The Effect of Religious Participation on Cognitive Function in Middle-
and Old-Aged Adults: A Sequential Explanatory Mixed Methods Study
of the Canadian Longitudinal Study on Aging

by

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Author's Declaration

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

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Abstract

Background: Preserving cognitive health is a crucial aspect of successful aging. Atypical cognitive decline is linked to the onset of dementia disorders such as Alzheimer's disease. Even normal cognitive deterioration can negatively influence the health of aging populations. Religious involvement has been shown to have a positive impact on cognitive function. However, this association has not been explored in the Canadian population.

Methods: This thesis aimed to investigate the association between frequency of religious participation and cognitive function among middle- and older-aged adults. The thesis included two parts forming a sequential-explanatory mixed methods study. The quantitative part of this study was conducted at the population-level and included analyses of baseline data from between 8,047 and 28,701 individuals aged between 45 and 85 years, depending on the analytical sample and regression model, who were recruited as part of the Canadian Longitudinal Study on Aging (CLSA). The quantitative analyses were supplemented and enhanced with a qualitative study involving members of Christian communities, including pastors and parishioners. These individuals mirrored the characteristics of CLSA participants. The intention of undertaking the qualitative component was to augment the quantitative results with pastors' and parishioners' interpretations and explanations of these results.

Results: The quantitative analyses did not find a substantial number of statistically significant associations between frequency of religious participation and cognitive function, following adjustment for an array of demographic, health related, social, and socioeconomic covariates. Based on the qualitative findings, frequency of religious participation may not be an accurate representation of the wider construct of religious involvement. The qualitative findings suggested that religious involvement, if considered in broader terms than just the act of participation, may

be associated with improved mental health, social interaction and support, and an active mind, all of which have positive impacts on cognitive function.

Conclusions: Frequency of religious participation did not capture the breadth of religious involvement in the quantitative sample and, as such, few of the findings were statistically significant, and some findings contradicted our hypothesis of a positive association between religious participation and cognitive function. However, religious participation extends beyond simply attending church services. Future research needs to employ a broader range of measures of religious participation to more fully assess the association between religious involvement and cognitive function.

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List of Abbreviations

aOR	Adjusted Odds Ratio
ADL	Activities of Daily Living
AFT	Animal Fluency Test
APOE	Apolipoprotein E
APP	Amyloid Precursor Protein
CCHS	Canadian Community Health Survey
CES-D	Center for Epidemiologic Studies-Depression
CI	Confidence Interval
CLSA	Canadian Longitudinal Study on Aging
COWAT	Controlled Oral Word Association Test
EMT	Event-based Prospective Memory Test
GSS	General Social Survey
HR	Hazard Ratio
IADL	Instrumental Activities of Daily Living
MAT	Mental Alternation Test
MCI	Mild Cognitive Impairment
MMSE	Mini Mental State Examination
NuAge	Quebec Longitudinal Study on Nutrition and Aging
RAVLT	Rey Auditory Verbal Learning Test
RDD	Random Digit Dialing
R/S	Religion/ Spirituality
SD	Standard Deviation
SPMSQ	Short Portable Mental Status Questionnaire
SSA	Social Support Availability
STROOP	Stroop Neurological Screening Test
TMT	Time-based Prospective Memory Test

CHAPTER I: THESIS SUMMARY AND GENERAL INTRODUCTION

1.0 Thesis Summary

This thesis is a sequential explanatory mixed methods study undertaken to investigate the association between religious participation and cognitive function. The Canadian Longitudinal Study on Aging (CLSA) [1] was used to explore this association quantitatively. The CLSA is a population-level study of persons aged between 45 and 85 years who were recruited from across Canada. Using regression models, we examined the relationship between the frequency of religious participation and two domains of cognitive function (i.e., memory, executive function), while controlling for a variety of covariates (e.g., age, chronic health conditions, social engagement). To assess religious participation, the CLSA asked participants the following question: "In the past 12 months, how often did you participate in church or religious activities such as services, committees, or choirs?" In recognition of the multifaceted nature of cognitive function, we assessed memory and executive function using seven of the cognitive measures available in the CLSA (i.e., Rey Auditory Verbal Learning Test, [2] Animal Naming Test, [3] Mental Alternation Test, [4] Victoria Stroop Test, [5] Controlled Oral Word Association Test, [6] and Time- and Event-Based Prospective Memory Tests [7]).

Previous studies examining religious service participation and cognitive function typically included a small number of measures of cognitive function, such as only the Mini Mental State Examination (MMSE). [8] Previous research also tended to recruit participants from highly select populations (e.g., Mexican-Americans aged 65 years or older; [9] individuals admitted to a single clinic [10, 11, 12]). This thesis adds to the existing literature by examining the association between religious participation and cognitive function using a wider variety of cognitive measures to reflect the depth of the construct of cognition. Further, the thesis analyzed

data from participants who were being followed in a population-level study, thereby avoiding

selection biases that may arise from attempts to make inferences about entire populations from

limited sample frames. The set of covariates controlled for in this thesis was also broader and

more inclusive than any set included in prior research on the topic.

A second component of this thesis was a qualitative analysis undertaken through

interviews with pastors and parishioners, who provided their perspectives and explanations of the

quantitative findings, making the design of this thesis a sequential-explanatory mixed-methods

study. No prior study of religious service participation and cognitive function employed a mixed-

methods approach to help explain quantitative research findings. The augmentation of the

quantitative results with the qualitative interviews allowed for a more in depth understanding of

the mechanisms that might explain the quantitative findings and delving deeper into the nature of

the association between religious service participation and cognitive function. Indeed, mixed-

methods research designs enrich one's understanding of complex health research questions (e.g.,

the association between religion and health) through the integration of different types of research

findings (quantitative and qualitative). [13] Understanding the association between religious

involvement and cognitive function is a complex issue because religious constructs are open to

subjective interpretation and therefore not easily measurable.

1.1 Introduction

1.1.1 Religion and Spirituality

Although religion and spirituality are different constructs, the terms are often used

interchangeably in the healthcare literature. [14] Religion is a social phenomenon characterized by

an organized set of beliefs, institutionalized practices, membership, and modes of organization,

all held common by a group of people who follow an authoritative dogma revolving around the worship of one or more deities. [14, 15] Religion is focused on the search for the sacred within a formal institutional structure or through a coherent set of identifiable beliefs.

Spirituality is an individualistic set of beliefs about the existence of a human spirit or soul that transcends the material or physical things experienced in daily life. [16] Spirituality is a component of many religions; however, people can be spiritual without being religious, or vice versa. Spirituality refers to a sense of connection with something bigger than oneself and involves a search for meaning in life through transcendence. [17]

According to Hill and colleagues, religion and spirituality involve thoughts, feelings and experiences. However, religion involves "the means and methods of the search [for the sacred] that receive validation and support from within an identifiable group of people" [p. 66]. [17] Thus, religion is defined as a construct that may encompass both organizational and individual beliefs and practices. Spirituality is defined as an individual's search for the sacred, which may or may not be religious. Although one could be spiritual without being religious, spirituality is one of religion's most central functions. [18]

1.1.2 Religion/Spirituality and Health

In recent years, interest in the connection between religion/spirituality (R/S) and health has increased markedly, and many journals now publish studies in this area. [19] Researchers in the field seek to identify the elements of R/S that are linked to health-related outcomes. These elements include the social component of religiosity (e.g., the sense of belonging and support derived from being part of a like-minded group of individuals) or the 'active' mind developed through religious and spiritual study (e.g., reading and interpreting the meaning of scripture).

Understanding exactly how R/S influences health is complicated because religion and spirituality are multidimensional concepts. [14] Thus, several proposed causal mechanisms exist to explain how R/S affects health. These mechanisms include: i) promotion of healthy behaviours (e.g., diet, exercise); ii) provision of social support; iii) provision of coping strategies in response to stressful situations and negative life events (leading to improvements in psychological states); and iv) promotion of healthy beliefs, positive self-perceptions, and overall mental health. Each mechanism is explained in detail below.

i) Promotion of healthy behaviours (e.g., diet, exercise)

R/S can promote psychological and physical well-being by encouraging a healthy lifestyle, which can reduce the risk of chronic disease. For example, in Christianity, the body is viewed as a 'temple of the Holy Spirit', meaning Christians should take care of their physical bodies to avoid defiling a gift from God. Further, Judaism promotes the importance of a healthy and balanced lifestyle and Islam places heavy emphasis on the importance of health and the promotion of health-enhancing activities.

R/S is associated with health-related behaviours such as better diet and exercise habits, and lower rates of smoking, [20-22] drinking, [23-25] and risky sexual activity. [26, 27] Further, many previous studies have reported inverse associations between R/S and outcomes such as coronary heart disease, [28-30] hypertension, [31-34] Alzheimer's disease and dementia, [35-36] cerebrovascular disease, [37, 38] cancer, [39-42] physical disfunction, [43-46] endocrine disfunction, [47-50] immune disfunction, [51-54] pain and somatic symptoms, [55] and poor self-rated health and mortality. [56-58]

ii) Provision of social support

According to Oman and Thorensen, [59] R/S can help people establish social ties in a community, which might promote psychological stability. Previous research has documented the beneficial effects of diverse types of social involvement on health outcomes and has found positive associations between socially active lifestyles and greater scores on memory and intelligence tests in community-dwelling older adults. [60, 61]

Bassuck and colleagues [62] posit that a socially-engaged lifestyle provides multiple benefits to one's cognitive health through: the mobilization of cognitive faculties leading to a dynamic environment; increased availability of emotional support from one's family and friends; and the provision of a sense of commitment and belonging to a community, hence creating a sense of purpose and fulfilment.

While few studies have tried to separate the health effects of R/S from broader social engagement, at least part of the apparent relationship between R/S and health outcomes may be due to the role of religious groups in providing social ties and support. [62]

iii) Providing a coping strategy in response to stress and negative life events

R/S provides a sense of meaning, coherence, hope, and purpose in life, which could provide an effective way of coping with feelings of stress, anxiety, and depression, particularly as people progress into old age. Using religion as a coping strategy may lead to reappraisals and reassessments of the meaning of negative life conditions, seeing them as opportunities for learning and growth, or as part of a larger divine plan. [63] According to Koenig, [64] religious faith can be an important source of hope among the elderly, offering both emotional and physical means of promoting well-being. By providing an outlet for feelings of stress and depression, R/S protects against the physiological effects of these feelings (e.g., elevated blood pressure).

Previous research suggests that R/S assists people in better dealing with hardship, including both external adversity (e.g., death of spouse, loss of employment) and internal adversity (e.g., genetic vulnerability to mental disorders). [65] Religious coping adds meaning to difficult life situations and creates a sense of purpose in life. Through providing a coping mechanism, and through reducing the strain on one's emotional and mental health, religious coping could exert protective effects against hippocampal atrophy and cognitive decline. [66] Koenig et al. [67] assert that religious activities are coping resources promoting mental health and protecting against physiological responses to stress. The physiological changes associated with stress and depression can adversely affect brain areas implicated in memory.

In the Handbook of Religion and Health, [67] Koenig and colleagues identified studies examining how R/S helped people cope with a variety of illnesses and stressful situations. They identified several mechanisms through which R/S could influence mental health, including: religion as a resource for coping with stress and potentially enhancing positive emotions and buffering against feelings of stress-associated emotional disorders, including depression, anxiety, suicide, and substance abuse; stress reduction through abiding by religious rules and guidelines; and promotion of feelings of love, compassion and acts of altruism toward others.

Further, the social support offered through religious participation could provide positive health effects through reduction of the negative impacts of stress in people's lives. According to the stress-buffering model, social support offers a buffering and protective effect against the potentially adverse influences of stressful situations. [68] Particularly, the provision of emotional support could lead to reduced physiological arousal and inhibit overactive arousal at times of stress, protecting against stress-associated adverse outcomes.

Stress arises because of one's perceived inability to cope with difficult situations that require an active response. Previous studies have shown the association between stress and a variety of illnesses; the major mechanisms through which chronic and excessive stress and illness are linked to one another include disruptions of neuroendocrine, or immune functioning, degeneration in brain parts including hippocampus, failure to care for oneself, or changes in health-related behaviours such as poor diet, or substance abuse. [68] The social support provided through activities such as religious participation could alleviate stress by intervening between a stressful situation and one's reaction through attenuating a stress appraisal response, or by intervening between a stressful experience and disease onset (e.g., through eliminating stress, or affecting physiological pathways directly).

iv) Promotion of healthy beliefs and positive self-perceptions

R/S may also lead to improved health by promoting feelings of self-worth or self-esteem, as well as perceptions of being in charge of one's destiny, and a sense of control over one's own affairs. [67] By believing that a higher power is in control and that praying to this higher power can change one's circumstances, people may develop a belief that their situations can be altered or that they can obtain the strength to overcome feelings of helplessness, hopelessness or loss of control. [68] In such a way, believing in a higher power could negate feelings of stress, and depression which could otherwise adversely impact one's mental and physiological health.

1.1.3 Measures of Religion/Spirituality

Due to the broad-based nature of R/S, researchers have developed and employed a variety of measures to assess levels of R/S in research studies. To date, no comparative review of the strengths and limitations of different R/S measures has appeared in the literature.

A large number of R/S measures rely on self-report. Researchers ask participants to report on their degree of religious activity, [69-71] which may include attendance at religious services, [10] frequency of prayer, [72] or the extent of involvement in organized or private religious activities (e.g., Bible study, member of a local religious governing body). [73] Other self-reported measures include intrinsic religiosity, [73] self-rated religiosity/spirituality, [73, 12] religious affiliation, [73, 74] religious belief, [34, 74] religious coping, [75] and religious self-identity. [76]

Some validated measures of religiosity have been developed and administered in prior research, including the following:

- 13-Item Muslim Religiosity Scale; [77]
- Behavioral Religiosity Scale (BRS); [78]
- Francis Short Scale (FSS); [79]
- Duke University Religion Index; [80] and
- Religious Coping Index; [81]

These scales are composed of open- and closed-ended questions asking about religious practices, [77] intrinsic religious beliefs, [77] frequency of participation in religious activities, [78] organizational and private religious practices, [80] intrinsic attitudes toward Christianity, [79] and the extent to which respondents use religion as a coping behaviour. [81] These scales generate scores representing the degree of respondents' religious involvement and beliefs.

1.1.4 Cognition

Cognition is "the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses". [82] Cognition is a multifaceted construct made up of several underlying domains, or mental processes, that involve learning, intuition, executive

function, language, awareness, judgment, reasoning and memory. Among these domains, memory and executive function are especially associated with healthy aging since they are important for performing daily independent tasks such as self-care or adherence to medications. [83]

1.1.4.1 Memory

Memory is an encoded representation of an event in life and involves changes happening in the brain as a result of one's experiences, thereby allowing people to modify behaviours based on past experiences. [84] Long-term memory involves the recollection of one's life and is divided into implicit and explicit memory. [84] The implicit memory, also called non-declarative memory, operates without conscious awareness once learned, and it requires repetition and practice. The implicit memory is the memory component containing the procedural memory related to tasks, skills, behaviours and habits (e.g., how to ride a bicycle). [84] The brain areas responsible for this type of memory include the basal ganglia and cerebellum. The explicit or declarative memory is responsible for facts, events, and spatial components. It can be consciously recalled and could easily be accessed or forgotten (e.g., recalling who attended a dinner party). [84] The explicit memory contains the declarative memories related to facts and events and is further broken down into episodic (memories related to events and experiences) and semantic (memories related to facts and concepts) memory types. [84] Assessments of declarative memory include tests such as Rey Auditory Verbal Leaning Test. [2] The explicit memory involves processing of information over time and several brain parts play key roles in this type of memory. These include cingulate gyrus, parahippocampal gyrus, anterior nuclei of thalamus, mediodorsal nucleus of thalamus, amygdala, and prefrontal cortex. [85]

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Episodic memory requires recognition and recall of information. The literature has shown age-associated declines in the episodic memory recall. [86] In contrast to the episodic memory, the semantic memory seems to improve with aging and procedural memory appears to remain well-preserved in normal aging. [86] However, these memory types may be affected in abnormal aging. [86] The episodic memory is controlled by key brain areas located in the medial temporal lobes including the hippocampus and the entorhinal and parahippocampal regions. [86] The hippocampus works closely with the frontal regions of the brain, including the prefrontal cortex (implicated in episodic memory and executive function). Evidence for the role of hippocampus in episodic memory comes from neuroimaging data revealing damage to the hippocampus in persons with Alzheimer's disease. [86]

1.1.4.2 Executive Function

Executive function is a broad term for a set of cognitive skills that involves mental control and self-regulation. [87] It refers to the processes needed to manage oneself and one's resources to achieve a goal. [87] According to Diamond, there are three subtypes of executive function, i.e., working memory, cognitive flexibility, and inhibitory control. [88] Working memory, which is independent from the memory domain of cognitive function, involves one's ability to hold information in mind and manipulate this information, not just to recall the information. [88] Working memory is important for understanding anything that unfolds over time and connecting it to future events. It develops early in life and continues to grow throughout childhood and teen years. Measures of working memory include tasks such as manipulation or reordering lists of memorized words. Cognitive flexibility develops later in life and involves being flexible enough to adapt to altered demands or priorities. [88] It is usually assessed through a variety of task switching and set shifting tasks such as the Mental Alternation Test. [4] Lastly, inhibitory control

requires being in control of one's behaviour, thoughts, attention and or emotions to prevail an internal or external distraction and instead carry on what is appropriate or necessary. [88] In particular, inhibitory control of attention allows individuals to selectively focus on the task at hand and suppress other stimuli enhancing self-control and discipline. Assessments of inhibitory control include tests like the Stroop Neurological test. [5]

Executive function is essential for mental and physical health, as well as for cognitive, social and psychological development. [89] The prefrontal cortex of the frontal lobe and the various neuronal connections to different cortical, subcortical and brainstem regions are primarily responsible for executive functions. [89] Dorsolateral prefrontal cortex, anterior cingulate cortex and orbitofrontal cortex are the main areas of the brain involved in tasks associated with executive function. [90] Since executive function controls a vast array of tasks produced by interconnection and collaboration between several major cortical structures, any deterioration in its functioning due to aging is a matter of clinical concern.

1.1.4.3 Deterioration in Cognitive Function

Cognitive impairment could limit a person's ability to carry out instrumental activities of daily living, perform self-care, or adhere to medication regimens. Although some declines in cognitive function may occur with aging, decline beyond a certain point exceeds the bounds of normality. Both biological and cultural/environmental factors influence cognition. Research has shown that some cognitive functions are impaired by aging, but other cognitive tasks are not. [91] For instance, tasks related to the domains of executive function and memory are more prone to age-associated cognitive decline. Particularly, episodic memory and the three sub-components of executive function decline throughout life and with aging. [88] Further, abnormal cognitive decline may involve deterioration in several other cognitive domains, including global functioning,

learning, comprehension, verbal expression and retention of new information. Although researchers originally thought that cognitive impairment in the elderly was part of the normal course of aging and therefore not preventable or alterable, evidence now demonstrates that cognitive features are adaptable across the lifespan and the loss of cognitive function is not a given as people age. [92] Indeed, impairments in memory could be an early sign of dementia or progression to Alzheimer's disease (AD), and dysfunction in other cognitive domains besides memory could signal vascular dementia or other non-Alzheimer dementias. [93-95] Overall, cognitive decline could lead to negative consequences for one's overall functioning and reduce one's ability to stay independent and respond to age-related environmental changes. [93, 96]

Several biological, lifestyle and environmental factors influence the risk and time of onset of cognitive decline. These include factors such as age, [97] sex, [98] genetic factors, [99] stroke, [100] depression, [101] education, [102] income, [103] marital status, [104] and loneliness and isolation. [105] These factors are briefly discussed below.

Studies have shown the negative associations between age and cognitive function, demonstrating that cognitive function reduces as age increases. [106] Further, the incidence and prevalence of dementia increase with age. [107-108]

Further, some studies have reported that being a female increases the incidence of dementia. [107] In the United States, about two thirds of community-dwelling dementia patients are female. [109] Previous research has also highlighted the importance of developing sex-specific timelines for the progression of Alzheimer's disease, since studies have shown that among Mild Cognitive Impairment (MCI) patients, cognitive scores worsen to a greater degree in females compared to males. [110]

Genetic factors, including being a carrier of the ε4 allele of the apolipoprotein (APOE) gene, as well as amyloid precursor protein (APP), have been reported to be associated with a higher risk for the development of Alzheimer's disease. [109, 111]

Stroke is a factor with modifiable risks that is negatively linked to cognitive function. A systematic review of the literature on the effect of strokes on cognitive function revealed that global cognitive function and executive function were significantly reduced post-stroke. [112]

Depression is another factor that is inversely linked to cognitive function. Longitudinal research has shown that depression is associated with lower cognitive functioning and persons with depression demonstrate worse cognitive performance. [101]

Education is a modifiable factor that is positively related to cognitive function. Lower education has been found as a risk factor related to greater incidence of dementia, [107] and higher levels of education have been found to be associated with higher cognitive scores in middle-aged adults. [102]

The beneficial effects of higher socioeconomic status and greater income have been shown in relation to better cognitive scores. [103] Further, lower monthly incomes have been reported for those with cognitive problems, compared to those without any cognitive issues. [113]

Being married in midlife lowers the risk of cognitive impairment by half, [104] whereas living with no spouse or as a single person increases the risk of cognitive impairment [104] and dementia. [107] In contrast to being married, loneliness and social isolation increase the risk of cognitive decline due to reduced social support. Further, loneliness has been identified as a risk factor for cognitive decline since it is associated with depression. [107] However, loneliness, in and of itself has been shown to independently affect cognition, and prior studies have found links

between loneliness and greater progression to dementia. [114] In particular, one study found a 20% faster rate of cognitive decline for those who were lonely at baseline (compared to participants who were not lonely) over the course of 12 years, after adjusting for socioeconomic factors, health, social networks, and baseline depression. [115]

1.1.4.4 Social Support and Cognitive Function

The literature points to the positive effect of social support in protecting against cognitive decline. [116- 119] A recent study reported several factors linked to maintenance of cognitive function, including engagement in social activities in mid- and later life. [120] This study found that engagement in such activities may lead to increasing cognitive reserve, stimulation of cognitive growth, and maintenance of neuronal function.

The role for social support and social integration as protective factors against cognitive decline is shown by prior work in the area. [120] Social support could provide people with feelings of esteem and confidence, [121] and protect against the negative impacts of stress and feelings of depression that lead to cognitive deterioration. People with better social support exhibit better cognitive functioning in later life; [122- 123] however, the mechanisms through which social support may promote better cognitive functioning are still unclear. Nevertheless, a few hypotheses are proposed regarding this association. These include: the stress-buffering hypothesis, cognitive stimulation theory, and physical activation theory. According to the stress-buffering hypothesis, provision of social support could indirectly affect cognitive function through reduction of physiological arousal in times of stress, which would otherwise adversely impact brain areas, including the hippocampus. [102] Hippocampal atrophy due to neuronal loss is a core feature of Alzheimer's disease, [121] and is associated with negative health consequences. [124- 129]

The cognitive stimulation theory posits that cognitive function is directly influenced by social support through the stimulation of several mental processes (e.g., memory, executive function, language) involved in social interactions. [123] The stimulation of these processes may promote neuronal growth and regeneration, and subsequently improve cognitive function.

Lastly, the physical activation theory proposes that physical activity increases as a result of social interactions and socialization, particularly within large social networks. [121] Through increased physical activity, one's general health can improve, potentially reducing the risk of vascular diseases that could lead to cognitive decline and development of dementia. [121]

1.1.4.5 Measures of Cognitive Function

Unlike clinical markers such as blood pressure, heart rate, bone density, or lung function, cognitive function cannot be measured using clinical tools like sphygmomanometers, dual-energy X-ray absorptiometry scanners, or spirometers. Instead, the various domains of cognition are assessed indirectly using a range of validated questionnaires or performance tasks, which can be administered in many fashions (in-person paper-and-pencil, in-person via computer, or over the telephone). Individuals' responses to these questionnaires/tasks are used to derive performance scores reflecting levels of cognitive functioning or impairment, depending on the instrument in question. Some of the most commonly assessed domains of cognitive function, and a list of questionnaires (not exhaustive) to measure cognition in each domain, are:

Attention: Continuous Performance Test, [130] Digit Span, [131] Digit Vigilance, [132] Paced Auditory Serial Addition Test (PASAT), [133] Serial Sevens; [134]

Executive Function: Wisconsin Card Sorting Test, [135] Trail Making Test, [136] Mental Alternation Test, [4] Animal Naming Test, [3] Victoria Stroop Test (and variants), [5] Controlled Oral Word Association Test (COWAT), [6] Mini-Mental State Examination (MMSE); [8]

Verbal Learning and Memory: Wechsler Memory Scale (WMS), [137] the Benton Visual Retention Test, [138] Verbal Paired-Associate Learning, [139] Rey Auditory Verbal Learning Test, [2] Hopkins Verbal Learning Test, [140] Tactual Performance Test, [141] the Symbol-Digit Learning Test; [142]

Psychomotor Ability: Finger Tapping Test, [143] Digit-Symbol Substitution Test; [144]

Visuospatial Processing Ability: Block Design, Object Assembly, Rey-Osterreith Complex Figure, [145] Hooper Visual Organization Test; [146]

Intellectual Functioning: The Weschler Adult Intelligence Scale (WAIS), [147] WAIS Revised, Stanford-Binet Intelligence Scale-IV; [148]

Language / Verbal Abilities: Boston Naming Test, [149] Token Test, [150] Multilingual Aphasia Examination; [151]

Processing Speed: Symbol Digit Modalities Test, [152] Choice Reaction Time Test; [153] and

Perceptual Ability: Critical Flicker Fusion test, [154] determination of auditory thresholds, and time estimation.

1.1.5 Religion and Cognition

Several studies have investigated the link between R/S and cognition, [74, 76, 77, 79, 155] with the general finding being that R/S preserves cognitive function. [156, 157] This is thought to occur because R/S encourages an active and socially engaged lifestyle that mobilizes cognitive

faculties and enhances neural reserves, leading to better cognitive functioning. [158] Indeed, R/S as a form of social participation provides social support within rich and dynamic environments (e.g., participation in prayer groups, reading scripture) that serve to stimulate high cognitive demands.

Further, the association between R/S and cognitive function has been reported to be mediated by psychological factors, including feelings of optimism and happiness, which are generated via integration into socially engaging and cognitively stimulating activities. [158] By promoting positive psychological states such as optimism, hope and happiness, various forms of religious involvement, including prayer, reading scriptures, and participation in religious discussions, could protect against stress, depression and cognitive deterioration. In fact, epidemiological studies have indicated that religious involvement is associated with a lower risk of depression, [158] which may preserve cognitive function. A study by Reyes-Oritz et al [36] found that people with symptoms of clinical depression and infrequent church attendance were at greater risk of cognitive decline, as assessed by the MMSE ($p < .001$), compared to persons with depression symptoms and frequent church attendance. The joyful nature of religious celebrations may counteract the symptoms of depression and buffer the effect of stress on cognitive function in persons suffering from depression.

1.2 Literature Review

As background preparation for this thesis, the doctoral candidate conducted a systematic review of the literature. This review, and the review's protocol, have both been published in peer-reviewed journals. [156-157] A copy of the review is included in Appendix A; a brief summary of the review is written below.

The primary objective of the systematic review was to investigate the association between R/S and cognitive function in adults of any age and any setting. The review also included two secondary questions: 1) does social engagement act as a mediator/moderator of the effect of R/S on cognitive function and 2) does the association between R/S and cognitive function differ according to how each of these constructs is measured?

The literature search encompassed studies indexed in OVID MEDLINE, PSYCHINFO, or EMBASE, and published between 1990 and September 2016. The search was re-run in May 2019 to determine if any eligible new articles were published between September 2016 and May 2019, and two new articles were identified [159-160] (for the list of new and existing articles see the systematic review in Appendix A). The references of included articles were also searched for relevant citations. We included studies with a comparison group (cohort, case-control, cross-sectional) that reported on R/S (exposure) and cognitive function (outcome).

A total of 6,300 citations were retrieved and 17 met our eligibility criteria for inclusion in the review. Most of the included studies reported that greater R/S was associated with better cognitive function and lower cognitive decline.

1.3 Theoretical Model (Framework)

Currently, no theoretical model exists to explain the specific association between R/S and cognitive function. However, Berkman et al.'s framework about the impact of social networks on health may be adapted to explain the relationships of interest in this thesis. [161] Social networks are defined as the number of people an individual is connected to through personal relationships, as well as the frequency of contact with these people. [162] In Berkman et al.'s model, social networks are embedded in a larger sociocultural context, where social and cultural factors (e.g.,

neighbourhood characteristics, norms and values such as children living with parents before getting married) influence the network structure. The network structure influences social and interpersonal behaviours (e.g., frequency of face-to-face interactions, reciprocity, reinforcement of meaningful social ties, attitudes and norms towards help-seeking), ultimately leading to a mix of health outcomes (e.g., varying life expectancies or chronic disease incidences).

Berkman et al.'s model suggests that social networks provide opportunities for psychosocial mechanisms to operate at the behavioural level through four primary pathways: (a) provision of social support, (b) social influence, (c) social engagement and attachment, and (d) access to resources and material goods. Through these psychosocial and behavioural processes, more proximate pathways to health outcomes are affected. These health pathways include direct physiological stress responses, psychological states, traits such as self-esteem and self-efficacy, behaviours that damage (e.g., alcohol or tobacco consumption) or promote (e.g., medical adherence, exercising) health, and exposures to infectious disease agents (e.g., tuberculosis). Thus, in Berkman et al.'s model, social networks are proposed as mechanisms of action that work alongside other sets of sociocultural factors (e.g., cultural, socioeconomic, political) to influence health outcomes.

This dissertation proposes that religious participation is a form of social engagement that can be studied alongside other forms of social networks, social support, and social participation. Figure 1a depicts a simplified version of the linkage between religion, social networks, support, participation on the one hand, and cognitive function on the other hand. As shown in the figure, the doctoral candidate does not propose that social engagement variables (social networks, social support, social participation) mediate the relationship between religious participation and cognitive function. Rather, religious participation functions alongside these other variables.
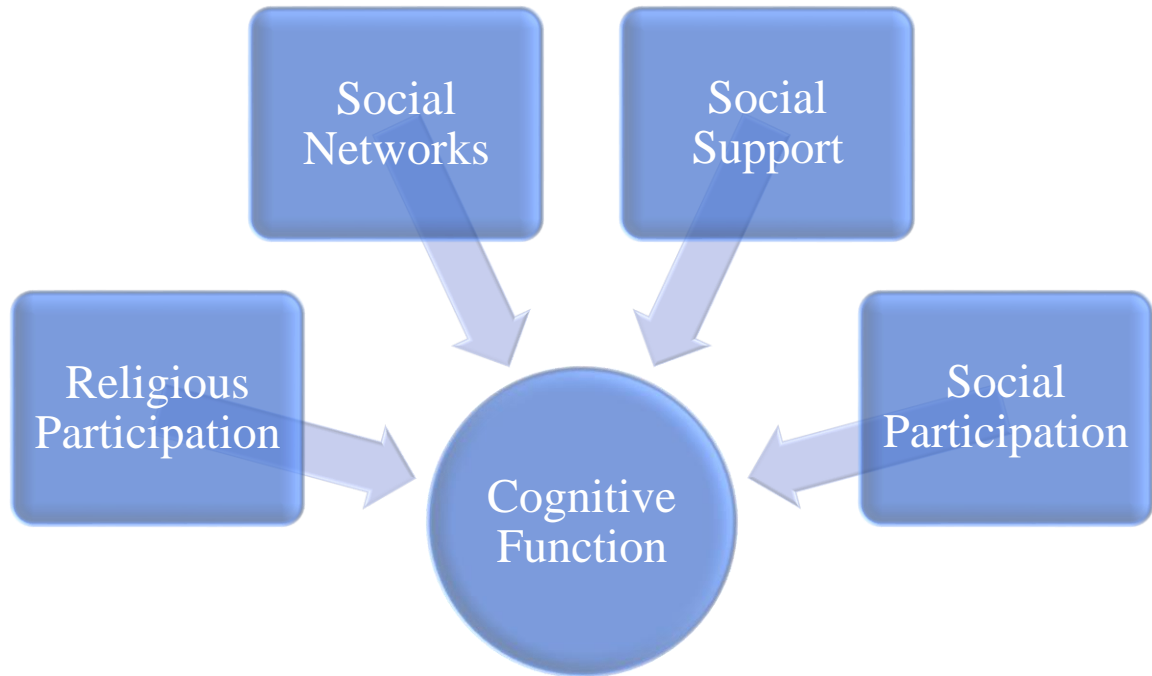
Figure 1a. Association between Religious Participation, Social Networks, Support, Participation, and Cognitive Function

1.4 Research Hypothesis and Thesis Rationale

This thesis investigated the following research question: what is the association between the frequency of religious participation and cognitive function in middle- and older-aged, community-dwelling adults in Canada? The doctoral candidate's hypothesis was that the frequency of religious participation would be positively associated with cognitive function in this group of people.

Given the theoretical framework depicted in Figure 1a above, coupled with the fact the doctoral candidate's systematic review showed that most published studies in the field failed to control for the effect of social engagement variables, the candidate decided to investigate the relationship between religious participation and cognitive function while controlling for social support, social networks, and social participation. In addition, she controlled for a variety of other covariates (see Figure 1b), including demographic (sex, age, marital status, highest

education level), socioeconomic (i.e., income status) and health variables (i.e., general health, chronic conditions including hypertension, diabetes, myocardial infarction).

Since the literature suggests an association between R/S and cognitive function, and many people in Canada have religious or spiritual affiliations, understanding this association is relevant from the perspective of lifestyle exposures and health. Indeed, approximately 76% of Canadians reported some R/S affiliation in 2011. [163]

Prior studies on the topic [157] (refer to Appendix A) enrolled highly selective samples, such as persons with Alzheimer's disease from single speciality clinics, people aged ≥ 65 years who resided in specific cities or regions, particular ethnic groups (e.g., Mexican-Americans aged ≥ 65 years), or persons admitted to specific medical centres or outpatient clinics. These studies also tended to employ limited means of measuring cognition (primarily the MMSE).
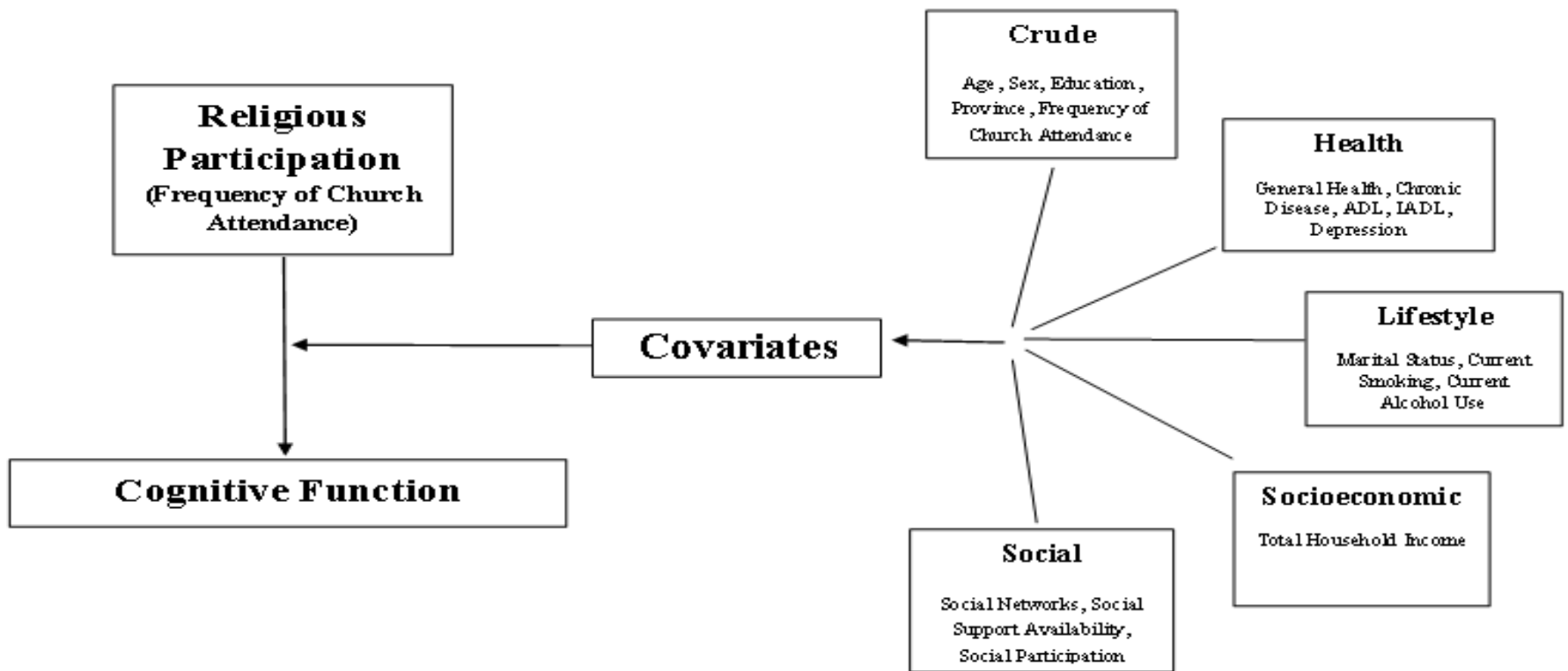
Figure 1b. Diagram of Associations between Frequency of Church Attendance, Cognitive Function, and Covariates

Exposure variable: Religious Participation

Outcome variable: Cognitive Function

Covariates: Age, Sex, Education, Province, General Health, Chronic Disease, Activities of Daily Living (ADL), Instrumental Activities of Daily Living (IADL), Depression, Marital Status, Current Smoking, Current Alcohol Use, Total Household Income, Social Networks, Social Support Availability, Social Participation

This thesis overcomes the limitations of previous research in several ways. First, this study included participants recruited at the population level, rather than from narrow sub-groups of the population, thereby limiting some selection bias. Second, this thesis included several different cognitive measures to enable the assessment of two cognitive domains (memory, executive function). The full range of cognitive measures (domains) in this study included the following: Rey Auditory Verbal Learning Test (memory), [2] Animal Fluency Test (executive function), [3] Mental Alternation Test (executive function), [4] Victoria Stroop Test (executive function), [5] Controlled Oral Word Association Test (executive function), [6] and the Event- and Time-Based Prospective Memory Tests (executive function). [7] Third, the thesis included a measure of religious participation along with data on most of the variables that have been included as potential covariates in prior studies of R/S and cognitive function (Section 2.0.3.3). Fourth, this thesis included data on social participation, social support, and social networking, which were absent from most of the previous studies on the association of interest. These 'social' data are essential to consider if one wishes to tease out any additional effect of R/S over other forms of social engagement.

In addition to the aforementioned points, the thesis included a qualitative component, where the findings from the quantitative data analysis were supplemented with explanations obtained from interviews with religious leaders and parishioners. This allowed the doctoral candidate to contextualize the quantitative results of the study using the perspectives of persons immersed in R/S, rather than relying solely on her own perceptions and interpretations of the results to craft the discussion.

CHAPTER II. METHODS

2.0 Quantitative Analyses

2.0.1 Data Source and Study Population

This dissertation used data from the CLSA, [1] a nation-wide longitudinal study of 51,338 men and women who were aged between 45 and 85 years at the time of recruitment. Baseline recruitment took place between 2010 and 2015. CLSA participants are being followed every three years for at least 20 years, with assessment undertaken on a range of clinical, social, neuropsychological, and lifestyle variables. The primary goals of the CLSA are to study aging from a multidisciplinary and life-course perspective, to identify factors that promote healthy aging, and to help guide policymaking in aging and health. Of the 51,338 participants, 21,241 were randomly recruited from across the 10 provinces to receive a 60-minute telephone interview (CLSA Tracking sample). The other 30,097 were randomly recruited from within 25 to 50 kilometers of 11 data collection sites for in-home interviews and in-person visits at their closest site (CLSA Comprehensive sample). Only baseline alphanumeric data were available to the doctoral candidate at the time of data analysis; these baseline data were used in the thesis.

The CLSA recruited participants through partnerships with provincial Ministries of Health, who sent mailouts to persons on the provincial health insurance rolls. Random digit dialing (RDD) through the auspices of a national polling firm (Leger Marketing) was also used to recruit participants. Further, the Tracking sample obtained recruits from the Canadian Community Health Survey-Healthy Aging (CCHS) [164] and the Comprehensive sample obtained participants from the Quebec Longitudinal Study on Nutrition and Aging (NuAge). [165] The CLSA sample frame excluded residents of the three territories, persons residing on federal First Nations reserves and other First Nations settlements in the provinces, full-time members of the

Canadian Armed Forces, institutionalized individuals, and persons who could not understand English or French. [166]

The CLSA established provincial recruitment targets for strata based on age group (45-54, 55-64, 65-74, ≥ 75), sex, and location in or out of the 25- to 50-kilometer catchment area surrounding each data collection site (Tracking sample only). As recruitment enfolded, the CLSA decided to increase recruitment efforts among low education (high school or less) segments of the population, thus leading to another stratum.

The ministries of health sent out introductory letters and information packages that were signed by provincial government representatives and the CLSA's lead principal investigator. These mailouts were targeted to individuals who fell within the CLSA's pre-defined strata. The introductory letter clearly indicated that the mailout was sent by the government on behalf of the CLSA, and that the CLSA did not have access to recipients' identifying information. Recipients who were interested in participating were invited to contact the CLSA via telephone or e-mail, where they provided their contact information and indicated their willingness to be contacted by a member of the CLSA team. During the initial RDD telephone call, interviewers obtained information on whether there was anyone in the household aged between 45 and 85 years. One person within the age group was randomly selected as a potential participant and vetted to determine whether any of the exclusion criteria applied to her or him. If this person was eligible to participate, then Leger Marketing asked for permission to transmit her or his contact information to the CLSA.

CLSA staff phoned all individuals who provided contact information and asked them whether they would be willing to participate in the CLSA. Persons who responded affirmatively were enrolled into the study. All 51,338 CLSA participants were subject to inclusion in this

thesis, although regression analyses (Section 2.0.4.1) only included subsets of participants for whom complete data were available.

2.0.2 Variables

In this thesis, the frequency of religious participation was the independent variable; the memory and executive function tests described in Section 1.1.4.5, as well as the grouping of these tests into the memory and executive function domains of cognitive function, were the primary outcomes (Section 2.0.3.1). The Rey Auditory Verbal Learning Test, Animal Naming Test, and Mental Alternation Test were administered in the Tracking and Comprehensive samples. The remaining tests were only administered in the Comprehensive sample.

The doctoral candidate also extracted the following information from the CLSA study: sample characteristics (i.e., age, sex, highest level of education), socio-economic factors (i.e., income), and health-related factors (i.e., social engagement, smoking, alcohol consumption, depression, functional ability, and co-morbidities [diabetes, hypertension, cerebrovascular event, myocardial infarction, heart disease, Alzheimer's Disease]). These variables were found to be covariates in previous studies on the topic. [138]

2.0.3 Variable Descriptions

2.0.3.1 Exposure Variable – Religious Participation

The CLSA included one question asking about the frequency of religious participation (i.e., church or religious activities including services, committees, choirs) in the last 12 months (daily, once a week, once a month, once a year, never [never = reference category]). This question was dichotomized to any level of participation (daily, once a week, once a month, once a year) versus no participation (never) and served as the main exposure/independent variable.

2.0.3.2 Outcome Variables – Tests of Cognitive Function

Trained CLSA interviewers administered the cognitive tests over the telephone (Tracking) or face-to-face (Comprehensive). Participants' responses to the tests were audio-recorded and scored afterward by CLSA staff in a standardized manner. [167-171] Full details of the administration and scoring of the cognitive tests in the CLSA are available elsewhere. [172-173]

The CLSA's Psychology Working Group selected cognitive tests for inclusion in the CLSA following a thorough literature search. The tests were chosen on the basis of their psychometric properties, adaptability for use in longitudinal studies, and relevance to age-related research in a sample of people aged between 45 and 85 years. The time and cost of administration also factored into test selection. Further, the three tests included in the Tracking sample had to be amenable to telephone administration. [174]

2.0.3.2.1 Memory

Rey Auditory Verbal Learning Test (*RAVLT*) [2] (Trial 1 and Delay Trial). The RAVLT is a 15-item word learning test that evaluates learning and retention. In this test, a recorded list of 15 words is played at the rate of one per second . This test requires participants to recite as many of the words as possible, right after hearing the complete list (REY I), with more recited words meaning better memory function. Five minutes after hearing the list, the participants are asked again to recite as many of the words as they can remember (REY II), without hearing the list a second time.

For REY I, participants received one point for each word that was correctly recalled (primary word), or any approved variant word defined as a word sounding similar to the recorded word (e.g., color and collar). For words other than the primary or variant word, the score was

zero. REY II was scored similarly to REY I, but if the participant mentioned a variant word in REY I and a matching primary word in REY II, the primary word in REY II did not receive a point. Also, if the participant was prompted by the interviewer, a score of zero was given. The RAVLT is one of the most commonly used neuropsychological assessments, has good test-retest reliability, and has been shown to be sensitive in detecting early cognitive decline. [175-176] In the thesis, REY I and REY II were treated as separate memory tests. As well, the scores from these two tests were combined into a single memory domain score.

2.0.3.2.2 Executive Function

Mental Alternation Test (MAT) [4]. The MAT requires participants to alternate between counting numbers and saying letters in ascending fashion (i.e. 1-A, 2-B, 3-C) over a period of 30 seconds. Using an electronic algorithm, the number of correct alternations in 30 seconds, disregarding any errors, determines the score (range 0-51). A 'correct alternation' is defined as the next correct number-letter sequence, based on the previous response. For example, 4-D would be considered a correct alternation if it immediately followed 3-C. Only responses beginning with number 1 were scored (e.g., responses starting from 1-A were scored, but responses beginning from 2B or 3C were not scored). The MAT is very sensitive and specific for identifying cognitive impairments in older adults. [177]

Animal Fluency (or Naming) Test [3]. This is a measure of verbal fluency requiring participants to name as many animals as possible in 60 seconds. Animal naming is very sensitive to normal cognitive decline and can differentiate normal aging from early-stage dementia. [178] For scoring, one point was awarded for each unique animal named (e.g., parrot and robin would each get one point), regardless of taxonomy. [179]

Stroop Neuropsychological Screening Test (Victoria Stroop Version)[5]. The Victoria Stroop test measures inhibition, attention, mental speed, and control. The Stroop test has three parts wherein participants need to indicate the ink color printed on stimulus cards. In the first part, participants name the colors of dots printed on individual sheets of paper. In the second part, participants name the ink colour of printed words (the words are not names of colours). In the third part, participants name the ink colour of another set of printed words. The words in the third part are the names of colours that differ from the ink. For example, the word 'blue' might be written in green ink, and the correct response would be 'green'.

In this thesis, performance on the Victoria Stroop test was assessed by computing an interference score: the score on part three (words are names of colours) was divided by the score on part one (colored dots). The scores for parts one and three were calculated as the average length of time in seconds needed to complete each part. Greater scores indicated lower cognitive performance since the Stroop is scored through calculation of the time to respond. Thus, the standardized Stroop scores were reversed for the higher Stroop scores to be reflective of better cognitive performance.

Controlled Oral Word Association Test[6]. This test measures phonological fluency and requires the time-restricted production of words that begin with a given letter. Three letters are used during three one-minute trials, with one letter per minute. Participants are asked to name as many words as possible that begin with the letters "F", "A", "S" in the one minute per letter. Scoring is based on the total number of words named across the three trials, with each unique word receiving one point. Sister words, which have the same root words as previously mentioned unique words, but with different suffixes, receive one point for the first mention and no points

for any additional mentions using different suffixes. The scores for the three trials are aggregated to get an overall score.

Event-based Prospective Memory Test (EMT)[7]. For the EMT, the participant is presented with an envelope containing three one-dollar coins, one five-dollar bill, one ten-dollar bill, one twenty-dollar bill, a quarter and a nickel, and shown the money inside. The participant is told to listen for a timer to sound, after which they are instructed to take the ten-dollar bill out of the envelop and present it to themselves, and take the five-dollar bill out of the envelop and present it to the interviewer. The timer is set for 30 minutes and the participant is not informed a priori of the duration of allotted time. During the 30-minute period, the participant answers other questions that make-up the in-person interview. Scoring is based on the participant's response when the alarm goes off, and is governed by three criteria: intention to perform, accuracy of response, and need for reminders. Each of these three categories receives a score out of three, and the three scores are then summed to get a total score out of nine.

Time-Based Prospective Memory Test (TMT)[7]. Similar to the EMT, the TMT is a performance task: the participant is given a clock set to 8:00 and asked to tell the time. The participant is then presented with an envelope containing cards with the following numbers printed on them (one number per card): 14, 17, 28, 13, and 11. The test administrator specifically shows the participant the card with number 17 on it. The participant is directed to interrupt the interview when the time reaches 8:15 and an alarm sounds, ask for the envelope, take out the card with number 17, and show it to the interviewer. The participant's response when the alarm goes off determines her or his score. A score of 0-3 was allocated to each of the following categories: intention to perform, accuracy of response, and need for reminders, which are summed to get a total score out of nine.

2.0.3.2.3 Scoring Cognitive Variables

As recommended by the former lead of the CLSA's Psychology Working Group (personal communication with Holly Tuokko), the cognitive scores were transformed into standardized scores (z-scores) prior to analyses to allow for comparisons across tests. For each test, the scores were transformed into z-scores separately for English and French speakers to account for differing language-based response profiles (raw scores tended to be higher for English versus French speakers). The scores of participants who completed a test in the language other than the language in which they received instruction for the test, were disregarded and not included in the analyses. Further, test-specific z-scores were aggregated to obtain composite scores for each of the cognitive function domains (memory, executive function).

Z-scores and aggregated domain scores were computed separately for the Tracking and Comprehensive samples. This was done in response to several factors: (1) different sample frames from which the Tracking and Comprehensive samples were recruited; (2) different modes of administering the tests in each sample (telephone versus in person); and (3) additional executive function tests in the Comprehensive sample.

2.0.3.3 Covariates

This thesis included data on the following covariates, collected from both the Tracking and Comprehensive samples. Covariate selection was guided by the covariates included in previous studies on the topic (see Table 1). These studies were included in the systematic review described in Section 1.2 above. [156]

Table 1. Covariates Included in Previous Studies

Study	Covariates Included in the Study	Included in Thesis?
Al Zaben et al. (2015)	Demographics,	✓
	Income,	✓
	Mental health,	✓
	Physical functioning,	✓
	Stressful life events,	✓
	Medical comorbidity,	✓
	Smoking,	✓
	Months receiving dialysis,	✗
	Severity of Chronic Kidney Disease	✗
Choi et al. (2016)	Demographics,	✓
	Socioeconomic factors,	✓
	Health factors,	✓
	Region of residency	✓
Coin et al. (2010)	Age,	✓
	Education level	✓
Corsentino et al. (2009)	Demographics,	✓
	Education,	✓
	Literacy,	✗
	Income,	✓
	Marital status,	✓
	Depressive symptoms,	✓
	Social support,	✓
	Health and physical functioning	✓

Fung et al. (2013)	Age,	✓
	Sex,	✓
	Education,	✓
	Marital status,	✓
	Socioeconomic status,	✓
	Occupational status,	✗
	Severity of physical and psychiatric illness	✗
Hill et al. (2006)	Psychological distress,	✗
	Sensory impairments,	✗
	Health behaviors,	✓
	Chronic disease,	✓
	Baseline cognitive functioning,	✗
	Physical functioning,	✗
	Baseline activities of daily life,	✓
	Socio-demographics,	✓
	Baseline social disengagement	✓
Hsu, (2006)	Demographics,	✓
	Socioeconomic status,	✓
	Health-related variables	✓
Kaufman et al. (2007)	Age,	✓
	Sex,	✓
	Education,	✓
	Baseline cognitive level,	✗
	MMSE rate of decline	✗

Koenig et al. (2004)	Age,	✓
	Sex,	✓
	Race,	✗
	Education,	✓
	Medical diagnosis,	✓
	Insurance status	✗
Lin et al. (2014)	Age,	✓
	Gender,	✓
	Education,	✓
	APOE e4 status	✗
Ritchie et al. (2014)	Education,	✓
	Socioeconomic status	✓
Van Ness et al. (2003)	Socio-demographics,	✓
	Behavioral factors,	✗
	Biomedical factors	✗
Yeager et al. (2006)	Socio-demographics,	✓
	Smoking,	✓
	Exercise,	✗
	Alcohol use,	✓
	Eating habits,	✗
	Social ties	✓
Zhang, (2010)	Demographics	✓

Note: Variables marked with an ✗ were not available for this study.

Basic/Instrumental Activities of Daily Living. For the entire CLSA sample, Basic

Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) were

measured to assess functional ability using the Older Americans Resources and Services (OARS)

Multidimensional Assessment Questionnaire. [180]

The ADL questions inquired whether the participant could perform each of the following

activities without help or with some help, or whether they were completely unable to do the

activity: eating, taking a bath, getting in and out of bed, getting to the bathroom, using the

telephone, dressing, taking care of own appearance, walking, showering, and getting to the

bathroom without trouble. The questions in the IADL questionnaire inquired about the

individual's ability to walk, answer the telephone, travel, shop, prepare meals, do housework,

take medicine, handle money, and get to places out of walking distance.

A separate dichotomous variable was included in the thesis for ADLs and IADLs. The

variable was coded 0 if a participant reported some help required, or a complete inability to

perform, at least one of the activities. Otherwise, the variable was coded 1 (complete ability to

perform all activities).

General Health. This thesis included one question asking the respondent to rate their

health (i.e., excellent [excellent = reference category], very good, fair or poor).

Chronic Conditions. The CLSA Tracking and Comprehensive questionnaires asked

whether a doctor ever told participants they had any one of numerous chronic illnesses, including

respiratory, cardiovascular, neurological, gastrointestinal, rheumatic, mental health, cancer, or

hearing/vision-related conditions. In this thesis, the doctoral candidate included the following

chronic conditions: Alzheimer's disease, [10, 11, 72] diabetes, cerebrovascular event, hypertension,

heart disease, or myocardial infarction (no previous studies had controlled for these conditions). For each participant, a categorical variable was coded dichotomously (0 or 1), with 0 representing no chronic conditions and 1 corresponding to the presence of at least one of the six aforementioned chronic conditions.

Depression. Depression symptoms were measured using the Center for Epidemiologic Studies Short Depression Scale (CES-D-10), [181] which included 10 questions about fearfulness, happiness, feelings of depression, loneliness, problems with concentration, being bothered by things, motivation, performing daily activities, hopefulness for the future, and restless sleep. Four possible response options exist for each question (all of the time, occasionally, some of the time, rarely or never), each option is assigned a numerical score from 0 to 3, and the total score can range from 0 to 30. The PhD candidate dichotomized this variable (< 10 [reference category] versus ≥ 10) such that scores less than 10 indicated the absence of severe depression symptoms. [179]

Social Networks. The CLSA included 15 items from the General Social Survey (GSS) [165] that asked about marital/partner status, living arrangements, family composition, social ties, and social contacts. In this dissertation, social network size was calculated by following Mick et al.'s approach of considering questions about the number of biological children, stepchildren, and adopted children, number of living siblings, close friends, and neighbours, as well as the marital status of the participant. [182] The participants were given one point per contact if they had interpersonal contacts with any of these individuals in at least every one or two weeks during the last year. They also received an additional point if they were married or in a common-law relationship. [182]

Social Support. Social support was measured using the 19-item Medical Outcomes Study Social Support Survey. [183] The survey questions asked about the availability of four different types of social support, each measured with a separate subscale: affectionate support, emotional/informational support, positive social interaction, and tangible support. The subscales can be aggregated to form an overall functional support index.

Specific questions by subscale included: (1) affectionate support (3 items; someone who shows love and affection, someone to love and make you feel wanted, someone who hugs you); (2) emotional support (8 items; someone you can count on to listen to you when you need to talk, someone to give you information to help you understand a situation, someone to give you good advice about a crisis, someone to confide in or talk to about yourself or your problems, someone whose advice you really want, someone to share your most private worries and fears with, someone to turn to for suggestions about how to deal with a personal problem, someone who understands your problems); (3) tangible support (4 items; someone to help you if you were confined to bed, someone to take you to the doctor if you needed it, someone to prepare your meals if you were unable to do it yourself, someone to help with daily chores if you were sick); and (4) positive social interaction (3 items; someone to have a good time with, someone to get together with for relaxation, someone to do something enjoyable with). An additional question (i.e., someone to do things with to help you get your mind off things) was added outside of the four subscales. Responses to each question were provided on a 5-point Likert scale ranging from 'none of the time' (score = 1) to 'all of the time' (score = 5). The overall functional support index was obtained by following Harasemiew et al.'s [184] method of calculating the average score for all 19 items included in the full survey.

Social Participation. Social participation was assessed using questions about the frequency of participant involvement in seven different social activities over the past 12 months (family/friend activities outside of the household, physical activities with others, educational or cultural activities, clubs or fraternal organization activities, association activities in neighbourhoods or communities, volunteer or charity work, other recreational activities). For each activity, responses ranged from 'none of the time' (score = 0) to 'all of the time' (score = 4). In this dissertation, the doctoral candidate followed the method employed by Harasemiew et al. [184] and summed the scores across the seven activities to produce a total social participation score that ranged from 0-28.

Tobacco Consumption. The CLSA included a question regarding current smoking status (i.e., at the present time, do you smoke cigarettes daily, occasionally or not at all [reference category]?). This question was analyzed using these three categories.

Alcohol Consumption. The CLSA included a question regarding the recent frequency of alcohol consumption (i.e., about how often during the past 12 months did you drink alcohol?). This question was categorized based on the recent frequency of alcohol use (almost every day, 4-5 times a week, 2-3 times a week, once a week, 2-3 times a month, once a month, less than once a month, never [reference category]). No response categories were combined.

Socio-demographic Information. In this thesis, the doctoral candidate controlled for socio-demographic variables by including sex, age group (45-54, 55-64, 65-74, 75-85 years), highest level of education (secondary education or less versus at least some post secondary education), and marital status (single; divorced/ separated/widowed; married/in a domestic partnership [reference category]) in her analyses.

Income. The CLSA included one question about the participant's total household income from all sources before taxes and deductions in the past 12 months. The response categories included the following: less than $20,000, between $20,000 and $50,000, between $50,000 and $100,000, between $100,000 and $150,000, and $150,000 or more [reference category].

2.0.4 Quantitative Analysis

All statistical analyses were conducted using SAS v9.4 (The SAS Institute, Cary, NC). Data cleaning was performed separately for the Tracking and Comprehensive samples. Some question responses (i.e., no response to a question, participant refused to answer, or did not know) were recoded as missing. To inspect the characteristics of the variables, techniques from exploratory descriptive data analysis were used to produce histograms, box plots, means and standard deviations (if normally distributed), or medians and interquartile ranges (if not normally distributed) for the continuous variables, and bar graphs and frequencies (counts, percentages) for the categorical variables. Furthermore, histograms were used to assess whether the distributions of cognitive test scores were normal.

Additional exploratory analyses examined the potential interaction effects of age group and sex on the relationship between religious participation and cognitive function. This was done by first examining the association between frequency of religious attendance and cognitive scores (individual test scores and domain-based scores) without including any covariates in the regression model. In the second step, sex and age group were entered into separate models with religious attendance, and the corresponding interaction term in each model was inspected for significance by examining its p-value.

The CLSA data were analyzed cross-sectionally with participants divided into exposure groups based on the frequency of religious participation (at least once a year versus never). The frequency of religious participation was the only R/S variable included in the CLSA. The frequency of religious participation in the categories of daily, weekly, monthly, and yearly were collapsed into 'at least once a year' following initial exploratory regression analysis (discussed above) because the doctoral candidate did not find a dose-response relationship between greater frequencies of attendance and improved cognitive function.

2.0.4.1 Multivariable Regression Analysis

Using the SURVEYREG procedure in SAS, we ran a series of multivariable regression models to investigate the association between religious participation and cognitive function, controlling for the covariates described above (Section 2.0.3.3).

The regression models only included cases for which the doctoral candidate had complete data (complete case analysis). The models were grouped according to the samples (Tracking, Comprehensive), cognitive domains and tests. The doctoral candidate felt it necessary to run separate analyses on both CLSA samples because of the different modes of cognitive test administration in the samples, the different sampling frames, and the additional executive function tests in the Comprehensive sample.

Each regression model contained a different block of covariates, in addition to the following five variables, which were included in all of the models: frequency of religious participation, age group, sex, level of education, and province. The models were not 'cumulative' in that subsequent models included new blocks of covariates that were added to the previous blocks already in the models.

The doctoral candidate developed six models for each analytical group. The initial model included frequency of religious participation, age group, sex, level of education and province. This 'initial' model was termed the 'crude' model, despite the inclusion of four other variables in addition to frequency of religious participation. The CLSA recommended researchers include age group, sex and province in all regression models since these factors helped determine the sampling weight in the complex survey design. [185] In this thesis study, level of education was also included in every model (including the crude) following a recent study that compared various cognitive assessments' scores across different levels of education for the CLSA Comprehensive sample. This study reported a main effect for level of education for several of these cognitive measures demonstrating lower performance times for those with a higher level of education for timed cognitive measures. [186]

Four of the remaining five models for each analytical group contained the five variables from the crude model and a single covariate block, beginning with the health block that included general health, chronic disease, depression, and basic and instrumental activities of daily living. The social block contained social participation, social networks, and social support. The socioeconomic (SES) block included total household income (in addition to age group, sex, province, and education level). The lifestyle block contained current smoking, current alcohol use, and marital status (in addition to age group, sex, province, and education level). The last model contained the crude model and the variables from all of the aforementioned blocks.

Following the examination of memory and executive function as outcomes in the aforementioned models, the model-building exercise described above was repeated for each cognitive test score as the dependent variable.

The effect size for the regression coefficient for the religion variable in each model was estimated using Hedges' g. The doctoral candidate utilized the *ESC* package in R-3.6.1 (2019) (The R Project for Statistical Computing, Vienna, Austria) to calculate Hedges' g and assess the clinical significance of the findings. Low Hedges' g values were considered to be less than or equal to 0.2, since a commonly used interpretation is to refer to effect sizes of 0.2 or less as small, those of 0.5 as medium, and 0.8 as large. [187]

To account for the CLSA's complex survey design, i.e., recruitment based on the strata described in Section 2.0.1 above, the doctoral candidate included the CLSA's recommended analytical weight and strata variables in all regression analyses. [185]

2.1 Qualitative Analysis

2.1.1 Design

To add context to the findings obtained from the analysis of the CLSA data, we collected and analysed qualitative data by interviewing spiritual leaders and parishioners who regularly attended church, making the design of this thesis a sequential explanatory mixed methods study. Two paradigms existed that could fit the epistemological stance of this dissertation study: the constructivist paradigm and the pragmatic paradigm. A constructivist epistemological stance views science and knowledge as "constructed" through the social experiences and is not reflective of an external reality. The pragmatic epistemological stance views something as true only if it is practical and works (has real effects). [188] It sees the truth as the joint product of people and the reality. This view believes in a reality and truth but only insofar as it works. Thus, it finds the truth constructed but non-arbitrary and rooted in practice. [188] The truth based on the pragmatic paradigm is ever changing based on people's actions. It opposes the distinction

between realism and anti-realism and in doing so reduces the opposing views of such paradigms with different underlying assumptions (e.g., postpositivism versus social constructivism). [188]

Although the qualitative portion of this study could follow a constructivist epistemological stance since it sought to understand the participants' views of the association of interest, problems exist with integrating this paradigm with the postpositivist paradigm (believes in an authentic and true scientific knowledge that is independent of and not constructed by the scientists) of this thesis's quantitative portion due to their fundamentally different underlying assumptions. [188]   Thus, this thesis adapted a pragmatic epistemological position which would be more appropriate for the mixed-method design of this study. The pragmatic paradigm allowed for positioning this thesis on the assumption that the collection of both quantitative and qualitative data would lead to a more comprehensive understanding of the research topic than either approach on its own by allowing the qualitative findings to complement the quantitative results. The quantitative findings informed the qualitative interview questions. Further, the qualitative data helped explain the quantitative findings and allowed the doctoral candidate to develop a deeper understanding of the association between religious involvement and cognitive function, an understanding that extended beyond the regression coefficients obtained in the quantitative analysis.

2.1.2 Participants and Procedures

The doctoral candidate employed semi-structured, one-on-one interviews (Appendix B) with pastors and parishioners to collect qualitative data. Pastors and parishioners were the most relevant group of individuals to add context to the quantitative results of this study because they had practical knowledge of the subject matter, which they obtained from regular involvement and commitment to religious/spiritual activities.

The qualitative interviewees were not part of the CLSA sample, but rather were recruited separately via purposive sampling to find individuals with comparable characteristics, in terms of age and sex, to CLSA participants. Further, the qualitative sample was recruited by approaching Catholic, Anglican, United, Baptist, and Orthodox churches in the City of Hamilton to enlist participation. The doctoral candidate recruited Christian individuals into the qualitative study because the majority of the CLSA participants across both the Tracking and Comprehensive samples professed the Christian faith (Tracking: 77.5%; Comprehensive: 70.7%).

Although recruitment from the City of Hamilton was not comparable to the Canada-wide setting of the CLSA study, no evidence existed to suggest pastors and parishioners from Hamilton would hold different opinions from people in other parts of the country.

Ten churches were approached to invite their members to participate in this study. The purposive sampling strategy allowed the doctoral candidate to approach churches in close proximity to her place of residence. Of the ten churches, a total of seven churches agreed to allow recruitment of their members, including 2 Catholic, 1 Anglican, 1 United, 2 Baptist, and 1 Orthodox. The doctoral candidate approached the churches and left study flyers with the church administrators, who passed along the flyers to their congregations. The flyers asked interested individuals to contact the doctoral candidate, learn more about the research, and schedule interviews. At the start of an interview, the doctoral candidate gave the participant a University of Waterloo Office of Research Ethics (ORE)-approved study letter and consent form to read and sign (Appendix C.1). The doctoral candidate presented every participant with a letter of appreciation following the interview (Appendix C.2).

2.1.3 Data Collection

The interviews were scheduled between December 2018 and February 2019. They took

place on the church sites or in the interviewees' homes and ranged in duration from 20 to 30

minutes. To facilitate data analysis, the interviews were audio-taped and transcribed verbatim.

Each participant chose a pseudonym at the start of her or his interview. The pseudonym was used

during the interview, on the transcripts, and in the thesis. The doctoral candidate served as the

interviewer.

The interviewer started by verbally explaining the research study and communicating the

findings obtained from the quantitative analysis of the CLSA data to the participants. Next, the

interviewer asked participants to explain whether and how they believed religious participation

could influence cognitive function. The interview questions guided the interviewer, who also

used further probing questions to follow-up on participants' responses. The interview questions

are included in Appendix B. The interviews were audio-recorded and transcribed verbatim. A

brief demographic questionnaire contained five questions (i.e., age, sex, ethnicity, education

level, years of religious practice) and was given to the participants prior to the interviews and

was collected upon completion. The questionnaire enabled the doctoral candidate to obtain

sample characteristics about the qualitative participants.

2.1.4 Field Notes

The interviewer generated individual field notes and memos shortly following the

completion of each interview. [189] The field notes included information about the time, date and

location of the interview, general identity of the participant (i.e., age, sex), the length of the

interview, the rapport between the interviewer and the participant (e.g., friendly, professional),

the tone of the interview (e.g., happy, serious, neutral), and other interviewer observations about

the interview (e.g., similarities or differences in responses compared to other interviews). The field notes were not coded and were merely used for reference to assist the doctoral candidate in recollecting the details of the individual interviews.

During the interviews, the doctoral candidate found that the concept of cognitive function was not something the participants could easily comprehend unless they framed their impressions and interpretations of cognition within the realm of 'mental health'. The doctoral candidate aimed to direct the participants to speak particularly in relation to cognitive function. However, some participants seemed not to be able to distinguish between these two constructs, and their explanations overlapped between the areas of cognitive and mental health. The doctoral candidate included this observation in her field notes.

2.1.5 Data Management and Analysis

Following the conduct of the interviews, the doctoral candidate produced verbatim transcripts of the audio-recordings. These transcripts served as the main source of qualitative data in the thesis. The transcripts were then imported to NVivo 12.3 (QSR International, 2018), a qualitative data analysis software, and organized by questions and participant pseudonyms.

Participants were recruited into the study until saturation was reached and no further information regarding the topic at hand emerged from interviewing further participants. [190] The literature suggests that small sample sizes could achieve saturation when study participants demonstrate a comparable set of consistent attitudes and beliefs, which was the case given the inclusion of a Christian sample in the qualitative portion of the thesis. [191] A similar study exploring the association between religious participation and coronary heart disease included twelve interviews. [192] In the present dissertation, the doctoral candidate had originally estimated that roughly 10 to 15 individuals would be needed to reach saturation. This study included 15

one-on-one interviews with pastors and parishioners across the seven churches, and no new data emerged after interviewing 11 participants.

Following the completion of all 15 interviews, thematic analysis was used to identify recurrent and overarching themes about the features of religious participation that were related to cognitive function. [193] The doctoral candidate developed the themes by reading and re-reading the individual interview transcripts and creating a list of key codes to identify different aspects of religious participation that might influence cognitive function. These codes were then manually applied to the transcribed interview texts and the ways that these codes related to each other were examined. This was done by viewing and examining the codes in the context of the transcripts and merging the codes with similar underlying concepts to produce themes. Thus, themes were either the same as the codes or were generated through merging several codes with similar underlying concepts.

The thematic analysis allowed for the generation of deductive and inductive codes. [194] The interview questionnaire assisted in determining whether a code was deductive or inductive. The deductive codes emerged from information gathered directly from asking the interview questions and follow-up prompts. The proposed model of this thesis guided the generation of the interview questions through guiding the doctoral candidate to inquire about both the non-social as well as social engagement components of religious participation during the process of the interview. The deductive codes were identified directly through asking about the questions.

On the other hand, the inductive codes arose from topics that were oriented toward newly captured findings independent of the semi-structured interview questions. The inductive codes were introduced by the participants or arose from information obtained by additional

questions that occurred to the interviewer as the interview progressed. All deductive and inductive codes were reviewed by two members of the doctoral candidate's committee.

The doctoral candidate created summary sheets of the thematic analysis containing a table showing the deductive and inductive codes, as well as direct quotes taken from the verbatim transcripts. Each cell in this table corresponded to a specific code and a specific participant. By creating the relevant deductive and inductive codes, new and different aspects of the data became visible. These codes were then further explored within the context of the transcripts and the ways that these codes related to each other were examined which led to the generation of final overarching themes. In most cases, codes and themes overlapped; however, in some cases, themes were developed by combining concepts that intersected across two or more codes. Each theme pertained to a unique overarching concept.

2.1.6 Credibility and Rigour

The doctoral candidate employed several strategies to ensure the credibility of, and increase the rigour of, the qualitative research. Credibility refers to determining whether the qualitative data agree with the participants' views and beliefs. [195] Regarding credibility, the interviews were audio-recorded and later transcribed verbatim to increase the accuracy and reliability of their content. The interviews and transcripts were supplemented with memos and field notes that recorded contextual data and emerging concepts, which assisted in the development of any follow-up questions. During the data analysis stage, the collected memos and fieldnotes allowed the doctoral candidate to better recollect the details discussed during the individual interviews, as well to assist her in interpreting the findings. For example, she noted that several interviewees framed their understanding of cognitive function within the context of

'mental health'. Thus, occurrences of the phrase 'mental health' in some transcripts were taken to mean 'cognitive function' unless specifically linked to psychiatric or psychological conditions.

The reflexivity and positionality were among some qualities that enhanced the transparency of this dissertation's qualitative research findings. [196] Reflexivity refers to adopting a certain attitude by the qualitative researcher during the research process, where the researcher considers his/her background and how it may affect the research process. [197] Through constant assessment of interview strategies (e.g., how an interview question was asked, being aware of her own beliefs and not letting them interfere with the interview process), the doctoral candidate continuously re-evaluated and improved the interviews (reflexivity). As a case in point, she revised the question asking, 'In your opinion, why might religious attendance contribute to a better cognitive function?' to 'In your opinion, what aspects of religious attendance are the most important contributors to a better cognitive function?' This revision was prompted by the participants' hesitation to answer the question, which arose out of a perceived ambiguity in the meaning of the original query.

The doctoral candidate's religious background did not interfere with the interview process. This reduced the potential for positionality. Positionality refers to those aspects of the interviewer such as age, gender, ethnicity or religion that might influence the qualitative research process. [198] Since the doctoral candidate did not come from a Christian background, she would ask more probing questions to understand the religious beliefs of the participants and how they perceived the effect of their religion on cognitive function.

Other methods of assessing quality in qualitative research include transferability, dependability, and confirmability. Transferability evaluates whether research results can be transferrable to other settings. [199] This research aimed to strengthen transferability by providing

descriptions of the study participants, including their demographics and the contextual

information related to the interviews (e.g., where the interviews took place), thereby allowing

other researchers to assess whether the results might be applicable to their own research settings.

Dependability assesses the research process to determine if it is traceable, logical, and clearly

delineated. [197, 199] Dependability was partially met in this thesis through ensuring reflexivity by

continuous criticism of the research process. This was done though the doctoral candidate's

continuous self-consciousness and self-assessment of her own views, beliefs, and positions, as

well as how these could potentially influence the execution and interpretation of her findings.

Dependability was also strengthened through peer review, which was done by the doctoral

candidate's committee members' evaluations and criticisms of the research process, particularly

in the data collection, analysis and discussion of the findings. This provided the doctoral

candidate with alternative perspectives and insights to consider when interpreting the research

findings. Lastly, confirmability refers to whether the qualitative findings would be verifiable by

assessing the researcher's effect on the research process, and conducting an audit trail. [199]

Although an audit trail was not conducted, the conformability of the findings may have been

enhanced through ensuring reflexivity by the doctoral candidate.

CHAPTER III. RESULTS

3.0 Quantitative Findings

3.0.1 Sample Characteristics

3.0.1.1 Tracking Sample

The mean age of participants in the tracking sample was 63.0 (SD: 10.7) years. Roughly half of the participants were male (49.0%), the majority were married (68.8%), and most had at least some level of post-secondary education (89.9%). Slightly over half of the participants (52.5%) attended church at least once a year. About half (48.1%) reported they were told by a doctor at some point in their life that they had at least one of the following chronic conditions: diabetes, hypertension, heart disease, cerebrovascular event, myocardial infarction, Alzheimer's Disease; the majority (86.5%) rated their own health as good, very good or excellent. The majority did not report CES-D-10 scores ≥ 10 (83.5%), did not currently smoke (84.8%), and did not report any functional impairment in their activities of daily living (86.1%) or instrumental activities of daily living (92.3%). More than a third of the participants reported drinking about once a month or less frequently (37.6%). Most participants also reported total annual incomes greater than $50,000 (63.8%) (Table D1, Appendix D). No statistically significant interactions between either age group or sex with frequency of religious participation were observed in the Tracking sample ($p > 0.05$ for all interaction terms).

3.0.1.2 Comprehensive Sample

Participants in the Comprehensive sample had a mean age of 63.0 (SD: 10.2) years. About half of the participants were male (49.1%), the majority were married (68.6%), most had at least some post-secondary education (91.2%), and just over half attended church services at least once a year (53.9%). About half of the sample reported having at least one chronic

condition (diabetes, hypertension, heart disease, cerebrovascular event, myocardial infarction, Alzheimer's Disease) (48.2%). The majority rated their general health as good, very good or excellent (90.7%), were not currently smoking (87.4%), did not report CES-D-10 scores ≥10 (84.5%), and did not report any functional impairment in their activities of daily living (85.4%) or instrumental activities of daily living (94.6%). Most had total annual incomes of at least $50,000 (71.8%) and almost a third of the Comprehensive participants consumed alcohol once a month or less frequently (31%) (Table D1, Appendix D). No statistically significant interactions between either age group or sex with frequency of religious participation were observed in the Comprehensive sample ($p > 0.05$ for all interaction terms).

3.0.2 Domain-Based Multivariable Regression Models of Religious Participation and Cognitive Function

Tables 2a and 2b show the summary statistics associated with each cognitive test and cognitive domain score in the Tracking and Comprehensive samples. Table 3 depicts the statistical significance and direction of association, and Figure 18 exhibits the effect sizes (Hedges' g), for the regression coefficients for religious participation in all of the domain- and test-based models included in the thesis. All the models demonstrated low effect sizes ($0 \leq$ Hedges' g < 0.20 for positive associations; $-0.20 <$ Hedges' g ≤ 0 for negative associations), thereby suggesting minimal clinical significance of the results.

Table 2a. Summary Statistics for Z-scores of each Cognitive Test and Domain in the Tracking Sample

Cognitive Variable	N	N Missing	Mean	SD	Median	25 Percentile	75 Percentile	Minimum	Maximum
REY I	19565	1676	1.338E-8	0.999	0.025	-0.826	0.451	-2.530	3.906
REY II	19454	1787	-1.237E-8	0.999	-0.135	-0.551	0.639	-1.701	4.126
AFT	19555	1686	3.269E-9	0.999	-0.039	-0.667	0.725	-3.246	5.154
MAT	18315	2926	-2.238E-9	0.999	0.102	-0.528	0.633	-2.737	2.626
Memory	18840	2401	0.010	1.892	-0.148	-1.315	1.090	-4.213	7.980
Executive Function	17816	3425	0.011	1.645	0.036	-1.073	1.123	-5.418	6.864

Abbreviation: SD (Standard Deviation)

Table 2b. Summary Statistics for Z-scores of each Cognitive Test and Domain in the Comprehensive Sample

Cognitive Variable	N	N Missing	Mean	SD	Median	25 Percentile	75 Percentile	Minimum	Maximum
REY I	29075	1022	1.174E-8	0.999	0.033	-0.490	-3.107	-3.107	4.220
REY II	28766	1331	7.664E-10	0.999	-0.031	-0.486	-1.952	-1.952	4.528
AFT	28851	1246	2.914E-9	0.999	0.030	-0.736	-3.338	-3.338	5.448
MAT	28063	2034	-4.700E-9	0.999	0.064	-0.576	-3.179	-3.179	2.855
COWAT	27797	2300	0.004	2.621	-0.041	-1.839	-7.542	-7.542	13.258
EMT	29853	244	-0.0002	1.001	0.397	0.397	-6.089	-6.089	0.419
TMT	29607	490	-1.159E-8	0.999	0.358	0.335	-9.639	-9.639	0.360
STROOP	29676	421	0.00006	0.999	0.194	-0.385	-49.869	-49.869	2.907
Memory	28766	1331	0.006	1.841	-0.066	-1.294	-4.960	-4.960	8.738
Executive Function	25178	4919	0.0940	4.585	0.319	-2.700	-50.757	-50.757	19.811

Abbreviation: SD (Standard Deviation)

3.0.2.1 Tracking Sample

Within the Tracking sample, the association between religious participation and cognitive

function was separately explored for the memory and executive function domains of cognition.

Memory. Table E1 in Appendix E shows the models for memory as the main outcome. The association between religious participation and memory scores was not statistically significant in any of the models (Figure 2).

Figure 2: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Memory as Outcome and Different Contextual Blocks (CLSA Tracking Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

Executive Function. Table E2 (Appendix E) depicts the models for executive function as the outcome. Religious participation was statistically significant only in the social and all blocks models. However, the regression coefficients in these two models were negative, demonstrating inverse associations between frequency of religious participation and executive function scores (Social: β: -0.110, *95% CI*: -0.176, -0.051; All blocks: β: -0.116, *95% CI*: -0.194, -0.038) (Figure 3). The Hedge's g for these two statistically significant findings was equal to -0.063 for the all block and -0.058 for the social block, indicating low levels of clinical importance.
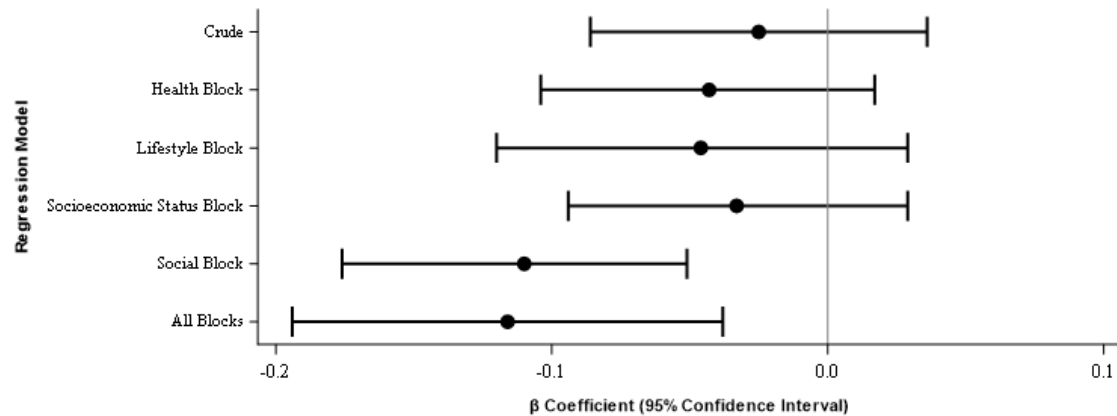
Figure 3: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Executive Function as Outcome and Different Contextual Blocks (CLSA Tracking Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

3.0.2.2 Comprehensive Sample

Memory. Table E3 (Appendix E) depicts the association between frequency of religious participation and memory in the

Comprehensive sample across the models. None of the associations were statistically significant (Figure 4).

Figure 4: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Memory as Outcome and Different Contextual Blocks (CLSA Comprehensive Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

Executive Function. When examining the models in the Comprehensive sample, all except the lifestyle model were statistically significantly associated with executive function (Table E4 – Appendix E). However, religious participation and executive function were inversely associated with one another in all of the models, with the social model exhibiting the greatest negative association between frequency of religious participation and executive function (β: -0.432, *95% CI*: -0.556, -0.309) (Figure 5). This showed that when the social block was added to the model, higher frequency of religious participation was associated with lower executive function scores in the Comprehensive sample. Hedges' g for the statistically significant models were -0.237 for the social block, -0.165 for the all block, -0.141 for the SES block, -0.133 for the health block, and -0.117 for the crude block, indicating low levels of clinical importance.
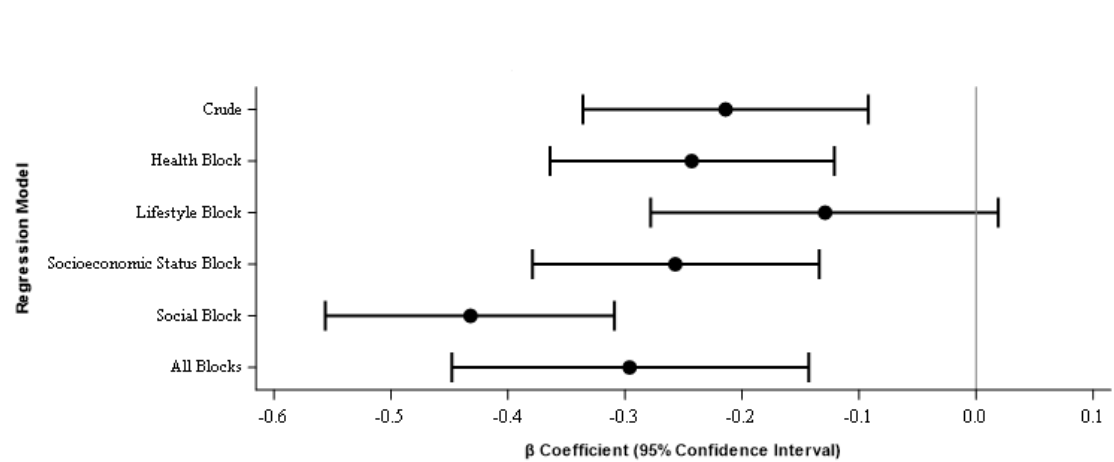
Figure 5: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Executive Function as Outcome and Different Contextual Blocks (CLSA Comprehensive Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

3.0.3 Test-Based Multivariable Regression Models of Religious Participation and Cognitive Function

The association between frequency of religious participation and cognitive function was further investigated across specific cognitive tests within the memory and executive function domains, separately for the Tracking and Comprehensive samples (Table 3). Figure 18 reports the effect sizes for religious participation in the individual models.

3.0.3.1 Tracking Sample

The results for the Tracking sample are described below and shown in Tables E5 through E8 in Appendix E.

REY I. When examining the models with REY I as the main outcome, only the crude model was statistically significant (See Table E5 in Appendix E). The regression coefficient for the crude model was the largest and was equal to 0.036 (*95% CI*: 0.0013, 0.071), and for the remaining models had a range of -0.015 (*95% CI*: -0.060, 0.030) (all blocks model) to 0.030 (*95% CI*: -0.005, 0.066) (SES model) (Figure 6). The Hedge's g for the statistically significant crude model was equal to 0.019, indicating a low level of clinical importance.

Figure 6: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Rey I Memory Test as Outcome and Different Contextual Blocks (CLSA Tracking Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

REY II. All models were non-significant (Table E6 in Appendix E). The crude model had a regression coefficient of 0.008 (*95% CI*: -0.027, 0.043). The regression coefficients of the rest of the models ranged from -0.042 (*95% CI*: -0.088, 0.003) (all blocks model) to 0.003 (*95% CI*: -0.032, 0.040) (SES block) (Figure 7).

Figure 7: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Rey II Memory Test as Outcome and Different Contextual Blocks (CLSA Tracking Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

AFT. With this test as the main outcome, all models produced statistically significant regression coefficients for religious participation. However, in all models, there was an inverse association between frequency of religious participation and the AFT scores (Table E7, Appendix E). The regression coefficients ranged from -0.098 (*95% CI*: -0.135, -0.060) (social model) to -0.050 (*95% CI*: -0.093, -0.006) (lifestyle model) (Figure 8). The Hedge's g for the statistically significant models were -0.052 for the social block, -0.051 for the all block, -0.032 for the SES block, -0.032 for the health block, -0.027 for the crude block, and -0.027 for the lifestyle block, indicating low levels of clinical importance.

Figure 8: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Animal Fluency Executive Function Test as Outcome and Different Contextual Blocks (CLSA Tracking Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

MAT. When MAT was examined as the outcome, none of the models were statistically significant (Table E8, Appendix E). The regression coefficients ranged from -0.021 (*95% CI*: -0.060, 0.018) (social block) to 0.022 (*95% CI*: -0.016, 0.060) (SES block) (Figure 9).
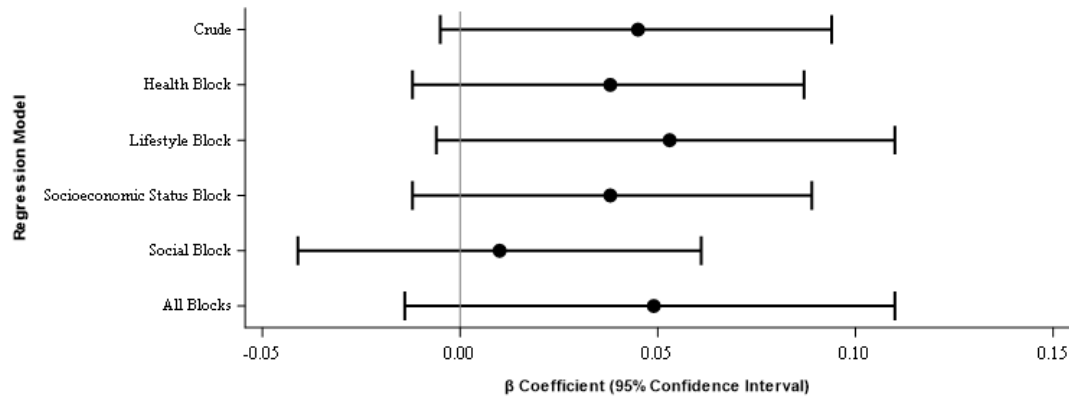
Figure 9: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Mental Alternation Test (Executive Function) as Outcome and Different Contextual Blocks (CLSA Tracking Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

3.0.3.2 Comprehensive Sample

The association between frequency of religious participation and cognitive function was also explored for each of the cognitive tests employed in the Comprehensive sample.

REY I. With REY I as the main cognitive outcome, the models with the crude, health, lifestyle, and SES blocks demonstrated statistically significant associations between religious participation and REY I scores. However, upon adjusting for the social variables (social block, all block), the regression coefficients for religious participation were no longer significant (See Table E9 in Appendix E). The crude model had the highest regression coefficient (β: 0.036, *95% CI*: 0.009, 0.063), and the social model exhibited the lowest

regression coefficient (*β*: 0.013, *95% CI*: - 0.014, 0.041) (Figure 10). Hedges' g for the statistically significant models were 0.017 for

the SES block, 0.018 for the health block, 0.019 for the lifestyle block, 0.2 for the crude block, indicating low levels of clinical

importance.

Figure 10: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Rey I Memory Test as Outcome and Different Contextual Blocks (CLSA Comprehensive Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

REY II. Religious participation was not statistically significant in any of the adjusted and unadjusted models (Table E10 in

Appendix E*).* The regression coefficient for religious participation was the largest in the all block model (*β*: 0.021, *95% CI*: -0.014,

0.056) and the smallest in the social block model (*β*: -0.0016, *95% CI*: -0.030, 0.027) (Figure 11).

Figure 11: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Rey II Memory Test as Outcome and Different Contextual Blocks (CLSA Comprehensive Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

AFT. When AFT scores were included as the main outcome, all models showed statistically significant associations between religious participation and cognitive function (Table E11 in Appendix E). However, all models had negative regression coefficients, indicating inverse associations between frequency of religious participation and AFT scores (Figure 12). The Hedges' g for the statistically significant models were -0.058 for the social block, -0.042 for the all block, -0.039 for the health block, -0.038 for the crude block, -0.038 for the SES block, and -0.029 for the lifestyle block, indicating low levels of clinical importance.
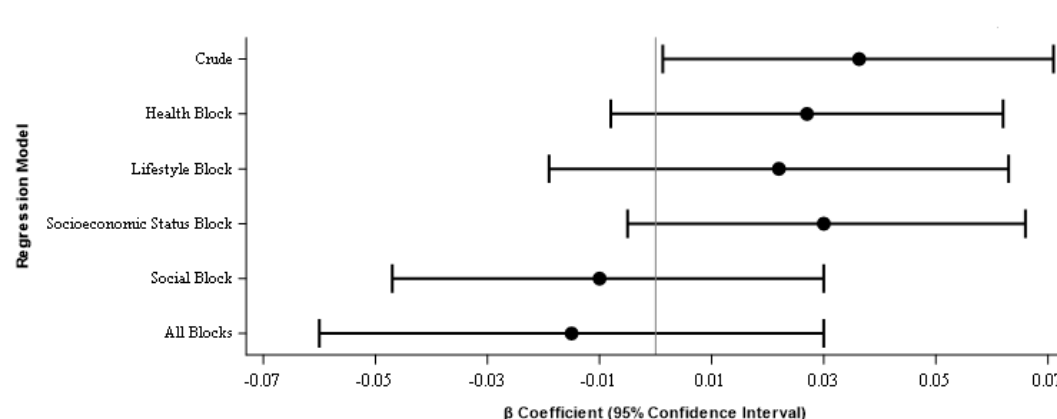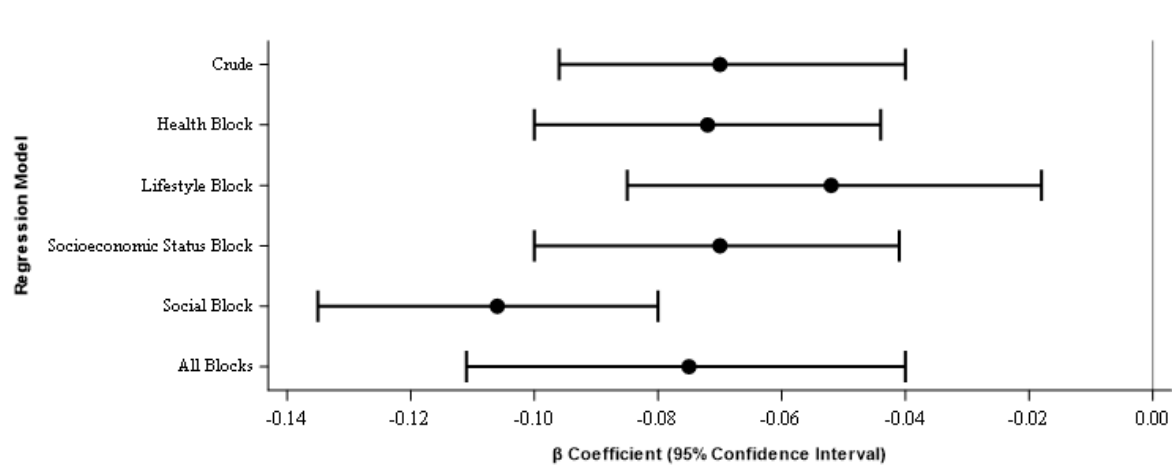
Figure 12: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Animal Fluency Test (Executive Function) as Outcome and Different Contextual Blocks (CLSA Comprehensive Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

MAT. With MAT scores as the main outcome, all models showed statistically significant associations between religious participation and cognitive function (Table E12 in Appendix E*)*. However, the associations were once again inverse. The lifestyle block showed the smallest association (β**:** -0.044, *95% CI*: -0.080, -0.010) and the social block demonstrated the largest association (β: **-**0.073, *95% CI*: -0.102, -0.045) (Figure 13). The Hedges' g for the statistically significant models were -0.033 for the all block -0.029 for the health block, -0.027 for the SES block, -0.024 for the crude block, -0.024 for the lifestyle block, and -0.04 for the social block, indicating low levels of clinical importance.
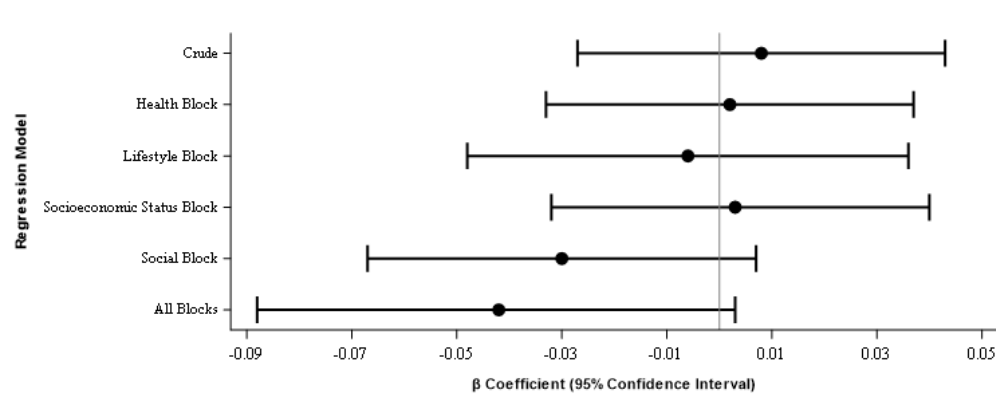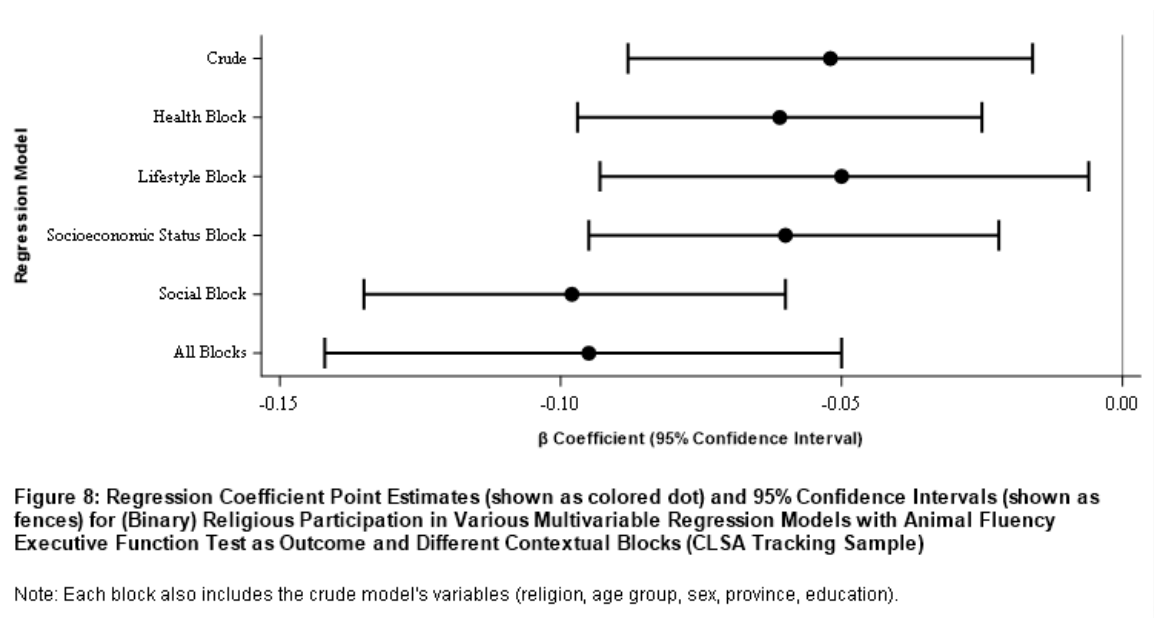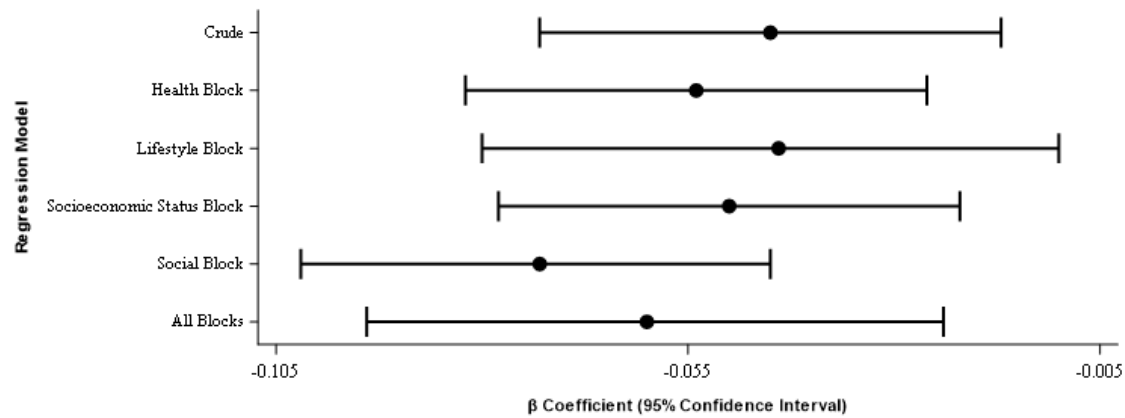
Figure 13: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Mental Alternation Test (Executive Function) as Outcome and Different Contextual Blocks (CLSA Comprehensive Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

COWAT. The health, SES, social and all block models demonstrated significant yet negative associations when COWAT scores served as the main outcome (Table E13 in Appendix E). The remaining models also had negative regression coefficients yet were not statistically significant. The social model showed the largest association (*β:* -0.190, *95% CI*: -0.263, -0.112) (Figure 14). The Hedges' g for the statistically significant models were -0.104 for the social block, and -0.072 for the all block, -0.046 for the SES block, and -0.04 for the health block, , indicating low levels of clinical importance.
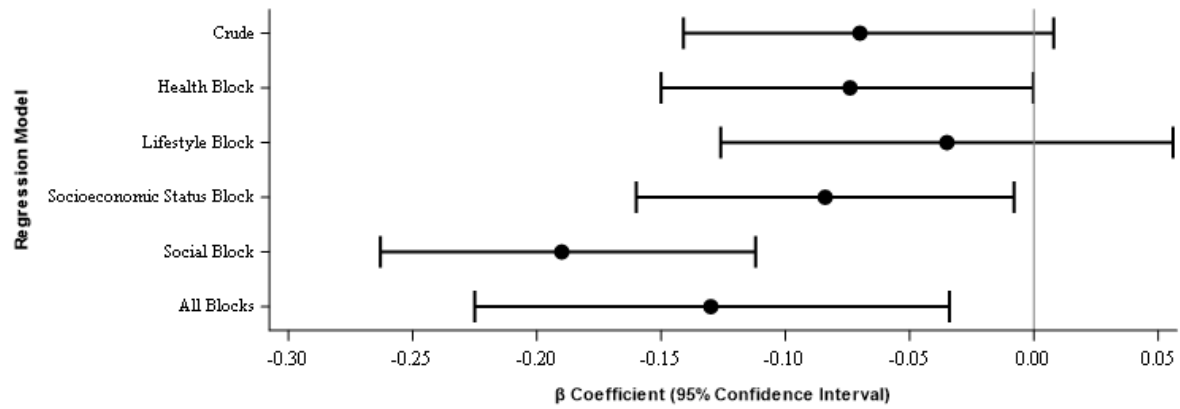
Figure 14: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Controlled Oral Word Association Test (Executive Function) as Outcome and Different Contextual Blocks (CLSA Comprehensive Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

EMT. All models showed statistically significant associations between religious participation and cognitive function when EMT scores served as the main outcome. However, all models demonstrated negative associations, with the lifestyle block having the smallest association (β: -0.045, *95% CI*: -0.071, -0.020) and the social model having the largest association (β: -0.065, *95% CI*: -0.087, -0.043) (Table E14 in Appendix E) (Figure 15). The Hedges' g for the statistically significant models were -0.038 for the all block, -0.035 for the social block, -0.033 for the health block, -0.03 for the SES block, -0.029 for the crude block, and -0.025 for the lifestyle block, indicating low levels of clinical importance.

TMT. With TMT as the outcome, all models demonstrated statistically non-significant associations (Table E15 in Appendix E). The crude block had the lowest association, and the social block showed the greatest (but negative) association (Figure 16).
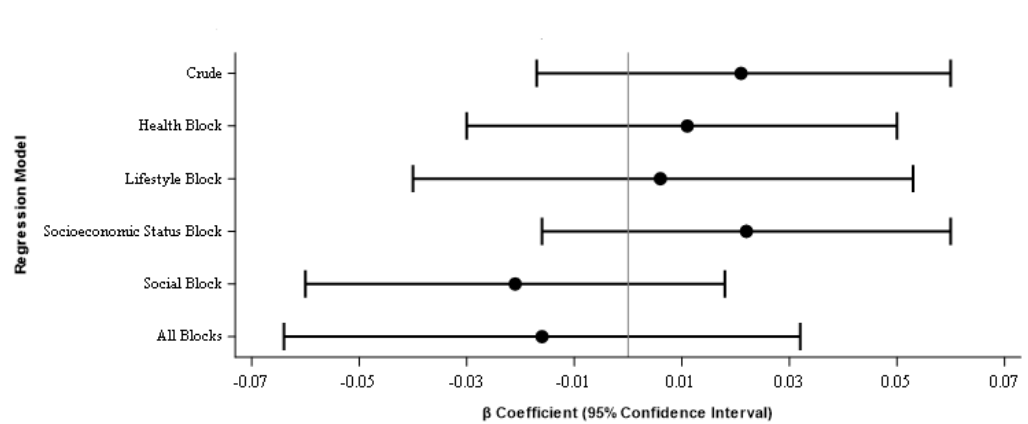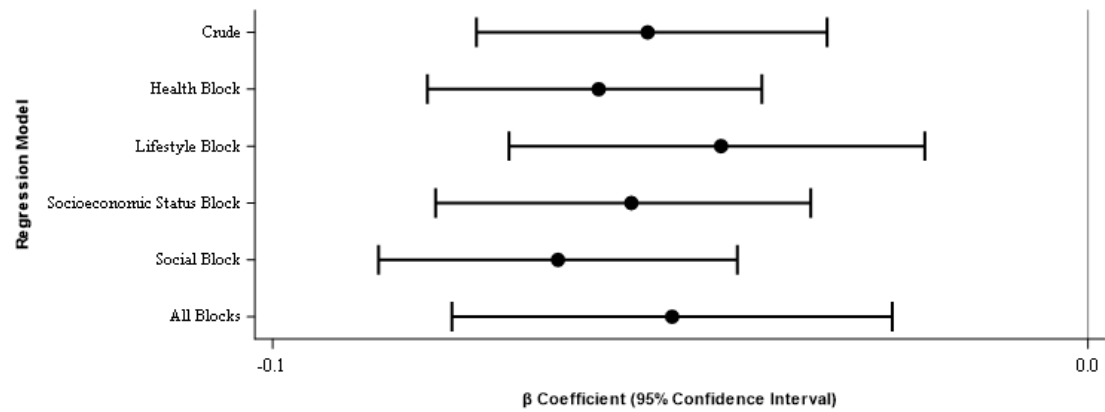
Figure 15: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Event-Based Memory Test (Executive Function) as Outcome and Different Contextual Blocks (CLSA Comprehensive Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).
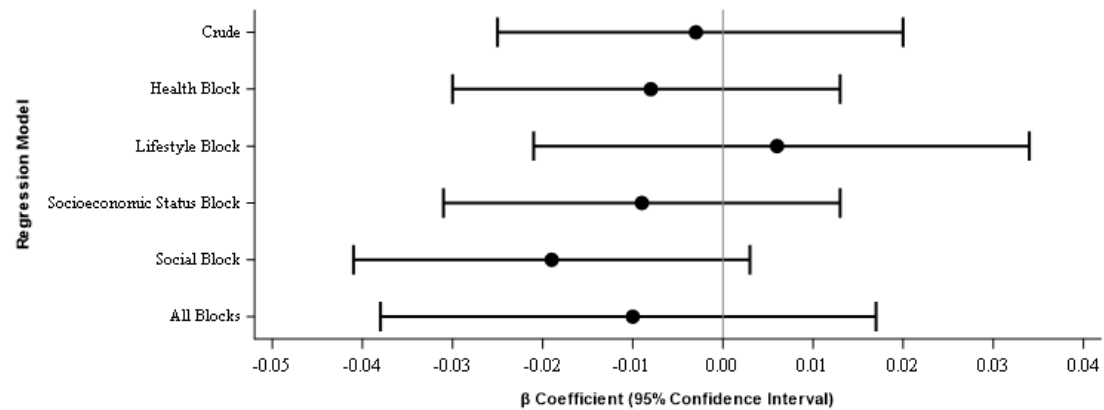
Figure 16: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Time-Based Memory Test (Executive Function) as Outcome and Different Contextual Blocks (CLSA Comprehensive Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

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STROOP. All models revealed statistically non-significant associations when the Stroop scores served as the main outcome (Table E16 in Appendix E). The lifestyle model showed the weakest association (*β*: -0.002, *95% CI*: -0.033, 0.030), and the all block model showed the strongest (but negative) association (*β*: -0.011, *95% CI*: -0.046, 0.023) (Figure 17).
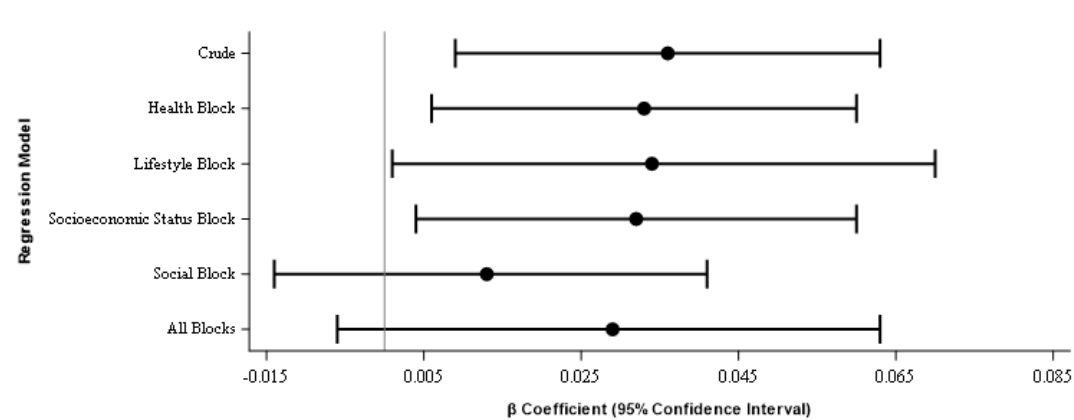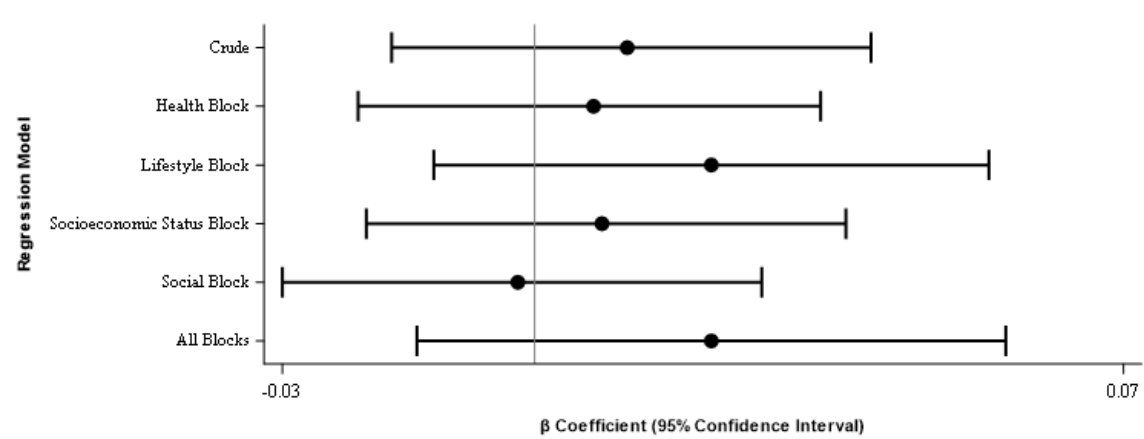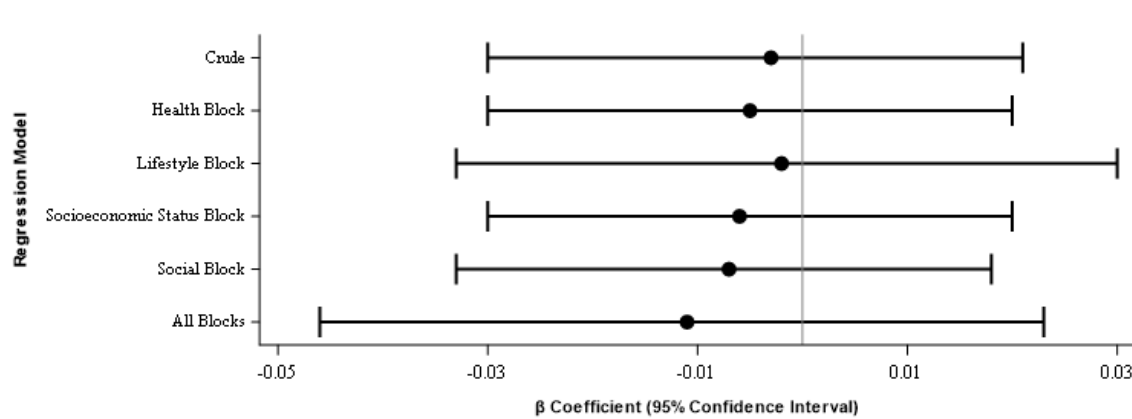

Figure 17: Regression Coefficient Point Estimates (shown as colored dot) and 95% Confidence Intervals (shown as fences) for (Binary) Religious Participation in Various Multivariable Regression Models with Victoria Stroop Test (Executive Function) as Outcome and Different Contextual Blocks (CLSA Comprehensive Sample)

Note: Each block also includes the crude model's variables (religion, age group, sex, province, education).

Table 3. Direction of Association and Significance ($\alpha = 0.05$): Regression Coefficients for Religious Participation – Multivariable Regression Models in the CLSA Tracking and Comprehensive Samples

a) **Domain-Based**

Cognitive Assessments /Models		Crude	Health Block	Lifestyle Block	SES Block	Social Block	All Blocks
Tracking Sample	**Overall Memory**	+ NS	+ NS	+ NS	+ NS	- NS	- NS
	Overall Executive Function	- NS	- NS	- NS	- NS	- S	- S
Comprehensive Sample	**Overall Memory**	+ NS	+ NS	+ NS	+ NS	+ NS	+ NS
	Overall Executive Function	- S	- S	- NS	- S	- S	- S

Abbreviations: S: Significant, NS: Not Significant; A '+' sign depicts a positive direction of association, whereas a '-' shows a negative direction of association.

b) Test-Based

Cognitive Assessments /Models			Crude	Health Block	Lifestyle Block	SES Block	Social Block	All Blocks
Tracking Sample	**Overall Memory**	**REY I**	+ S	+ NS	+ NS	+ NS	- NS	- NS
		REY II	+ NS	+ NS	- NS	+ NS	- NS	- NS
	Overall Executive Function	**AFT**	- S	- S	- S	- S	- S	- S
		MAT	+ NS	+ NS	+ NS	+ NS	- NS	- NS
Comprehensive Sample	**Overall Memory**	**REY I**	+ S	+ S	+ S	+ S	+ NS	+ NS
		REY II	+ NS	+ NS	+ NS	+ NS	- NS	+ NS
	Overall Executive Function	**AFT**	- S	- S	- S	- S	- S	- S
		MAT	- S	- S	- S	- S	- S	- S
		COWAT	- NS	- S	- NS	- S	- S	- S
		EMT	- S	- S	- S	- S	- S	- S
		TMT	- NS	- NS	+ NS	- NS	- NS	- NS
		STROOP	- NS	- NS	- NS	- NS	- NS	- NS

Abbreviations: S: Significant, NS: Not Significant; A '+' sign depicts a positive direction of association, whereas a '-' shows a negative direction of association.
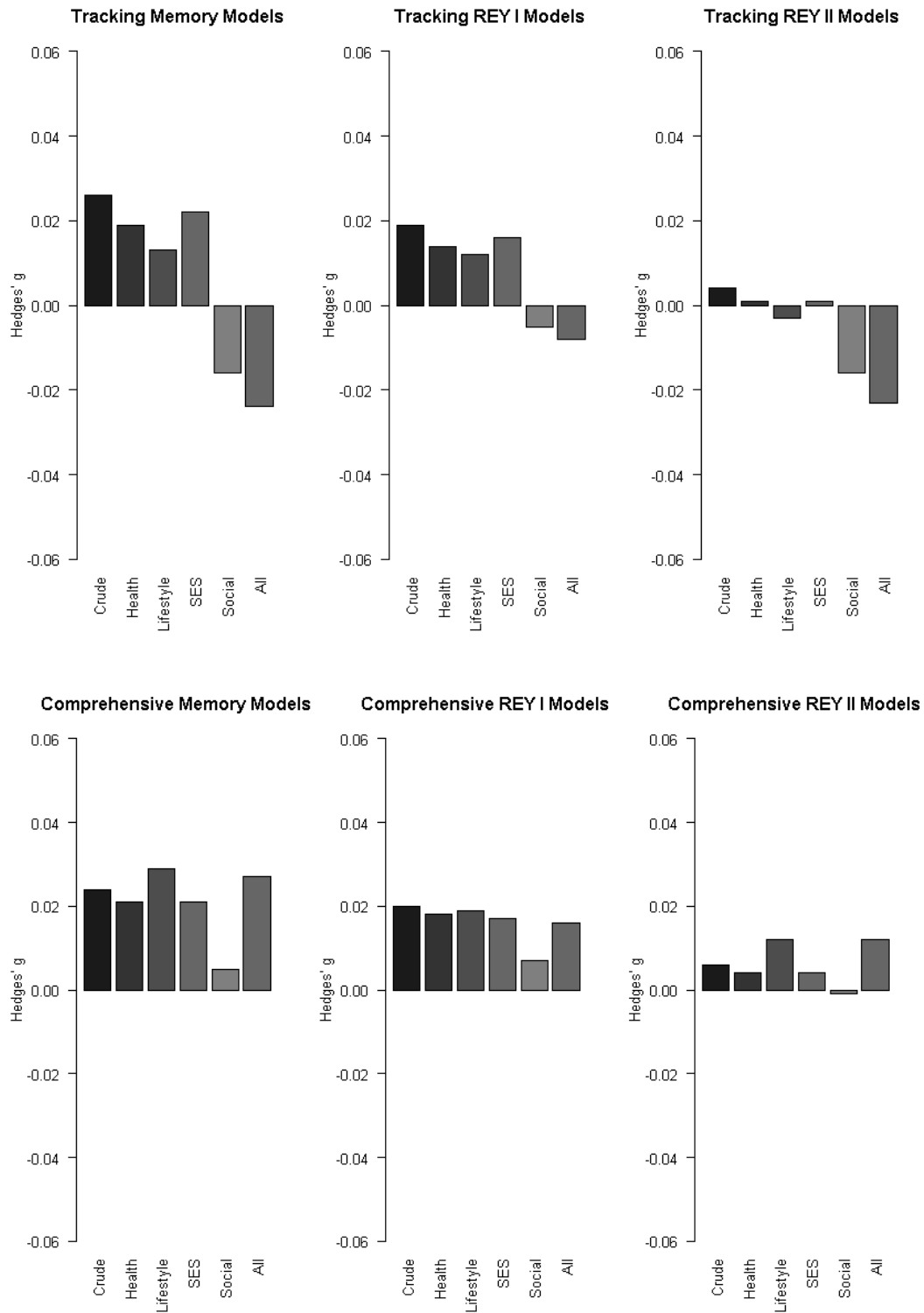
Figure 18a. Effect Sizes (Hedges' g) for Religious Participation in Domain-Based and Test-Based Memory Models of Tracking and Comprehensive Samples
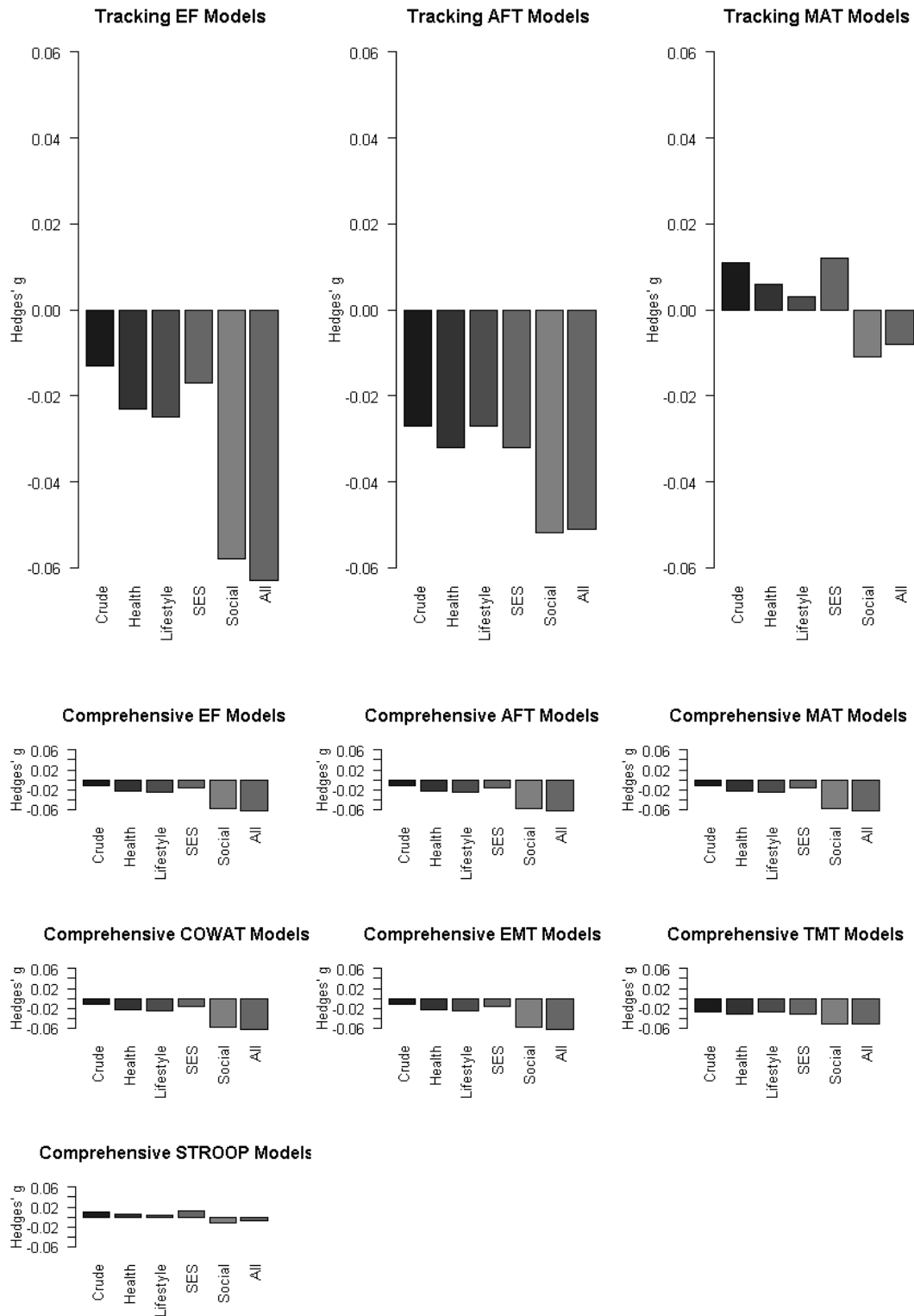
Figure 18b. Effect Sizes (Hedges' g) for Religious Participation in Domain-Based and Test-Based Executive Function Models of Tracking and Comprehensive Samples

An effect size ≤ 0.2 is small; whereas medium effect = 0.5, and large effect = 0.8.

3.1 Qualitative Findings

Table F1 in Appendix F depicts qualitative participants' characteristics. The qualitative sample was fairly similar to the CLSA quantitative sample in terms of age and sex distribution. The mean age of the qualitative sample was 59 years of age, whereas the mean CLSA sample's age was 63 years of age. In the qualitative sample 46% of the population were male, whereas in the CLSA sample about 49% of the sample were male. The doctoral candidate interviewed 15 participants (three Anglican, three Baptist, two United, six Catholic, and one Orthodox), including six pastors and nine parishioners, who were recruited from seven different churches in the City of Hamilton.

The qualitative data obtained from the semi-structured interviews led to the generation of three overarching themes. Each of these themes included several sub-themes (Figure 19) to explain the relationship between religious participation and cognitive function. These themes were: 1) religious involvement as a promoter of positive psychological states; 2) religious involvement as a provider of social interactions and support; and 3) religious involvement encouraging an active mind and exercising cognitive abilities. In the following sections, the themes and illustrative quotes are discussed in depth.

The doctoral candidate began the interviews by verbally describing the lack of significant findings in the quantitative analyses, and she then asked participants for any potential explanations for these findings. This was followed by posing the interview questions in the semi-structured interview guide (see Appendix B).

Promotion of Positive Psychological States	Provision of Social Interactions and Support	Exercising Mind and Cognitive Abilities
Sense of Worth and Value	Sharing a Faith Community	Keeping an Active Mind and Exercising Cognitive Abilities
Stress Reduction		
Religious Coping	Exercising Current Skills and Developing New Skills	Regular and Routine Practice
Observing through a Different Lens		

Figure 19. Themes and Subthemes to Explain the Association between Religious Participation and Cognitive Function: The Results of Interviews with Pastors and Parishioners

No differences between the participants' views based on their religious denomination were observed. All participants believed in an association between religious involvement and cognitive function:

"Religion is a vehicle for us by which people build their intellectual and cognitive abilities. Even though this is on a spiritual level and the goal is on a spiritual level, it uses very human abilities in a deeper way." (Michael, Catholic Priest)

3.1.1 Promotion of Positive Psychological States

The first identified theme was the role of religion in promoting healthier psychological states. This theme included subthemes of religion's role in fostering a sense of self-worth, value and dignity, reduction in stress levels, religious coping through making life purposeful and meaningful, and observing life through a different lens. All participants believed that religious participation could enhance one's psychological state, in turn affecting cognitive function.

3.1.1.1 Sense of Self-Worth, Value, and Dignity

Participants believed an increased sense of self-worth and value were components of religious participation that were related to improved cognitive function. They believed that religious involvement would promote the acknowledgement of self-worth and sense of dignity, with concomitant improvement in psychological health and cognitive function:

"I think religion and cognitive health support each other because of our ability to understand our value and dignity of the person." (John, Catholic priest)

Participants discussed how religious participation could instill feelings of dignity and value in people. It provides people with *"a sense of worth and purpose that they are all*

important, and it gives each person their sense of dignity which in turn could influence their

cognitive well-being." (Mum, Catholic Parishioner)

There is some evidence from the literature that a greater sense of self-worth may improve individuals' cognitive performance, including better executive control and higher fluid intelligence, particularly among persons from lower socioeconomic status. [200] Also, the literature supports a link between self-esteem and cognitive function. Although self-worth and self-esteem are not exactly the same constructs, the participants may have used the terms interchangeably. Self-worth includes having love, value and innate worth toward oneself, whereas self-esteem is how one evaluates him/herself. Self-worth acts as a form of positive self-perception and an anchor that keeps one stable when self-esteem fluctuates. [201]

The relationship between self-esteem and cognitive function might be explained through the ability of self-esteem to reduce depressive symptoms that may adversely impact cognitive functioning. Lower self-esteem leads people to be more vulnerable to depression, [202] and there is support from longitudinal studies that have reported on the negative predictive effect of low self-esteem on depression as well as the adverse effect of depression on cognitive functioning. [203, 204] People with depression experience a lower sense of self-worth and self-esteem, which could adversely impact their cognitive functioning through further reinforcement of depressive symptoms. [204] Consequently, a higher sense of self-worth may keep one's self-esteem stable, protecting against depression that could negatively affect cognitive functioning. Further, prior research has also reported direct links between low self-esteem and deficits in cognitive function as assessed by verbal and non-verbal IQ and executive functioning tests. [205]

3.1.1.2 Stress Reduction

Psychological stress is an important risk factor for the development of cognitive impairment as individuals proceed to old age. [206] Prior research has shown the detrimental effect of stress on cognitive function, particularly on learning and memory. [207] Chronic stress can lead to greater risks for biological wear, resulting in the dysregulation of the endocrine function and pro-inflammatory effects that can disrupt the neuronal structures underlying cognitive function. [208] Further, prolonged and sustained stress levels may lead to neuronal loss and deficits in hippocampus and prefrontal cortex related functions, [209] accelerated cognitive decline, [210] and increased incidence of dementia. [211] Thus, stress appears to be a strong predictor of cognitive decline as people age, and the participants felt religious involvement may exert its ameliorating effect on cognitive function through reducing stress levels.

Several participants discussed the healing effects of prayer on stress. They felt prayer was a coping mechanism that reduced the burdens on their minds and consequently relieved stress. Prayer was referred to as "*a channel from the person to the supreme being*" that helps with handling stress where: *"people know that they can take that feeling and ask for help" (Jane, Anglican Parishioner).* Further, one's religious belief was also illustrated as "*an anchor*" that could assist in dealing with stress and difficult life situations: *"In difficult times, you have something rooted that you can grab on and ask for help." (Peggy, Catholic Parishioner)*

Bringing stress into the relationship with God was proposed as a healthy strategy offered through religious activity:

"It [religious activity] helps in dealing with stress in a healthy way. People dealing with stress bring that to their relationship with God. Religious practice assists people to look at their difficulties in a very holistic way and this would really improve the problem, because they are

dealing with it and not ignoring it, and this could affect their cognitive function." (Michael,

Catholic Priest)

Another factor that was discussed through the interviews included the role of religious teachings in response to facing both individual and community stress where *"theological statements on unconditional love, forgiveness or compassion help not only the individual stress but also community stress and help a community to get through a stressful situation in ways that are cognitively healthier." (Frida, United Pastor)*

3.1.1.3 Religious Coping

Religious and spiritual coping is defined as the use of spirituality, religious belief, or religious activity to deal with stressful situations. [212] Interviewees saw religious coping as a way to enhance psychological health and preserve cognitive function. [213] Examples of positive religious coping include placing one's trust in God to handle life's troubles, thinking of one's life as part of a larger spiritual force, asking for help and support from spiritual leaders, aiming to support others particularly in spiritual matters, and turning to religion to receive guidance and new directions in life. Such positive coping mechanisms assist with providing meaning in life, particularly when dealing with difficult life situations.

Participants mentioned using religion to cope and make life intentional and meaningful, which they believed would contribute to healthier cognitive function*: "My religious involvement has provided my life with a deeper sense of purpose and meaning. Knowing what I can do to help someone else, whether mental, psychological or physical improves my life. This has allowed me to live my life much more intentional, and meaningful." (John, Catholic Priest).*

Through its stress buffering effect, religion protects against feelings of depression. Religious coping provides one's life with a sense of meaning and purpose and promotes feelings of hope and optimism. [65] There is strong support from the literature regarding the association between positive religious coping strategies and better physical and psychological outcomes (e.g., positive life perception, lower depression, lower mortality, improved immune function) across people of all ages. [65] Religious coping has been shown to be an effective strategy to deal with depressive symptoms and is associated with increased rates of recovery from depression. [214] Further, it was found to be inversely associated with depression, [81, 215] to be the only predictor of depressive symptoms at a six-month follow up, [81] and to be predictive of higher cognitive functioning among medically ill elderly. [81] Therefore, religious coping is another potential way through which religious involvement may protect against depression and lead to improved cognitive function.

3.1.1.4 Observing Life through a Different Lens

Through the interviews, people also alluded to religious involvement offering *"different perspectives to look through" (Peggy, Catholic Parishioner)*, including going through life *"keeping positive and getting through with the negative"(Mum, Catholic Parishioner)* and *"looking at everything whether positive or negative through the lens of love and compassion"(Carmen, Baptist Parishioner)*. These outlooks can *"guard"* and preserve cognitive health: *"because of my faith, I choose to see the beauty rather than all the negativity and I think that this frees my mind" (Mum, Catholic Parishioner)*.

Optimistic outlooks toward life provide one with positive affect, which can guard an individual against feelings of depression. [216] The psychology literature claims positive attitudes and outlooks toward successful and healthy aging [216] have a preventive function against

emotional disorders, including depression. [217] Positive attitudes and outlooks have been reported as an important coping mechanism against depression among nursing home residents. [218] Studies suggest that positive attitudes and outlooks appear to defend against depression and improve emotion regulation through promotion of coping strategies and engagement in healthy behaviours, as well as through the creation of psychological resilience against depression. [219] Thus, religious activity could serve its protective purpose against feelings of depression through yet another path, the promotion of positive outlooks and perspectives in life, in turn battling against cognitive deterioration.

3.1.2 Provision of Social Interactions and Support

Another main theme identified in this thesis was the provision of social engagement and support. Two subthemes or forms of engagement/support were identified: staying connected and sharing a faith community, and exercising existing skills and developing new skills. These subthemes are separately discussed below.

3.1.2.1 Staying Connected and Sharing a Faith Community

In emphasizing the beneficial effects of religious involvement on cognitive function, the role of religious community and sharing one's faith with a larger community as a form of social engagement was brought forward. One form of social engagement was communal prayer: *"When I go to mass it is not just about me, I share with a community. When I go to communion, I share with the community my belief, which is something that we share collectively. We join with community in one belief and I think that is very helpful that it is not just me and God, but me and God and community. You have to have individual prayer, but you also need to have communal prayer." (Mum, Catholic Parishioner)*

Church-based activities such as informal gatherings before/after service provided another venue for social interactions. In the words of one participant, church is *"a vehicle by which people could grow in connection with one another"* and a place that allows for *"transcending people of different social backgrounds and ages who become socially aware, engaged and receive the support that they each need, affecting their cognitive function" (Michael, Catholic Priest)*. Church was also introduced as a venue that allows for concurrent worshipping and socialization among fellow worshippers, and where *"many relationships are built"*. It provides the opportunity *"to be with people, interact with them and help them, which affects cognitive function" (Spencer, Baptist Pastor)*.

Church was also illustrated as a social venue that is cognitively stimulating to its' members: *"Because of the community that is formed, it is a constant stimulation, constant support and constant encouragement in a bunch of levels of people's lives" (Bill, Baptist Pastor)*. The *"demands or the possibilities because of the communal life together"* was speculated as an important component of religious participation that could affect cognitive function. Participation in church involves interacting with a wide array of people with different ways of life and professions, making it *"quite stimulating cognitively"* and involving *"a whole lot of stimulations in a whole lot of levels of a person's cognitive functioning" (Bill, Baptist Pastor)*.

Interviewees also saw religious participation as beneficial for persons already on the path to cognitive decline. Through religious participation, such people could feel *"part of a community"* from which they derive support: *"not only because it is a religious experience for them, but there are other people there that have the same or similar problems and they also talk to people who don't have the same problems"(Tricia, Catholic Parishioner)*. When asked about

the potential role of religious involvement in providing social interaction opportunities, the notion of support was further reinforced by other participants who described the religious community's attitude of "*practicing the message of love alongside the other people in the community and experiencing a loving support" (Carmen, Baptist Parishioner)*, and of community members *"being able to count on each other, build on experiences that they had together at the church or outside"*, as well as *"to build up a sense of belonging, friendship and support specially in times of hardship" (Scarbay, Catholic Parishioner).*

The role of religious participation in overcoming isolation and problems associated with loneliness was another proposed way through which religious activity may guard against cognitive decline: "*Isolation is related to more cognitive function issues because you are not able to problem solve and connect" (Mum, Catholic Parishioner).* One pastor indicated that when the elderly are isolated *"they do not have a sense of what other people know or what other people may find easy that they themselves don't" (Farida, United Pastor).* Thus, being part of the *"intergenerational community of the church"* could provide people with *"a sense of where they are standing"* and help them notice at an earlier stage when they are *"out of step compared to their peers or out of step with what would be others' expectations of their cognitive function" (Farida, United Pastor),* which may assist with the early detection of cognitive deterioration. The anti-isolation role of religious participation was especially emphasized for the elderly:

 "Church attendance contributes to getting you involved with people. I just think especially for seniors, it provides an opportunity not to be isolated, and that is very important. It is a wonderful social interaction. Churches could provide people with both spiritual and social support, particularly at the times of hardship, and this affects their cognitive health." (Jane, Anglican Parishioner)

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Finally, in emphasizing the important role of religious involvement in providing social participation opportunities, the participants also discussed the difference between socialization in religious versus secular contexts. They highlighted the role of love, caring and deep commitment within religious settings, which can enhance the value of the social support mechanisms emerging from religious participation: *"the Christian element has that extra layer of love and is not just casual friendship. It has a deep love that binds you to others" (Marie, Anglican Parishioner).* Further, in a religious community as opposed to a secular social setting, there is a *"heightened sense of social awareness"* where *"people ask why, if you disappear" (Farida, United Pastor).* The community also has "*religious expectations that people care for each other and the care and social piece of it is embedded within the theology of the community. And the purpose of the community helps to shape how the community does that, in a way that is more beneficial to health than other social contexts" (Farida, United Pastor).*

3.1.2.2 Exercising Existing Skills and Developing New Skills

Another point was that socializing with others in religious venues would allow people to exercise their existing mental, cognitive, and behavioural skills:

"Interacting with others as well as learning new skills or exercising existing skills during these involvements in the church allows you to both be mentored and mentor others, which could affect cognitive function by strengthening people's elasticity of their brain. One way I think is that you are known to other people and they have an expectation of your cognitive functioning, whether that is because you are volunteering, or you fill a particular role. When people take on certain tasks in the church, there is a sense of understanding your role or relationship with other people, keeping track of tasks, which is a cognitive exercise that holds you accountable when performing a function. It also helps in terms of positive-self-perception, which motivates them to keep up that

persona and to value their cognitive abilities and skills that they have gained over time."

(Farida, United Pastor)

Religious venues are also settings wherein one may exercise their skills (including cognitive skills) through helping others:

"Also, being active in the church community helps. You know there is an old saying 'to whom much is given, much is expected'. So, if you have certain skills, you have an obligation to give of yourself. The more you give, the more it helps you, and that includes its effect on your cognitive abilities." (Peggy, Catholic Parishioner)

Interacting with people in church can also provide chances for teaching and learning, which could further stimulate one's cognitive resources:

"Anyone that comes to church, could challenge your mind. You meet new people and learn new skills when you are interacting with other people in church and teaching them and learning things." (Marie, Anglican Parishioner)

Interacting with others during religious participation could influence people's existing skills or assist with the development of new skills. During such interactions, people not only benefit from opportunities to teach and learn, which could enhance their cognitive function, but also such interactive venues may provide people with social and emotional support. Greater social support is seen to be correlated with better cognitive function and reduced cognitive decline in old age. [101, 103, 220] Despite speculation about the proposed role of social support in preventing or delaying cognitive deterioration, no clear understanding of the temporal association between these constructs exists.

Social support and cognitive function may well affect each other in such a way that earlier cognitive function determines later access to social support, which could in turn influence future cognitive function. [221] However, most prior research on the topic has considered social support as an exposure variable and cognitive function as an outcome variable, thereby implying a largely unidirectional temporal relationship. [123, 222] This view is consistent with the cognitive stimulation theory, where social support and consistent social relationships lead to cognitive stimulation, enhancement of neuronal capacity, and synaptic density, all of which combine to prevent or postpone cognitive decline.

There is also evidence from longitudinal studies demonstrating that among the elderly, those with no social ties are at a higher risk of cognitive decline. [222] This may be explained by the role of social and emotional support in reducing stress (consistent with the stress-buffering hypothesis) and fighting off feelings of depression, which otherwise could be detrimental to cognitive functioning. Indeed, studies have found greater risk of comorbid depressive symptomatology and cognitive decline among those with lack of satisfaction with the degree of social support in their lives. [223]

All in all, regardless of the direction of the relationship, there is clear evidence from previous studies regarding the existence of positive associations between social support and cognitive function.

3.1.3 Exercising Mind and Cognitive Abilities

Participants discussed the effect of religious involvement and participation on exercising the mind, which could stimulate cognitive assets and enhance cognitive function over time. The two subthemes in this area were keeping an active mind and regular and routine practice.

3.1.3.1 Keeping an Active Mind

The effect of religious involvement on reasoning as a component of cognitive functioning was described by one participant as the following:

"It is very important in the Catholic tradition, the ability to use one's mind to think for oneself and to delve into what is true and what is good. The Catholic tradition emphasizes the need to be attentive to everything on a good and rational level and by which to use those as vehicles to understand God. So, reasoning is essential to faith. And faith engages that rational faculty within us." (Michael, Catholic priest)

Further, the effect of religious practice on the cognitive components of attention and verbal skills were also discussed:

"Regarding attention, prayer demands a certain attentiveness within us and what is happening around us. Also, verbal and language skills are important in terms of the articulation of why somebody is a Christian. Since Christian life is to be shared with others, you need to have the proper verbal skills to be able to share what our faith is, so the other people could understand. Within our prayers and the mass there is a strong tradition of the language as a vehicle to communicate faith. Latin and Greek languages are built within the Christian tradition. The language is itself a vehicle to reach the transcendent. In a very tangible way, the word language is very central for us as Christians." (Michael, Catholic Priest)

Another participant found participating in religious activities to be a constant source of mind stimulation that encourages thinking and exercises cognitive assets:

"When you are religiously involved, your brain is regularly active and you're getting new ideas all the time and you have to process them. It involves what is being said in church and thinking

about it. Also reading religious verses, and sometimes you don't agree with everything, but you think about it." (Marie, Anglican Parishioner)

One participant felt religious participation offers more cognitive benefits than merely being a venue for social engagement:

"Religious participation and practice like taking bible studies, helps your mind. It is a practice that normally happens once a week. In church, you are being told a religious perspective but then you take from it how you understand what is being taught. There are many aspects to the church, not just the social. In bible studies for example, you are understanding the faith more, then you get into discussions and in many ways, that can be challenging to your mind, because you may get into discussions." (Rick, Anglican Parishioner)

The effect of theological reflection was also mentioned as a component of religious involvement that could enhance cognitive function:

"The religious activity of theological reflection requires the individual to hold a bunch of information from scripture, and from history, in order to be able to bring that to bear to a current situation. So, there is a fair amount of cognitive elasticity and also making a lot of internal decision making about what is applicable and what is not and then planning on that basis so as to move forward. So, I think there is a fair amount of cognitive exercise that is going on in theological reflection." (Bill, Baptist Pastor)

Mindfulness and contemplative prayer were mentioned as other potential aspects of religious involvement that could stimulate cognitive function:

"There is a mindfulness practice within most religious traditions. In Christianity, there is contemplative prayer and those practices do affect brain activity in measurable ways which is

being able to stay present, being able to stay attentive, having a cognitive elasticity and to face problems and coming back to a place that is quite resourced in response to what you are facing." (Bill, Baptist Pastor)

In line with mindfulness and contemplative prayer, another participant brought up the act of silent meditation as one of the most important aspects through which religious practice could influence cognitive function:

"I think what might contribute to cognitive function is the act of silent meditation. For example, the Lord's prayer, those that can say it with a sense of meditativeness, as opposed to those that just say it without paying attention to what they are saying. If you are not mindful of the prayer, it will not do anything. The act of being present in my opinion, the silent meditation is the part that will make a difference." (Soulman, United Pastor)

3.1.3.2 Regular and Routine Practice

Participants pointed to how the routine of regular religious involvement could affect cognitive functioning and in particular memory:

"When we think about memory, a great part of religious participation requires to have a very active and conscience sense of what is happening in one's life. So, it means taking guide each day and to examine, and delve deeper into the experiences of one's life" (Michael, Catholic Priest). Further, *"remembering how the church year changes, singing hymns and the process of revisiting these things on a weekly or seasonal basis help to strengthen memory" (Frida, United Pastor).*

One participant discussed the role of religious routine in creating a balanced life, which in turn influences one's cognitive function: *"Religious activity could affect cognitive function*

because of the routine of it, and over a long time, it kind of grounds it into your brain. It helps

you with your memory" (Mum, Catholic Parishioner).

Regular practice and the ongoing upgrading and learning about one's faith was also

stated as an important aspect of religious practice on cognitive function:

"One important aspect is regular practice, and ongoing formation. Ongoing formation is the

constant upgrading or the ongoing learning about one's faith. The continuity of being in a

setting that worships and practices on a regular basis is very healthy to the mind." (Scarbay,

Catholic Parishioner)

Keeping an active mind and being intellectually engaged could assist in preserving

against cognitive deterioration through the stimulation of cognitive resources, creation of

cognitive reserves, and improvement of cognitive function. Through such processes, the brain

may compensate for age-associated brain changes, as well as brain changes related to various

health conditions (e.g., stroke, epilepsy, Parkinson's disease). [224]

3.1.4 Role of Religious Organizations in Impacting Cognitive Function

Participants were further asked if they thought religious organizations, including

churches, play a role in healthy brain aging and improving their members' cognitive function:

"There is a role for the church because it helps us with the deeper dimensions of our lives which

is the spiritual dimension, and this deeper place has relationship to people's intellect and their

cognitive function." (Michael, Catholic Priest)

The role of churches in promoting feelings of value and worthiness among their

congregants was raised as a way that may subconsciously affect people's cognitive health:

"I think places of worship and spiritual sites are really places that promote the common good from both the society and the individual points of view. Their teachings revolve around promoting the inner goodness of the individuals and this would promote cognitive health in a very positive way. By the promotion of feelings of confidence and value, cognitive functioning could be improved." (John, Catholic Priest)

Participants recommended that churches could incorporate scientific research findings, and employ mindfulness and similar spiritual activities, in their practices to mitigate the negative effects of stress and burn-out, and to assist with the promotion of cognitive health:

"Religious sites could use the research findings and scientific models in looking at their own practices and to consider and understand how they can talk more openly about that. They would also need to include more mindfulness and spiritual practices that could help with preventing burn out among ministers and congregants." (Frida, United Pastor)

The need for interdisciplinary approaches was discussed as a way to promote better cognitive functioning among individuals. These approaches would need to include various aspects of individuals' health, including spiritual, cognitive, mental and physical: *"There is a need for interdisciplinary approaches. Connections need to be formed between churches and practitioners in different fields especially in the mental, cognitive and physical health areas. And that the church really emphasizes the need for that approach, as we deal with the issues of all ages (Michael, Catholic Priest).* These interdisciplinary approaches need to be built between various systems where people are learning but "*that learning could be separated from their spiritual life" (Michael, Catholic Priest).* The importance of the spiritual aspect of care on enhancing people's cognitive functioning, particularly within palliative care contexts, was brought forward: *"There are so many aspects of care, dietary, recreation, social, and spiritual.*

Those domains need to be part of a team approach for the health of the person in the care

facility and I feel that in some places the spiritual domain is given less emphasis. I think the lack

of the spiritual emphasis does affect some people's cognitive function." (Spencer, Baptist Pastor)

Participants also felt that churches would need to be provided with some directions on how to foster cognitive health among their members. An additional point included augmenting medical models with the story-based approaches used within the faith institutions to obtain a more comprehensive approach to well-being and health:

"Our medical model responds to mental and cognitive health in a very medical and

pharmacological way as opposed to the story-based way that people discover their lives'

meaning. And those story-based encounters are certainly within the faith communities. There is a

role for the faith communities, but we just need to do a better job of occupying. The churches

need some direction and leadership on how to practice the practices that foster cognitive

health." (Bill, Baptist Pastor)

Offering leadership positions and volunteer opportunities to further enhance people's skills were among other proposed ways through which churches could help with the promotion of cognitive health: *"The more leadership and volunteer roles the churches provide people with, the more helpful this would be for their cognitive functioning. These opportunities would help because you come across all sorts of personalities and characters and need to develop the skills to interact with them." (Peggy, Catholic Parishioner)*

Lastly, presenting socializing opportunities that could assist with building relationships and fighting off feelings of isolation and loneliness was another proposed way through which churches could assist in maintaining or enhancing cognitive health among their members:

"Churches could provide people with both spiritual and social support at times of hardship particularly. Also, they could offer social clubs and opportunities to build relationships for people who are lonely." (Jane, Anglican Parishioner)

3.1.5 Explanations of the Quantitative Findings by the Qualitative Participants

The doctoral candidate gave the qualitative participants a brief summary of the quantitative findings from the analyses of the CLSA data. She asked the participants to share any thoughts about the findings. Most specifically, the doctoral candidate was interested in the pastors' and parishioners' views about the absence of statistically significant or clinically important findings.

All participants expressed surprise about the fact the study did not find unequivocal, positive associations between frequency of religious participation and cognitive function. Some participants shared their explanations for the unexpected results. The general feeling was that frequency of participation in religious activities was a superficial indicator of true religious engagement:

"I think frequency of religious attendance is not the correct indicator. I think it is more a matter of what effect the information imparted during religious attendance has on the cognitive function of the individual. Given the complexity of the human beings and all the components that make up our ongoing cognitive function, perhaps that is where the effect can be found." (Carmen, Baptist Parishioner)

As such, the quantitative analyses used an inadequate exposure measure.

One pastor explained the issue by focusing on the Sunday service:

"Most or many mainstream religions do not nurture creativity of the mind in a way they ought to. It [Sunday service] can become an exercise in ritualism that can almost make cognition to become idle. Sometimes people in my capacity have helped enable a numbness." (Soulman, United Pastor)

From this pastor's perspective, some religious services fail to nurture creativity of the mind or cultivate cognitive stimulation and growth. Therefore, measuring participation via these types of events would be an inadequate means of assessing the full extent of one's religious engagement.

Other participants agreed and felt the benefits of religious participation were related to the depth and richness of one's involvement with the church. Merely being present at religious functions (e.g., Sunday service) was unlikely to promote health, including cognitive health.

"I would say that a lot of people just go there but do not really participate in a way that really keeps them engaged. There are a lot of people that go there because they're lonely, but they don't really interact much." (Marie, Anglican Parishioner)

Certainly, regular church attendance does not necessarily mean people practice their beliefs on a day-to-day basis:

"In our culture, God is something or someone you talk to with the people at church on a Sunday morning. We are not encouraged here culturally to have a continuous personal relationship with God and lack cultural examples of people living their faith in day to day settings." (Mum, Catholic Parishioner)

Under this type of religious practice, persons who attend religious services regularly may not engage in many of the activities that promote cognitive function (e.g., extensive prayer, reading and interpreting Biblical passages).

Overall, the gist of participants' feedback was that the frequency of religious participation was an inadequate measure of the depth of one's religious/spiritual commitment or involvement. Frequency of participation alone does not capture even a small portion of the varied means by which an individual might benefit cognitively from religious involvement, as described in the themes discussed above.

Due to the nature of the question on religious participation in the CLSA (i.e., frequency of participation only), this thesis could not ascertain the full degree to which CLSA participants were substantively involved in religious or spiritual activities. Therefore, among CLSA participants who reported any level of participation in religious activities, the richness of their involvement was unmeasured, leading the quantitative results to be biased toward the null.

CHAPTER IV. DISCUSSION

Previous literature has supported the positive effect of religious and spiritual involvement on cognitive function, as seen in several of the studies included in the systematic review (see Appendix A). This thesis was conducted to examine the association between frequency of religious participation and cognitive function in middle- and older-aged adults using data from the CLSA, a large, population-level study of persons recruited from across Canada.

The CLSA had several advantages over previous studies in the area, including population-level data, multiple measures of cognitive function, and a rich variety of covariate data. Previous studies did not always control for important and relevant covariates (e.g., social engagement). In regression models, the doctoral candidate controlled for a range of demographic, health related, socioeconomic, and social variables, which were far greater in number than the covariates used in previous research. Many previous studies enrolled very select groups of participants (e.g., persons over the age of 65 years,[9] persons recruited from specialty clinics[10]) and their findings may not be applicable to larger elements of the population. In an effort to overcome the limitations of prior research, this thesis included participants aged 45 to 85 years who were recruited from across Canada. The findings revealed no particular trend or pattern in the results, regardless of cognitive outcome or sample (Tracking, Comprehensive). Further, adjusting for social factors (social and all blocks models) did not lead to any findings that were substantively different from other models.

Regarding the qualitative findings, several themes emerged as important explanations for the link between religious involvement and cognitive function, including promotion of positive psychological states, provision of social engagement, and stimulation of more active mindsets. Although the quantitative analyses did not show social engagement to be a statistically

significant factor in the association of interest, qualitative interviews found it to be an important ingredient of the link between religious practice and healthier cognitive states. One possible explanation for the discrepancy between the results of the quantitative and qualitative components of this thesis came forward in the interviews with pastors and parishioners: frequency of religious participation was not an accurate and ideal representation of one's actual degree of religious involvement and commitment. Therefore, the quantitative analyses may have been unable to detect some potential associations. The doctoral candidate could not explore this possibility quantitatively because the frequency of religious participation was the only religion variable in the CLSA.

4.0 Quantitative Analysis

4.0.1 Discussion of Findings across the Cognitive Tests

With the REY I memory test as the main outcome in the Tracking sample, only the crude model was statistically significant and had a positive direction of association. With this test as the outcome in the Comprehensive sample, the crude, health, lifestyle, and SES blocks were statistically significant: more frequent religious participation was associated with higher memory scores. However, upon controlling for the social covariates (social, all blocks models) in the Comprehensive sample, the association between REY I and religious participation was positive yet no longer statistically significant.

With REY II as the outcome in both the Tracking and Comprehensive samples, none of the models were statistically significant. In the Tracking sample, only the crude, health, and SES models demonstrated positive associations; in the Comprehensive sample, all of the models except the social block showed positive associations.

Regardless of which memory test (REY I or REY II) was used in the thesis, analyses adjusted for the social variables (social block and all block models) did not produce statistically significant associations between frequency of religious participation and memory function. However, the direction of association was not always the same once the social factors were included in the model. When social factors were accounted for (i.e., social model, all block model), the direction of association became negative for the Rey I and Rey II tests in the Tracking sample. However, this only happened for the Rey II test in the Comprehensive sample, once the social block was controlled for (see Appendix E). These findings can be distinguished from those of prior studies, as none of the earlier studies had investigated the memory domain of cognitive function using the REY assessment. Among the studies that had explored memory using other assessments (the East Boston Memory Test-Immediate and Delayed Recall), [225] social variables had not been controlled for in the analyses. [160]

With the executive function tests used as the main outcomes in the analyses, each test yielded different findings. Considering AFT scores in both the Tracking and Comprehensive samples, following the inclusion of each block of covariates, the association between the independent variable and outcome remained statistically significant. However, in both samples, the frequency of religious participation was inversely associated with the AFT scores. This finding was at odds with the original hypothesis of this thesis, namely that higher frequency of religious participation was likely to be associated with better cognitive function. However, due to the cross-sectional nature of the analysis, the doctoral candidate could not ascertain whether lower cognitive function flowed from more frequent religious participation (reverse causality bias). Perhaps persons who were already on the path to cognitive deterioration were more likely to increase their religious participation by attending church as a means of coping with their

declining health situation. Thus, the negative associations found in this dissertation should not be taken as definitive evidence that more religious participation temporally precedes lower cognitive function.

When MAT scores were included in the analysis as the primary outcome, the results varied across the Tracking and Comprehensive samples. In the Tracking sample, none of the models were statistically significant and the associations were positive in all except the social and all block models. In the Comprehensive sample, the associations of interest were all negative. However, as explained previously, this finding needs to be interpreted considering the cross-sectional design of the thesis and the possibility of reverse-causality bias. It is also possible that the differences between the Tracking and Comprehensive samples might have contributed to the discrepancy in findings for the MAT. In the Tracking sample, comparable urban and rural populations were included, whereas in the Comprehensive sample, mainly urban populations were recruited. The point about potential differences between urban and rural samples is discussed in further detail below.

The remaining executive function tests were only employed in the Comprehensive sample. With the TMT and Stroop test scores serving as the outcome, almost all associations were negative (except for the lifestyle block in TMT) and none of the models were statistically significant. For COWAT, all of the associations were negative and only the health, social and all blocks models exhibited statistically significant associations between the predictor and outcome. With EMT scores as the main outcome, all models showed significant yet inverse associations between frequency of religious participation and executive function scores. Similar to the results obtained when AFT and MAT (Comprehensive) test scores served as the main outcome, these findings need to be considered carefully due to reverse-causality bias.

To assess a potential temporal association between frequent and regular religious participation and cognitive function, longitudinal studies that adjust for baseline cognitive function levels would be required. It is plausible that those who struggle with cognitive problems and are on the way to cognitive decline are more likely to participate in religious events as a means of dealing with their symptoms or seeking help. In fact, some of the qualitative participants pointed to the beneficial effects of religious participation for persons with cognitive decline, including the provision of (1) social and emotional support, (2) a means of assessing one's own cognitive status relative to others, and (3) follow-up when someone is unexpectedly absent from religious functions.

4.0.2 Inconsistencies in Findings from the Thesis

As described in Section 4.0.1 above, the doctoral candidate found inconsistencies in results across the cognitive tests and Tracking and Comprehensive samples. Inconsistencies across the samples could be due to differences in sample frames and modes of administering the cognitive tests across the two samples. Regarding the different sample frames, urban and rural participants were included in the Tracking sample, whereas primarily urban participants were included in the Comprehensive sample. The predominantly urban population of the Comprehensive sample may have influenced the cognitive outcomes. A Chinese study on the effect of urban-rural living on cognitive decline used data from a nationally representative sample of seniors and found that urban living in later life was associated with faster rates of cognitive decline. [226] On the other hand, another study reported a greater prevalence of cognitive impairment in rural settings. [227]

The present dissertation study found many negative associations between religious participation frequency and scores of cognitive functioning (in particular executive functioning)

in the Comprehensive sample with a primarily urban sample frame which is at odds with some of the findings of prior research regarding the positive effects of urban living on cognitive function. [227-228] One explanation for such discrepancy might be that although urban living might allow for better access to resources such as healthcare, public transport and community resources, the quality of social relationships in rural settings might be stronger and offer better emotional support than those offered in urban contexts. Thus, in the comprehensive sample with an urban sample frame, greater frequency of participation in religious activities might not necessarily offer the same degree of social engagement and emotional support as those obtained in rural venues.

Turning to modes of administration, Tracking participants provided data via telephone, while Comprehensive participants provided data through in-person interviews. Distortions over telephone lines could have led to misunderstandings or missed responses which could have led to nondifferential misclassification for the Tracking sample only. In fact, the effect sizes for the cognitive tests administered in the Tracking sample (i.e., REY I, REY II, AFT, MAT) were mostly smaller than the corresponding effect sizes in the Comprehensive sample. This is because nondifferential misclassification biases the results to the null. Until there is evidence for the existence of measurement invariance for each individual cognitive test across the two CLSA samples, these tests should be assumed as distinct.

The literature suggests that different modes of administration of interviews could influence participants' response patterns in long interviews with nationally representative samples. [229] Prior research has found greater social desirability response bias in telephone interviews than responses provided in face-to-face interviews. Further, persons taking part in telephone interviews were less motivated, less cooperative and more suspicious than those interviewed in face-to-face settings. Thus, the rapport developed in face-to-face interviews may

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inspire the participants to provide more objective answers that may not be necessarily socially desirable. [229]

Despite the differences in results across the various analyses undertaken for the thesis, the effect sizes (Figure 18) associated with the regression coefficients for religious participation were within 0.089 points of one another. Therefore, the differences across coefficients were not clinically important regardless of the direction of association. This implies less discrepancy and heterogeneity in the results than what is shown in Figures 2 to 17, with the difference between the most extreme negative association and the most extreme positive association being quite minute. In fact, the regression coefficient and effect size associated with religious participation in each model was quite small and very close to the null value of 0, which suggests almost no association between religious participation and cognitive function in the CLSA data.

Finally, another potential explanation for this thesis's null findings could be the complete case analysis. This dissertation's regression analyses only included those participants who provided complete responses and excluded those with incomplete data, which might have led to non-response bias by omitting incomplete responses. This could have occurred by under- or over-estimating the degree of religious participation caused by missing data. This in turn, may have resulted in biasing the effect of religious participation on cognitive function in the included models.

In order to investigate this, separate analyses were undertaken for the Tracking and Comprehensive samples. In the Tracking sample, once the participants were divided into two groups based on whether they had missing data on any one of the cognitive test scores, the proportion of individuals in each group was statistically significantly different across the two categories of religious participation (any attendance versus no attendance). In this sample, there

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was a slightly lower percentage of participants with missing data on any of the cognitive test scores who reported any level of religious attendance (49.6 %) compared to those who reported any level of religious attendance with no missing data on any of the cognitive tests (53.3%). This was indicative of a greater proportion of participants with any level of religious attendance that was retained in the analysis. However, as stated earlier in this section, the effect sizes for the cognitive test scores in the Tracking sample were for the most part smaller than those in the Comprehensive sample, thereby failing to support a bias away from the null affecting the results in the Tracking sample.

In the Comprehensive sample, once the participants were divided into two groups based on if they had missing data on any one of the cognitive tests scores, the proportion of individuals in each group was not statistically significantly different across the two categories of religious participation (any attendance versus no attendance). This finding suggested that missing data on any of the cognitive test scores in the Comprehensive sample was not likely to have influenced the results. All in all, there appeared to be little evidence regarding the potential effect of missing data on this study's findings, particularly in the Comprehensive sample.

4.0.3 Differences in Findings between the Thesis and Prior Research

Some discrepancies existed between the findings of the thesis and published research. Several factors might have contributed to the discrepancies. One factor was the array of cognitive assessments included in this study compared to earlier research. Further, several earlier studies on the topic were longitudinal, which allowed the researchers to adjust for baseline cognitive function, whereas the thesis was cross-sectional in nature. Another factor could be the differences between the sample frames which were more narrowly defined in prior studies compared to the population level sample included in this dissertation. Differences in findings

could also have arisen from the different methods of defining the main exposure of religious involvement. Finally, the inclusion of several social elements as covariates in the present research may have contributed to differences in findings compared to prior studies.

Beginning with differences in cognitive measures, the findings from nine published cross-sectional studies all showed positive associations between measures of religious involvement and global cognition assessed using the MMSE. [12, 71-73, 75, 159-160, 230-231] The majority of the cross-sectional studies focused on the broader area of global cognitive function and did not separately report outcomes by cognitive domain. [12, 71-73, 75, 159-160, 230-231] All of these studies included the MMSE either alone, or in addition to other measures (only in two studies), to assess cognitive function.

In this thesis, the MMSE was not one of the measures employed to evaluate cognitive function. In fact, there are some important differences between the MMSE and the cognitive assessments included in this dissertation. The MMSE does not assess executive function [232] and only one of its subcomponents assesses memory recall. [233] As such, the findings of prior studies may not be comparable to the results of this dissertation because the outcomes are measuring different constructs. Also, only one cross-sectional study reported positive associations between religious activities and the memory domain of cognitive function, [159] with memory measured through the aggregation of several memory test scores included in the Consortium to Establish a Registry for Alzheimer's Disease Assessment Packet [159] (see Appendix A).

Regarding the results of prior longitudinal studies, contrary to the findings of this thesis, most studies reported positive associations. [9-11, 69-70, 76, 234] The majority of the longitudinal studies employed the MMSE to assess cognitive function. However, three studies utilized the Short Portable Mental Status Questionnaire (SPMSQ) and also reported positive associations

(see Appendix A).[70, 76, 234] The SPMSQ assesses organic brain deficits in the elderly, and the findings of studies using this measure should therefore not be compared with the results reported in this thesis, which do not assess organic brain deficits. [235]

Another factor that might account for the differences in findings between this thesis and the published literature was that prior longitudinal studies assessed changes in cognitive function over time, and some adjusted for baseline cognitive function in their analyses, whereas this thesis was unable to do so on account of its cross-sectional nature. Moreover, the samples in prior research were mainly chosen from select and narrow groups, but this dissertation employed a population-level sample of individuals to investigate the association of interest.

Prior studies also differed with each other, and with the thesis, in terms of defining the main exposure. Among the cross-sectional studies, [12, 71-73, 75, 159-160, 230-231] religious involvement was variously defined as weekly spiritual activity, [231] religious affiliation, [73, 159] religious coping, [75] organizational and non-organizational religiosity, [73] religious belief, [73] midlife praying, [73] engaging in Muslim religious activities, [230] and frequency of religious service attendance. [160] Prior longitudinal studies also demonstrated diversity in terms of how they defined and evaluated religiosity. Among the longitudinal studies, one study examined religious affiliation, [34] three studies defined their exposure group as participation in religious organizations/religious participation, [69-71] and the remaining studies explored the effect of frequency of religious service attendance/church attendance on the outcome. [9-10, 24, 74, 76, 234]

Lastly, most previous studies did not adjust for any form of social engagement in their analyses. Only four longitudinal studies controlled for social elements (i.e., social support, [234] social engagement, [76] baseline social disengagement, [9] social ties [34]) in regression models. Three of these studies reported positive significant associations even following adjustment for social

factors, [9, 76, 234] while one did not find any such association once social factors were included in regression models. [34] The cognitive outcomes in these studies were assessed using the MMSE, [9] or the SPMSQ (or its modified versions). [34, 76, 234] The analyses in the thesis adjusted for a variety of social factors, including social networks, social participation, and social support availability. Previous research defined social variables differently from those included in this thesis study. One study assessed social disengagement through summation of four items including marital status, monthly contact with family and friends, secular group membership, and living arrangements. [9] Another study defined social ties as the number of close friends and neighbours with whom the person had at least weekly contact. [34] In another study, social engagement was adapted from the Social Disengagement Scale of Bassuk et al. [222] by removing the items related to religious attendance and any other items that were separately accounted for as covariates by this study's authors. [76] Finally, a fourth study assessed social support through summation of two items, one asking if the person could count on at least some family or friends for support in times of trouble, and another asking if the person could talk to at least some family or friends about their deepest problems. [234] Thus, another factor that might have contributed to the differences in the findings of this thesis compared to prior research might be due to the different ways of measuring the social variables. The current dissertation study was one of the few studies to control for social engagement (networks, participation, and support), which was done by including three different social variables in the regression models (social networks, social support availability, social participation). Controlling for these social elements did not result in findings that were substantively different from the other models (including the crude model). With or without the inclusion of the social factors in the models, no consistent trends or patterns regarding the independent effect of religious participation on the cognitive scores were detected

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across the various models. The social variables did not appear to have any impact on the findings, as the small effect sizes for the frequency of religious participation persisted across all of the models, regardless of whether the other social variables were included in the models or not.

4.1 Qualitative Analysis

The main outcome of the qualitative portion of this study was to obtain pastors' and parishioners' explanations of the association between religious participation and cognitive function. The analyses of the interviews uncovered three main themes, i.e., promotion of positive psychological states, provision of social interactions and support, and exercising mind and cognitive abilities. These themes demonstrated that religious involvement is a multidimensional phenomenon that cannot be measured by a single factor (such as frequency of church attendance). Rather, religious involvement is made up of a combination of beliefs, practices, actions, and environments that work together to impact cognitive function. Simply attending religious functions, without a personal devotion to growing in awareness of God, or without earnest involvement in the broader church community, was suggested to be unlikely to benefit cognitive function.

4.1.1 Promotion of Positive Psychological States

Promotion of psychological well-being through enhancement of sense of self-worth, positive outlooks, stress reduction and religious coping was one identified theme through which religious involvement may affect cognitive function. The literature on the impact of religion on psychological health is substantial. The effects of religion on psychological health and well-being may be positive or negative (Appendix G, Figure G1). Religion provides guidelines that

assist people in managing their lives, ultimately reducing the degree of stress and uncertainty experienced in times of hardship.

The distinction between extrinsic versus intrinsic religiosity may be the determining factor as to whether the psychological outcomes associated with religious involvement are positive or negative. An extrinsic religious orientation involves using religion for one's own ends (e.g., to get security, sociability, status, distraction). Intrinsic religious orientation involves the use of faith and worship to follow the tenets of the Bible because living a Godly life is seen as the 'right thing to do'. The literature supports that an intrinsic religious orientation is associated with more positive and healthier psychological health status. [236] The extrinsic/intrinsic distinction can help explain this study's failure to detect consistently significant associations between frequency of religious participation and cognitive function. Frequency of religious participation is a largely extrinsic indicator that does not assess one's degree of intrinsic religiosity. [236] Therefore, the main effect variable in this thesis did not measure the component of religion that would most likely have had an impact on cognitive function.

Regarding the link between psychological health and cognitive function, psychological issues like depression are associated with deficits in cognitive functioning. [237] Religious activity offers resources (e.g., worship practices and community interactions that provide more positive outlooks on life, as well as a greater sense of self-worth and dignity) for coping with adverse life situations, which can reduce depressive symptoms and the effect of these symptoms on cognitive load, thereby enhancing cognitive capacity and protecting against cognitive deterioration.

Moreover, religion diminishes stress by adding meaning and purpose to difficult life situations, as well as by providing faith-based outlets for these situations. [238] Consequently, religious beliefs shape and affect appraisals of adverse life situations in ways that make these

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situations appear less stressful.[66] For example, Christians believe praying to God and placing stressful situations 'in God's hands'—asking God to take care of the problem—will positively affect the outcome. The belief in divine intervention to solve problems gives Christians a sense of psychological comfort that reduces stress.

The literature supports the detrimental effect of stress on cognitive functioning. [239] Stress refers to a consequence of environmental events exceeding a person's perceived ability to cope. [240] This could in turn influence an individual's physical and psychological health. Stress-associated physiological symptoms, including increases in the secretion of glucocorticoids, is found to adversely affect the nervous system (responsible for cognitive function) and hippocampus (involved in memory function). The effect of psychosocial stress on memory is particularly described by prior research in humans and animals. Psychosocial stress can lead to a series of changes in the hippocampus due to a high density of cortisol (stress hormone) receptors in this region of the brain. [241] These cortisol receptors are also present in the prefrontal cortex, making it likely that stress could result in deficits in executive functioning. [241-242] Indeed, studies have reported deficits in both memory [242] and global cognition [243] that appear to be linked to cortisol and prolonged stress.

A recent study investigated the link between perceived stress and cognitive decline in different cognitive domains in a cohort of African-Americans. The authors found significant associations between higher perceived stress and faster declines in global cognition, episodic memory and visuospatial ability (a component of executive function), following adjustment for age, sex, education and vascular risk factors. [241] Further, stress has been shown to be linked to inflammatory and hormonal markers of accelerated aging, including lower brain volume, [244] brain infarcts, and higher risk of strokes, [245] which have been found to be associated with rates of

cognitive decline. Thus, the detrimental effects of stress on various domains of cognitive functioning is well-documented by previous research.

In the qualitative part of this dissertation, stress was identified as a factor that appears to mediate the association between religious participation and cognitive function. Thus, religious involvement could build resilience to stress and consequently help preserve cognitive function.

The mediating role of stress is supported by Koenig's theoretical framework explaining how monotheistic religions impact mental health (see Appendix G, Figure G1). According to this model, religious activity may provide a venue in which one can potentially benefit from promotion of prosocial behaviours and feelings (i.e., honesty, forgiveness, altruism, gratefulness), social relationships and support, and more successful coping in response to adverse life events, thereby leading to lower stress and better health outcomes.

4.1.2 Provision of Social Interactions and Support

Facilitation of social support was another distinct pathway through which religious participation may affect cognitive function. Cognitive function appears to be positively affected by enhanced social engagement and social support, which occur by living a faith-based lifestyle. Social engagement opportunities provided by religious venues affect cognitive function through the stimulation of mental and cognitive processes. [246] For example, memory may be enhanced or preserved by receiving Biblical teachings during church gatherings, and by later applying these teachings to guide one's life; executive function may be so affected through stimulating discussions and debates with fellow church members during bible studies. Moreover, belonging to a faith community not only provides individuals with opportunities to engage and interact with others, but also provides people with psychosocial support in times of hardship, stress and sorrow. This is consistent with the stress-buffering model, where social support exerts a

protective influence against the stress associated with adverse life events, which could otherwise lead to potential pathogenic outcomes including depression and cognitive decline. [247] Religious participation acts as a unique form of social engagement that permits access to various types of social support (e.g., emotional, informational, companionship) and allows for social influence, which promotes cognitive stimulation and cognitive health through psychological pathways that reduce stress and depression. [204] Specifically, among older adults, religious involvement could allow for the provision of social and emotional support that could buffer the negative effects of stress on cognitive function.

This dissertation also advanced some potential explanations for how socializing within religious venues, as opposed to non-religious settings, might offer additional social and emotional support. These explanations are also supported by the literature. [248] Compared to secular social groups, religious contexts seem to encourage social cohesion by offering a substantive degree of love, commitment, belonging, and relationship continuity. The qualitative interviews implied that religious contexts can supply people with structural and functional social support. There is support from prior research regarding the existence of structural and functional aspects of social support offered through religious venues. [249] The structural aspect of social support refers to the frequency and number of social contacts, whereas the functional feature involves the quality and level of support one may derive from these contacts. For example, one may regularly see dozens of friends, relatives, acquaintances, etc. (high structural support), but functional support will be low if very few of these people can be counted upon to provide aid in times of necessity. [249] The qualitative interviewees emphasized that the relationships formed within church communities are cemented through bonds of love, care and friendship, meaning members of faith communities can count on their brethren for substantive help and aid when

needed. However, without consistent and dedicated engagement in the church and its activities, congregants may not benefit from the functional social advantages of religious participation.

4.1.3 Exercising Mind and Cognitive Abilities

Finally, this dissertation described how religious involvement can stimulate cognitive faculties and lead to healthier cognitive functioning. Religious practices such as reading, meditating, and reflecting on scripture—as well as praying—involve exercising cognitive components to keep the brain active and guard against cognitive deterioration. Similarly, while memory loss and dementia are associated with shrinkage of the frontal lobes of the brain, these lobes have been found to be larger in persons who regularly engage in religious practices, versus those who do not. [250] Religious practices are associated with increased activation of frontal brain parts related to increased attention, focus, planning skills, and the ability to form complex arguments. [250]

4.2 Quantitative and Qualitative Findings Taken Together

The quantitative component of this dissertation did not find clinically meaningful associations between the frequency of religious participation and memory or executive function, following adjustment for relevant covariates. Some associations were negative. An explanation for the unexpected findings emerged from the qualitative interviews and was linked to the main exposure variable. Frequency of religious participation is a common indictor for assessing religiosity in research. Ten of the studies included in the systematic review (Appendix A) used religious attendance/participation as the main exposure variable. [9-10, 34, 69-71, 74, 76, 160, 234] However, this variable may not be an optimal measure of religiosity (also refer to the extrinsic/intrinsic distinction discussed in Section 4.1.1 above). The qualitative analysis showed how multiple components of religious involvement can affect cognition. Therefore, the themes

detected in the qualitative study may capture the effect of the broader concept of religious involvement on cognitive function, whereas participation alone would not. Essentially, showing up for weekly service, without more substantive participation in the church community or living according to the tenets of one's faith every day, will not promote cognitive health. The qualitative participants acknowledged during their interviews that when they were speculating on the inquired associations, they were considering the broader concept of religious practice and involvement, and not just the frequency of religious participation. For these individuals, a simple 'attendance check' was not seen to capture the depth and breadth of their religious activities.

Participants asserted that some churches might not encourage levels of religious involvement that substantively engage congregants. As such, parishioners in these venues might not derive any cognitive benefits from participating in religious activities. Sometimes, people who attend church services regularly do not participate in community events (Bible studies, social gatherings) or engage in personal worship (e.g., read and meditate over scripture). This passivity, whether rooted in a church or a person, means congregants will essentially miss out on the religious activities linked to cognitive health. These congregants should properly be classified into the unexposed group of a variable measuring religious involvement. However, given the nature of the 'religious participation variable (participation in religious activities such as services, committees, choirs) in the CLSA, these individuals were misclassified into the exposed group. Thus, the participation variable suffered from nondifferential misclassification and some regression coefficients could consequentially have been biased to the null (i.e., the coefficients underestimated true effects). [251]

4.3 Strengths and Limitations

Overall, the thesis adds to the literature on the association between religious participation and cognitive function. Previous research on the topic was undertaken in highly select populations, did not account for the effect of many important covariates, and employed limited measures of cognition. This thesis utilized data from a large, population-level study, which optimized statistical power in the regression analyses. Further, this study controlled for a variety of covariates, including three different variables on social engagement (social network, social support availability, social participation), and included various cognitive tests from the memory and executive function domains as study outcomes. Moreover, previous research on the relation between religious factors and cognitive outcomes had only included quantitative data, with no qualitative elements to help interpret and explain the quantitative findings. [252] Through the qualitative interviews, this thesis was able to capture potential explanations (social, psychological, cognitive) for the quantitative findings that were not evident in the regression models. The qualitative part of this thesis also found that religious involvement was a multidimensional factor and measuring the frequency of religious participation alone was an incomplete means of capturing the panoply of factors composing the construct of religious involvement.

Nonetheless, this thesis had a few shortcomings, which encourage readers to interpret its findings carefully. First, this thesis used only one religion variable as the main exposure. Due to this limitation, the doctoral candidate could not assess the extent to which her findings might have differed if she could have measured other forms of religious involvement as well. Second, the qualitative participants came from several Christian denominations (Catholic, Anglican, Baptist, United, Orthodox), and some of the participants were Christian pastors, which might

limit the generalizability of findings to other religions (e.g., Judaism, Islam, Hinduism), or even to Christians whose level of religious involvement is less substantial than pastors. Third, at the time this thesis was undertaken, only the CLSA's baseline data were available for release to researchers, which prevented the doctoral candidate from conducting longitudinal analyses or mediation analyses. [253-254] Fourth, the qualitative study only recruited persons who attended church regularly. Thus, the doctoral candidate could not comment on whether the themes that would emerge from interviewing sparse attendees or non-attendees would be the same as the themes described above. Fifth, stress reduction was identified as a sub-theme through its effect on promotion of positive psychological states. However, this dissertation was not able to control for stress in its regression analyses because this variable was not included in the CLSA. Lastly, although cognitive function and its various components were described to all qualitative participants prior to the commencement of the interviews, due to the scientific nature of cognitive function, some participants had difficulty differentiating it from mental health. This led to some participants placing their explanations within the realm of mental health and equating mental health with cognitive function in some cases.

4.4 Future Directions

Future studies on the topic need to address the limitations of current research. First, most prior studies have measured the exposure as the frequency of religious participation. Inclusion of additional aspects of religious involvement (e.g., private religious activities, prayer, etc.) would help to more validly understand how the complex construct of religiosity relates to cognitive function. Second, longitudinal studies are needed to examine changes in religious involvement and cognitive function over time, as well as to investigate potential mediators (e.g., stress, depression) using methods such as conditional process analysis. [255] Third, since there remains

much disagreement on whether religious participation is merely a surrogate for social engagement, all future studies on the topic are advised to control for measures of social engagement. Studies that investigate the differences between social support obtained from religious versus non-religious settings, and their potential distinct effects on cognitive function, would be a helpful means of resolving the disagreement.

4.5 Conclusions

The findings of this dissertation study did not detect significant associations between frequency of religious participation and cognitive function after controlling for a number of demographic, health, social, and socioeconomic covariates. This thesis serves as a steppingstone for future research and warrants further studies to investigate longitudinal changes in the relationship between religious indicators and cognitive function. Such research will enhance our understanding of the health benefits that are derivable from religious involvement.

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Appendix A. The Effect of Religion and Spirituality on Cognitive Function: A Systematic Review

Purpose of the Study

Rationale

Preservation of cognitive function is crucial to healthy aging. Reduced cognitive function can adversely affect the health of aging populations and is associated with dementing disorders such as Alzheimer's disease (AD). According to Koenig (2012), and Koenig, King, and Carson (2012), religious/spiritual involvement (R/SI) influences health through various mind-body mechanisms. For example, R/SI may provide an outlet for psychological stressors such as anxiety and depression, which otherwise might negatively impact memory areas of the brain through physiological changes like elevated blood cortisol (Conrad, 2008; Csernansky et al., 2006; Sapolsky, 2000). R/SI also stimulates higher cortical functions related to abstract thinking because persons who regularly engage in religious activities often ponder 'deep' thoughts about morality and the meaning of life (Koenig, 2012).

Hill (2008) believes R/SI promotes an active, stimulating, and socially engaged lifestyle that preserves healthy cognitive function. Religious attendance involves activities such as singing, praying, attending sermons, studying scripture, and socializing with others during faith-based activities which can maintain dense neocortical brain synapses and delay cognitive deterioration in the elderly. Hill argues that people with substantial R/SI possess a greater sense of meaning and life purpose, which can be protective against feelings of stress, anxiety, and

depression. Reduced pressure on emotional and mental health can protect against hippocampal atrophy and potentially guard against cognitive decline (Hill, 2008). Further, R/SI could assist in maintaining cognitive health through the enhancement of those behaviors that are protective against cognitive decline among elderly (i.e., lower smoking or drinking rates among religious individuals).

Objectives

We conducted a methodologically rigourous and up-to-date systematic review of the literature to address the following primary research question: what is the evidence for an association between R/SI and cognitive function in adults recruited from any setting and followed for any period of time? The review included studies of adults aged 18 years or older to permit us to examine the research question from the life-course perspective (Kuh, Ben-Shlomo, Lynch, Hallqvist, and Power, 2003). This perspective views progression through life as a dynamic process whereby intrinsic (e.g., biological) and extrinsic (e.g., environmental) factors, as well as changes in these factors over time, combine to effect health in later life.

The life-course perspective is the optimal means of gaining a better understanding of whether R/SI can protect against cognitive decline in adult populations. Limiting our consideration to studies conducted in population subgroups such as the elderly would weaken the review's ability to address whether maintaining steady levels of R/SI over time could lead to better cognitive outcomes than fluctuating R/SI in later life. To be as comprehensive as possible, the review included studies conducted in any setting (e.g., community, hospital, long-term care facility) over any length of follow-up.

We also examined two secondary research questions in this review. First, does any form of social engagement serve as a mediator, effect modifier, or confounder of the association between R/SI and cognitive function? Social engagement is defined as maintaining several social connections and participating in social activities and has been proposed to protect against cognitive decline (Bassuk, Glass, Berkman., 1999). R/SI is a form of social engagement and social engagement is a construct that is operationalized through measuring R/SI. Derivatives of social engagement include factors such as social networks or social participation which may take on the role of mediator, effect modifier or confounder in the association between R/SI and cognitive function. Thus, adjusting for various forms of social engagement is needed in this topic area because R/SI involves a social component (e.g., attending services, singing in choirs, serving on committees, attending retreats, taking courses [e.g., Bible study]). Adjustment will help assess whether R/SI has an effect over and above social engagement (Van Ness & Kasl, 2003). Second, does the association between R/SI and cognitive function differ (in strength or direction) according to the means of measuring R/SI or cognitive function?

In a recent systematic review, Agli, Bailly, and Ferrand (2015) examined the evidence for a link between religion and dementia in persons aged 65 years or older. Our review differs from this existing review because we studied R/SI from the wider perspective of cognitive function (not only dementia) and we included studies undertaken in any setting and in any population.

Design and Methods

Protocol and Registration

We published the protocol for this systematic review (Hosseini, Chaurasia, Cooke, and Oremus, 2016). The protocol is also registered in PROSPERO (identification #

CRD42016032331). We followed the PRISMA guidelines to design, conduct, and report the systematic review (Liberati et al., 2009). The methods are summarized in brief below.

Eligibility Criteria

The articles included in the review had to fulfill the following eligibility criteria.

Types of studies: Cohort, case-control and cross-sectional studies that investigated the association between R/SI and cognitive function over any length of follow-up and published between 1990 and September 2016 (without language restrictions).

Types of participants: Adult participants aged 18 years or older, regardless of gender or comorbidities, recruited from any setting (e.g., community-dwelling, long-term care facility, hospital or medical clinic, etc.).

Types of exposure: Studies with any sort of religious or spiritual exposure were included. Exposures could be self-reported frequencies of religious service attendance, prayer, watching or listening to religious programming, reading religious books, or engaging in private religious activities. Exposures could also be measured with questionnaires to assess subjective attitudes toward religion, spiritual activities or practices, intrinsic religiosity, religious affiliation, daily spiritual experiences, the importance of religion in life, and religious coping.

Types of outcome: The primary outcome was cognitive function. The included studies had to assess this outcome using any means of measuring cognitive function.

Information Sources

We searched OVID MEDLINE, EMBASE, PsycINFO, and the reference lists of the included studies. We also searched the gray literature using Google Advanced Search. A

publication date of 1990 or later was imposed on our search process. Our literature search criteria were developed with the help of a medical librarian. The first author and a research assistant conducted the search itself. The final day of the search was September 16, 2016.

Search

The following terms were used to search the databases: religio*; spirituality; church attendance; cogniti*; executive function; processing speed; prospective memory; episodic memory; declarative memory. Appendix 2 (Supplementary Material) presents a sample search strategy for OVID MEDLINE. The search syntax, but not the search terms, was changed when necessary to suit the parameters of the other databases.

Study Selection

Two reviewers used the eligibility criteria to independently screen all of the citations retrieved in the literature search. The reviewers were not blinded to author identity. Two levels of screening were performed: 1) title/abstract and 2) full-text. We excluded abstracts, letters to the editor, narrative and systematic reviews and commentaries. Studies that met the eligibility criteria at the title/abstract screening level, as well as studies that the reviewers could not confidently call as relevant based on the eligibility criteria, advanced to full-text screening for further consideration. At each screening level, disagreements between the reviewers were resolved by consensus. Article screening was managed through *Covidence* systematic review software (Veritas Health Innovation, Melbourne, Australia).

Data Collection Process

A data extraction table was developed and piloted on the first 10 included studies and modified accordingly. Two reviewers independently extracted the relevant data from each included study. Any disagreements were resolved by consensus.

Data Items

The following information was extracted from the included studies: study details (e.g., author, year, country, setting, length of follow-up), sample characteristics (e.g., age, sex, sample size), study design (e.g., case-control, cohort, cross-sectional), descriptions of how R/SI and cognitive function were measured, lists of covariates included in regression models (including social engagement), and cognitive function outcomes.

Risk of Bias

Two reviewers independently assessed the risk of bias of the included studies using the Newcastle-Ottawa Scale (NOS) (http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp). The reviewers resolved discrepancies through consensus.

Grading the Strength of Evidence

We used the BMJ guidelines (GRADE; BMJ Evidence Center, 2016) to grade the strength of evidence. Grading of recommendations, assessment, development and evaluations (GRADE) is a means of evaluating and rating existing evidence to assess whether any new evidence would change the conclusions of a review. In the GRADE system, the evidence is rated on five different categories: type of evidence, quality, consistency, directness and precision.

Departures from the Published Protocol

We used *Covidence* instead of *Distiller Systematic Review (DSR)* software (Evidence Partners, Ottawa, ON) to conduct the literature screening process. Further, we did not conduct a meta-analysis because the included studies were far too heterogeneous to permit the pooling of results. Points of heterogeneity included differences in the quantitative reporting of results and in the measurement of exposure. For example, studies reported their results using a variety of statistics, including regression coefficients and *p*-values, odds ratios and confidence intervals, F-statistics and correlation coefficients. Although formulas exist to convert these statistics into common metrics (Borenstein, Hedges, Higgins, & Rothstein, 2009), the included studies often failed to report all of the components needed to perform the conversions.

For the exposure, the studies employed many different measures of R/SI. These measures categorized responses differently. Examples included intrinsic religious beliefs, consistent participation in religious organizations, degree of religiosity (low versus high), religious attendance (low versus high; more than weekly, weekly, monthly or never), spirituality, organizational and non-organizational religious activities, frequency of prayer, religious affiliation, religious coping, and importance of religion in life. Rather than a meta-analysis, we narratively synthesized the studies according to design (cohort, etc.) and cognitive test.

Results

Our literature search retrieved 8247 studies. The search of OVID MEDLINE provided 1249 studies, PsycINFO yielded 4377 studies and EMBASE provided 2621 studies. We also identified seven relevant studies through Google Advance Search. After removing duplicates, 6300 studies remained at the start of screening and we excluded 6252 studies (99%) during title and abstract screening. We excluded 31 of the remaining 48 studies (65%) at full-text screening. These 31 studies were excluded because they did not address cognitive function, they included

cognitive function yet not as an outcome, they did not contain a comparison group, they measured R/SI as mediators/moderators only (not as main effects) or the full-text articles were unavailable following inter-library loan requests and contacting the study authors. The remaining 17 studies met our eligibility criteria and were included in the systematic review. We also searched the reference lists of the included studies to identify additional relevant papers and found none. Figure A depicts article flow through the systematic review screening process. A complete list of excluded studies is available upon request from the authors.

Study Characteristics

The 17 included studies were cohort (Choi, Park, Cho, Chun, and Park, 2016; Coin et al., 2010; Corsentino, Collins, Sachs-Ericsson, and Blazer, 2009; Hill, Burdette, Angel, and Angel, 2006; Hsu, 2007; Kaufman, Anaki, Binns, and Freedman, 2007; Ritchie, Gow, and Deary, 2014; Van Ness & Kasl, 2003; Yeager et al., 2006), cross-sectional (Al Zaben et al., 2015; Fung & Lam, 2013; Inzelberg et al., 2013; Koenig, George, and Titus, 2004; Koenig, Weiner, Peterson, Meador, and Keefe, 1997; Lucchetti et al., 2011; Zhang, 2010) or case-control (Lin et al., 2015) designs that were all published in English. In cohort studies, the duration of follow-up ranged from 12 months (Coin et al., 2010) to 7 years (Ritchie et al., 2014). Overall the included studies involved 35,741 participants with an age range of 46 to 92 years. Among the 35,741 participants, 506 had Alzheimer's disease (AD), 680 had dementia, 238 had mild cognitive impairment (MCI) and 310 had chronic kidney disease. Article authors did not report the health status of the remaining 34007 participants.

The included studies defined R/SI very differently: i.e., engaging in obligatory group prayer (Al Zaben et al., 2015), reading religious books (Coin et al., 2010), frequency of watching religious programming on TV or radio (Coin et al., 2010), giving money to the poor (Al Zaben et

al., 2015), fasting (Al Zaben et al., 2015), making religious pilgrimages (Al Zaben et al., 2015), intrinsic religious beliefs (Koenig et al., 2004), participation in religious organizations (Choi et al., 2016; Hsu, 2007; Zhang, 2010), going to church/place of worship (Coin et al., 2010), intrinsic attitudes toward Christianity (Coin et al., 2010), frequency of attending religious services/meetings (Coin et al., 2010; Corsentino et al., 2009; Hill et al., 2006; Koenig et al., 2004; Ritchie et al., 2014; Van Ness & Kasl, 2003; Yeager et al., 2006), spiritual activity (Fung & Lam, 2013; Ritchie et al., 2014), midlife praying (Inzelberg et al., 2013), organizational and private religious activities (Koenig et al., 2004), non-organizational/private religious activities (Koenig et al., 2004), intrinsic religiosity (Koenig et al., 2004), self-rated religiosity/spirituality (Koenig et al., 2004; Lucchetti et al., 2011), observer-rated religiosity/spirituality (Koenig et al., 2004), religious affiliation (Koenig et al., 2004; Lin et al., 2015; Yeager et al., 2006), religious belief (Yeager et al., 2006), religious coping (Koenig et al., 1997), and the extent of religious self-identity (Van Ness & Kasl, 2003).

The common outcome investigated by all of the included studies was cognitive function/cognitive decline. The studies used several measures of cognitive function: i.e., the Mini-Mental State Examination (MMSE) (Folstein, Folstein, and McHugh, 1975) (complete or brief versions, as well as translated versions), the Short Portable Metal Status Questionnaire (SPMSQ) (Pfeiffer, 1975), Raven's Standard Progressive Matrices (Raven, Court, and Raven, 1977), phonemic verbal fluency (Lezak, Howieson, and Loring, 2004), and the logical memory component of the Wechsler Memory Scale—Revised (Wechsler, 1987).

Cohort Studies - MMSE

Four studies employed the MMSE to assess global cognitive function as the outcome. Higher scores on the MMSE indicate better global cognitive status. Choi et al. (2016)

investigated the association between participation in social activities, including religious

organizations, on cognitive function in 6,076 community-dwelling Korean adults aged 45 years

or older (mean age = 58.5 years) who were followed up for 6 years. Self-reported participation

was categorized into four different levels based on the previous two years of experience:

consistent participation, consistent non-participation, participation to non-participation and non-

participation to participation. The authors reported significant positive associations between

consistent participation in religious activities and cognitive function ($\beta = 0.32$, $p < .0001$).

A study by Coin et al. (2010) examined the relationship between low versus high

religiosity and cognitive impairment in 64 persons with AD who had a mean age of 75 years and

who were followed up for 12 months. These persons were divided into two groups of no/low

religiosity and moderate/high religiosity using the Behavioural Religiosity Scale (BRS) (Glock,

1965; Adamson, Shevlin, LIoyd, and Lewis, 2000) and Francis Short Scale (FSS) (Francis,

1993). The BRS investigates the frequency of the respondent's participation in four different

religious activities. Participants were placed in the no/low religiosity group if their BRS scores

were less than 24 and in moderate/high religiosity group if their BRS scores were higher. FSS

investigates the participant's attitude toward Christianity and is scored on a five-point scale. FSS

scores range from seven to 35 and higher scores indicate more positive attitudes toward

Christianity. In comparison to the high religiosity group, the low religiosity group exhibited

markedly greater cognitive impairment at the 12-month follow-up timepoint ($OR = 6.7$, $CI =$

[1.8, 24.7]) (Individual MMSE scores were adjusted using the Italian correction coefficients

(Magni et al., 1996)).

Hill et al. (2006) retrospectively studied 3,050 Mexican Americans aged 65 years or older

from 1995-2000 to explore the association between frequency of religious attendance and rates

of cognitive decline. Following adjustment for baseline cognitive functioning, physical functioning, sensory impairments, health behaviors, psychological distress, chronic conditions, and sociodemographic characteristics, the authors found slower rates of cognitive decline for Mexican-Americans who attended church monthly ($\beta = 0.54$, $p < .05$), weekly ($\beta = 0.61$, $p < .01$) or more than weekly ($\beta = 0.75$, $p < .01$) compared to those who did not attend church. Upon adjusting for these covariates, the results were attenuated by 36%, 24% and 29% respectively for the monthly, weekly and more than weekly church attendance potentially indicating that a significant amount of the total relationship between religious attendance and cognitive functioning may be due to those factors that may restrict one's ability to attend church such as functional disability, lower baseline cognitive functioning, sensory impairments and old age (Hill et al., 2006). The authors interpreted the positive regression coefficients as meaning slower rates of cognitive decline on the MMSE over the study period.

A study by Kaufman et al. (2007), with a mean follow up of 3.14 years, examined the effect of religiosity and spirituality on the rate of progression of cognitive decline in 70 patients with probable AD and a mean age of 78 years. After controlling for baseline cognitive function levels, private religious practices (*partial correlation [r]* = - 0.37, β = - 0.48, $p < .005$) and higher levels of spirituality (r = - 0.31, β = - 0.37, $p < .05$) were associated with slower rates of cognitive decline on the MMSE.
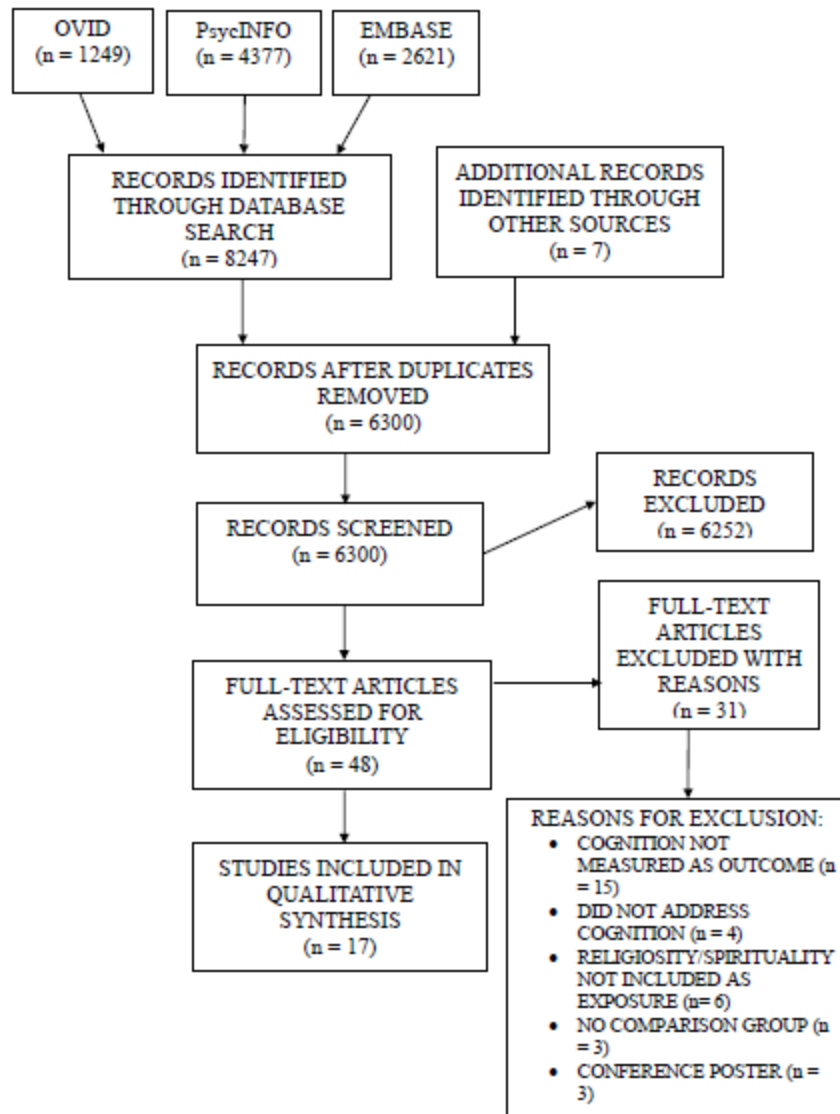
FIGURE A. ARTICLE FLOW THROUGH THE SCREENING PROCESS.

Cohort Studies - SPMSQ

Four cohort studies assessed the association between R/SI and cognitive function, with

the latter measured using the Short Portable Mental Status Questionnaire (SPMSQ). The SPMSQ

contains 10 factual questions such as current day/month/year, current age, and name of current

president, and one performance question (i.e., counting backward from 20 by threes). Scoring is based on the total number of errors, with two or more errors indicating at least mild cognitive impairment.

A study by Corsentino et al. (2009) evaluated the effect of gender and depressive symptoms on the relationship between religious attendance and cognitive decline among 2,938 community-dwelling older adults with a mean age of 72 years who were followed up for three years. The authors reported a statistically significant main effect for baseline religious attendance on cognitive function. Attendance was measured on a 6-point Likert scale ranging from 'never/almost never' to 'more than once a week' and the number of errors on the SPMSQ decreased as attendance increased ($\beta = -0.07$, $CI = [-0.11, 0.03]$).

Another study by Hsu et al. (2006) examined whether participating in religious groups affected cognitive decline in 4,049 persons aged 60 years or older who were recruited as part of the Survey of Health and Living Status of the Elderly in Taiwan (Health and Living Status of the Elderly in Taiwan, 1989) and followed up for ten years. This study did not find any statistically significant protective effects for participation in religious group activities against cognitive decline in men ($OR = 1.20$, $p > .05$) or women ($OR = 0.98$, $p > .05$).

Yeager et al. (2006) utilized data from the Longitudinal Survey of Older Taiwanese (Hermalin, Liang, & Chang, 1989) to evaluate the effect of religious affiliation, attendance, beliefs and practices on self-reported measures of overall health status, including cognitive function. This study found that religious attendance was significantly associated with better cognitive functioning in bivariate analysis; however, after controlling for health behaviours and social networks, the relationship was no longer significant for religious beliefs ($\beta = -0.001$, $p > .05$) and religious practices ($\beta = -0.002$, $p > .05$) and the coefficients became attenuated for

religious attendance (Rare: $\beta = -0.050$, $p < .05$; Sometimes: $\beta = -0.042$, $p < .1$; Often: $\beta = -0.057$, $p > .05$). This study found that following controlling for prior health status, most of the association between religiosity and health outcomes disappeared suggesting that the relationship between religious attendance and health outcomes such as cognitive function might be due to the fact that people with greater religious attendance exhibit better health and social participation which in turn has an enhancing effect on health. The results of this study indicated that following adjustment for prior health status, social participation seem to have a more robust effect on health outcomes (i.e., cognitive function) compared to religious attendance. This study measured social networks through 1) social ties, i.e., the number of close relatives whom the participants contacted at least once per week, and 2) social involvement, i.e., the number of activities out of 11 total activities for which participants reported current involvement.

Finally, Van Ness and Kasl (2003) studied the association between religious service attendance and cognitive dysfunction in 2,812 community-dwelling older adults by following them for six years (1982-1988) and assessing them every three years. This study reported inverse associations between religious attendance in 1982 and cognitive dysfunction in 1985 ($OR = 0.64$; 95 % $CI = [0.49, 0.85]$), but not in 1988 ($OR = 1.00$; 95 % $CI = [0.71, 1.41]$). The authors explained the short-term nature of this effect by the differential mortality for frequent versus infrequent religious attendees, where those with infrequent religious attendance and high cognitive dysfunction at baseline were more likely to die between 1985 and 1988.

Cohort Studies - Other

Ritchie et al. (2014) explored the association between religiosity, intelligence and cognitive decline among 550 individuals of the 1921 Lothian Birth Cohort in Scotland. Cognitive ability of the participants was assessed at each follow-up using Ravens' Standard Progressive

Matrices (Raven et al., 1977), phonemic verbal fluency (Lezak et al., 2004) and logical memory

from the Wechsler Memory Scale-Revised (Wechsler et al., 1987). In this publication, the

authors assessed the associations between religious belief (composed of religious involvement

and religious well-being) and attendance at age 83 years and cognitive function at ages 83, 86

and 90 years. The authors found no significant associations between the exposures and outcome

at any of the three timepoints (religious involvement: $\beta = 0.03$, $SE = 0.16$, $p > .05$; religious well-

being: $\beta = -0.04$, $SE = 0.15$, $p > .05$; religious attendance: $\beta = 0.07$, $SE = 0.09$, $p > .05$). The

authors mentioned that one of the limitations of their study was that no measure of religiosity

from the cohort was available prior to age 79 years and no measure of religious belief was

available earlier than age 83 years. Thus, religiosity was measured after the age where

participants would be most likely to experience further cognitive change, meaning that the study

could not adequately assess the temporal relation between religiosity as an exposure and

cognitive function as an outcome.

Cross-Sectional Studies - MMSE

Several cross-sectional studies examined the association between religious involvement

and cognitive function. A study by Al Zaben et al. (2015) examined the effect of religiosity using

the 13-item Muslim Religiosity Scale (Koenig et al., 2014) on multiple health factors, including

cognitive functioning, in a group of patients with chronic kidney disease who had an average age

of 46 years. This study reported finding a statistically significant association between intrinsic

religious beliefs and cognitive functioning ($\beta = 0.11$, $p < .05$).

One study by Inzelberg et al. (2013) evaluated the association between midlife prayer

(assessed by the number of monthly praying hours at midlife) and cognitive decline in 778

Israelis aged 65 years or older, 448 of whom were healthy, 92 of whom had Alzheimer's disease

(AD), and 238 of whom had mild cognitive impairment (MCI). Among women, prayer was significantly associated with a lower risk of MCI ($OR = 0.55$, $CI = [0.33, 0.94]$), but not AD. Inzelberg et al. did not investigate the association in men because 94 % of the males in their sample engaged in prayer.

Fung et al. (2013) examined the association between spiritual activity and cognitive function in 380 community dwelling adults aged 60 years or older with a mean age of approximately 70 years. They developed a weekly spiritual activity measure by multiplying the number of spiritual activities per week by the duration of each activity. This study found a significant positive association between spiritual activity and cognitive function ($B = 0.45$, 95% $CI = [0.13, 0.76]$, $p = .01$).

In a study by Koenig et al. (2004), the authors investigated the effect of religion and spirituality on several health factors, including cognitive function, in 838 medically ill, hospitalized older patients with a mean age of approximately 64 years. Several religious and spiritual factors, including religious affiliation, organizational and non-organizational religious activities, intrinsic religiosity, and self-rated and observer-rated religiosity and spirituality, were assessed in association with cognitive status. This study found significant associations between several measures of R/SI and cognitive function, including non-organizational religious activities (standardized $\beta = 0.11$, $p < .001$), self-rated religiousness (standardized $\beta = 0.06$, $p < .05$), observer-rated religiousness (standardized $\beta = 0.13$, $p < .0001$), and observer-rated spirituality (standardized $\beta = 0.12$, $p < .0001$).

In another study, Koenig et al. (1997) examined the health correlates of religious coping (measured by the Religious Coping Index (Koenig et al., 1992)) in 115 chronic nursing home

residents with an average age of 79 years. This study reported a significant correlation between religious coping and cognitive functioning ($r = 0.22$, $p = .02$).

Lucchetti et al. (2011) investigated how religiousness affected mental health, cognitive function, pain and quality of life in a group of 110 patients aged 60 years or older in a rehabilitation clinic. They found that self-reported importance of religion in life (response options were not specified in the article) was significantly associated with less cognitive impairment (Standardized $\beta = 0.24$, $t = 2.42$, $p = .02$).

Finally, Zhang (2010) used data from the 'Chinese Healthy Longevity Survey' (Zeng, Vaupel, Xiao, Zhang, & Liu, 2001) to investigate the relationship between religious participation and cognitive impairment among a group of oldest old with a mean age of 93 years. Following adjustment for a wide range of covariates, including age, gender, education, urban/rural residence, marital status, and ethnicity, religious participation (participation in religious activities: every day or sometimes versus never) was significantly related to a lower odds of cognitive impairment ($OR = 0.52$, $p < .001$).

Case-Control Studies-MMSE

Lin et al.'s (2015) case-control study investigated the effect of religious affiliation on the odds of dementia among a group of persons aged 60 years or older who were diagnosed with AD or vascular dementia (VaD). Cognitive function was assessed using MMSE and clinical dementia rating. The comparison group consisted of aged-matched, healthy controls. Three religious affiliations were included in this study: Taoism, Buddhism and Christianity. The authors found that in comparison to no religious affiliation, only a Christian affiliation was associated with a lower odds of AD (adjusted $OR = 0.46$, 95% $CI = [0.25, 0.87]$). However, none

of the affiliations were associated with the odds of VaD (Christianity: *OR* = 0.43, 95% *CI* = [0.19, 1.00], Buddhism/Taoism: *OR* = 1.20, 95% *CI* = [0.72, 2.01]).

Studies that Controlled for Social Engagement

Four cohort studies reported associations between religiosity and cognitive function after controlling for social support/engagement. One study adjusted for social support (Corsentino et al., 2009), but did not report the crude association between religiosity and cognitive function before the adjustment. A second study controlled for social engagement (Van Ness & Kasl, 2003) and reported no differences between the crude and adjusted ORs (crude *OR* = 0.62, 95% *CI* = [0.48, 0.81]; adjusted *OR* = 0.64, 95% *CI* = [0.49, 0.85]). A third study controlled for social networks (Yeager et al., 2006) and found no differences between the crude and adjusted regression coefficients: rare religious attendance: crude β = - 0.06, adjusted β = - 0.05; often religious attendance: crude β = - 0.08, adjusted β = - 0.06). Finally, the study by Hill et al. (2006) also provided support for the protective effect of church attendance as a specific form of social engagement against cognitive decline over and above other forms of social engagement. This study did not report crude and adjusted values.

Differences across R/SI and Cognitive Function Measures

Although the included studies employed a wide range of measures to assess R/SI and cognitive function, the majority reported statistically significant findings regarding the positive association between the exposure and outcome. We could not find any particular trends in the reported findings with respect to the types of R/SI and function measures employed in the included studies.

Risk of Bias in Included Studies

We assessed the risk of bias of included studies using the Newcastle-Ottawa Scale (NOS). Variants of the NOS were administered for cross-sectional, cohort and case-control studies. Figure B depicts the percentage of cohort and cross-sectional studies that satisfied each NOS criterion (received at least one 'star' in each category). Since only one study used a case-control design, we did not produce a similar graph for this study. The majority of the cross-sectional studies failed to include adequate sample sizes, were not representative of the population at large and did not elaborate on non-respondents' characteristics. In the cohort studies, exposure was primarily ascertained through self-report (also was the case for the cross-sectional studies) and many studies failed to include adequate follow-ups or provide rates and/or descriptions of persons lost to follow-up. The majority of the included studies received a score of medium in terms of risk of bias. See Table 1 (Appendix 1) for details of the individual studies. Taking all of the included studies together, the overall assessment of risk of bias was medium because the bulk of the studies demonstrated a medium score for bias using the NOS.
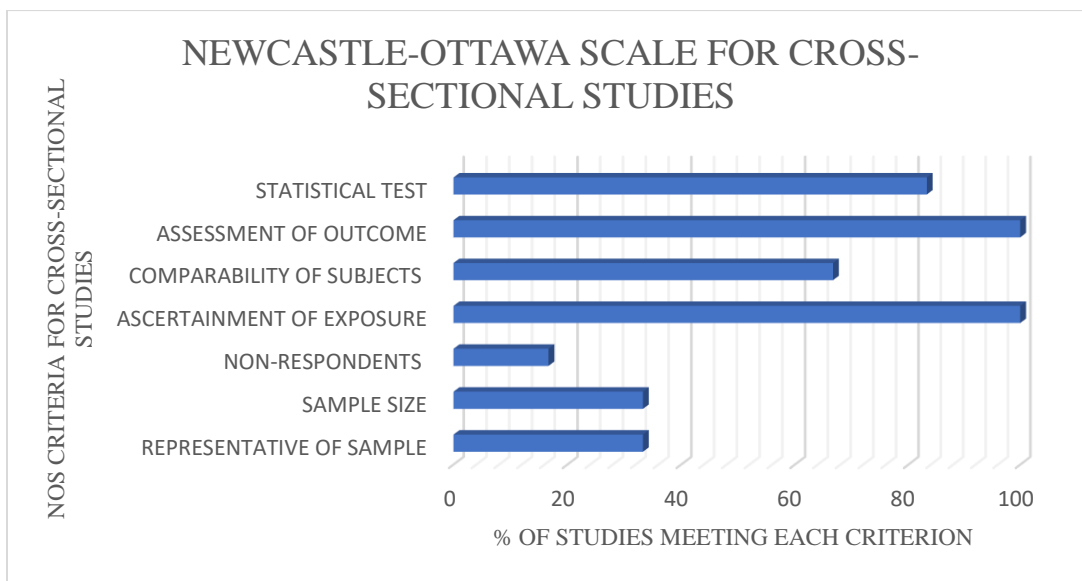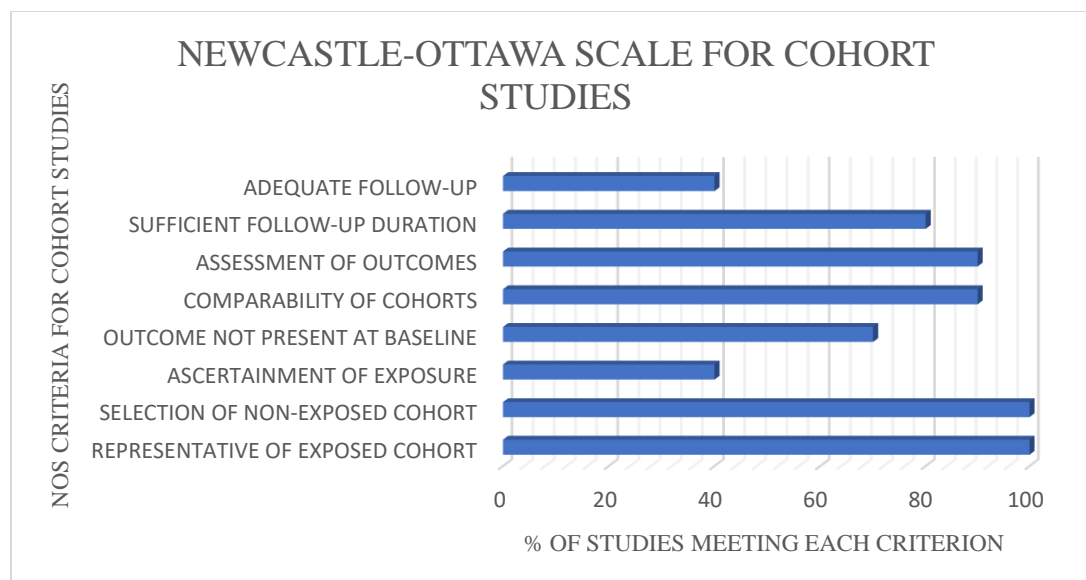
FIGURE B. NEWCASTLE-OTTAWA SCALE RISK OF BIAS ASSESSMENT FOR CROSS-SECTIONAL AND COHORT STUDIES.

Grading of Recommendations, Assessment, Development and Evaluations (GRADE)

Type of evidence. All of the studies included in this review were observational. According to the GRADE guidelines (GRADE; BMJ Evidence Center, 2016), we must assign a score of +2 to the evidence obtained from observational study designs.

Quality. The quality component of GRADE evaluates the evidence based on problems with factors including 'blinding and allocation process', 'follow-up and withdrawals', 'sparse data' and 'methodological concerns'. Due to the observational nature of all of the included studies, blinding and allocation were not relevant to the assessment of GRADE in our review. For follow-up and withdrawals, we found that several studies did not include information on follow up rates and those lost to follow-up. Further, the BMJ GRADE guidelines describe comparisons containing less than 200 participants as sparse data. We came across four studies (two cross-sectional) in our review that contained less than 200 participants (Coin et al., 2010; Kaufman et al., 2007; Koenig et al., 1997; Lucchetti et al., 2011). However, since this was less

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than 25% of the included studies, we did not count it as a problem with the quality of evidence. Finally, studies were very diverse in their reporting styles and many did not report data regarding the mean scores of different exposure levels, which was one factor that prevented us from performing a meta-analysis. Since we found problems with two of these factors, we assigned a score of -2 to the quality of evidence.

Consistency. All except three of the included studies reported positive associations between R/SI and cognitive function. According to the BMJ GRADE guidelines, a score of 0 is assigned when most or all studies show similar results. Thus, we assigned a score of 0 to the consistency of the evidence.

Directness. Directness assesses the generalizability of the reported findings to the specified population of interest, which is adults across the lifespan in our review. The majority of included studies contained samples that were predominantly Christian or aged 65 years or older. Thus, little evidence exists regarding an association between R/SI and cognitive function in non-Christians or in young- and middle-age populations. Since the existing body of literature does not contain evidence to assess the association of interest across the life-span, and does not include samples from diverse religions, we assigned a score of -2 to directness.

Precision (Effect size). Since the majority of the studies reported effect sizes greater than 2 or less than 0.5, and most of these results were statistically significant, we assigned a score of 0 to the precision (effect size) of the evidence.

The overall GRADE score for the quality of the evidence on the association between R/SI and cognitive function was -2, which indicates very low evidence quality.

Implications

Summary of Evidence

Overall, the current evidence suggests R/SI may serve as a lifestyle factor that helps promote healthy cognitive functioning and successful aging in seniors from a Christian background. Results supporting this conclusion were consistent across multiple measures of R/SI and cognitive function, as well as across groups with diverse characteristics in areas such as sex, ethnicity, setting, and diagnosis.

Since most included studies recruited seniors, or their sample compositions were skewed toward seniors, we could not investigate the association between R/SI and cognitive function from a life-course perspective. Also, many of the studies followed participants for time periods that were too short (one to seven years in cohort studies) to study the association of interest from a life-course perspective. Additionally, we could not draw conclusions about the impact of R/SI on cognitive function in younger or non-Christian persons. Finally, only three studies adjusted for social factors such as social networks or social engagement, thereby precluding us from assessing the independent effects of R/SI on cognitive function after adjusting for these factors.

The assessment of risk of bias showed that the bulk of the studies were medium quality. This reduces the extent to which we can assert that the results are unbiased. Further, evaluation of the strength of evidence using GRADE found the evidence to be low quality, which suggests future studies might produce stronger evidence and change the conclusions of our review. Therefore, our findings with regard to seniors and Christians must be interpreted with caution.

Strengths and Limitations

This review revealed several knowledge gaps in the literature on R/SI and cognitive function, i.e., a lack of information on younger and non-Christian groups, a dearth of long-term

follow-up data, and little evidence regarding whether R/SI has an effect over and above social engagement. Future research should work to address these gaps by including participants from young- and middle-age groups, and from varied religious backgrounds, who are followed for longer periods of time. To encourage standardization of results, future studies should utilize a uniform battery of tests to assess R/SI and cognitive function, and social engagement should be measured and included in multivariable regression analyses. From a methods perspective, our review was governed by the PRISMA guidelines (Liberati et al., 2009) for systematic reviews and we self-evaluated our work using the AMSTAR tool for assessing systematic review quality (Shea et al., 2007). This review received a score of 10 out of 11 on AMSTAR. To receive a score of 11, we would have had to assess the likelihood of publication bias. However, creating a funnel plot to investigate possible publication bias would have required us to obtain a uniform measure of effect (e.g., log OR) for the plot's x-axis, and this was not possible because of heterogeneity in outcome reporting across the included studies.

Some potential limitations of the review exist. First, we limited our literature search to studies published in 1990 or later. This may have led to the exclusion of some studies. Second, due to between-study heterogeneity, we could not conduct a meta-analysis.

The current systematic review provides the most up-to-date state of knowledge on the association between R/SI and cognitive function. The findings from the included studies indicate a positive association between the exposure and outcome in select groups (i.e., Christians, seniors). Future studies on the topic should recruit individuals from the entire adult life span, examine the association in different religious denominations and include longer follow-up periods.

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Appendix 1 (Part of the Systematic Review Publication)

Table 1. Characteristics of Eligible Studies

Study Identification	Population Characteristics	Study Design	Exposure Assessment	Outcome Assessment	Duration of Follow-Up	Covariates	Results
Al Zaben et al. (2015)	n = 310 Saudi Arabia % Male: 61 Mean age: 46 years Hospital-based recruitment *Source of funding: Deanship of Scientific Research, King Abdulaziz University, Jeddah*	Cross-sectional	Engaging in individual or small group prayer at mosques, reading the Quran, watching/listening to religious programs, religious pilgrimage, intrinsic religious beliefs, Assessed by the 13-item Muslim Religiosity Scale	Cognitive functioning, MMSE[a]	0 months	Demographics, income, mental health, physical functioning, stressful life events, medical comorbidity, smoking, months receiving dialysis, severity of Chronic Kidney Disease	Association between intrinsic religious beliefs and cognitive functioning ($b = 0.11$, $p < .05$)

[a] Mini-Mental State Exam

Choi et al. (2016)	n = 6076 South Korea % Male: 49.2 Mean age: 58.5 Study based recruitment *Source of funding: NR[b]*	Cohort	Participation in social activities at religious organizations	Cognitive function, MMSE-Korean	6 years	Demographic, socioeconomic, health factors, region of residency	Consistent participation in religious organizations associated with reduced cognitive decline ($b = 0.32$, $p < .0001$)
Coin et al. (2010)	n = 64 Italy % Male: 25 Mean age: 75.85 Clinic based recruitment *Source of funding: NR*	Cohort	Religious service attendance, praying, reading religious literature, listening to religious programs via television or radio, interior attitude toward Christianity, Behavioral Religiosity Scale, the Francis Short Scale	Cognitive decline, MMSE	12 months	Age, education level	Low religiosity associated with greater risk of cognitive impairment, 3-point decrease in MMSE score (OR = 6.7, 95% CI = [1.8, 24.7])

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[b] Not reported

Corsentino et al. (2009)	n = 2938 USA % Male: 33 Mean age: 72.87 Study based recruitment *Source of funding: National Institute on Aging*	Cohort	Attendance to religious services or meetings (Frequent attenders versus Non-frequent attenders), Likert scale	Cognitive decline, SPMSQ[c]	3 years	Demographics, education, literacy, income, marital status, depressive symptoms, social support, health and physical functioning	Significant main effect of baseline religious attendance on cognitive decline (β = - 0.07, *CI* = [-0.11, 0.03])
Fung et al. (2013)	n = 380 Hong Kong % Male: 49.7 Mean age: 70.4 Community based recruitment *Source of funding: NR*	Cross-sectional	Spiritual activity, (Activity completed per week multiplied by the duration)	Cognitive function, MMSE-Cantonese	None	Age, sex, education, marital, socioeconomic and occupational status, severity of physical and psychiatric illness	Significant positive association between spiritual activity and cognitive function (B = 0.45, 95% *CI* = [0.13, 0.76], p = .01)

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[c] Short Portable Mental Status Questionnaire

Hill et al. (2006)	n = 3050 USA % Male: 42 Mean age: NR, 65 and older Recruitment from prior survey *Source of funding: National Institutes of Health (National Institute on Aging)*	Cohort	Religious church attendance	Cognitive decline, MMSE	2.5 years	Psychological distress, sensory impairments, health behaviors, chronic disease, baseline cognitive functioning, physical functioning, baseline activities of daily life, socio-demographics, baseline social disengagement,	Slower rates of cognitive decline for those who attend church (Regression coefficient [Effect size]): Monthly: 0.543* [0.07] Weekly: 0.615** [0.08] > Weekly: 0.753** [0.10]
Hsu, (2006)	n = 4049 Taiwan % Male: 56.4 Mean Age: NR, 60 and older Recruitment from prior survey	Cohort	Religious participation	Cognitive decline, SPMSQ	3 years	Demographics, socioeconomic status, health-related variables	No protective effect of religious participation against cognitive decline: Men (*OR* = 1.20, *p* > .05) Women (*OR* = 0.98, *p* > .05)

Inzelberg et al. (2013)	n = 778 Israel % Male: NR Mean Age: NR Community based recruitment *Source of funding: National Institutes of Health*	Cross-sectional	Midlife praying, interviews	Cognitive decline, MMSE	None	NR	Analysis of females only: Prayer significantly associated with reduced risk of MCI but not AD (*OR* = 0.55, 95% *CI* = [0.33,0.94], *p* = .03)
Kaufman et al. (2007)	n = 70 Canada % Male: 31 Mean Age: 78.4 Clinic Based Recruitment *Source of funding: Canadian Institutes of Health Research, Saul A. Silverman Family Foundation*	Cohort	Religiosity and Spirituality, DUREL[d]	Cognitive decline, MMSE, Behavioral Neurology Assessment	Mean Longitudinal follow-up: 3.14 years	Age, sex, education, baseline cognitive level, MMSE rate of decline	Slower rate of cognitive decline related to higher levels of spirituality (r = - 0.31, β = - 0.37, *p* < .05) and private religious activities (r = - 0.37, β = - 0.48, *p* <.005)

[d] Duke University Religion Index

Koenig et al. (2004)	n = 838 USA % Male: 46.9 Mean age: 64.3 Recruited from general medicine service (Duke Medical Center) *Source of funding: John Templeton Foundation, the Arthur Vining Davis Foundation, the Fetzer Institute, the Mary Biddle Duke Foundation*	Cross-sectional	Religious affiliation, organizational and non-organizational religious activity, religious television and radio, intrinsic religiosity, self-rated and observer-rated spirituality and religiousness	Cognitive status, MMSE-abbreviated	None	Age, sex, race, education, medical diagnosis, insurance status	Significant associations between cognitive function and Non-organizational religious activities (Standardized β = 0.11, $p < .001$), Self-rated religiousness (Standardized β = 0.06, $p < .05$), Observer-rated religiousness (Standardized β = 0.13, $p < .0001$), Observer-rated spirituality (Standardized β = 0.12, $p < .0001$)
Koenig et al. (1997)	n = 115 USA % Male: 56 Mean age: 79 Nursing home recruitment	Cross-sectional	Religious coping, Religious coping index	Cognitive function, MMSE	None	NR	Significant correlation between religious coping and cognitive functioning ($r = 0.22$, $p = .02$)

Lin et al. (2014)	n = 884 Taiwan % Male: 43% Mean age: 77.3 Hospital based recruitment *Source of funding: National Science Council*	Case-control	Self-identified religious affiliation – Buddhism, Christianity, Taoism	Cognitive decline, MMSE	None	Age, gender, education, APOE e4 status	Christianity affiliation was associated with lower odds of AD (Adjusted *OR* = 0.46, 95% *CI* = [0.25, 0.87])
Lucchetti et al. (2011)	n = 110 Brazil % Male: 26.4 Mean age: 68.9 Rehabilitation clinic based recruitment *Source of funding: NR*	Cross-sectional	Self-reported religiousness, Private and social religious practice scale	Cognitive impairment, MMSE	None	NR	Significant association between self-reported importance of religion in life and less cognitive impairment (Standardized *β* = 0.24, *t* = 2.42, *p* = .02)

Ritchie et al. (2014)	n = 515 UK % Male: 42.55 Mean age: 83.4 Prior study based recruitment	Cohort	Frequency of church attendance, religious belief, Self-reported	Cognitive change, Raven's Standard Progressive Matrices	7 years	Education, socioeconomic status	No significant associations between the exposures and outcome: Religious involvement ($\beta = 0.03$, $SE = 0.16$, $p > .05$), Religious well-being ($\beta = -0.04$, $SE = 0.15$, $p > .05$), Religious attendance ($\beta = 0.07$, $SE = 0.09$, $p > .05$)
Van Ness et al. (2003)	n = 2,812 USA Mean Age: NR, 65 and older % Male: 41.6 Community based recruitment *Source of funding: National Institute of Mental Health*	Cohort	Attendance at religious services, religious self-identify, Self-reported	Cognitive dysfunction, SPMSQ	6 years	Socio-demographics, Behavioral, Biomedical factors	Inverse association between religious attendance in 1982 and cognitive dysfunction in 1985 (*OR*: 0.64; 95% *CI* = [0.49, 0.85]), but not with cognitive dysfunction in 1988 (*OR*: 1.00; 95 % *CI* = [.71, 1.41])

Yeager et al. (2006)	n = 4049	Cohort	Religious affiliation, religious attendance, religious belief,	Health outcomes including cognitive functioning	4 years	Socio-demographics, smoking, exercise, alcohol use, eating habits, social ties	After controlling for prior health, and social networks, religious beliefs and practices not significantly related to health outcomes ($p < .05$)
	Taiwan						
	% Male: 54						
	Mean age: 68.4		Religious Practices Index				
	Prior study recruitment						
	Source of funding: the Behavioral and Social Research Program of the National Institute of Aging, the National Institute of Child Health and Human Development						No consistent differences in health by religious affiliation
Zhang, (2010)	n = 8703	Cross-sectional	Religious participation,	Cognitive impairment, MMSE-Chinese	None	Demographics	Religious participation significantly associated with lower odds of cognitive impairment ($OR = .52, p < .001$)
	China		Surveyed about participation levels				
	% Male: 40.4						
	Mean age: 91.65						
	Recruitment from prior survey						

| Jung et al. (2019)[e] | n = 325

Korea

% Male: 27.7

Mean age: 79.15

Recruitment from psychiatry outpatient clinic

Source of funding:

Funded by the Hallym University Research fund and the National Research Foundation of Korea (NRF) grant funded by the Korean government | Cross-sectional | Religiosity assessed by Duke University Religion Index, religious affiliation | Cognitive data accessed from the Consortium to Establish a Registry for Alzheimer's Disease Assessment Packet (CERAD) translated to Korean | None | Demographics | Organizational religious activity showed positive relationships with memory ($r = 0.144$, $p = .010$), language ($r = 0.149$, $p = .007$), and constructional ability ($r = 0.191$, $p = .001$).

Nonorganizational religious activity and intrinsic religiosity were positively associated with memory ($r = 0.115$, $p = .040$; $r = 0.140$, $p = .012$) and constructional ability ($r = 0.207$, $p = .000$; $r = 0.136$, $p = .015$) |

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[e] Newly identified study

| Teng et al. (2018)[f] | n = 3159

U.S.

% Male: NR

Mean age: 60 or older

Recruitment from the Population Study of Chinese Elderly (Wave I)

Source of funding: No funding | Cross-sectional | Frequency of attending organized religious services | MMSE-Chinese (C-MMSE), East Boston Memory Test Immediate and Delayed Recall, Digit Span Backwards Assessment, 11-item Symbol Digit Modalities Test | None | Demographics (age, sex, education, income, marital status, number of household members), health variables (mobility, chronic conditions) | Religious activity was significantly associated with working memory ($B = .07$, $SE = 0.0$) |

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[f] Newly identified study

Appendix 2 (Part of the Systematic Review Publication)

Search Strategy: MEDLINE (OVID)

1. cogniti*.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, nm, kf, px, rx, an, ui, tc, id, tm]

2. religio*.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, nm, kf, px, rx, an, ui, tc, id, tm]

3. church attendance.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, nm, kf, px, rx, an, ui, tc, id, tm]

4. spirituality.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, nm, kf, px, rx, an, ui, tc, id, tm]

5. processing speed.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, nm, kf, px, rx, an, ui, tc, id, tm]

6. executive function.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, nm, kf, px, rx, an, ui, tc, id, tm]

7. declarative memory.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, nm, kf, px, rx, an, ui, tc, id, tm]

8. prospective memory.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, nm, kf, px, rx, an, ui, tc, id, tm]

9. episodic memory.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, nm, kf, px, rx, an, ui, tc, id, tm]

10. 1 or 5 or 6 or 7 or 8 or 9

11. 2 or 3 or 4

12. 10 and 11

13. Limit 12 to yr="1990-Current"

Appendix B. Sample Interview Questions for the Study's Qualitative Component

Introductory Script

Thank you for accepting to take part in this study. My name is Sheri Hosseini and I am a PhD student in the School of Public Health and Health Systems at the University of Waterloo. My PhD study looks at the association between religious participation and cognitive function in the Canadian population. We found that people who regularly attended religious services did not perform better on cognitive function tests. As part of the study, we are interviewing spiritual leaders and congregants to get their opinions on why we might have found these results. Cognitive function affects your ability for decision making, making judgments, thinking, learning, reasoning, and memory performance.

Your name and identifying information will not be shared with anyone. You will be assigned a pseudonym and will be identified and referred to using the pseudonym. We will also audio-record the interview to accurately capture your explanations, which will be transcribed later to identify the most important points. Your name and location will be numerically coded to protect your identity and ensure privacy, and we will store the recordings on password protected computers.

Are you ready to begin the interview?

Interview Questions

- In your opinion, what aspects of religious participation are the most important contributors to a healthy cognitive function? (Cognitive function refers to things including memory, judgement, reasoning, learning, verbal skills, and attention).

    INSTRUCTION: GIVE INTERVIEWEES FREE REIGN TO ANSWER THE QUESTION, AND PROMPT WITH THE POINTS BELOW, IF NECESSARY.

    i)   Promotion of healthy habits (i.e., physical activity, healthy diet, avoiding smoking / drinking)
    ii)   Stress reduction and improving mental health
    iii) Provision of social support /engagement

- Do you think social engagement (such as socializing with friends, and community members during religious services) positively influences cognitive health? If so, how?

- Do you think participating in religious activities has influenced your health? If so, how?

- Do you think religious sites can play an important role in affecting people's cognitive function and educating people about healthy brain aging?

- Please mention anything else that you would like to add.

Appendix. C.1. Letter of Information/ Consent

UNIVERSITY OF
WATERLOO

DATE: _____

<div align="center">

LETTER OF INFORMATION / CONSENT

</div>

Study Title: The Association between Religious Service Attendance and Cognitive Function

Principal Investigator:

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519-888-4567   ext. 39187

E-mail: samantha.meyer@uwaterloo.ca

Purpose of the Study:

The purpose of this study is to investigate a link between religious participation and cognitive function. Cognitive function refers to things such as memory, attention, language, verbal skills, thinking, reasoning, decision making, and judgement.

You are invited to take part in this study, which is being conducted as part of my PhD thesis. Part of the study involves interviews with spiritual leaders and congregants to gain their opinions on why attendance at religious services might affect cognitive function.

Procedures involved in the Research:

To start off, I will be asking you a series of open-ended questions in the interview. These questions will cover the topic of religion/spirituality and cognitive function (e.g., brain health). The interview will take no more than 30 minutes and, with your permission, it will be audio-recorded. I also will be taking some handwritten notes as you speak. If any question is unclear, please ask me to clarify it further for you.

Potential Harms, Risks or Discomforts:

There are no known risks to you for participating in this study. You may stop the interview at any time. You do not need to answer questions that you do not want to answer or that make you feel uncomfortable. I describe below the steps I am taking to protect your privacy.

Are there any benefits to doing this study?

Research is designed to benefit society by gaining new knowledge. There is little chance you will personally benefit from being in this research study. I hope that what is learned as a result of this study will help me better understand the relationship between religion/ spiritual involvement and cognition.

Confidentiality

You are participating in this study confidentially. I will not use your name or any information that would allow you to be identified. The only people who will have access to the audio recordings and completed questionnaires will be myself and members of this research team. Your name or any names of persons or places that will identify you will be removed from the data collected and replaced with a number. All completed interviews from digital audio recordings will be stored on computers that are password protected. Once the study has been completed, the data will be destroyed.

What if I change my mind about being in the study?

Your participation in this study is voluntary. It is your choice to be part of the study or not. If you decide that you do not want to be part of this study, you can withdraw from this study at any time, without penalty.

Information about the Study Results:

I expect to have this study completed in approximately 10-12 months. If you would like a brief summary of the results, please contact me by email.

Questions about the Study:

You have the right to ask, and have your questions answered about this research. If you have questions or need more information about the study itself, please contact me at:

Sheri Hosseini, MSc.

University of Waterloo

Waterloo, Ontario, Canada

E-mail: s45hosse@uwaterloo.ca

This study has been reviewed by the University of Waterloo Research Ethics Board and received ethics clearance (ORE# XXXX). If you have concerns or questions about your rights as a participant or about the way the study is conducted, please contact:

University of Waterloo, Office of Research Ethics

Telephone: 519-888-4567 ext. 36005

CONSENT

- I have read the information presented in the information letter about a study being conducted by Shera Hosseini of University of Waterloo.

- I have had the opportunity to ask questions about my involvement in this study and to receive additional details I requested.
- I understand that if I agree to participate in this study, I may withdraw from the study at any time.
- I have been given a copy of this form.
- I agree to participate in the study.

Signature: _____   Date: _____

Name of Participant (Printed) _____

1. I agree that the interview can be audio recorded.

[ ] Yes

[ ] No

2. I agree to be contacted about a follow-up interview, and understand that I can always decline the request.

[ ] Yes, please contact me at: _____

[ ] No

Appendix. C.2. Letter of Appreciation

UNIVERSITY OF WATERLOO

Date

Dear

I would like to thank you for your participation in the study entitled 'The Association between Religious Participation and Cognitive Function'. As a reminder, the purpose of this study was to understand the link between religious and spiritual involvement and cognitive health.

The data collected during your interview will help me understand whether more frequent religious participation might be associated with healthier cognition.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE# 40081). If you have questions for the Committee contact the Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca.

For all other questions contact Shera Hosseini at s45hosse@uwaterloo.ca.

Please remember that any data pertaining to you as an individual participant will be kept confidential. Once all the data are collected and analyzed for this project, I plan on sharing this information with the research community through seminars, conferences, presentations, and journal articles. If you have any questions about the study, please do not hesitate to contact me by email as noted above.

Shera Hosseini

University of Waterloo
School of Public Health and Health Systems

Appendix D. Table D1. Demographics of CLSA Participants

Variable	Tracking %	Comprehensive %
Age mean (*SD*)	63.0 (*10.7*)	63.0 (10.2)
Sex		
Male	49.0	49.1
Female	51.0	50.9
Marital Status		
Married/ Common Law	68.8	68.6
Single/ Separated/ Divorced	20.1	22.03
Widowed	11.1	9.3
Education		
Secondary or Less	10.1	8.8
Post Secondary or More	89.9	91.2
Household Income		
< $20 K	6.8	5.6
Between $20 K and $50 K	29.4	22.6
Between $50 K and $100 K	36.3	35.2
Between $100 K and $150 K	16.2	19.6
More than $150 K	11.3	17.04
Chronic Conditions		
Diabetes	16.7	17.7
Hypertension	38.2	37.1
Heart Disease	10.3	11.7
Cerebrovascular Event	1.8	1.7
Myocardial Infarction	6.2	4.9
Alzheimer's Disease	0.2	0.2
Self-rated Health		
Excellent	18.7	19.9
Very Good	38.3	41.3
Good	29.5	29.5
Fair	10.5	7.7
Poor	2.95	1.6
Depression		
CES-D-10 Scores < 10	83.5	84.5
CES-D-10 Scores ≥10	16.5	15.5
Current Smoking Status		
Daily	12.7	10.2
Occasionally	2.5	2.4
Never	84.8	87.4
Current Drinking Frequency		
Almost Daily	14.3	16.5
4-5 Times a Week	7.7	10.2

2-3 Times a Week	18.6	20.9
Once a Week	11.4	11.2
2-3 Times a Month	10.3	10.2
About Once a Month	7.9	6.7
<Once a Month	16.4	12.6
Never	13.3	11.7

Functional Ability
Activities of Daily Living

Mild, Moderate, or Severe Impairment	13.9	14.6
No Functional Impairment	86.1	85.4

Instrumental Activities of Daily Living

Mild, Moderate, or Severe Impairment	7.7	5.4
No Functional Impairment	92.3	94.6

Frequency of Church Attendance

At least daily	1.0	0.9
At least weekly	26.4	21.7
At least monthly	10.1	9.8
At least yearly	15.0	21.4
Never	47.5	46.1

Frequency of Church Attendance (Binary)

At least yearly	52.5	53.9
Never	47.5	46.1

Appendix E. Multivariable Regression Models in the Association between Frequency of Church Attendance and Cognitive Function

The variables included in each block are shown below. All blocks also contained the crude model.

Crude Block: frequency of church attendance, sex, age group, province, highest education level

Health Block: general health, chronic disease, activities of daily living, instrumental activities of daily living, depression

Lifestyle Block: marital status, current smoking status, current alcohol use

Socioeconomic Block: total income

Social Block: social support availability, social networks, social participation

All Block: Included all of the above variables.

Table E1. Memory Domain and Tracking Sample

MODEL	Church Attendance REGRESSION COEFFICIENT	95% CI	Adjusted R^2
CRUDE (RELIGION, AGE, PROVINCE, SEX)	0.050	-0.016, 0.12	0.11
HEALTH BLOCK	0.036	-0.031, 0.103	0.12
LIFESTYLE BLOCK	0.024	-0.056, 0.103	0.12
SES BLOCK	0.042	-0.025, 0.110	0.12
SOCIAL BLOCK	-0.030	-0.100, 0.040	0.12
ALL BLOCKS	-0.044	-0.130, 0.041	0.13

Table E2. EF Domain and Tracking Sample

MODEL	REGRESSION COEFFICIENT	95% CI	*Adjusted R²*
CRUDE (RELIGION, AGE, PROVINCE, SEX)	-0.025	-0.086, 0.036	0.11
HEALTH BLOCK	-0.043	-0.104, 0.017	0.12
LIFESTYLE BLOCK	-0.046	-0.12, 0.029	0.12
SES BLOCK	-0.033	-0.094, 0.029	0.13
SOCIAL BLOCK	-0.11	-0.176, -0.051	0.13
ALL BLOCKS	-0.116	-0.194, -0.038	0.14

Table E3. Memory Domain and Comprehensive Sample

MODEL	REGRESSION COEFFICIENT	95% CI	Adjusted R²
CRUDE (RELIGION, AGE, PROVINCE, SEX)	0.045	-0.005, 0.094	0.15
HEALTH BLOCK	0.038	-0.012, 0.087	0.15
LIFESTYLE BLOCK	0.053	-0.006, 0.11	0.16
SES BLOCK	0.038	- 0.012, 0.089	0.16
SOCIAL BLOCK	0.010	- 0.041, 0.061	0.15
ALL BLOCKS	0.049	-0.014, 0.11	0.17

Table E4. EF Domain and Comprehensive Sample

MODEL	REGRESSION COEFFICIENT	95% CI	Adjusted R²
CRUDE (RELIGION, AGE, PROVINCE, SEX)	-0.214	-0.336, -0.092	0.11
HEALTH BLOCK	-0.243	-0.364, -0.121	0.14
LIFESTYLE BLOCK	-0.129	-0.278, 0.019	0.13
SES BLOCK	-0.257	-0.379, -0.134	0.14
SOCIAL BLOCK	-0.432	-0.556, -0.309	0.13
ALL BLOCKS	-0.296	-0.448, -0.143	0.16

Table E5. REY I Test, Memory Domain and Tracking Sample

MODEL	REGRESSION COEFFICIENT	95% CI	Adjusted R²
CRUDE (RELIGION, AGE, PROVINCE, SEX)	0.0363	0.0013, 0.071	0.10
HEALTH BLOCK	0.027	-0.008, 0.062	0.11
LIFESTYLE BLOCK	0.022	-0.019, 0.063	0.11
SES BLOCK	0.030	-0.005, 0.066	0.11
SOCIAL BLOCK	-0.010	-0.047, 0.03	0.11
ALL BLOCKS	-0.015	-0.060, 0.030	0.12

Table E6. REY II Test, Memory Domain and Tracking Sample

MODEL	REGRESSION COEFFICIENT	95% CI	Adjusted R²
CRUDE (RELIGION, AGE, PROVINCE, SEX)	0.008	-0.027, 0.043	0.09
HEALTH BLOCK	0.002	-0.033, 0.037	0.10
LIFESTYLE BLOCK	-0.006	-0.048, 0.036	0.10
SES BLOCK	0.003	-0.032, 0.040	0.10
SOCIAL BLOCK	-0.030	-0.067, 0.007	0.10
ALL BLOCKS	-0.042	-0.088, 0.003	0.12

Table E7. AFT Test, EF Domain and Tracking Sample

MODEL	REGRESSION COEFFICIENT	95% CI	Adjusted R²
CRUDE (RELIGION, AGE, PROVINCE, SEX)	-0.052	-0.088, -0.016	0.10
HEALTH BLOCK	-0.061	-0.097, -0.025	0.11
LIFESTYLE BLOCK	-0.050	-0.093, -0.006	0.11
SES BLOCK	-0.060	-0.095, -0.022	0.11
SOCIAL BLOCK	-0.098	-0.135, -0.060	0.12
ALL BLOCKS	-0.095	-0.142, -0.050	0.12

Table E8. MAT Test, EF Domain and Tracking Sample

MODEL	REGRESSION COEFFICIENT	95% CI	Adjusted R²
CRUDE (RELIGION, AGE, PROVINCE, SEX)	0.021	-0.017, 0.060	0.05
HEALTH BLOCK	0.011	-0.030, 0.050	0.06
LIFESTYLE BLOCK	0.006	-0.040, 0.053	0.06
SES BLOCK	0.022	-0.016, 0.060	0.07
SOCIAL BLOCK	-0.021	-0.060, 0.018	0.06
ALL BLOCKS	-0.016	-0.064, 0.032	0.07

Table E9. REY I Test, Memory Domain and Comprehensive Sample

MODEL	REGRESSION COEFFICIENT	95% CI	Adjusted R²
CRUDE (RELIGION, AGE, PROVINCE, SEX)	0.036	0.009, 0.063	0.12
HEALTH BLOCK	0.033	0.006, 0.060	0.13
LIFESTYLE BLOCK	0.034	0.001, 0.070	0.13
SES BLOCK	0.032	0.004, 0.060	0.14
SOCIAL BLOCK	0.013	-0.014, 0.041	0.13
ALL BLOCKS	0.029	-0.006, 0.063	0.14

Table E10. REY II Test, Memory Domain and Comprehensive Sample

MODEL	REGRESSION COEFFICIENT	95% CI	Adjusted R²
CRUDE (RELIGION, AGE, PROVINCE, SEX)	0.011	-0.017, 0.040	0.13
HEALTH BLOCK	0.007	-0.021, 0.034	0.14
LIFESTYLE BLOCK	0.021	-0.012, 0.054	0.15
SES BLOCK	0.008	-0.020, 0.037	0.14
SOCIAL BLOCK	-0.002	-0.030, 0.027	0.14
ALL BLOCKS	0.021	-0.014, 0.056	0.15

Table E11. AFT Test, EF Domain and Comprehensive Sample

MODEL	REGRESSION COEFFICIENT	95% CI	Adjusted R²
CRUDE (RELIGION, AGE, PROVINCE, SEX)	-0.070	-0.096, -0.040	0.10
HEALTH BLOCK	-0.072	-0.100, -0.044	0.11
LIFESTYLE BLOCK	-0.052	-0.085, -0.018	0.11
SES BLOCK	-0.070	-0.100, -0.041	0.12
SOCIAL BLOCK	-0.106	-0.135, -0.080	0.12
ALL BLOCKS	-0.075	-0.111, -0.040	0.12

Table E12. MAT Test, EF Domain and Comprehensive Sample

MODEL	REGRESSION COEFFICIENT	95% CI	Adjusted R²
CRUDE (RELIGION, AGE, PROVINCE, SEX)	-0.045	-0.073, -0.017	0.06
HEALTH BLOCK	-0.054	-0.082, -0.026	0.08
LIFESTYLE BLOCK	-0.044	-0.080, -0.010	0.06
SES BLOCK	-0.050	-0.078, -0.022	0.08
SOCIAL BLOCK	-0.073	-0.102, -0.045	0.07
ALL BLOCKS	-0.060	-0.094, -0.024	0.08

Table E13. COWAT Test, EF Domain and Comprehensive Sample

MODEL	REGRESSION COEFFICIENT	95% CI	Adjusted R²
CRUDE (RELIGION, AGE, PROVINCE, SEX)	-0.070	-0.141, 0.008	0.03
HEALTH BLOCK	-0.074	-0.150, -0.0002	0.05
LIFESTYLE BLOCK	-0.035	-0.126, 0.056	0.05
SES BLOCK	-0.084	-0.160, -0.008	0.05
SOCIAL BLOCK	-0.190	-0.263, -0.112	0.05
ALL BLOCKS	-0.130	-0.225, -0.034	0.07

Table E14. EMT Test, EF Domain and Comprehensive Sample

MODEL	REGRESSION COEFFICIENT	95% CI	*Adjusted R²*
CRUDE (RELIGION, AGE, PROVINCE, SEX)	-0.054	-0.075, -0.032	0.06
HEALTH BLOCK	-0.060	-0.081, -0.040	0.06
LIFESTYLE BLOCK	-0.045	-0.071, -0.020	0.06
SES BLOCK	-0.056	-0.080, -0.034	0.06
SOCIAL BLOCK	-0.065	-0.087, -0.043	0.06
ALL BLOCKS	-0.051	-0.078, -0.024	0.06

Table E15. TMT Test, EF Domain and Comprehensive Sample

MODEL	REGRESSION COEFFICIENT	95% CI	Adjusted R²
CRUDE (RELIGION, AGE, PROVINCE, SEX)	-0.003	-0.025, 0.020	0.03
HEALTH BLOCK	-0.008	-0.030, 0.013	0.05
LIFESTYLE BLOCK	0.006	-0.021, 0.034	0.04
SES BLOCK	-0.009	-0.031, 0.013	0.04
SOCIAL BLOCK	-0.019	-0.041, 0.003	0.04
ALL BLOCKS	-0.010	-0.038, 0.017	0.05

Table E16. STROOP Test, EF Domain and Comprehensive Sample

MODEL	REGRESSION COEFFICIENT	95% CI	Adjusted R²
CRUDE (RELIGION, AGE, PROVINCE, SEX)	-0.003	-0.030, 0.021	0.05
HEALTH BLOCK	-0.005	-0.030, 0.020	0.05
LIFESTYLE BLOCK	-0.002	-0.033, 0.030	0.05
SES BLOCK	-0.006	-0.030, 0.020	0.05
SOCIAL BLOCK	-0.007	-0.033, 0.018	0.05
ALL BLOCKS	-0.011	-0.046, 0.023	0.05

Appendix F. Table F1. Qualitative Study Participants' Demographics

Participant Characteristics	N/ Mean
Pastors (n = 6)	
Age	55.3 Years
Sex (male)	5
Ethnicity	
Caucasian	6
African-American	0
Asian	0
South Asian	0
South-East Asian	0
Middle-Eastern	0
Other	0
Education Level	
< Secondary	0
Secondary	0
College Diploma	0
Some Post-Secondary	0
	0
Bachelor's Degree	0
Master's Degree	6
Doctoral Degree	0
Other	0

Length of time **as Pastor (mean)**	15.7 Years

Christian **Denomination**	
Catholic	2
Anglican	0
United	2
Baptist	2
Orthodox	0

<u>**Parishioners**</u>
<u>**(n=9)**</u>

Age	63.9 Years

Sex (male)	2

Ethnicity	
Caucasian	9
African-American	0
Asian	0
South Asian	0
South-East Asian	0
Middle-Eastern	0
Other	0

Education Level	
< Secondary	0
Secondary	1
College Diploma	5

Some Post-Secondary	0
Bachelor's Degree	2
Master's Degree	1
Doctoral Degree	0
Other	0

Length of time regularly practicing (range)

7 Years - Lifetime

Christian Denomination

Catholic	4
Anglican	3
United	0
Baptist	1
Orthodox	1

Appendix G. Figure G1. Theoretical Model of Causal Pathways for Mental Health based on Western Monotheistic Religions