2014; Pattern et al., 2006) put the individual at risk of developing major depressive disorders. Other risk factors include relationship status such as being widowed, separated or divorce (Meng et al., 2017, Pattern et al., 2006, Yang, 2007) and lower socioeconomic status (Meng & D'Arcy, 2014; Meng et al., 2017; Pattern et al., 2006; Yang, 2007). There are also reported racial and ethnic differences in the prevalence of depressive disorders, with being white associated with the

incident of major depressive disorder (Meng & D'Arcy, 2014; Meng et al., 2017) although this difference may be inflated by the underdiagnoses of the health care provider for Black Americans compared to white Americans (Bailey, Mokonogho & Kumar, 2019). Depressive symptoms have also demonstrated a relationship with lower levels of education (Chang-Quan, Zheng-Rong, Yong-Hong, Yi-Zhou & Qing-Xiu, 2010; Meng & D'Arcy, 2014; Meng et al., 2017). Retirement status has shown to predict depression in spousal caregivers, although its relationship might be partly explained by the older age and poorer health of retirees compared to those still working (de Zwart, Bakx & van Doorslaer, 2017; Doshi, Cen & Polsky, 2008).

Informal caregiving has an enormous reach and affects many Canadians. While providing support and care to a loved one can bring a sense of accomplishment and giving back, it can also bring tremendous strain to the caregiver (Van der Lee, Bakker, Duivenvoorden, & Dröes, 2014). They often pay expenses out of pocket, including transportation costs and care aids (Health Council of Canada, 2012). Caregivers are at an increased risk of reduced exercise, unhealthy eating habits and increased alcohol consumption (Ysseldyk et al., 2019). The additional stress of caregiving can put caregivers at a higher risk for developing depressive disorders or depressive symptoms than the general population (Bernabeu-Mora, Garcia-Gullamon, Montilla-Herrador, Escolar-Reina, Garcia-Vidal & Medina-Mirapeix, 2016, Hajek & Konig, 2017, Pinquart et al, 2003, Rabia & Miri, 2016, Schulz & Sherwood, 2008, Smith et al., 2011, Van der Lee et al., 2014).

Certain caregiving characteristics may also be associated with depressive symptoms. As the number of hours per week caregiving increases so does the strain on the carer (CARP, 2014). Research has shown that caregiving intensity, or the number of hours per week of caregiving and duration of caregiving can impact depression amongst informal caregivers (Papastavrou,

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Charalambous, Tsangari, & Karaylannis, 2012; Pinquart & Sörensen, 2011). Studies have also reported an increased risk of subjective caregiver burden depending on the relationship with the care recipient. In particular, spousal and child caregivers have been associated with higher subject caregiver burden (Bernabeu et al, 2016; Hirdes et al, 2012). The type of care provided (i.e., financial, transportation etc.) may also impact the caregivers' mental health. For example, if a caregiver is providing personal care, they are likely aiding a recipient in worse health than someone who only provides transportation, and the care recipient's health has been associated with more caregiving distress (Hirdes et al, 2012, Mitchell et al 2015). It is possible that an increase in caregiver tasks could be an indicator of recipient's health and caregiving intensity.

Personality is defined by an individual's thought pattern, affect and behavior (American Psychological Association, 2019). Through refinement of work of previous personality investigators, Robert McCrae and John Costa developed the Five Factor model, which is one of the most widely used theories in personality psychology. Their theory includes five broad traits: Extraversion, Neuroticism, Openness to New Experiences, Conscientiousness and Agreeableness (McCrae & Costa, p. 25, 2003). Each of the Big Five traits is on a continuum with polar ends and individuals fall somewhere between the poles for each of the traits. Individuals high in Neuroticism tend to worry, be temperamental, emotional, self-conscious, vulnerable and experience high levels of self-pity (McCrae & Costa, p. 27, 2003). People high in Extraversion are out-going, passionate, fun-loving, talkative and active (McCrae & Costa, p. 27, 2003).

Neuroticism and Extraversion have shown consistent links with depressive disorders in the literature. Neuroticism has consistently shown a strong positive association with depressive disorders in various populations (Hayward, Taylor, Smoski, Steffens & Payne, 2013; Kotov et al., 2010; Koorevaar et al., 2013, Sadeq & Molinari, 2018) which means that those with patterns

of negative thoughts feelings and behaviours are more at risk for developing depressive symptoms. The negative association between Extraversion and depressive disorders is well understood and those with more outgoing personalities are generally better protected from depressive disorders (Luan et al., 2018; Koorevaar et al., 2013; Kotov, et al., 2010; Sadeq & Molinari, 2018).

In the caregiving population in particular, Neuroticism showed similar results to other populations (Carter & Acton, 2006; Kim, Duberstein, Sörensen, & Larson, 2005; Melo et al., 2011; Nordtug, Krokstad, & Holen, 2011; Ruiz, Matthews, Scheier, & Schulz, 2006; Tew, Naismith, Pereira, & Lewis, 2013; Trujillo, Perrin, Doser, & Norup, 2016) but the results for Extraversion were mixed with some finding a negative association (Kim et al., 2017; Melo et al., 2011) and the others finding null results (Kim et al., 2005). Most of these studies were cross-sectional in nature and the longitudinal studies were performed on very specific caregiver populations, such as spousal caregivers of coronary bypass patients (Ruiz et al., 2006) or family care givers of patients with severe brain injury (Trujillo et al., 2016). Longitudinal studies with large sample sizes have been recommended (Kim et al., 2014; Kim et al., 2005; Lautenschlager et al., 2013; Melo et al., 2011; Möller-Leimkühler & Mädger, 2011; Nordtug et al., 2011; Ruiz et al., 2006; Trujillo et al., 2016; Weaving, Orgeta, Orrell, & Petrides, 2014). Therefore, the objective of this study is to determine the association between Extraversion and Neuroticism at baseline and depressive symptoms at three-year follow-up in informal caregivers, 45 years and older, in Canada. It is hypothesized that, after controlling for other factors, Neuroticism at baseline will be positively associated with depressive symptoms at follow-up, whereas Extraversion will show a negative association with depressive symptoms.

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## 5.3 Methods

### 5.3.1 Study Design

An observational prospective cohort design was used to determine the association

between Neuroticism, Extraversion and depressive symptoms in informal caregivers in Canada.

Analyses were performed on data provided by the Canadian Longitudinal Study on Aging

(CLSA). A proposal for use of the data was accepted by the CLSA. Anonymized data were sent

to the principal investigator. An ethics waiver was obtained from the Lakehead University

Research Ethics Board (see appendix A).

### 5.3.2 Sample Selection

The goal of the CLSA is to help us live longer, healthier lives and uncover reasons why

some individuals age more successfully than others (Raina et al., 2008). The CLSA is a twenty-

year prospective cohort national study of more than 50,000 men and women between the ages of

45 and 85 (at baseline) (Raina, Wolfson, & Kirkland, 2008; Raina et al., 2019). The participants

will be followed until at least 2033, or until death (Raina et al., 2008; Raina et al., 2019).

Recruitment began in 2010, baseline was completed in 2015 and the first follow-up was

completed in 2018 (Raina et al., 2019). The CLSA comprises of two groups; the tracking

assessment group (n=21,000) who provide information over telephone interviews and the

comprehensive assessment group (n=30,000) who provide in-home and telephone interviews, as

well as providing information at data collection sites every three years (Raina et al., 2008). The

CLSA collects information on social and demographic measures, health status, functioning

measures, psychological measures, lifestyles and behavioural measures and health care

utilization.

The study population included individuals in the comprehensive assessment group of the CLSA 2015 baseline and 2018 follow-up data. To be included in the CLSA, participants must be 45 years or older and the participants in the comprehensive group must live within 25 to 50 km radius of one of the 11 major academic centers (Raina et al., 2008; Raina et al., 2019). The comprehensive assessment group completes Main Wave Questionnaire which includes information on social and demographic measures, health status, functioning measures, psychological measures, lifestyles and behavioural measures and health care utilization (Raina et al., 2019). They also complete cognitive measures and these participants also provide physical assessments, including physical function assessments, vision and hearing test, Main Wave Disease Symptoms Questionnaire, neuropsychological battery and blood and urine samples (Raina et al., 2008; Raina et al., 2019). The reason these participants were chosen for this study is because they completed the personality inventory and the tracking assessment group did not.

Participants were excluded if their score on the CES-D 10 at baseline exceeded the cut-off (i.e., 10 or more). Participants were then included if they indicated 'yes' to informal caregiving over the last 12 months in the CLSA at both baseline and follow-up. This left 6,812 informal caregivers who were included in this study.

### 5.3.3 Measures

### 5.3.3.1 Outcome Variable: Symptoms of depression

The outcome of this study was depressive symptoms score at follow-up. The CLSA used the Centre for Epidemiologic Studies Depression scale 10-item scale (CES-D, 2018; Andresen, Malmgren, Carter, & Patrick, 1994). The CES-D is designed for epidemiologic use of depressive symptoms in the general population; it measures depressive symptoms in the past week, with an emphasis on affect and depressed mood (Andreson et al., 1994). The scale includes items on

depressed mood, feelings of guilt and worthlessness, feeling of helplessness and hopelessness, and sleep disturbances (Andreson et al., 1994). The overall scores range from 0-30 and higher scores indicate more depressive symptoms (Andresen et al., 1994). The recommended cutoff score for significant depressive symptoms is ten or more (Andreson et al., 1994). For the multivariable model, the participants' full score was used; however, the cut-off was used for eligibility to this study and to calculate the incidence rate. The CES-D has been validated in older adult populations (Andreson et al., 1994; Irwin, Artin & Oxman, 1999) and has shown good internal consistency ($\alpha$=0.92) (Irwin et al., 1999) and used in caregiving populations (Pinquart & Sörensen , 2003).

**5.3.3.2 Personality Variables**

The CLSA used the Ten-Item Personality Inventory (TIPI) to measure personality following the Five Factor framework. The TIPI measures the five personality domains and was created by Gosling, Rentfrow and Swann (2003) as a brief alternative the traditional measures of the Five Factor model. The scale has demonstrated acceptable test-rest reliability (Gosling, et al., 2003) and convergent validity (Gosling, et al., 2003).

The TIPI contains ten items, two for each of the Big Five personality traits. For each of the five personality traits, one item represents each end of the continuum. All the items begin with "I see myself as" (Gosling et al., 2003), followed by two descriptors. The ten items are measured on a seven-point scale, from 1: disagree strongly, to 7: agree strongly. For example, the items to measure Extraversion include "I see myself as: extraverted, enthusiastic" and "I see myself as: reserved, quiet" (Gosling et al., 2003). The two items for each personality trait are averaged together and each participant receives a score from 1-7 on each of the five personality dimensions. Personality traits are conceptualized as a spectrum with two opposite ends. For

Neuroticism, the TIPI measures its counterpart: Emotional Stability (Gosling et al, 2003). For the sake of consistency throughout this study, the scores of Emotional Stability were reversed to represent Neuroticism. The incidence rate was calculated for depressive symptoms based on high or low scores on the personality variables. In order to achieve this, we had to divide the TIPI variables as well. There were no previous studies to model this, so the scores were divided by the scale's halfway point such that less than four was considered low in a trait and greater than four was considered high in a trait.

### 5.3.3.3 Potential confounding variables

Variables known to have significant associations with depressive symptoms were included in this study. The following *socio-demographic characteristics* were used: age (Kessler et al., 2010; Pattern et al, 2006, Regan, et al., 2013; Yang et al., 2007), sex (APA, p.166, 2013; Meng et al, 2014; Meng et al., 2017), marital status (Meng et al., 2017, Pattern et al., 2006, Yang, 2007), race (Bailey et al., 2019), total household income (Meng & D'Arcy, 2014; Meng et al., 2017; Pattern et al., 2006; Yang, 2007), education (Chang-Quan et al., 2010; Meng & D'Arcy, 2014; Meng et al., 2017), and retirement status (de Zwart et al., 2017; Doshi et al., 2008).

*Age* was measured in years, and *sex* was measured by asking the participant if they were male or female. *Marital status* was obtained from the variable "SDC_MRTL_COM" and the possible responses were 1) Single, never married or never lived with a partner 2) Married/Living with a partner in a common-law relationship 3) Widowed 4) Divorced 5) Separated. To measure *race*, we originally used the variable "SDC_DCGT_COM" which refers to participants cultural and racial background. There 14 possible responses; however, because of the overwhelming majority of people who indicated they were white, the other cells were very small. Instead of

looking at race for the bivariable and multivariable analyses, it was decided it would be more statistically appropriate to investigate white vs non-white for the bivariable and multivariable analyses. *Total household income* was measured by the CLSA variable "INC_TOT_COM" and the possible responses were 1) less than $20,000 2)$20,000-49,999 3)$50,000-99,999 4)$100,000-149,999 or 5)$150,000 or greater. Three *education* variables from the CLSA data ("ED_ELHS_COM", "ED_HSGR_COM"  and "ED_HIGH_COM") were combined to create the education variable used in the present study. The CLSA questionnaire asks participants what the highest grade of elementary or high school they had completed ("ED_ELHS_COM"). They then asked if the participant had received any other education that could be counted towards a degree ("ED_HSGR_COM"). If the participant answered "yes", they would be asked the highest degree, certificate or diploma they had obtained ("ED_HIGH_COM"). If they answered "no", the highest degree/certificate/diploma question was skipped. These three items were combined to include all educational information in one variable and avoid missing data because of the CLSA skip pattern. For *retirement status*, the variable "RET_RTRD_COM" was used and there were three possible answers: 1) Completely Retired 2) Partly Retired and 3) Not retired.

The *self-reported health of the caregiver* was also included as a potential confounder (Fekete et al., 2017). This was measured using the variable "GEN_HLTH_COM" (CLSA, 2018), which asked, "in general, would you say your health is… 1) Excellent 2) Very good 3) Good 4) Fair and 5) Poor."

*Characteristics of caregiving* were also considered, including relationship with care recipient (Bernabeu et al, 2016, Hirdes et al, 2012), type of care provided, hours per week of care (Ysseldyk, Kuran, Powell & Villeneuve, 2019), total number of tasks, and duration of caregiving (Papastavrou et al., 2012; Pinquart & Sörensen, 2011).

The caregiver's *relationship to the care recipient* was measured by "CAG_RELN_COM" and the possible answers included husband/wife, common-low partner, parent, child, sibling, grandchild, father-in-law/mother-in-law, son-in-law/daughter-in-law, brother-in-law/sister-in-law, other relative and friend/neighbour/other. There were seven *type caregiving* variables, including personal care, medical care, managing care such as making appointments, household care such as home maintenance, transportation, meal preparation and other. Responses to these seven variables was yes/no. *Hours per week* was categorized from the CLSA variable "CAG_HRWK_NB_COM", because of the non-linear relationship exhibited with the CES-D score. The categories are less than seven hours, 7-21 hours, 21-48 hours, 48-96 hours and 96+ hours per week (Ysseldyk et al., 2019). *Total number of tasks* was created by adding the number of yes responses to the caregiving duties variables and responses range from 0-7. The *number of weeks caregiving* was measured by the number of weeks in the past 12 months they provided assistance "CAG_WEEK_NB_COM".

**5.3.4 Statistical Analysis**

All data were analyzed using STATA software, version 16.

**5.3.4.1 Descriptive Analysis**

Univariable frequency distributions were used to report baseline age, sex, household income, race, education, retirement status, marital status, relationship with care recipient, caregiving tasks and self-rated health. Means, standard deviations and medians were reported for age, the TIPI variables, number of caregiving hours per week, duration of caregiving, number of caregiving tasks and the CES-D score. Next, simple linear regression models were used to examine bivariate associations between the main predictors and the baseline covariates and the

CES-D score at follow-up. We also calculated the cumulative incidence rate for informal

caregivers ten or above and below ten, the recommended cut-off of the CES-D scale. This was

done to take advantage of the prospective cohort design as well as support any findings from the

multivariable analysis.

**5.3.4.2 Multivariable linear regression**

Multivariable linear regression models were used to examine the association between the

two personality variables at baseline and depressive symptoms in informal caregivers at follow-

up while controlling for important confounding variables. The modelling process followed

guidelines presented by Greenland, Daniel and Pearce (2016). Two separate models were run;

one for Neuroticism as the main exposure and the other with Extraversion as the main exposure.

Sex and age were forced into the model as these variables are suggested to always be included in

the final model (Greenland et al., 2016). The remainder of the potential confounding variables

were considered non-forced variables. Because the data set is large and unlikely to have issues

with data sparsity, a backward stepwise approach was used (Greenland et al., 2016).

Next, the possibility of effect modifiers was considered in each model. Neuroticism*age,

Neuroticism*sex and Neuroticism*caregiving hours per week were examined in the Neuroticism

model and Extraversion*age, Extraversion*sex and Extraversion*caregiving hours per week

were tested in the Extraversion model. Age by personality effects were tested because as a

person ages, they're more likely to suffer from health ailments or lose autonomy. Extraversion

might be more of an important protective factor for depressive symptoms as a person ages

because they have fewer preventative faculties in place. For Neuroticism the exact opposite

effect might be true for the same reasons. The caregiving hours*personality effect modifiers

were included because if Neuroticism is high and the amount of caregiving hours are low, the

caregiver role may offer the individual a sense of accomplishment and giving back and have a protective influence on depressive symptoms. As the hours increase, those high in Neuroticism might become overwhelmed with added responsibilities, and higher Neuroticism would predict higher levels of depressive symptoms. The same scenario might be true for individuals low in Extraversion. We tested if sex changed the association between the personality traits and depressive symptoms because males and females have been shown to manifest depression differently (Martin, Neighbors & Griffith, 2013) and they might also experience Extraversion and Neuroticism differently. For example, women score higher in the facets such as low self-esteem and anxiety of Neuroticism while men score higher in anger or anger hostility (Costa et al., 2001). Similarly, women score higher in warmth and gregariousness facets of Extraversion, while men score higher in assertiveness and excitement seeking (Costa et al., 2001).

Next, the models were run with the exposure, forced and non-forced variables. These were considered the full models. The models were rerun with each of the non-forced variables excluded. For each iteration, $\Delta MSE = (\beta_{reduced} - \beta_{current})^2 - (SE_{current}^2 - SE_{recduced}^2)$ was calculated. Any covariate with $\Delta MSE < 0$ was dropped and this process continued until there were no unforced variables with $\Delta MSE < 0$. These steps produced the final models (Greenland et al., 2016).

**5.3.4.3 Model diagnostics**

Multivariable linear regression has several assumptions that must be met: linear relationship, multivariable normality, no multicollinearity and homoscedasticity. Scatterplots were used to examine the linearity (or curvilinearity) of the relationship between the outcome variable and independent variables. Histograms, Q-Q plots and the Shapiro-Wilks test (Shapiro & Wilk, 1965) were used to examine the distribution of residuals. Following the methodology

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for confounder selection described by Greenland et al., (2016) decreased the possibility of

breaking the assumption related to multicollinearity, though this was also tested by looking at

Variance Inflation Factors; any VIF over ten would indicate collinearity in the model (Hair,

Anderson, Tatham & Black, 1995). Finally, homoscedasticity was examined by plotting the

standardized residuals versus predicted values to show whether points are equally distributed

across all values of the independent variables. In the event that any assumptions were violated,

we addressed them with a more robust approach. For example, a generalized linear model with a

log link would be used to account for the lack of normality of residuals.


## 5.4 Results

Based on the inclusion criteria, 6,812 participants from the CLSA Comprehensive

Assessment group were eligible for this study. See tables 1 and 2 for univariate results. The

group had a mean Neuroticism score of 2.01 (considered low in this study) and an Extraversion

score of 4.53 (considered high in this study). Their average CES-D 10 sore was 4.28, which is

well-below the cut-off of 10. The average age of the study population was 61.47 years and

females represented over half this population (55.86%). The vast majority, 92.38%, reported

being White, and over half of the study population had a Bachelor's degree or above. The most

common income bracket was $50,000-99-999 (35.31%) and they reported their general health

positively with 94.78% of participants indicating good or above general health. The majority

were married (73.75%) and 46.98% were not retired while 40.24% were completely retired. As

for the caregiving characteristics, on average they provided 12.67 hours per week of caregiving

and they had been caregivers for 27.35 weeks prior to baseline data collection, on average. The

most frequent relationship with care recipient was taking care of their parent (35.75%). They

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performed on average, 2.74 different caregiving tasks with transportation (77.11%), assistance

with activities (57.13%) and managing care (39.02%) being the most frequently reported tasks.

The cumulative incidence rate for the significant depressive symptoms cutoff in those in

the scoring higher half of Neuroticism was 0.20 and 0.07 for those in the lower half; this

difference was statistically significant ($x^2$=162.33, p<0.01). The cumulative incidence rate for the

significant depressive symptoms cutoff, in those scoring at the top of the Extraversion scale was

0.08 and 0.11 for those in the lower half; this difference was statistically significant ($x^2$=15.70,

p<0.01).

Table 7. *Descriptive results of continuous variables of CLSA Comprehensive Group at baseline, 2015, and CES-D 10 item score at follow-up, 2018 (N=6,812)*

| Variable | Min/Max | Mean (SD) | Don't Know | Refused |
|---|---|---|---|---|
| Neuroticism | 1/7 | 2.01 (1.24) | 28 | - |
| Extraversion | 1/7 | 4.53 (1.79) | 51 | - |
| Age | 45/86 | 61.47 (9.46) | | - |
| Hours of caregiving per week | 1/168 | 12.67 (23.76) | | - |
| Number of weeks providing care | 1/52 | 27.35 (21.15) | 73 | 1 |
| Total number of tasks | 0/7 | 2.74 (1.63) | - | - |
| CES-D 10 | 0/30 | 4.28 (3.73) | - | - |

Table 8. *Descriptive results of categorical variables of CLSA Comprehensive Group at baseline, 2015 (N=6,812)*

| Variable | N (%) |
|---|---|
| Age Category | |
| 45-54 | 1,856 (27.25%) |
| 55-64 | 2, 636 (38.70%) |

| | | |
|---|---|---|
| | 65-74 | 1, 474 (21.64%) |
| | 75+ | 846 (12.42%) |

**Sex**

| | | |
|---|---|---|
| | Female | 3, 805 (55.86%) |
| | Male | 3, 007 (44.14%) |

**Race**

| | | |
|---|---|---|
| | white | 6, 293 (92.38%) |
| | Non-white | 469 (6.89%) |

**Education**

| | | |
|---|---|---|
| | No High School | 213 (3.13%) |
| | No post-secondary degree, certificate or diploma | 1, 038 (15.24%) |
| | Trade certificate or diploma from a vocational school or apprenticeship training | 616 (9.04%) |
| | Non-university certificate or diploma from community college, CEGEP, school of nursing etc. | 1, 230 (18.06%) |
| | University certificate below bachelor's level | 274 (4.02%) |
| | Bachelor's degree | 1, 788 (26.25%) |
| | University degree or certificate above bachelor's degree | 1, 653 (24.27%) |

**Total Household income**

| | | |
|---|---|---|
| | <20,000$ | 215 (3.16%) |
| | 20,000-49,999 | 1, 128 (16.56%) |
| | 50,000-99,999 | 2, 405 (35.31%) |
| | 100,000-149,999 | 1, 479 (21.71%) |
| | >150,000 | 1, 264 (18.56%) |
| | Don't Know | 112 (1.64%) |
| | Refused | 209 (3.07%) |

**Marital Status**

| | | |
|---|---|---|
| | Single, never married or never lived with a partner | 559 (8.21%) |
| | Married/Living with a partner in common-law relationship | 5,024 (73.75%) |
| | Widowed | 449 (6.59%) |
| | Divorced | 637 (9.35%) |
| | Separated | 140 (2.06%) |
| | Refused | 3 (0.04%) |

**Retirement Status**

| | | |
|---|---|---|
| | Completely Retired | 2, 741 (40.24%) |
| | Partially Retired | 851 (12.49%) |
| | Not Retired | 3,200 (46.98%) |
| | Don't Know | 19 (0.28%) |
| | Refusal | 1 (0.01%) |

**General Health**

| | | |
|---|---|---|
| | Excellent | 1, 590 (23.34%) |
| | Very Good | 3, 063 (44.96%) |
| | Good | 1, 804 (26.48%) |

|  |  |
|---|---|
| Fair | 315 (4.62%) |
| Poor | 39 (0.57%) |
| Don't Know | 1 (0.01%) |
| **Relationship with care recipient** |  |
|  |  |
| Husband/Wife | 979 (14.37%) |
| Common-Law Partner | 65 (0.95%) |
| Parent | 2, 435 (35.75%) |
| Child | 424 (6.22%) |
| Sibling | 328 (4.82%) |
| Grandchild | 26 (0.38%) |
| Father-in-law/mother in law | 605 (8.88%) |
| Son-in-law/daughter-in-law | 20 (0.29%) |
| Brother-in-law/sister-in-law | 114 (1.67%) |
| Other relative | 264 (3.88%) |
| Friend, neighbor, other | 1, 545 (22.68%) |
| Don't Know | 7 (0.10%) |
| **Care giving task** |  |
|  |  |
| Provided personal care | 1, 934 (28.29%) |
| Medical Care | 1, 795 (26.35%) |
| Managing Care | 2, 658 (39.02%) |
| Assistance with Activities | 3, 892 (57.13%) |
| Transportation | 5, 253 (77.11%) |
| Meal Preparation | 2, 997 (44.00%) |
| Other | 109 (1.60%) |
| **Hours per week caregiving** |  |
|  |  |
| >7 | 4, 611 (67.69%) |
| 8-21 | 1, 306 (19/17%) |
| 22-48 | 447 (6.56%) |
| 49-96 | 230 (3.38%) |
| >96 | 218 (3.20%) |

Next, a bivariate analysis was run using a simple linear regression of the exposure variables and potential confounders at baseline and CES-D 10 score at follow up (table 3). Higher levels of Neuroticism predicted higher levels of depressive symptoms, while higher Extraversion was associated with lower levels of depressive symptoms.

Table 9. *Simple Linear Regression results regressing CES-D scores at 2018 follow-up on 2015 baseline exposure and potential confounding variables using the CLSA comprehensive data*

| Variables | Coefficient | Std. Err | P>[t] | 95% CI |
|---|---|---|---|---|
| Neuroticism | **.84** | **.04** | **<.01** | **.77, .91** |

| | | | | |
|---|---|---|---|---|
| Extraversion | **-.22** | **.03** | **<.01** | **-.27, -.17** |
| Age | **.02** | **.00** | **.04** | **.00, .01** |
| Sex (Ref: Female) | **-.72** | **.09** | **<.01** | **-.90, -.54** |
| Total Household Income | | | | |
| <20,000 | 0.0 | - | - | - |
| 20,000-49,999 | **-.71** | **.28** | **<.01** | **-1.25, -.17** |
| 50,000-99,999 | **-1.20** | **.26** | **<.01** | **-1.72, -.68** |
| 100,000-149,999 | **-1.74** | **.27** | **<.01** | **-2.27, -1.21** |
| >150,000 | **-1.73** | **.27** | **<.01** | **-2.27, -1.19** |
| white | 0.0 | - | - | - |
| Non-white | .07 | .19 | .68 | -.27, .42 |
| Marital Status | | | | |
| Single | 0.0 | - | - | - |
| Married/Living with a partner in common-law relationship | **-.73** | **.17** | **<.01** | **-1.06, -41** |
| Widowed | **-.26** | **.24** | **.27** | **-.72, .20** |
| Divorced | -.08 | .22 | .72 | -.50, .35 |
| Separated | -.52 | .35 | .14 | -1.21, .17 |
| Education | | | | |
| No high school leaving | 0.0 | - | - | - |
| High school | -.26 | .28 | .34 | -.81, .28 |
| Trade School | -.28 | .30 | .34 | -.86, .30 |
| Non-university diploma or certificate | -.35 | .28 | .20 | -.89, .19 |
| University certificate below bachelor's | **-.71** | **.34** | **.04** | **-1.37, -.04** |
| Bachelor's degree | **-.80** | **.27** | **<.01** | **-1.33, -.27** |
| University degree or certificate above bachelor's degree | **-.88** | **.27** | **<.01** | **-1.41, -.35** |
| Retirement Status | | | | |
| Completely Retired | 0.0 | **-** | **-** | **-** |
| Partially Retired | **-.33** | **.15** | **.02** | **-.62, -.05** |
| Not Retired | .04 | .10 | .72 | -.15, .23 |
| General Health | **1.00** | **.05** | **<.01** | **.90, 1.10** |
| Hours Per Week Caregiving | | | | |
| <7 | 0.0 | - | - | - |
| 8-21 | .18 | .12 | .13 | -.05, .41 |
| 22.48 | .22 | .18 | .23 | -.14, .58 |
| 49-96 | .49 | .25 | .05 | -.01, .98 |
| 96+ | **1.01** | **.26** | **<.01** | **.55, 1.56** |
| Number of weeks caregiving | **.01** | **.01** | **<.01** | **.00, .01** |
| Relationship with care recipient | | | | |
| Husband/Wife | 0.0 | **-** | **-** | **-** |
| Common-Law Partner | .13 | .48 | .79 | -.81, 1.06 |
| Parent | **-.31** | **.14** | **.03** | **-.58, -.03** |
| Child | -.16 | .22 | .45 | -.59, .26 |
| Sibling | **-.49** | **.24** | **.04** | **-.96, -.03** |

| | | | | |
|---|---|---|---|---|
| Grandchild | .48 | .74 | .52 | -.97, 1.93 |
| Father-in-law/Mother-in-law | **-1.00** | **.19** | **<.01** | **-1.37, -.62** |
| Son-in-law/Daughter-in-law | -.70 | .84 | .41 | -2.34, .95 |
| Brother-in-law/sister-in-law | **-1.10** | **.37** | **<.01** | **-1.83, -.34** |
| Other Relative | **-.85** | **.26** | **<.01** | **-1.36, -.34** |
| Friend, neighbor, other | -.13 | .15 | .38 | -.43, .16 |
| | | | | |
| Quantity of Tasks | **.07** | **.03** | **.02** | **.01, .12** |
| Provided Personal Care | **.31** | **.10** | **.02** | **.11, .50** |
| Provided Medical Care | **.28** | **.10** | **<.01** | **.07, .48** |
| Provided Managing Care | .13 | /09 | .15 | -.05, .31 |
| Provided Assistance with Activities | -.16 | .09 | .08 | -.34, .02 |
| Provided Transportation | .06 | .11 | .56 | -.15, .27 |
| Provided Meal Preparation | **.22** | **.09** | **.02** | **.04, .40** |
| Provided Other types of care | .09 | .36 | .81 | -.62,.79 |

## 5.4.1 Multivariable Model: Extraversion

There was a significant modifying effect of age in years on the association between Extraversion and depressive symptoms, so the main effect of Extraversion was no longer interpretable. Instead the study population was stratified by the preexisting age group categories (CLSA, 2018), and separate models were run for each of the four age categories. The categories included 45-54, 55-64, 65-74 and 75+ year of age. None of the other interaction terms were significant. For the remaining confounders, a backwards stepwise method, proposed by Greenland et al., 2016 was used to decide which covariates would stay in the final model. All potential confounders were included in all four Extraversion models. See appendix B for a table of the results of the Greenland approach.

## 5.4.2 Multivariable Model: Neuroticism

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There were no significant effect modifiers in the Neuroticism model. The same Greenland et al., (2016) approach was used to identify potential covariates to include in the final model as the Extraversion models. None of the confounders increase the mean square error, so they were all included in the final Neuroticism model.

### 5.4.3 Model Diagnostics

The linear model was not a good fit for the data. See appendix C for graphical diagnostics of the ordinary least square regression. For the four Extraversion groups a Shapiro-Wilks test was used to test the normality of the residuals. All four were significant and, hence, violated the assumption of normally distributed residuals. Neuroticism had too many observations Shapiro-Wilks test, because the test is not appropriate for dataset with over 4000 observations, however a visual examination of the residuals graphs resulted in the same finding. Instead of an ordinary least squares regression, a generalized linear model was used because of its robustness. Three different families were compared; Gaussian, Gamma and inverse-Gaussian families. Based on the AIC values, the Gaussian family performed the best and within the Gaussian family, a log link was best suited for the data (Hardin & Hilbe, 2018).

To verify the response on the main predictor did not influence the variance of the residuals, Extraversion and Pearson's residuals were plotted (Hardin & Hilbe, 2018) (see appendix D, graph 1). The outlying points with a Pearson residual were identified. They both had very high depressive symptoms score (26, 27) and were both male. Their Extraversion scores were 3 and 6.5 and so were their Neuroticism scores. They were real scores so there was no justification to remove them from the model. Appendix D, graph 2 displays the Pearson residual versus the fitted values. Overall, the data look randomly distributed. Graph 3 in appendix D

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displays the distribution of the residuals with acceptable normality. The same methods were used

for the following four models with the same conclusions. See Appendix D graphs 4-15.

Table 10. *Final results from the Generalized Linear Models of the personality trait of informal caregivers at CLSA 2015 baseline in each model and their CES-D 10 score as outcome at 2018 follow-up*

| Main Effect | Coefficient | Exp(β) | Std. Err | P-value | 95% CI |
|---|---|---|---|---|---|
| Extraversion Group 1 Ages 45-54 | -.006 | .994 | .003 | .099 | -.012, .001 |
| **Extraversion Group 2 Ages 55-64** | **-.007** | **.993** | **.003** | **.014** | **-.012, -.001** |
| **Extraversion Group 3 Ages 65-74** | **-.017** | **.983** | **.002** | **<.001** | **-.025, -.010** |
| **Extraversion Group 4 75+** | **-.018** | **.982** | **.005** | **.001** | **-.029, -.007** |
| **Neuroticism** | **.049** | **1.05** | **.002** | **<.001** | **.045, .053** |

*Bold indicate significance at p=.05. All models controlled for sex, caregiving task, the number of weeks caregiving, hours per week of caregiving, total household income, education, marital status, general health, retirement status, white versus non-white, relationship with care recipient and quantity of tasks. The four Extraversion models included Neuroticism and the Neuroticism model controlled for Extraversion and age.

Overall, Extraversion was a significant predictor of depressive symptoms for people aged

55+ after controlling for sex, Neuroticism, caregiving task, the number of weeks caregiving,

hours per week of caregiving, total household income, education, marital status, general health,

retirement status, white versus non-white, relationship with care recipient and quantity of tasks.

Those with higher Extraversion scores generally scored lower on the CES-D 10 score as

hypothesized. It showed no effect in those aged 45-54. Neuroticism was a significant predictor

for depressive symptoms for all study participants after controlling for sex, age, Extraversion,

caregiving task, the number of weeks caregiving, hours per week of caregiving, total household

income, education, marital status, general health, retirement status, white versus non-white,

relationship with care recipient and quantity of tasks.

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**5.5 Discussion**

The objective of this study was to determine the association between personality traits at baseline and depressive symptoms at three-year follow-up in informal caregivers, 45 years and older, in Canada. A number of demographic and caregiving variables were included in the analysis in order to control for their confounding effects.

The results for Neuroticism were as hypothesized, and present across the study sample. As Neuroticism increased, so did depressive symptoms after controlling for several confounders. For example, if one individual from this study scored five on the Neuroticism scale and another scored three, we'd expect to see the person with the five score 1.39 higher on the CES-D score, all other variables held constant. This translates to approximately 0.70 increase in the CES-D score for every unit increase in the Neuroticism score. Intuitively, this makes sense. If a person is inclined towards negative thoughts and emotions, they would likely have a predisposition towards depressive symptoms. Informal caregivers who are high in Neuroticism might be at an increased risk for developing depressive symptoms because caregiving is associated with additional stress (Vitaliano et al, 2003) and stress is a risk factor for depressive disorders (APA, p.158, 2013; Meng & D'Arcy, 2014; Meng et al., 2017, Pattern et al., 2006; Regan et al., 2013) and therefore symptoms.

Previous cohort studies on Neuroticism and depressive symptoms/depressive disorders in informal caregivers are limited. In a 2-year cohort study, Neuroticism was a significant negative predictor of psychological well-being (Möller-Leimkühler & Mädger, 2011). The study included 64 German family caregivers of in-patients diagnosed with schizophrenia or depression and the sample consisted of caregiver spouses of the patients (Möller-Leimkühler & Mädger, 2011). An 18-month cohort study examined 97 caregivers whose husbands were bypass patients (Ruiz et

al., 2006). Depressive symptoms were assessed using the CES-D and the authors found Neuroticism to be a predictor of depressive symptoms at 18 months. This study found effect sizes of B=0.75 or 1.05, on the CES-D 20 scale, depending on the model (Ruiz et al., 2006). Their coefficients were slightly larger than the current study, however the CES-D 20 item scale ranges from 0-60, so the coefficient of the present study found a comparable association between Neuroticism and depressive symptoms. In a study of 52 caregivers of severe brain injury patients, Neuroticism again was a significant predictor of depression assessed by the Symptom Checklist 90 depression subscale (Trujillo et al., 2016). The cofficient they found was .14 (p=.006) on a scale that ranges from 0-4. It is difficult to compared effect estimates from different scaling, however the coefficients from Trujillo et al., (2016), Ruiz et al., (2006) and the current study all suggest an important relationship between Neuroticism and depressive symptoms. Together they indicate that the results from this study are not just the consequence of a large sample size.

Although the results are less reveared than cohort studies, several cross-sectional findings support the claims of the longitudinal studies on the relationship between Neuroticism and depressive symptoms (Carter & Acton, 2006; Kim et al., 2017; Kim, et al., 2005; Melo et al., 2011). The present study confirms the findings that Neuroticism is associated with increased depressive symptoms, but also extends them to a more general caregiver population. Previous cohort studies were highly specific in the type of injury/illness of the care recipient and this study uses a much broader scope of care recipients. One of the two longitudinal studies examined specifically spousal caregivers (Ruiz et al., 2006). This is important to point out because past studies have found spousal caregivers to be at increased risk of distress compared to other relational caregivers (with the exception of child) (Bernabeu et al, 2016, Hirdes et al, 2012). This

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means the impact of their findings between Neuroticism and depressive disorders are not extendable to populations outside spousal caregivers. The findings of the current study can be applied to a much more general type of caregiver than previous studies. It also uses a larger sample which means the results are less likely due to chance (type II error) and we can be more confident that there is a true effect of Neuroticism on depressive symptoms. Because of the cohort design, the results of the current study strongly suggest Neuroticism predicts future depressive symptoms in informal caregivers in Canada. Based on the incidence rate of those with high versus low Neuroticism scores this study found people high in Neuroticism to be 191% increased risk of developing clinical depressive symptoms, compared to people low in Neuroticism. The findings of this study, together with the body of literature surrounding Neuroticism and depressive symptoms, highlights that intervention studies or policies supporting informal caregivers should consider this personality trait.

In this study, Extraversion was found to be a protective factor for depressive symptoms for caregivers 55 and older. For those in the age group 55-64, a one-point increase in Extraversion would decrease the CES-D 10 score by .08. A one-point increase in Extraversion would decrease the CES-D score by .23 for those in the 65-74 age group, and .24 for those 75+. Extraversion showed no effect in caregivers aged 45-54. The findings for the effect of Extraversion were mixed in the literature. Cross-sectional studies have found Extraversion to be negatively associated with depression in informal caregivers (Kim et al., 2017; & Melo et al., 2011) while other cross-sectional studies found null results (Kim et al., 2005). Other studies have shown high levels of Extraversion to be associated with low levels of adverse mental outcomes, such as caregiver burden (Kim et al., 2014). No longitudinal studies on Extraversion and depressive symptoms or disorders among informal caregivers were identified. The present

studied showed an interaction effect of age on the association between Extraversion and depressive symptoms. This means that the effect of Extraversion on depressive symptoms depends on age in informal caregivers. This result could also explain why the findings in previous literature were mixed. If the studies didn't stratify by age, they would get mixed effects that might mask important associations. This also means that future research into informal caregivers and depressive symptoms and personality must look at possible interaction effects in their data and adjust their analyses accordingly.

In caregivers aged 45-54, Extraversion at baseline showed no effect on depressive symptoms at follow-up. At 55+, an increase in Extraversion was a protective factor for developing depressive symptoms, so that a one-unit increase in Extraversion decreased depressive symptoms score by .08. As the age category increased, Extraversion had a larger influence on the CES-D scores so that a one-unit increase in Extraversion decreased the CES-D 10 score by .23 and .24 in the age groups 65-74 ad 75+ respectively. There has been evidence to suggest a decline in Extraversion between 30-50 years old. This means the first group would still be in this period of decline (Costa & McCrae, 1994). Literature has also found younger age to be a risk factor for depressive symptoms (Kessler et al., 2010, Pattern et al, 2006, Regan et al., 2013), although other studies have found an increase in depression in late life (Yang, 2007). The scores in the present study reiterate these findings. The youngest age category had significantly higher CES-D scores than the two middle age categories, whereas the oldest age category (75+), had the highest CES-D mean. The combination of the decline in Extraversion in the earliest age category and the change in depressive symptoms could explain the interaction effect found in our sample. Another explanation could be that those who are in the younger age category have more protective features against depressive symptoms in place. They are generally healthier, and

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they'd be more likely to be working so they would have larger resources. Maybe Extraversion has more of an impact when there are fewer protective factors available, as in when someone ages.

Past studies on Extraversion and depressive symptoms in informal caregivers have been cross-sectional in design. Their findings must be interpreted with caution. Likewise, the findings of this study should be interpreted with the strengths of the design. Caregivers who scored 10 or over on the CES-D scale were excluded at baseline so the primary exposure measures predate the outcome. Because of this we were able to calculate the incidence rates of depressive symptoms in those high versus low in Extraversion. The risk ratio for developing depressive symptoms for those high in Extraversion aged 45-54 years old was 0.89, compared to being low in Extraversion but this was non-significant ($x^2$=0.60, p=0.438). In the 55-64 category, those high in Extraversion had a 27% reduction in risk of developing significant depressive symptoms, compared to those low in Extraversion ($x^2$=4.48, p=0.034). In the 65-74 age group, those high in Extraversion had 0.68 times the risk compare to those low and finally, caregivers 75+ had 43% reduction in risk for developing significant depressive symptoms, compared to those who were low Extraversion ($x^2$=9.67 p<0.002).

The Extraversion coefficients of this study are very small and there is a chance that their significance is due to the sample. For example, if someone between 55 and 64 scored one on Extraversion and another person in the same age group score seven, and all other variables held constant, the difference between their CES-D scores would be 0.59. That is miniscule change that is statistically significant but probably not meaningful and a consequence of the large sample size. As the age increases the change increases as well so that in the same scenario, but with caregivers 75 years and older, the difference between one and seven on the Extraversion score

would reflect a 1.42 change in the CES-D score. This result, coupled with the risk ratio for this age group, does indicate real world implications of this study's findings and strengthens evidence for an age by Extraversion effect modification. Similar conclusions can be drawn with the 65-74 year-old age group, as the coefficient for this age group was very similar to 75+.

## 5.6 Strengths and Limitations

### 5.6.1 Limitations

This study was limited by the variables available from the CLSA and as such, the analysis was unable to control for certain constructs that may have been important. For example, there was not much information provided on the care recipient aside from the relationship they have with the caregiver. Care recipient worsening health has been shown to increase caregiver stress (Hirdes et al, 2012, Mitchell et al 2015). The type of care that the caregiver provided was used as a proxy; however, having a more direct conceptualization of care recipient health would have given the study better insight into the effect it has on depressive symptoms in informal caregivers.

The CLSA aims to assess a multitude of characteristics so they often use short questionnaires for each construct. Instrument quality can threaten internal validity and there are times where shorter questionnaires sacrifice quality for conciseness. They used the TIPI to measure personality which is a 10-item instrument that uses two items to evaluate each personality trait. As such, it is not as thorough as other personality questionnaires such as the BFI or the NEO-FFI although the TIPI has demonstrated reasonable reliability and validity (Gosling et al., 2003).

The same is true of the outcome measure. The CLSA used the CES-D 10 item scale to assess the participants' depressive score. The 10 item is the condensed version of the CES-D 20 item scale and some studies have shown that the positively worded items in the CES-D 10 scale may not perform as well in caregiver populations. In one study comparing the two CES-D scales, the authors found that the item "hopeful about the future" was not acceptable based on a Rasch analysis (Andreson et al., 2013), in the 10-item version. The authors hypothesized that those who are taking care of more impaired recipients are likely to have less hopeful outlook of their future in the context of their caregiving role (Andreson et al., 2013). This doesn't necessarily indicate that they are at higher risk of depressive symptoms. However, they also mention positive worded items might be beneficial for tracking changes in depressive symptoms over time, and as the CLSA is set to continue, this may prove beneficial for future studies (Andreson et al., 2013). Furthermore, the CES-D 10 has been validated in older populations (Andreson et al., 1994; Lewinsohn, Seeley, Robert & Allen, 1997) and caregiving populations (Pinquart et al., 2003). Another issue with the CES-D 10 is that it asks participants to report on the last week; however, the data collection waves occur every three years. Any variation in depressive symptoms over the three-year period would be missed.

The current study does not have much information about the caregiving status in the three years between baseline and follow-up. To be included in this study, the participants had to indicate that they were providing informal care in the 12 months preceding both baseline and follow-up data collections. However, the caregivers could have provided informal care in the last 12 months prior to baseline then stopped caregiving immediately following baseline and then resumed caregiving in the months before follow-up. Or they could have been caregiving throughout the three years between assessments. Or they could have been caregiving on and off.

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Either way, they would have been considered eligible for the current study and it is possible that the different caregiving status could have an effect on the outcome score but was uncontrolled for by this study, although this was minimized as much as possible by only including those who answered yes to caregiving at both baseline and follow-up.

Finally, generalizability of these findings does not extend to remote caregivers. Because the participants were part of the comprehensive assessment group, the had to live a maximum of 25 km or 50 km, depending on geographic region, to an assessment center. That means very rural or remote caregivers would not be captured by this study.

### 5.6.2 Strengths

One major strength of this study is due to the size of the CLSA, both in sample and the number of constructs that were measured. It allowed the current study to control for many possible confounders that had been mentioned by previous studies. It also provided enough statistical power to avoid any Type II errors. Another strength of this study was the prospective cohort design. We were able to exclude those with clinical depressive symptoms at baseline. This allowed us to only capture new cases at follow-up and therefore be more confident that personality and caregiving played a role in the development of depressive symptoms.

### 5.7 Implications

The knowledge around Neuroticism and its effect on depressive disorders in the informal caregiver population is fairly static and at this point should be turned into applied knowledge. This could be done through intervention studies, targeting those who were high in Neuroticism and therefore at risk for developing depressive symptoms. This information could also be disseminated to the caregiving population so caregivers can be aware of their own vulnerability.

This study also adds to the knowledge around Extraversion and depressive symptoms. To our understanding, the effect modification between age and Extraversion was a novel finding in the caregiving population and may help explain past contradictory findings. Future study should look further into this finding to see if it is replicated in other caregiver populations. Future research could also extend the findings and see if the Extraversion by age effect is recorded in other populations and if the effect modification can be better explained.

**5.8 Conclusion**

High levels of Neuroticism at baseline increased the development of depressive symptoms at follow-up. The link between Extraversion at baseline and depressive symptoms at follow-up depended on age. Extraversion in those who were 45-54 showed no effect on follow-up CES-D scores. After 54, high levels of Extraversion decreased depressive symptoms in informal caregivers and the influence of Extraversion on depressive symptoms increased with each additional age category. The coefficient for Extraversion in the 55-64 age category was very small and had little impact on the CES-D 10 score even though it was statistically significant. This finding might be the consequence of a large sample size instead of a clinically meaningful finding. The association between Neuroticism and depressive symptoms is well established and has been demonstrated in the informal caregiving population. At this point, future studies should explore possible methods to apply this knowledge, including intervention studies and support programs to help individuals based on their level of Neuroticism.

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## Chapter 6: Discussion

### 6.1 Overview

The overall goal of this project was to determine the association between Extraversion and Neuroticism, and the development of depressive symptoms in informal caregivers, over 45 years of age, in Canada. The first objective of this study was to identify factors that are associated with depressive symptoms in informal caregivers, 45 years and older, in Canada, using the CLSA baseline data. The second objective was to determine the association between personality traits at baseline and depressive symptoms at three-year follow-up in informal caregivers, 45 years and older, in Canada. A number of demographic and caregiving variables were included in the analysis in order to control for their confounding influences.

### 6.2 Main Findings

### 6.2.1 First Objective: Factors associated with depressive symptoms in informal caregivers

The first objective identified factors associated with depressive symptoms in informal caregivers in a cross-sectional context. Age had a significant positive relationship with depressive symptoms, so that when one increased, so did the other. Sex was associated with depressive symptoms with females having higher CES-D scores compared to males. Our findings align with previous literature that suggest females are at increased risk for depression and/or depressive symptoms (APA, p.158, 2013; Meng & D'Arcy, 2014; Meng et al., 2017, Pattern et al., 2006; Regan et al., 2013). We also found informal caregivers are more likely to be female (Adelman et al., 2012, Metzelthin et al., 2017).

In addition to age and sex, our findings suggest that as total household increased, depressive symptoms decreased. This finding is not surprising and has been well documented in the literature (Meng & D'Arcy, 2014, Meng et al., 2017, Pattern et al., 2006, Yang, 2007). What

was interesting about this is that the study population from the first objective reported much lower total household income than those from the second objective. The informal caregivers in Chapter four were not excluded based on CES-D score, 41.50% indicated total household income less than $50,000. In Chapter five, participants were excluded if their CES-D score was over nine, and only 19.72% reported a total household income of less than 50,000$. Those who were above the cutoff for significant depressive symptoms were disproportionately in a lower income bracket and income has a strong association with depressive symptoms in informal caregivers. It could be that more depressive symptoms make it harder to gain income or that those with a higher income are less likely to experience depressive symptoms.

Perceived general health was strongly associated with depressive symptoms in this study. As general health deteriorated, depressive symptoms increased. Alternatively, as depressive symptoms increased as general health deteriorated. It could also be that those who exhibit more depressive symptoms perceive their health in poorer condition compared those with lower depressive symptoms. This finding was supported by previous studies (APA, p.158, 2013, Meng & D'Arcy, 2014, Meng et al., 2017, Pattern et al., 2006, Regan et al., 2013) and has been demonstrated in studies involving other informal caregivers (Fekete et al., 2017).

Marital status was found to be statistically associated with depressive symptoms. Specifically, being widowed was positively associated with depressive symptoms compared to being single. Again, marital status is a well-known risk/protective factor (Meng et al., 2017, Pattern et al., 2006, Yang, 2007). Being a spousal caregiver has also been shown to be associated with higher depressive symptoms, in this study and others (Bernabeu et al, 2016, Hirdes et al, 2012), however being married in general is a protective factor against depressive disorders compared to being widowed, separated or divorced (Meng et al., 2017, Pattern et al., 2006,

Yang, 2007). Those who are married/common-law are the ones who would be the spousal caregivers. This could explain the lack of association between being married and depressive symptoms in this study. Being non-white compared to white was associated with a higher CES-D score. This finding was opposite to previous studies that report a higher prevalence of depressive disorders in Caucasian individuals (Bailey et al., 2019; Meng & D'Arcy, 2014; Meng et al., 2017), however our study grouped many cultural and ethnic backgrounds into one category because the study population was predominately white. Because of this, no inferences can be made about the relationship between depressive symptoms and racial or ethnic background aside from being white was associated with lower levels of depressive symptoms.

We did not find a significant relationship between education and depressive symptoms although it has been associated depression (Chang-Quan et al., 2010; Meng et al., 2017) and caregiver distress (Adelman et al., 2014). It could be that low socioeconomic status is associated with depressive symptoms, and income better explains the variation in depressive symptoms than education does. Keeping education in the multivariable regression did the improve model, based on the incremental F-test which means while it wasn't associated with depressive symptoms, including it helped the prediction. Retirement status was also non-significant and was excluded from the final model because it did not show a significant relationship with depressive symptoms. It may be that retirement status does not itself have a relationship with depressive symptoms, rather health that tends to decrease as people age and therefore retire, that has a relationship with depressive symptoms (de Zwart et al., 2017).

As for the caregiver characteristics, the number of hours spent caregiving per week was positively associated with depressive symptoms. Those who indicated they spent 22-48 or 96+ hours per week on their caregiving duties, were more likely to have a higher CES-D score than

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those who spent seven hours or less hours caregiving per week. Other studies have found that as

the caregiving hours increase, the caregiver is more vulnerable to caregiver distress (Hirdes et al,

2012, Mitchell et al., 2015; Adelman et al, 2014, Pinquart & Sorensen, 2003; Hirst, 2005). It

would be increasingly difficult to juggle all responsibilities as the hours taking care of someone

else pushes past the hours of a full-time job. Providing medical care compared to not providing

medical care was positively associated with the CES-D score. This was the only caregiving role

that showed a significant relationship with depressive symptoms. All seven of the caregiver tasks

were merged into one variable to represent the quantity of tasks. The thought behind this was

that the more tasks the caregiver performs, the higher the intensity of caregiving, which, if

intensity of caregiving is conceptualized as number of hours per week, has been associated with

caregiver distress (Adelman et al., 2014; Hirdes et al, 2012; Hirst, 2005; Mitchell et al., 2015;

Pinquart & Sorensen, 2003). The relationship was non-significant.

Taking care of one's parent-in-law, sibling-in-law or other relative was negatively

associated the CES-D score, compared to taking care of one's spouse. This finding is supported

by previous studies that have suggested taking care of one's spouse is a risk factor for caregiver

distress (Bernabeu et al, 2016, Hirdes et al, 2012). There could be several explanations for this.

Firstly, if an informal caregiver is taking care of their spouse, they likely live in the same

residence as the care recipient. It would be difficult for them to leave their caregiver role, as they

are constantly around their spouse. If the recipient's spouse needs caregiving due to deteriorating

health or disability that has developed with age, it would be hard for the caregiver to watch their

spouse's health decline, especially with a lifetime of healthy memories. We found a null result

for the number of weeks caregiving which was in contradiction to the literature (Papastavrou, et

al., 2012; Pinquart & Sörensen, 2011). The question about the duration of caregiving asks

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participants about the past year. It could be that in order to see the association between depressive symptoms and duration of caregiving, we must look beyond one year.

**6.2.2 Second Objective: Personality and depressive symptoms**

The results from the Neuroticism-depressive symptoms association were as hypothesized. As Neuroticism increased, so did depressive symptoms. A one-unit change in Neuroticism increased the CES-D score by approximately 0.70. This was after controlling for several confounders. Intuitively, this makes sense. If a person is inclined towards negative thoughts and emotions, they would likely have a predisposition towards depressive symptoms. Informal caregivers who are high in Neuroticism might be at an increased risk for developing depressive symptoms because caregiving is associated with additional stress (Vitaliano et al, 2003) and stress is a risk factor for depressive disorders (American Psychological Association, p.158, 2013; Meng & D'Arcy, 2014; Meng et al., 2017, Pattern et al., 2006; Regan et al., 2013) and therefore symptoms.

This study found an age and Extraversion effect modification. This means the association between Extraversion and depressive symptoms, depended on the informal caregiver's age. For informal caregivers between the ages of 45 and 54, there was no statistically significant relationship between Extraversion and depressive symptoms. For caregivers 55 to 64 years old, a one-unit increase in the Extraversion score reflected a decrease of 0.08 on the CES-D 10 score. Caregivers between the ages of 65 to 74 and 75+ had a decrease in CES-D score of 0.23 and 0.24 respectively, with every one-unit increase in Extraversion. Cross-sectional studies have found Extraversion to be negatively associated with depression in informal caregivers (Kim et al., 2017; Melo et al., 2011) while other cross-sectional studies found null results (Kim et al., 2005). Other studies have shown high levels of Extraversion to be associated with low levels of adverse

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mental outcomes, such as caregiver burden (Kim et al., 2014). No longitudinal studies on Extraversion and depressive symptoms or disorders among informal caregivers were identified. Because the present study showed an interaction effect of age on Extraversion and depressive symptoms, future research into informal caregivers and depressive symptoms and personality must look at possible interaction effects in their data and stratify their analyses accordingly.

The association between personality traits and CES-D 10 score in Chapter four was stronger than the association in Chapter five. For example, a one-unit increase in Neuroticism in the first objective, was associated with a 1.01 increase on the CES-D 10 score. In the second objective, the same scenario was associated with a 0.70 increase. The Extraversion score was not stratified in objective one like it was in two so the difference between the strength of association depends on the age category from objective two. For example, in study one, the coefficient for Extraversion on depressive symptoms was -0.26 which is similar to the -0.23 and -0.24 found in study two for the age groups. However, the association between Extraversion and depressive symptoms in 55-64 year-old from the second objective and all caregivers in the first objective is quite pronounced. In Chapter five, those 55-64 saw a -0.08 change in their CES-D score for every unit increase in Extraversion, compared to -0.26 change in Chapter four.

The higher Extraversion association found in Chapter four is partially explained by the lack of stratification by age group. If an effect modification term had been included in the model, we would have likely found that the association between Extraversion and depressive symptoms was dependent on age like it was in study two. Another explanation for the stronger associations found in study one compared to study two could be explained by the differing populations. In Chapter four, all those who indicated that they provided informal caregiving in the last 12 months were included in the study, regardless of CES-D score. In Chapter five, informal

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caregivers were excluded if the 2015 baseline CES-D score was over the cutoff for significant depressive symptoms. As such, the mean CES-D score was higher in the cross-sectional study (5.46) compared to the cohort study (4.28). It could be that Extraversion and Neuroticism are more strongly associated with higher levels of depressive symptoms than lower levels of depressive symptoms. This explanation is supported by the incidence rates presented in the cohort study. Although the coefficients from the generalized linear model were rather small, the risk ratios, specifically Neuroticism and the two highest age categories of Extraversion, were large. Dividing the depressive symptoms using the cutoff strengthened the association so that those higher in Neuroticism had a 191% increase in risk over and above those lower in Neuroticism. And in those 75 years and older, there was a 43% reduction in the risk of developing significant depressive symptoms for those higher in Extraversion, compared to those lower in Extraversion.

The two studies varied in other ways. The dependent variable in the two studies was different; in study one we looked at the CES-D 10 score at 2015 baseline, and in study two, we looked at the CES-D 10 score at 2018 follow-up. The designs were also different, with Chapter four employing a cross-sectional design and Chapter five a prospective cohort design. This means the inferences between the two studies differed. In the cross-sectional study, only association claims can be made between the independent and dependent variables. In the cohort study, the design allows for causal claims. Because of this, the results from the cohort should be weighted more heavily with the findings from cross-sectional, adding support to the claims.

**6.2.3 Implications**

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This study reiterates what is known about the effect of Neuroticism on depressive symptoms in the general population and verifies it in the informal caregiving population. The effect modification between age and Extraversion on depressive symptoms could explain why previous studies found mixed results about the relationship. One way to interpret this finding is that younger caregivers have multiple features in place that might protect the individual for developing depressive symptoms, but as they age, they lose protective factors, like health and autonomy, so Extraversion becomes an increasingly strong protective characteristic against depressive symptoms.

Because of the prospective cohort design of Chapter five, we were able to answer questions about the causality of Neuroticism and Extraversion and depressive symptoms, specifically if high or low levels of the personality traits can predict future depressive symptoms in informal caregiver populations. As mentioned, the findings that Neuroticism predicts depressive symptoms are plenty in the literature, and now in caregiving populations. At this point, the results do not need to be confirmed and efforts should focus on translating this knowledge to help caregivers. Not as much literature is available on Extraversion and a lot of it is mixed. But it might be because of the effect modification, as mentioned in previous chapters, or because the association between Extraversion and depressive symptoms isn't strong. The effect modification does mean that future studies must consider age by Extraversion interaction effect and this should be extended outside caregiving populations.

### 6.2.4 Future Studies

It's unlikely that every new informal caregiver will receive a personality test prior to the commencement of their caregiving duties; however, information could be distributed broadly to the informal caregiver community to educate the population on the possible adverse effect of

their new role, and who may be more at risk to feel these effects. It would give the caregivers a chance to prevent a depressive episode that might occur or push them to seek help for any mental health issues that arise. Organizations and programs that are aimed at helping caregivers and older adults could help disseminate the findings surrounding personality and depressive symptoms on their platforms.

Programs that aim to support the informal caregivers should consider Neuroticism. This study and others have provided evidence of the differential impacts of Neuroticism on depressive symptoms. This means that individuals' differences need to be considered when planning intervention programs to prevent depressive symptoms in caregivers (Ferrario et al., 2003; Kim et al, 2017; Trujillo et al., 2016) and interventions should to be tailored to meet the needs of different family caregivers. Individuals high in Neuroticism might benefit from emotional-coping strategies as they are already prone to negative feelings but for someone low in Neuroticism, the same strategies might not be worth the resources. Intervention studies that have aimed to help those high in Neuroticism outside of the caregiving population could be used for family caregivers. Mindfulness-based cognitive therapy programs have shown to lower Neuroticism in people with depression (Spinhoven, Huijbers, Ormel & Speckens, 2017) and similar studies could be performed within the caregiver population.

At this time, the findings surrounding Extraversion do not warrant any great investment for intervention studies. For caregivers between 45-54, this study found no effect. For caregivers between 55-64, the effect was so minuscule, it was likely an artifact of a large sample. Even for those 65 and older, the effect size was large enough to suggest true effects, but it was still small and there are probably characteristics of caregivers that have more of an impact on depressive symptoms, and future research should focus its resources on those characteristics.

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The objective of the CLSA is to follow the participants for at least 20 years or until death (Raina et al., 2008). It would be useful to continue to monitor these participants and to keep an eye on the changes/stability of Neuroticism, depressive symptoms score and their caregiving status, to ensure the findings of this study hold true over time so the most accurate information can be used in future studies and caregiver support policies.

**6.3 Epidemiological Implications**

**6.3.1 Internal Validity**

**6.3.1.1 Confounding**

One of the major strengths of this study is that it had a comprehensive list of potential confounding factors that were measured by the CLSA and it had the sample size to include many confounders that were previously established in the literature. As such, we were able to include many caregiver and demographic variables so long as they did not increase the mean squared error of the main predictors by increasing the prediction error. The mean squared error is the combination of the bias in the coefficient and the squared standard error. Adding more variables brings the potential of increasing the prediction error in the model. As the number of variables grows, the more points the model has to fit. The standard error might then be raised because it could enlarge the distance between predicted and observed values. This occurs when two or more variables are colinear; adding the additional variable offers no prediction value but increases the prediction error. To ensure there was no collinearity, a backward stepwise deletion outlined in Greenland et al., (2016) was followed, to determine which confounders were important to consider in the etiologic models. None of the additional predictor variables increased the mean squared error of the main effects, and were therefore included in the analysis.

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There were some things that the analysis was unable to control for and poses a threat to internal validity. For example, there was not much information provided on the care recipient aside from the relationship they have with the caregiver. Care recipient worsening health has been shown to increase caregiver stress (Hirdes et al, 2012, Mitchell et al 2015). The type of care that the caregiver provided was used as a proxy; however, having a more direct conceptualization of care recipient health would have given the study better insight into the possible confounding effect it has on personality traits and depressive symptoms.

**6.3.1.2 Misclassification Bias**

As mentioned above, this study used a large number of variables in the analysis, because of the extensive questionnaire of the CLSA. The CLSA aims to assess a multitude of characteristics so they often use short questionnaires for each construct. Instrument quality can threaten internal validity and often times, shorter questionnaires sacrifice quality for conciseness. They used the TIPI to measure personality which is a ten-item instrument that uses two items to evaluate each personality trait. The TIPI has demonstrated reasonable reliability and validity (Gosling et al., 2003); however, it is likely that the BFI or the NEO-FFI would have produced a better assessment of the participants' personality, introducing measurement bias into this study.

The same is true of the outcome measure. The CLSA used the CES-D 10 item scale to assess the participants' depressive score. The 10 item is the condensed version of the CES-D 20 item scale and some studies have shown that the positively worded items in the CES-D 10 scale may not perform well in caregiver populations. In one study comparing the two CES-D scales, the authors found that the item "hopeful about the future" was not acceptable based on a Rasch analysis (Andreson et al., 2013), in the 10-item version. The authors hypothesized that those who are taking care of more impaired recipients are likely to have less hopeful outlook of their future

in the context of their caregiving role (Andreson et al., 2013). This doesn't necessarily indicate that they are at higher risk of depressive symptoms, meaning there would be misclassification bias. This would also artificially elevate the depressive symptoms scores; however, it would likely do that for all participants, regardless of personality score. The misclassification would be non-differential and would not change the association between the personality traits and depressive symptoms.  Furthermore, the CES-D 10 has been validated in older populations (Andreson et al., 1994; Lewinsohn, Seeley, Robert & Allen, 1997) and caregiving populations (Pinquart et al., 2003).

The CES-D 10 item scale measures depressive symptoms in the past week (Andreson et al., 1994) and there are three years between baseline and follow-up, so any variation in depressive symptoms between data collection points would have been missed. The variation would likely equal out so this wouldn't change the associations found in the generalized linear models; however, it would affect the incidence of significant depressive symptoms so that they were likely underestimated. If the coefficients from Chapter four and five are compared, Extraversion and Neuroticism have stronger associations with depressive symptoms in Chapter four than five. This might suggest Neuroticism and Extraversion are better at predicting current depressive symptoms than future depressive symptoms. The study population used was different, so this conclusion is not certain. For example, Neuroticism and Extraversion could have a stronger association with higher levels of depressive symptoms and because Chapter four did not exclude participants based on CES-D score so it reported higher associations.

Both the outcome and main predictors were kept on their original continuous scales so no categorizing was done for the primary and secondary analyses. Informal caregivers for the study in Chapter five were excluded if their CES-D was above the recommended cutoff. There are

always concerns when dichotomizing a continuous scale because the difference of one point means the difference between significant and non-significant depressive symptoms and cut points can often be arbitrary. This would have introduced misclassification in this study; however, it would likely be non-differential. In Chapter five, incidence rates and risk ratios are reported. Again, there could be misclassification because of the cut point on the CES-D scale, but also on the personality traits scale. There was no precedent for dividing the TIPI variables into groups, so participants were split down the scales' middle to represent those high or low in Neuroticism and Extraversion. Again, there would likely have been some misclassification because of this divide, however it would have likely been non-differential. Misclassification bias can happen when there is vagueness surrounding who qualifies for the research project. For the current study, participants were included if they had provided informal care in the last 12 months, because of a health condition or limitation (CLSA, 2018). The interviewer was to then explain the assistance could be because of physical, mental, cognitive health problems or because limitations due to aging (CLSA, 2018). But it does not offer any other inclusion/exclusion criteria outside of that. For example, based on this inclusion, providing a ride to a doctor's appointment for your grandparent eight months ago would qualify a person as an informal caregiver. There could be the chance for differential misclassification bias. People who aren't necessarily informal caregivers, but instead someone who has offered the odd favour, might be included in this study. In fact, 43.34% of participants in the CLSA indicated they had provided caregiving, while the General Social Survey, 2012: Caregiving and Care Receiving 33.90% to 40.40% of participants 45 and older reported informal caregiving in the last 12 months (Statistics Canada, 2014). There is a time lag between the 2015 CLSA baseline data and the 2012 General Social Survey, and informal caregivers are growing, so the actual difference

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might not be as large. Fortunately, this study also controlled for hours per week caregiving and the amount of weeks caregiving, so if it were the case that people who were not informal caregivers were included, they would have been controlled for in the analysis.

### 6.3.1.3 Chance

The sample size was large enough to ensure the results were not due to chance. The smallest cohort, those in the 75+ Extraversion model, consisted of 846 informal caregivers. There were a number of covariates, between 34-43 including the dummy variables, in the multivariable models for both the first and second objectives; however, the sample sizes were still large enough that any outlier variables would be anchored by the mean and results were not due to chance outliers. Because the sample was large, there is always the possibility that statistically significant findings can be found in non-meaningful differences.

### 6.3.1.4 Selection Bias

Self-selection could have been a threat to this study. Based on the frequency distributions, 81.64% of the study population had tertiary education. In the general population in Canada, aged 45-65, 48% had the same level of education in 2018 (Statistics Canada, 2020). The study population is highly educated compared to the general population. Higher education is a protective factor against depressive disorders (Bauldry, 2015) so the findings from this study might underestimate depressive symptoms in a broader group of informal caregivers. This would not impact the association between the predictors and outcome, however the incidence rates and risk ratios might underestimate the incidence of depressive symptoms in the general informal caregiving population.

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### 6.3.2 External Validity

The CLSA is a large national study that aims to capture participants from all provinces and territories across Canada. The current study is using the comprehensive group of the CLSA. This includes almost 30,000 participants at baseline. However, because the comprehensive group also provides information that must be collected in person, they must live a maximum of 50 kilometers from one of the eleven assessment centers. As such, remote or very rural older adults are excluded from this study. This limits the generalizability of the results compared to the results from the tracking group, but the personality traits of the tracking group were not measured. The CLSA did capture a large number of people from the four major regions of Canada and these results are, therefore, likely applicable to many Canadian informal caregivers.

### 6.3.3 Causation

In order to make a causal claim, three criteria must be satisfied. There must an association between the two variables. Both Chapter four and Chapter five verified the association between Neuroticism and Extraversion, for those over 45, and depressive symptoms. There must also be temporal precedence. In order to ensure this, caregivers who were over the CES-D cutoff at baseline were excluded from Chapter five. This means that those already at a significantly high level of depressive symptoms were excluded and the personality traits were measured before the outcome. This means the personality traits came before the change in depressive symptoms. This is further supported through the incidence rates. Finally, a causal claim would need control for other variables, which this study did. Because this study met all three criteria for causation, it can conclude that high Neuroticism at baseline predicts the development of depressive symptoms at three-year follow-up, in informal caregivers in Canada

over the age of 44. High levels of Extraversion at baseline predicts the reduction of depressive

symptoms in informal caregivers, over the age of 64, at three-year follow-up. Although

statistically significant, caregivers between the age of 55-64 were not included because the

change was so miniscule that it was likely due to large sample size, not true effects.

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A LONGITUDINAL STUDY OF THE CLSA DATA

**Chapter 7: Ethical Considerations**

**7.1 Autonomy**

The data that was used in the study was secondary data from the CLSA. As such, the autonomy of participants had already been insured by the CLSA during the original data collection. Participants were made aware that they are allowed to withdraw from the CLSA study at any time (Raina et al, 2010). The CLSA received ethical approval from all Research Ethics Boards (REB) across Canada that are associated with the project. These REBs approved baseline and the first follow-up procedures (Raina et al., 2010). As this study represents a secondary data analysis, it is exempt from Research Ethics Board review, and an ethics waiver was granted. See appendix A for ethics waiver.

**7.2 Beneficence**

The purpose of this study was to advance the knowledge on factors that could influence depressive symptoms in informal caregivers. As the population ages, the subpopulation of informal caregivers is set to grow, and it is important to identify those at risk of adverse health outcomes. This study aimed to enhance the ability to identify those at risk of developing depressive symptoms, and as such, help guide future intervention programs to prevent or reduce depressive symptoms in informal caregivers. This information has the potential to help not only informal caregivers, but also the care recipients and the Canadian health care system, as informal caregivers play such an integral role in aiding seniors and others who need extra assistance. Individual participants received no direct benefit by participating in this study and participation in the CLSA is entirely voluntary.

A LONGITUDINAL STUDY OF THE CLSA DATA

**7.3 Nonmaleficence**

The current study uses anonymized data and any identifying information was removed prior to receiving the dataset. As such, no harm from the results of this study could fall upon a single individual as there would be no way to distinguish any one participant. When subjects such as depressive symptoms are measured in a study, they can bring up negative emotions and thoughts. Information on informal caregiving might bring up negative feelings as well because it could remind the participant about an ill loved one. Because this was secondary data, there was no chance the current study brought negative feelings to the participants through the data collection.

**7.4 Scientific Integrity**

This study was honest and transparent. The methods described in this study were followed and therefore reproduceable. Results are clearly and accurately reported, including null findings. This study was necessary because it furthers the scientific literature around the informal caregiving population. It offers important conclusions for future studies, mainly drawing attention to the importance of considering Neuroticism when designing support programs for caregivers.

A LONGITUDINAL STUDY OF THE CLSA DATA

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## Chapter 8: Limitations, Strengths and Relevance

### 8.1 Limitations

The findings of this study must be interpreted with the limitations. It was limited by the variables available from the CLSA and the analysis was unable to control for certain constructs that may have been important. Chapter four reported a low $r^2$ suggesting that important variables that are associated with depressive symptoms are missing from the model. Generalized linear models do not offer an $r^2$, but it is likely any variable that would have increased the $r^2$ in Chapter four would have helped the models in Chapter five. Furthermore, the goal of the second objective was not to explain the variance in the outcome but to determine the precise relationship between the exposures and the outcome. Self-perceived general health was included as a measure of physical health, however more thorough health variables, such as number chronic conditions or an objective measure of physical health might have better indicators of physical health of the caregiver. Depression is known to have a heritability component and having blood relatives with a history with depression or suicide is a known risk factor (APA, p.158, 2013). This would be difficult information to obtain but it might explain a portion of the missing $r^2$. There was not much information provided on the care recipient aside from the relationship they have with the caregiver. Care recipient's worsening health has been shown to increase caregiver stress (Hirdes et al, 2012, Mitchell et al 2015). The type of care that the caregiver provided was used as a proxy; however, having a more direct conceptualization of care recipient health would have given the study better insight into the effect it has on depressive symptoms in informal caregivers. There might be a difference between caring for someone because of cognitive limitations compared to aging needs. Or, for example, between a cancer patient and someone with dementia. This information would have added value to the study.

A LONGITUDINAL STUDY OF THE CLSA DATA

The current study does not have much information about the caregiving status in the three years between baseline and follow-up. To be eligible for this study, the participants had to provide informal care in the last 12 months preceding baseline and follow-up. However, the caregivers could have provided informal care in the last 12 months prior to baseline then stopped caregiving immediately following baseline, and then resumed providing care before follow-up. Or they could have been caregiving throughout the three years between assessments. Or they could have been caregiving on and off. Either way, they would have been considered eligible for the current study and it is possible that the different caregiving status could have an effect on the outcome score but was uncontrolled for by this study, although this was minimized as much as possible by only including those who answered yes to caregiving at both baseline and follow-up.

There was a lot of potential for misclassification bias in this study, as mentioned in detail in Chapter seven. Cut-offs were used to exclude participants based on the CES-D score, and for the calculation of incidence rates in Chapter five. Cut-offs can be arbitrary and have the potential to misclassify participants. There was some ambiguity surrounding who qualifies as an informal caregiver, based on the CLSA questionnaire, and this might have led to people who would not normally be considered caregivers to be included in the present study.

Finally, generalizability of these findings does not extend to remote caregivers. Because the participants were part of the comprehensive assessment group, they had to live a maximum of 25 km or 50 km, depending on geographic region, to an assessment center (Raina et al., 2018). The assessment centers were in urban areas and this means very rural or remote caregivers would not be captured by this study.

A LONGITUDINAL STUDY OF THE CLSA DATA

**8.2 Strengths**

One major strength of this study is the size of the CLSA, both in sample and the number of constructs that were measured. It allowed the current study to control for many possible confounders that had been mentioned by previous studies. It also gave the study statistical power to discover any real small effects and avoid Type II error. Another strength of this study was the prospective cohort design - we were able to exclude those with clinical depressive symptoms at baseline. Any of the limitations from Chapter four concerning design, we were able to address in Chapter five. It allowed us to only capture new cases at follow-up and therefore be more confident that personality and caregiving played a role in the development of depressive symptoms.

**8.3 Relevance**

This study is important because of the volume of Canadians who provide informal care for others. In the current study, 43.34% of the entire CLSA comprehensive group indicated that they had provided informal caregiving in the last 12 months. As a group, they take on a tremendous burden and contribute to the individual care recipient, and the Canadian health care system. They sacrifice their time, finances and physical and mental health in order to provide care for loved ones who might not be able to afford or don't want formal care. It is essential that we try to understand every aspect of their experience as caregivers. If those who are higher/lower in a characteristic might be more vulnerable to the adverse effects of caregiving, we should target those people before a potential mental health decline.

There was limited literature about the effects of Neuroticism, Extraversion and depressive symptoms in caregiving populations; however, there is substantial information about the association between personality and depressive disorders outside this subgroup. This study helps

translate the literature on Neuroticism and Extraversion and depressive symptoms from the general population to informal caregivers and our study lines up well with their findings. At this stage, energies and resources should be directed towards applied knowledge on this topic so that support for informal caregivers can be tailored to meet their needs.

## 8.4 Conclusion

The overall goal of this thesis was to determine the association between Neuroticism and Extraversion and depressive symptoms in informal caregivers, 45 years and older, in Canada. To do this, this thesis had two objectives. The first objective was to describe informal caregivers in Canada at baseline and identify which factors are associated with depressive symptoms among informal caregivers. The second objective of this thesis aimed to explain the relationship between Neuroticism and Extraversion at 2015 baseline and depressive symptoms at 2018 follow-up, in informal caregivers, 45 years and older, in Canada.

In Chapter four, we addressed the first objective through a cross-sectional study using the CLSA 2015 baseline data. We described caregivers on a number of demographic variables, including age, sex, total household income, white versus non-white, marital status, retirement status and education. We also asked participants their self-perceived general health. Caregiving related characteristics were assessed, such as type of caregiving task, the amount of caregiving tasks, relationship with care recipient, the number of weeks they had been caregiving and the number of hours per week they spend caregiving. Finally, their Extraversion and Neuroticism scores were reported. A multivariable linear regression was used to determine the important associations between the independent and dependent variables. We found the demographic variables: age, sex, total household income white versus non-white and marital status to be statistically associated with depressive symptoms. Education was not significant but based on an

incremental F-test, it was an important variable, so it was left in the final model. For the caregiving characteristics, hours per week caregiving, relationship with care recipient and providing medical care were had a significant relationship with the CES-D score. Both personality traits were also statistically associated with depressive symptoms; Extraversion showed a negative relationship while Neuroticism showed a positive relationship with depressive symptoms.

In Chapter five, we addressed the second objective through a prospective cohort design. Participants from the comprehensive assessment group were included if they indicated caregiving at both baseline (2015) and follow-up (2018). Participants were excluded if they had CES-D 10 score 10 or above at baseline. We focused on explaining the relationship between Neuroticism, Extraversion and depressive symptoms. A significant age by Extraversion effect modification was found, so age was stratified into four age groups. For those 45-54, there was no effect of Extraversion on depressive symptoms. For those 55-64 years of age, there was a statistically significant effect, however the coefficient was so small, the significance was likely due to the large sample size. For those 65-74 or 75+, high Extraversion did predict low depressive symptoms. The effect was small, but it was large enough to indicate that the effect was true. Neuroticism showed a stronger association with depressive symptoms and higher Neuroticism scores predicted the development of depressive symptoms.

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**Appendix A**

**Ethics Waiver**

Lakehead
UNIVERSITY

Research Ethics Board
t: (807) 343-8283
research@lakeheadu.ca

July 16, 2019

Dr. Vicki Kristman
Associate Professor
Department of Health Sciences
Lakehead University
cc. Grace Herring

VIA Email: vkristma@lakeheadu.ca, with cc to mherring@lakeheadu.ca

**RE: Secondary use of non-identifiable data – Research Ethics Board exemption**

Dear Dr. Kristman and Ms. Herring:

Thank you for providing the Lakehead University Research Ethics Board information regarding your project titled, "*Personality determinants for depression amongst informal caregivers*". You intend to access anonymous, secondary data from the Canadian Longitudinal Study on Aging (CLSA) to seek to understand the relationship between personality traits and depression in informal caregivers.

Your use of the data meets the criteria of the Tri-Council Policy Statement 2 (TCPS 2), Chapter 2, Article 2.4, exemption from Research Ethics Board review as it involves secondary use of anonymous data and there is no opportunity of re-identification of this data through your analysis.

*"REB review is not required for research that relies exclusively on secondary use of anonymous information, or anonymous human biological materials, so long as the process of data linkage or recording or dissemination of results does not generate identifiable information."*

~TCPS 2, Chapter 2, Article 2.4

If the above process related to your project changes, please contact the Research Ethics Board. On behalf of the Lakehead University Research Ethics Board, I wish you success with your research study.

Sincerely,

Dr. Kristin Burnett
Chair, Research Ethics Board

/sw

955 Oliver Road, Thunder Bay, ON, Canada, P7B 5E1 | lakeheadu.ca

A LONGITUDINAL STUDY OF THE CLSA DATA

## Appendix B

**Greenland Approach**

Table 11. *Change in MSE using the Greenland approach by age group Extraversion models and Neuroticism*

|  | 45-54 | 55-64 | 65-74 | 75+ | Neuroticism |
|---|---|---|---|---|---|
| **Full Model** | | | | | |
| Coefficient | -.08 | -.09 | -.24 | -.28 | -.74 |
| Standard Error | .05 | .04 | .05 | .08 | .04 |
| R-Squared | .11 | .17 | .13 | .16 | .14 |
| **Basic Model** | | | | | |
| Coefficient | -.20 | -.21 | -.32 | -.33 | -.83 |
| Standard Error | .05 | .04 | .05 | .08 | .04 |
| ΔMSE | .0144 | .0144 | .0064 | .0025 | .0081 |
| R-Squared | .01 | .02 | .04 | .04 | .08 |
| **Without Neuroticism** | | | | | |
| Coefficient | -.12 | -.14 | -.26 | -.30 | - |
| Standard Error | .05 | .04 | .05 | .08 | - |
| ΔMSE | .0016 | .0025 | .0004 | .0004 | - |
| R-Squared | .05 | .10 | .10 | .11 | - |
| **Without Tasks** | | | | | |
| Coefficient | -.08 | -.09 | -.23 | -.28 | -.74 |
| Standard Error | .05 | .04 | .05 | .08 | .04 |
| ΔMSE | 0 | 0 | .0001 | 0 | 0 |
| R-Squared | .11 | .17 | .13 | .16 | .14 |
| **Without Weeks Caregiving** | | | | | |
| Coefficient | -.08 | -.10 | -.23 | -.27 | -.74 |

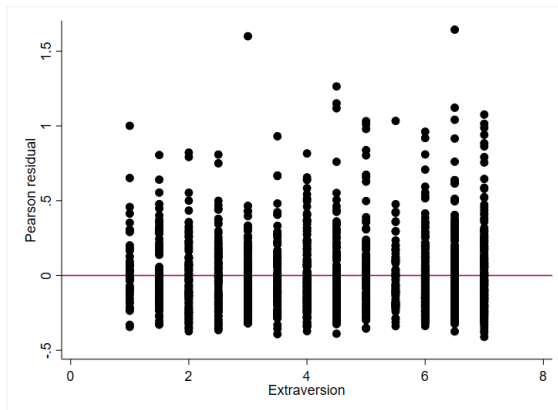| | | | | | |
|---|---|---|---|---|---|
| Standard Error | .05 | .04 | .05 | .08 | .04 |
| ΔMSE | 0 | .0001 | .0001 | .0001 | 0 |
| R-Squared | .11 | .17 | .13 | .15 | .14 |
| **Without Hours per week** | | | | | |
| Coefficient | -.08 | -.09 | -.24 | -.28 | -.74 |
| Standard Error | .05 | .04 | .05 | .08 | .04 |
| ΔMSE | 0 | 0 | 0 | 0 | 0 |
| R-Squared | .11 | .17 | .13 | .15 | .14 |
| **Without Income** | | | | | |
| Coefficient | -.10 | -.11 | -.25 | -.30 | -.74 |
| Standard Error | .05 | .4 | .05 | .08 | .04 |
| ΔMSE | .0004 | .0004 | .0001 | .0004 | 0 |
| R-Squared | .11 | .17 | .13 | .16 | .14 |
| **Without Education** | | | | | |
| Coefficient | -.08 | -.09 | -.23 | -.28 | -.74 |
| Standard Error | .05 | .04 | .05 | .08 | .04 |
| ΔMSE | 0 | 0 | -.0015 | 0 | 0 |
| R-Squared | .11 | .17 | .13 | .15 | .14 |
| **Without Marital Status** | | | | | |
| Coefficient | -.08 | -.10 | -.24 | -.28 | -.74 |
| Standard Error | .05 | .04 | .05 | .08 | .04 |
| ΔMSE | 0 | .0001 | 0 | 0 | 0 |
| R-Squared | .11 | .17 | .13 | .16 | .14 |
| **Without General Health** | | | | | |
| Coefficient | -.08 | .13 | -.26 | -.31 | -.81 |
| Standard Error | .05 | .04 | .05 | .08 | .04 |
| ΔMSE | 0 | .0016 | .0004 | .0009 | .0049 |

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| | | | | | |
|---|---|---|---|---|---|
| ΔMSE | .11 | .13 | .10 | .12 | .11 |
| R-Squared | | | | | |
| **Without Retirement Status** | | | | | |
| Coefficient | -.08 | -.09 | -.24 | -.26 | -.73 |
| Standard Error | .05 | .04 | .05 | .08 | .04 |
| ΔMSE | 0 | 0 | 0 | .0004 | .0001 |
| R-Squared | .11 | .17 | .13 | .15 | .14 |
| **Without white vs non-white** | | | | | |
| Coefficient | -.09 | -.10 | -.24 | -.27 | -.73 |
| Standard Error | .05 | .04 | .05 | .08 | .04 |
| ΔMSE | .0001 | .0001 | 0 | .0001 | .0001 |
| R-Squared | .11 | .17 | .13 | .15 | .14 |
| **Without Relationship** | | | | | |
| Coefficient | -.08 | -.10 | -.24 | -.23 | -.74 |
| Standard Error | .05 | .04 | .05 | .08 | .04 |
| ΔMSE | 0 | .0001 | 0 | .0025 | 0 |
| R-Squared | .11 | .17 | .13 | .14 | .14 |
| **Without Quantity of Tasks** | | | | | |
| Coefficient | -.08 | -.09 | .23 | -.28 | -.74 |
| Standard Error | .05 | .04 | .05 | .08 | .04 |
| ΔMSE | 0 | 0 | .0001 | 0 | 0 |
| R-Squared | .11 | .17 | .13 | .15 | .14 |
| **Without Extraversion** | | | | | |
| Coefficient | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Standard Error | - | - | - | - | -.74 |
| ΔMSE | - | - | - | - | .04 |
| R-Squared | - | - | - | - | 0 |
| | - | - | - | - | .14 |

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**Appendix C**

**Diagnostic graphs for ordinary least squares**

**Group 1:**

Graph 1: Residuals vs Fitted
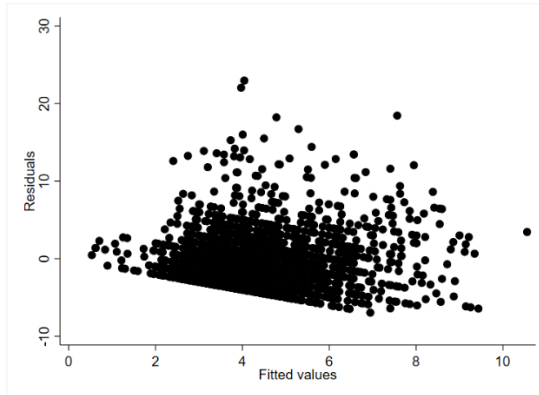
Graph 2. Normality of residuals

Graph 3. Leverage
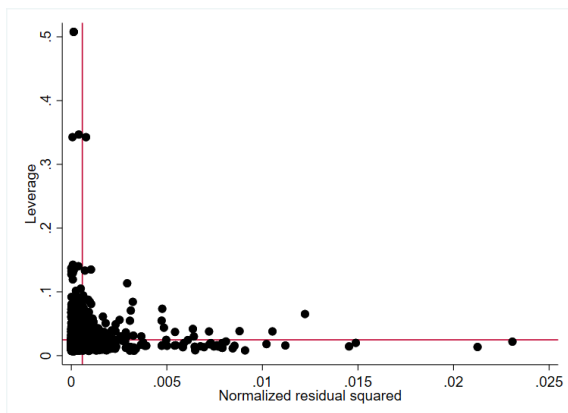
## Group 2

Graph 4. Normality or Residuals
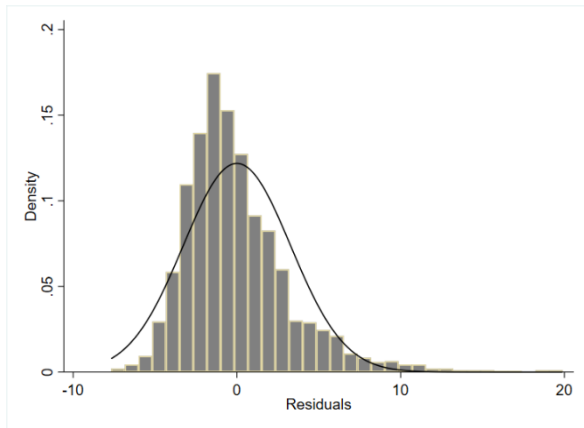
Graph 5. Residuals vs Fitted
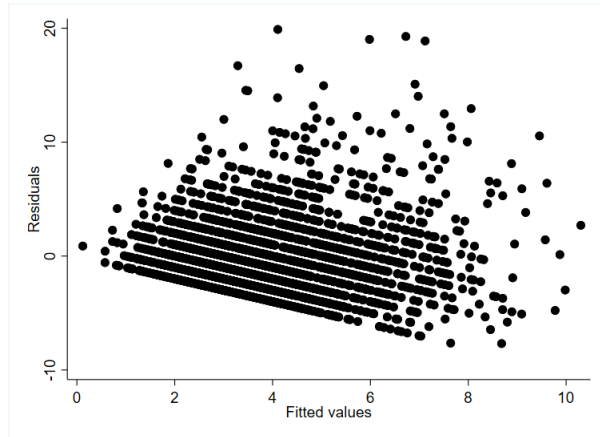


Graph 6. Leverage
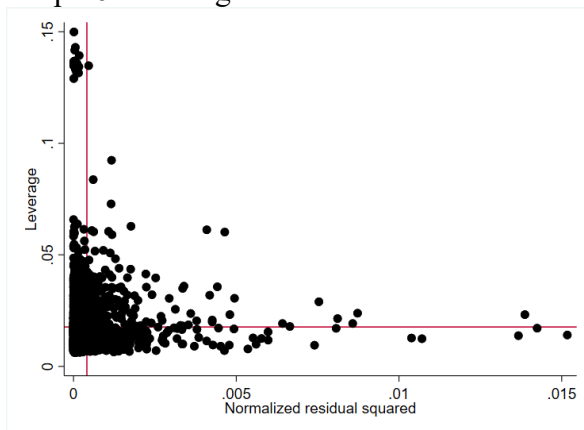


## Group 3

Graph 7. Normality or Residuals
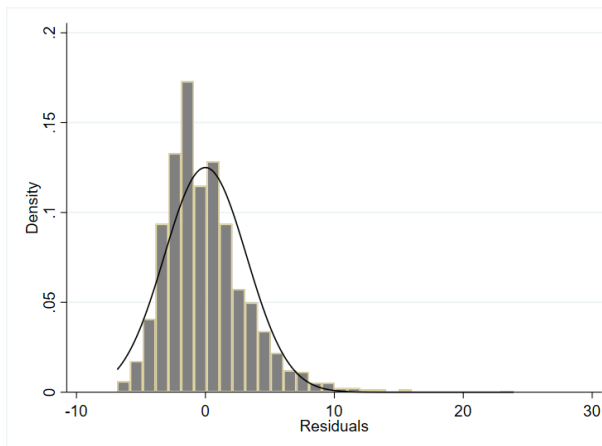
Graph 8. Residuals vs Fitted
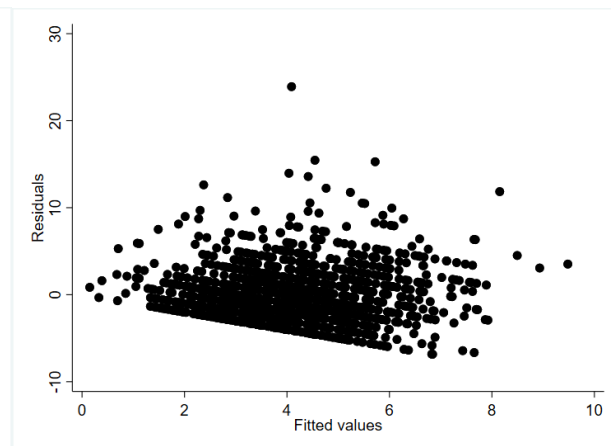
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Graph 9. Leverage
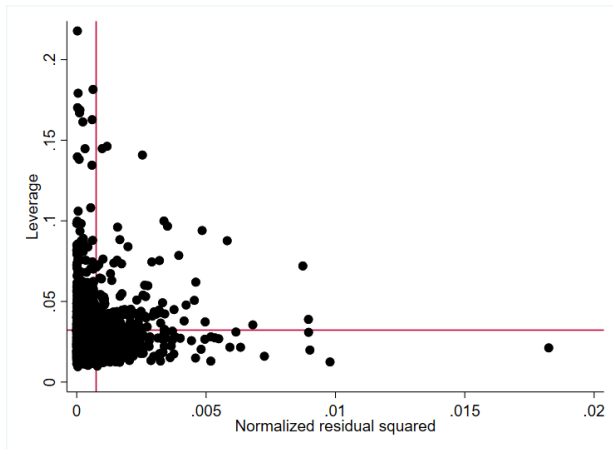


**Group 4**

Graph 10. Normality of Residuals
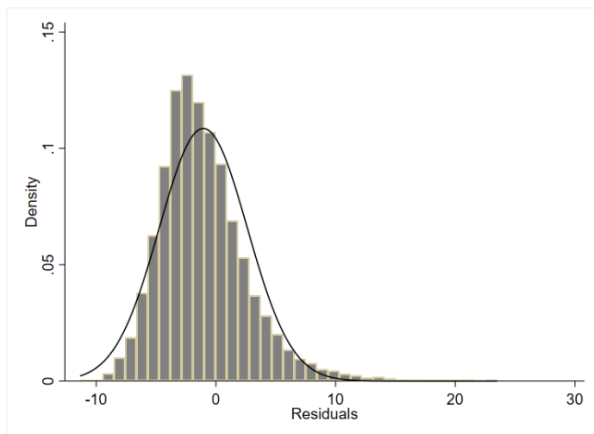
Graph 11. Residuals vs Fitted
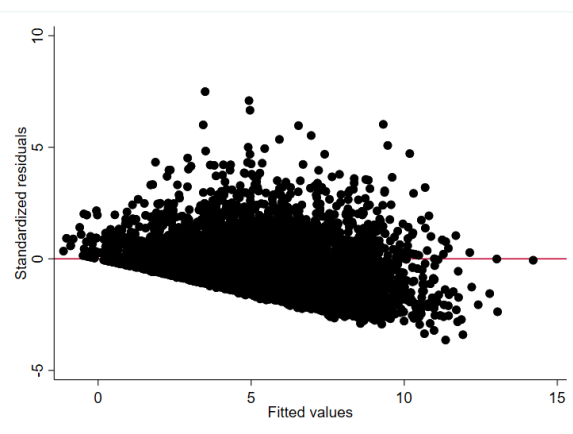




Graph 12. Leverage
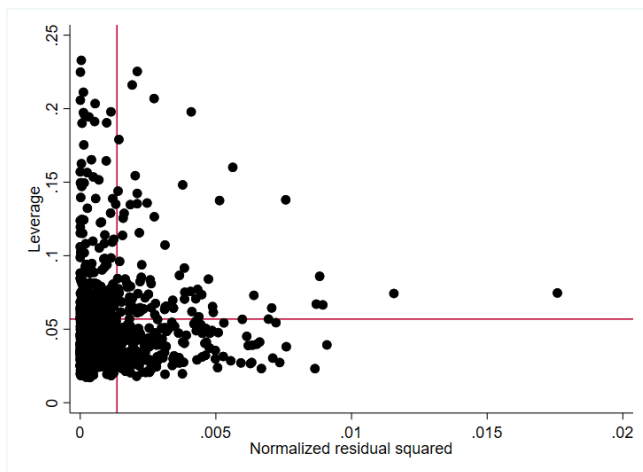
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**Appendix D**

**Diagnostic graphs for generalized linear model**

**Group 1: Extraversion model for participants aged 45-54**

Graph 1**.** *Residuals and Extraversion*          Graph 2. *Residuals versus Fitted values*
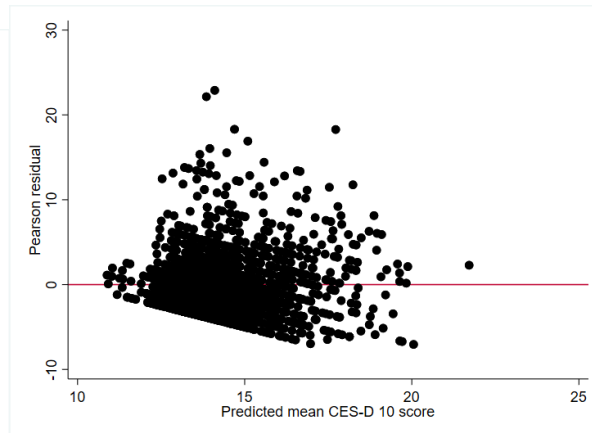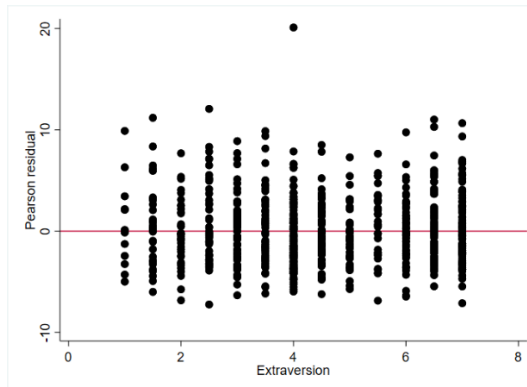


Graph 3. *Distribution of residuals*
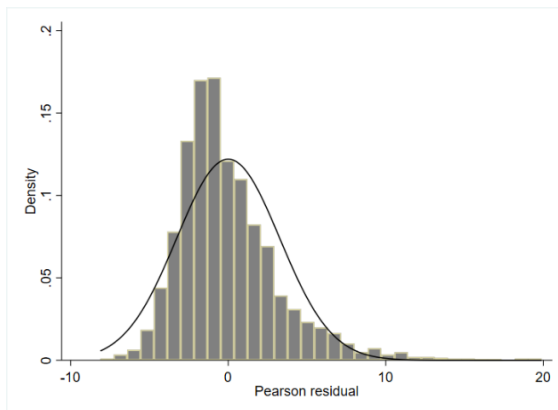


**Group 2: Extraversion model for participants aged 55-64**

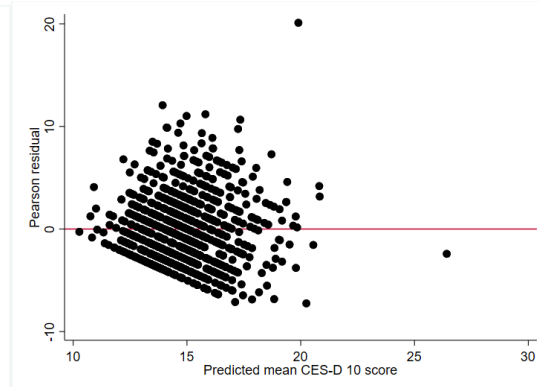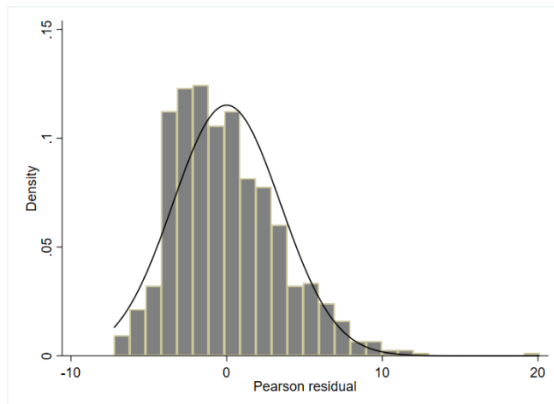Graph 4**.** *Residuals and Extraversion*          Graph 5. *Residuals versus Fitted values*
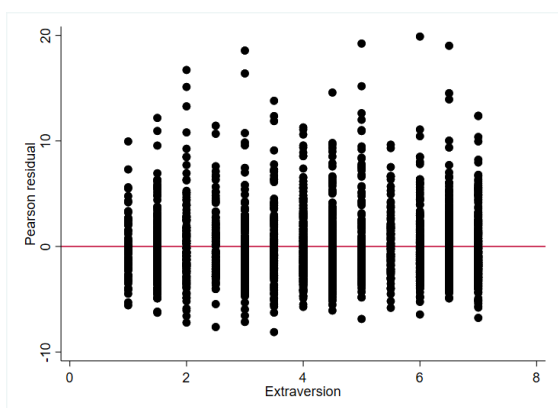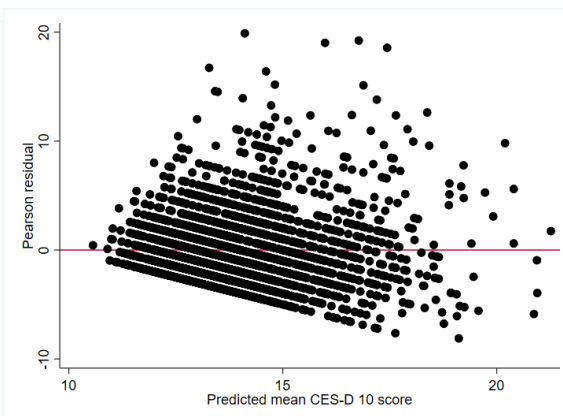
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Graph 6. *Distribution of residuals*
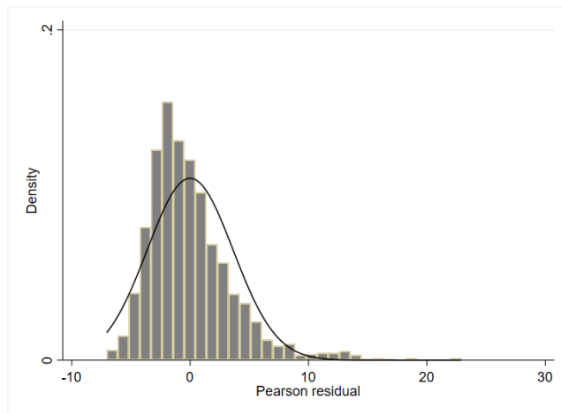


**Group 3: Extraversion model for participants aged 65-74**

Graph 7. *Residuals and Extraversion*    Graph 8. *Residuals versus Fitted values*
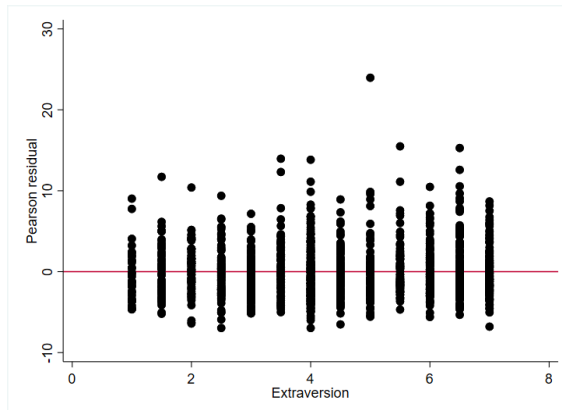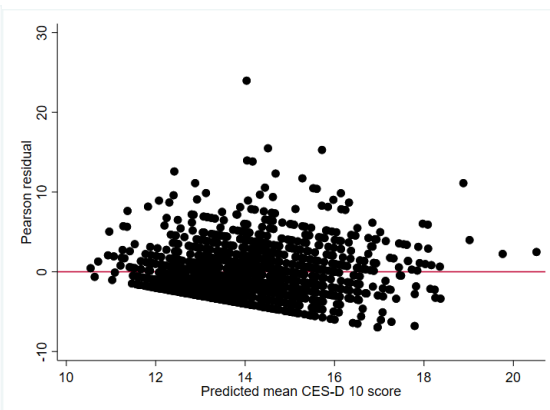


Graph 9. *Distribution of residuals*
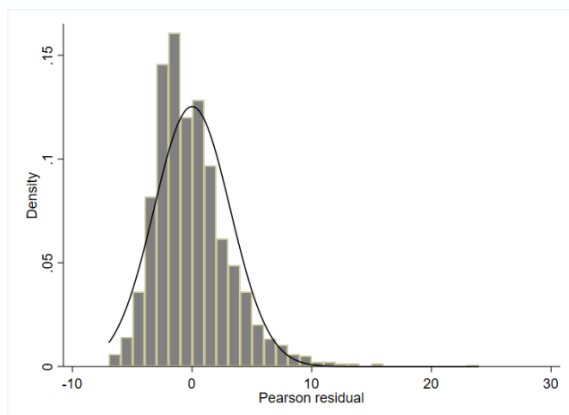


There was one observation with a large Pearson residual. This person had a CES-D 10 score of 28, an Extraversion score of 5 and a Neuroticism score of 6. The participant was a 66-

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year-old female. Again, there was no reason to believe anything wrong with the observation, so it

was kept in the model.

**Group 4: Extraversion model for participants aged 75+**

Graph 10. *Residuals and Extraversion*          Graph 11. *Residuals versus Fitted values*



Graph 12. *Distribution of residuals*



The one outlier had a CES-D 10 score of 30, an Extraversion score of 4 and a

Neuroticism score of 6.5. It was a 77-year-old male.

**Neuroticism Model**

Graph 16. *Residuals and Emotional Stability*     Graph 17. *Residuals versus Fitted values*

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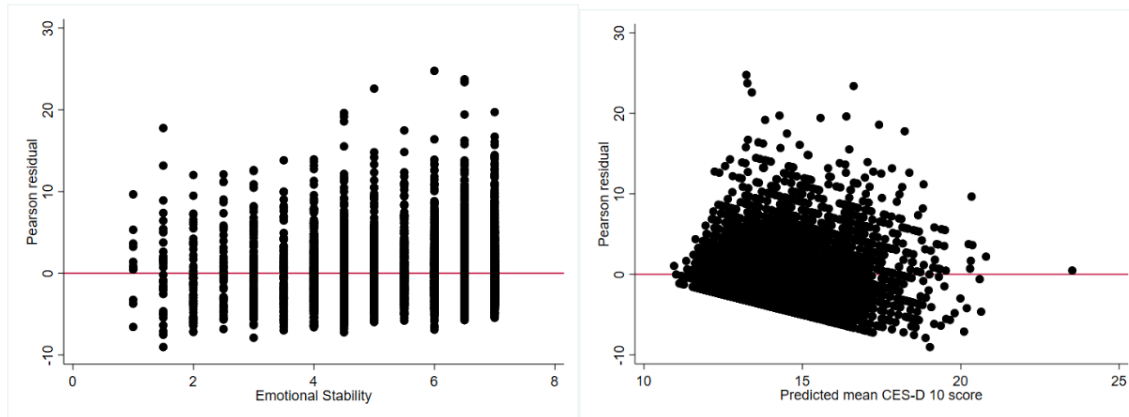


Graph 18. *Distribution of residuals*
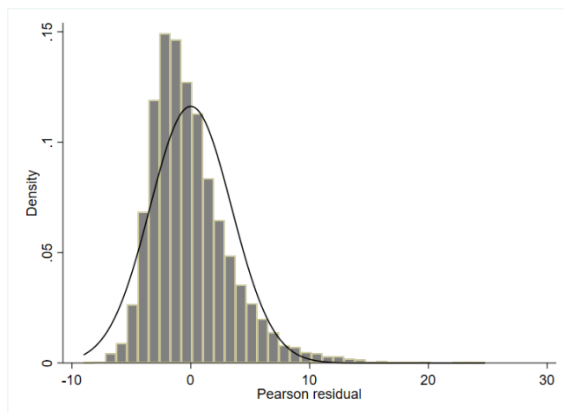


There were four observations with large Pearson residuals. All four had high depressive symptoms score (26-30) as well as high Emotional Stability scores (5-6.5). The four observations had been identified in previous models and all shared two commonalities: they had high CES-D scores and high Emotional Stability scores. It makes sense that these four participants would be outliers as their high score on both scales is opposite to the model's prediction.